EUROPEAN COMMISSION / Research & Innovation

# Innovation Union Competitiveness report

2011 edition

RESEARCH & INNOVATION POLICY

**EUROPEAN COMMISSION**
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EUROPEAN COMMISION

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# Innovation Union

**Directorate-General for Research and Innovation**

**Research and Innovation**

EUR 24211

More information on the European Union is available on the Internet (http://europa.eu).

Cataloguing data can be found at the end of this publication.

Luxembourg: Publications Office of the European Union, 2011

ISBN 978-92-79-14541-4
doi 10.2777/87066

*Printed in France*

PRINTED ON ELEMENTAL CHLORINE-FREE BLEACHED PAPER (ECF)

# Foreword

The main messages presented in the executive summary of the Innovation Union Competitiveness report confirm that Europe is in a state of "Innovation emergency" which makes the building of an Innovation Union essential for the success of the Europe 2020 strategy for growth and jobs.

Most importantly, this analysis is substantiated and enriched by a solid body of evidence. This report constitutes the most comprehensive publication to date of statistical data and economic analysis on research and innovation from a European perspective. It brings together in a single document the information needed to properly understand the innate complexity of the European economy from an innovation point of view.

For each theme, a dedicated chapter provides the key data at European and at country level and outlines the strategic and operational issues that need to be addressed. The report aims to be a practical tool to help policy makers and stakeholders in regions, in Member States and Associated Countries to evaluate the situation in their country and to understand the contribution that building the Innovation Union and the European Research Area can make to tackling their economic challenges and addressing their citizens' concerns.

The report and the annexed country profiles will also support the design and development of ambitious and realistic national or regional innovation strategies, consistent with each country's particular strengths, economic structure and policy objectives as well as with an overall European view of the common challenges before us. While a great deal of detailed information is presented, the report is user-friendly and allows the reader to quickly find the information most relevant to his or her interests.

We are now at the start of the ambitious long term work to create a sustainable Innovation Union. The size of the challenge is all the greater because we face it at a time when most Member States are confronted with strong budgetary constraints. The solution is smarter investment in growth-enhancing policies that get excellent value from the money invested, prioritising the most cost-effective reforms that help develop new markets for innovative products and services. This approach will help create the conditions for a smart and creative economy, based on knowledge and on innovation, bringing concrete benefits to everybody.

Faced with an innovation emergency, now is the time to act. This report provides an excellent evidence basis for action and constitutes a reference-point to measure the progress that we'll accomplish together in the next decade. It is my sincere hope that you will find it useful for achieving our common goal: the Innovation Union.

Máire Geoghegan-Quinn

Máire Geoghegan-Quinn

# Acknowledgements and Editors' Note

The first edition of the Innovation Union Competitiveness (IUC) report has been published, at the request of Maíre Geoghegan-Quinn, member of the European Commission in charge of research, innovation and science, by the Directorate General for Research and Innovation, Director General Robert Jan Smits. Directorate C, Research and Innovation policy, under the direction of Clara de la Torre, was responsible for producing the report.

This IUC report was prepared under the leadership and policy guidance of Pierre Vigier, Head of Unit for Economic Analysis and Indicators. Johan Stierna was the overall coordinator and was responsible for the analytical perspective of the report. The authors of individual chapters or sections are, in alphabetical order: Maria Herminia Andrade, Beñat Bilbao Osorio, Jacques Bonin, Matthieu Delescluse, Benedikt Herrmann, Carmen Marcus, Carmen Mena Abela, Johan Stierna, Giuseppe Veltri, Pierre Vigier, and Werner Wobbe. Beñat Bilbao Osorio reviewed the economic analysis, Matthieu Delescluse supervised the indicators' consistency, Dermot Lally prepared the statistics, Fotini Chiou assisted in the publication process and Jolanta Chmielik designed the maps. Mihaela Varnav assisted in the overall production of the report and Eleonora Mavroeidi assisted in the data analysis.

The report has benefitted from valuable analytical and statistical contributions from several Commission services, in particular by DG Joint Research Centre IPTS (which also contributed with chapter 3 in Part III), DG Eurostat, DG Regional Policy, DG Communication, DG Education and Culture, DG Enterprise, DG Internal Market, DG Information Society, the European Research Council and other units of DG Research and Innovation. The authors of this report gratefully acknowledge critical advice, external peer review and analytical input given by Isidro Aguillo, Alexandros Arabatzis, Rémi Barré, Patrick Brenier, Paraskevas Caracostas, Emmanuelle Cauwe, Giorgio Clarotti, Laura De Dominicis, Janine Delahaut, Nicole Dewandre, Susana Elena Perez, Ana Fernandez Zubieta, Peter Fisch, Dominique Foray, Luke Georghiou, Tassos Giannitsis, Bronwyn Hall, Jennifer Harper, Luisa Henriquez, Hugo Hollanders, Branco Huc, Morten Kroger, Jos Leijten, Petros Macridis, Franco Malerba, Belmiro Martins, Patrick McCutcheon, Fulvio Mulatero, Tomas Niklasson, Erkki Ormala, Marianne Paasi, Adian Pascu, Daniel Pasini, Dimitrios Pontikakis, Celine Ramjoue, Pierre Regibeau, Helmar Rendez, Lorenza Saracco, John Smith, Lena Tsipouri, Pierre Valette, Rene van Bavel, Ludger Viehoff, Virginia Vitorino, Marco Weydert, Peter Whitten, and Emily Wise.

The structure of this report reflects the main policy developments in the EU: ensuring investment in research and innovation, construction of the European Research Area and effective outcomes for economic competitiveness and for addressing societal challenges. The report also contains an overall benchmarking of the EU with other world R&I centres, a more experimental section presenting new perspectives on country grouping for mutual learning, an evidence base for smart specialisation, and an analysis of citizens' trust in science and technology. Finally, the report reviews strengths and weaknesses in research and innovation in all EU Member States and six Associated Countries. More information can be found at the website, ec.europa.eu/iuc2011, together with the full report, the executive summary in all EU official languages, country fact sheets and all underlying statistical data. The cut-off date for data from Eurostat and OECD was March 2011.

Pierre Vigier and Johan Stierna

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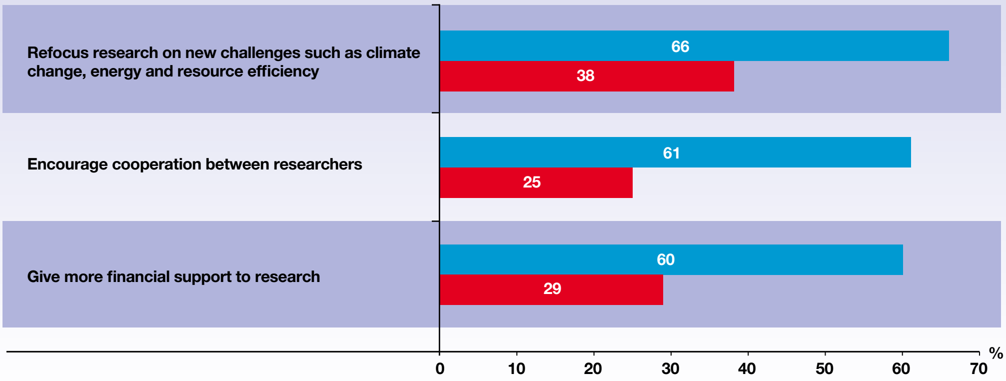
# EXECUTIVE SUMMARY

## Introduction

Against a backdrop of rising societal concerns and lagging economic performance, the European Union launched in 2010 the *Europe 2020 strategy*[1] to guide Europe's economic recovery and present a comprehensive agenda towards becoming a more competitive, sustainable and inclusive economy. At the core of this strategy, the Innovation Union Flagship Initiative[2] sets out how Europe will tackle the 'innovation emergency' it is facing, through a strategic approach integrating research and innovation instruments and actors. It commits the EU and Member States to put in place framework conditions to make the business environment more innovation friendly, facilitate access to private finance, complete the European Research Area, and address major societal challenges.

The result should be an Innovation Union where fast-growing innovative firms strive and create new, high added value jobs and where innovation offers products and solutions responding to society's needs and expectations. The aim is to address both a competitiveness challenge (closing Europe's gap in innovation) and a cultural challenge (integrating research and innovation to focus on societal challenges) which should lead to structural change towards more knowledge intensive economic activities. These priorities correspond largely to the main preoccupations expressed by the European citizens as regards Innovation:

FIGURE 1 **Opinion of European citizens on the three main priorities for Innovation in Europe, 2010**



*Source*: DG Research and Innovation
*Data*: DG Communication; Eurobarometer 73, Spring 2010

🟦 Total answers
🟥 First answer

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1 COM (2010) 2020.

2 *Europe 2020 Flagship Initiative Innovation Union* COM (2010) 546 final. The Europe 2020 strategy also includes other Flagship initiatives enhancing competitiveness: "an Industrial Policy for the Globalisation Era", "the Agenda for New Skills and Jobs", "the Digital Agenda".

The Innovation Union flagship initiative calls for setting in place a strong monitoring mechanism for measuring innovation performance and progress towards Europe's shared objectives. This echoes Treaty provisions[3] regarding periodic monitoring and evaluation in that domain.

To this end, a three-tier monitoring framework has been developed constituted of:

**Headline objectives**: *where do we want to go?* One of the five headline objectives in the Europe 2020 strategy is to improve the conditions for research and development, in particular with the aim of raising combined public and private investment levels in this sector to 3 % of GDP. In complement, the European Council of 4 February 2011 called for the development of a new, single integrated indicator to allow a better monitoring of progress in innovation. The European Commission, in cooperation with the National Statistical offices and with the OECD, is currently developing such an indicator, focusing on the share in the employment of the fast-growing innovative enterprises.

**A performance scoreboard**: *where do we stand?* The Innovation Union Scoreboard (IUS) was published in early 2011 and will be updated annually to provide comparative benchmarking of EU and Member State performance against 25 core R&I indicators and, for 12 of them, against major international partners.

An **analytical strategic report**: *what are the causes and remedies for insufficient performance?* Every two years, the Innovation Union Competitiveness report (IUC) will provide an in-depth statistical and economic analysis covering the main features of an efficient and socially effective research and innovation system. It will constitute a key tool for evidence-based policy making in the context of the Innovation Union.

The present *Innovation Union Competitiveness report* monitors progress towards the EU and national R&D headline targets and provides economic evidence and analysis to underpin EU and national policy making in support of Innovation Union. It aims to complement the overall review of Europe 2020 targets in the European Commission Annual Growth Survey by offering a deeper perspective on R&D intensity targets at EU and national level and presenting evidence on the dynamics of knowledge-intensive firms and other aspects of innovation. The report also extends and complements the Innovation Union scoreboard indicators to address the whole cycle of innovation, including the impact of research and innovation on raising competitiveness and tackling societal challenges.

This executive summary presents a selection of the key findings from the 2011 Innovation Union Competitiveness report.

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[3] Article 181, §2: "In close cooperation with the Member States, the Commission may take any useful initiative to promote the coordination referred to in paragraph 1, in particular initiatives aiming at the establishment of guidelines and indicators, the organisation of exchange of best practices, and the preparation of the necessary elements for periodic monitoring and evaluation."

# Key findings

## *Investing for the future*

### 1. The EU is slowly advancing towards its 3 % R&D target - but there is a widening gap between the EU and its world competitors notably due to weaker business R&D investment

Investment in research and innovation is a key driver of growth and innovative ideas for the future of Europe. This is why increasing investment in R&D is one of the five priorities of the Europe 2020 strategy.

During the period 2000-2007, the EU **R&D intensity** stagnated as a result of a parallel increase in GDP and Gross Expenditure on R&D (GERD). More recently, EU R&D intensity has grown from 1.85 % of GDP in 2007 to 2.01 % in 2009 as the result of a decrease in GDP and widespread budgetary prioritisation of public R&D funding combined with the resilience of private investment in R&D. This can be attributed to the positive impact of the Lisbon agenda and national reforms initiated starting in 2005.

Between 2000 and 2009, R&D intensity progressed in 24 Member States with acceleration in the period 2006-2009 in a majority of Member States. Despite this progress, most Member States in 2009 were still far short of the national 2010 R&D targets they set for themselves in 2005. In 2010, nearly all the EU Member States set new R&D targets for 2020, which are generally ambitious but achievable.

Between 1995 and 2008, total **research investment in real terms** rose by 50 % in the EU. However, performance was higher in the rest of the world, as the world economy became more knowledge-intensive. During the same period, the United States increased its total research investment in real terms by 60 %, the four most knowledge intensive countries in Asia (Japan, South Korea, Singapore and Taiwan) by 75 %, the BRIS countries (Brazil, Russia, India, South-Africa) by 145 %, China by 855 % and the rest of the world by almost 100 %. The result is that a rapidly growing share of R&D activities in the world is being carried out outside Europe. **In 2008, less than a quarter** (24 %) **of the total world R&D expenditure was performed in the EU** compared to 29 % in 1995. On the current trend, China is set to overtake the EU by 2014 in terms of intensity of R&D expenditure.

EU under-investment in R&D is most visible in the business sector where Europe is falling further behind the United States and the leading Asian economies. **Relative to GDP, business invests twice more in Japan or in South Korea than in Europe**[4].

The business R&D intensity gap in the EU is due to two main reasons: (i) the EU has a smaller and decreasing share of high-tech manufacturing sectors in its economy than the United States and (ii) these sectors are less research-intensive in the EU than in the United States. This is largely attributable to the framework conditions in place in Europe which are less favourable to investing and attracting investors than, for instance, in the United States. The slow speed of structural change in Europe makes also investment in R&D in Europe less likely to develop in fast growing sectors. As a result, the average annual growth rates of business R&D intensity in Japan and South Korea were much higher than those of the EU. Chinese firms are also becoming increasingly R&D intensive, with the result that **since 2000 business R&D intensity in China has been growing 30 times quicker than in Europe** to reach a level of 1.12 % in 2008[5].

*Major obstacles to be tackled include access to finance, e.g. venture capital, the much higher cost of patenting in Europe particularly for SMEs, and the framework conditions required in order to enhance knowledge-intensive entrepreneurial activities.*

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[4] In the last decade, EU business expenditure on R&D has indeed stagnated at around 1.20 % of GDP (1.25 % in 2009), a much lower level than in the United States (2.01 % in 2008), South Korea (2.45 % in 2007) and Japan (2.68 % in 2007).

[5] With an average annual rate of 9.2 % against 0.3 %.

## 2. The economic crisis has hit business R&D investments hard. However, as part of a counter-cyclic effort, many European countries are maintaining or increasing their levels of public R&D funding

Despite the economic crisis, there was a positive continuity in public R&D funding trends in 2009 and 2010, with sustained investment rates in many Member States. Seventeen Member States were able to maintain or increase their R&D budgets in nominal terms in 2009 compared to 2008, and only seven Member States decreased their R&D budgets over the same period[6]. **In 2010, sixteen Member States planned to increase their R&D budgets**. However, the preliminary data available shows that, relative to GDP, R&D budgets decreased in more countries in 2010 than in 2009 and this trend seems to be maintained in 2011. These are worrying signs, since evidence from previous crises shows that maintaining public R&D funding during an economic downturn is key to ensuring a more rapid return to sustained economic growth.

While the crisis has had a stronger impact on private R&D investment than on public funding, **R&D spending by firms headquartered in the EU fell in 2009 half less than that by US firms** (-2.6 % and -5.1 % respectively). This impact was greater in the automotive and IT hardware sectors than in the electronic & electrical equipment and the health sector (which actually posted an increase in R&D investment in 2009). However, as a whole it is noticeable that due to intense competition based on investment in knowledge creation and innovation, private R&D investment proved to be relatively resilient in 2009, and even increased in Asia. This demonstrates the determination of the business sector to preserve R&D investments in times of crisis to maintain their competitiveness in the present globalisation context.

*The challenge to invest more in knowledge remains a key priority even under the current tight budgetary constraints in Europe. Member States should, therefore, both consolidate public finances and safeguard the resources for future growth and competitiveness by investing in growth-enhancing policies, such as research, innovation and education.*

## 3. Europe is host of a large and diversified pool of skilled human resources in particular in Science and Technology, which the business sector is not fully nor optimally making use of; in terms of new tertiary educated graduates, China now weights as much as the EU, the United States and Japan combined

Its large **number of researchers** and skilled human resources is one of Europe's major assets. In 2008, there were 1.5 million full time equivalent researchers in the EU, compared to 1.4 million in the United States and 0.71 million in Japan. However, in absolute terms, China has taken the world lead with 1.6 million researchers in 2008. The EU will need to create at least 1 million new research jobs if it is to reach an R&D intensity of 3 %. This net **increase by two thirds of the number of European researchers by 2020** should primarily benefit the business sector, where there is a large gap with the United States. In addition a large number of the existing research work-force will retire by 2020. This, combined with the need to strongly adapt the profiles of researchers to new priorities and market demands, will constitute one of the main challenges facing national research and one innovation systems in the years to come.

More than half (54 %) one of the researchers in the EU work in the public sector, and only 46 % work in the business sector. This is a European exception. **The share of researchers employed by the private sector is much higher within our main economic competitors, e.g. 69 % in China, 73 % in Japan and 80 % in the United States**.

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[6] This does not add up to 27: data is not available for Greece; break in series in Spain and Poland in 2009 prevents a direct comparison of the 2009 R&D budget (Government Appropriations or Outlays on R&D) with 2008 for these two countries.

In dynamic terms, a sizeable and increasing share of the EU population graduates from academic tertiary education every year and represents a unique chance to meet this quantitative and qualitative challenge. The EU produces more than 940,000 students with a tertiary degree in Science and Engineering every year, and the number of tertiary degrees in the EU increased at an average annual rate of 4.9 % per year in the period 2000-2008. The same applies at the doctoral level. With 111,000 new doctorates awarded every year, **the EU produces nearly twice as many doctorates than the United States**. This proportion is even higher for Science and Engineering where the EU produces more than twice the number of doctorates as the United States. However, relative to GDP, the United States invests about 2.5 times more in higher education than the EU, mainly due to much lower private spending in the EU. As a result, education expenditure per graduate or PhD student in Europe is a fraction of what it is in the US, sacrificing quality for quantity at the risk of not meeting the expectations of the business sector.

Regarding the enrolment of students, the real breakthrough of the last decade, however, occurred in China: in 2009, China enrolled as many undergraduate students as the EU, the United States and Japan combined, i.e. more than 6 million. Less than seven years ago, China enrolled a similar number of undergraduate students as the EU (around 3 million) or the United States (2.5 million).

*A central issue for the success of Innovation Union is for Member States to adapt their (tertiary) education systems in view of substantially increasing the number of available researchers and engineers while ensuring a better match of their skills with the needs of the business sector and improving the attractiveness of research careers for top talents from around the world.*

## 4. While remaining a top player in terms of knowledge production and scientific excellence, Europe is losing ground as regards the exploitation of research results

**The EU is the first producer of peer-reviewed scientific publications in the world**, with 29 % of the world production in 2009, ahead of the United States (22 %), China (17 %) and Japan (5 %).

In terms of **scientific excellence**, during the period 2001-2009, the EU as a whole increased its share of total scientific publications in the top 10 % most cited in the world from 10.4 % to 11.6 %, the world average being by definition at 10 %. This means that Europe's capacity to produce high-impact scientific publications, which is a proxy for scientific quality, is 16 % above the world average and has been increasing since 2000. The Netherlands, Denmark, Switzerland and Iceland score highest and rank amongst world leaders on that criterion. This achievement is correlated with the gradual development of a European Research Area and the improvement of EU and national R&D funding instruments as part of the Lisbon strategy.

In spite of such recent progress **the United States is still performing one third better than Europe in terms of R&D excellence**, with 15.3 % of US publications among the world's 10 % most cited.

In terms of development of competitive technology, Europe is losing ground in a context of increased competition. Today, the world share of PCT patents is at a comparable level for the EU, the United States and the five leading Asian countries (all at 25-30 %). However, **the rate of growth in the number of PCT patent applications over recent years in Japan and South Korea is almost double that of the EU**. On current trend, by 2020, the respective shares of PCT patent applications could be: EU: 18 %; United States 15 % and 55 % for the five leading Asian countries.

European Patent Office (EPO) patent applications, while not a perfect indicator for international comparisons with third countries, is an indication of the propensity of different countries to take a leading role in innovation processes. The share of the EU Member States in EPO patent applications declined from 44.8 % in 2000 to 44.2 % in 2007. Moreover, **the number of EPO patents relative to GDP has also decreased in the EU since 2000** while this ratio increased in the rest of the world. Even more worrying, about **half of the Member States do not produce high-tech EPO patents at all**. It is, therefore, not surprising that

**licence and patent revenues from abroad are three times higher in the United States than in Europe**[7], evidencing the difficulty for Europe to acquire a leading role on world technology markets.

The relative **high cost of filing and maintaining a patent in Europe** may partly explain this situation: An SME must disburse EUR 168,000 of legal fees to obtain and maintain a patent protection in all 27 EU Member States. It would cost only EUR 4000 for a protection of the same duration in the United States.

*The development of the European Research Area, past and ongoing structural reforms of the national R&I systems and the deepening of the single market for knowledge are instrumental in improving the excellence of European science. However, further steps are needed – in particular towards more cost-efficient intellectual property protection and management - to strengthen technological and regain innovation leadership in view of ensuring Europe's future competitiveness, growth and jobs.*

### *A European Research Area for a more efficient R&I system*

### 5. Member States are introducing reforms to improve the functioning of the public research base and increase public-private cooperation - however knowledge transfer in Europe remains weak

During the period 2000-2009, the EU Member States started reforming their higher education institutions and organisations performing public research. In many Member States universities have been given more autonomy and have developed institutional strategies to prioritise research activities and attract top foreign researchers. In addition, the allocation of public funds is increasingly based on the monitoring and evaluation of performance and on a competitive basis. The development of the so called "third mission" of universities is progressing in most Member States, in particular through the development and promotion of public-private cooperation. Out of 200 European Universities recently surveyed, 86 % had a Technology Transfer Office and more than a third had created 10 or more spin off companies.

However, these reforms are often still underway, with large differences between countries. As a result, scientific and technological cooperation between the public and private sectors remains generally weak in Europe. **The number of joint publications between private and public actors per population in the EU is roughly half that of the United States** and one third lower than in Japan. It is, however, much higher in a number of Member States (Sweden, Denmark, Finland, the Netherlands). An encouraging sign is the 20 % increase between 2000 and 2008 in the share of public R&D funded by business enterprises in the EU (which is superior to the situation in the United States and Japan). On this aspect as well, there are large variations amongst EU Member States and Associated Countries with Germany, Finland and Iceland performing much better than the EU average.

*The modernisation of the tertiary education system and public science base in Europe is a key structural reform for the deepening of the single market for knowledge. While it is well underway in most EU Member States as part of the efforts to complete the European Research Area, further efforts are still needed to foster public-private cooperation and knowledge transfer through e.g. the opening up of research institutions and the development of a demand-led approach to innovation.*

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[7] Accounting for only 0.21 % of its GDP, compared to 0.53 % for Japan and 0.64 % for the United States.

## 6. The development of the ERA underpins the evolution and efficiency of scientific activities in Europe

The European Research Area is still far from being a reality and progress has sometimes been slow since the launch of the first initiative in 2000. It is estimated that in 2008 only 4.5 % of the national R&D budgets of the EU Member States was allocated to trans-nationally coordinated research (4.3 % in 2007). An important part of this funding was constituted by the financing of large-scale trans-national research infrastructures (e.g. CERN) or corresponded to national R&D programmes coordinated by the Framework Programme's instruments (ERA-NET, ERANET+, Joint technology Initiatives, article 185 initiatives) and other Europe-wide R&D coordination schemes (e.g. Eureka, COST). There is currently no quantitative estimation of the share in Europe of "**open national R&D programmes**"[8]. However, first investigations show that they are very few of them.

**Intra-European mobility** remains at a modest level. In 2008, only 7 % of European doctoral candidates studied in another Member State. When it comes to established researchers however, 56 % of researchers based in Europe have worked at least three months in another country during their career.

Indicators on co-publications show that researchers based in the EU are increasingly integrated in transnational networks, as evidenced by the higher growth of transnational co-publications (both within the EU and with non-EU countries) compared to the growth of publications within individual Member States over the same period 2003–2008. The growth of extra-EU scientific cooperation is lower but relatively close to the intra-EU growth (average annual growth rates of 8 % and 9.8 % respectively). **The figures show, therefore, both a greater EU integration in recent years and an increasing openness of EU research towards the rest of the world**.

Network analyses show that **knowledge flows inside Europe** (i.e. flows of students, electronic academic links, co-publications and co-patenting cooperation) **are, however, very unbalanced**, with a strong concentration amongst a few Western European countries, marginal involvement of EU-12 Member States and of most Southern European countries.

A major and visible progress towards a more efficient and integrated research funding landscape in Europe lies in the marked increase in EU-wide competitive research funding, mostly through the 7th Framework Programme, as well as in the **increasing orientation of Structural Funds towards research and innovation**. In 2008, almost 11 % of the total EU budget was devoted to research and innovation, compared to less than 3 % in 1985. This has a considerable impact on the European research community. In most EU-12 Member States, Structural Funds directed to Research, Technological Development and Innovation represent more than 60 % of the national R&D budget, and even more than 100 % in a few cases. This is a unique opportunity for these Member States to increase their research and innovation capacity. As to the **EU Research Framework Programme, according to preliminary Europe-wide estimates, it represents some 20 % to 25** % **of all project-based funding in Europe.**

*The development of an ERA framework will contribute to increasing the efficiency and performance of the European research system and help to overcome bottlenecks in the free circulation of knowledge in Europe. The increasing channelling of research and innovation funding through different EU instruments offers the prospect of improving the overall EU scientific excellence while strengthening cohesion.*

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[8] i.e. fully open to research teams that do not reside in the country where the programme is launched

## 7. Europe is increasing its international cooperation in science and technology, while striving to catch up with the United States

In a globalised economy, the competitive advantage of Europe mainly lies in its ability to compete on high value added products. However, the share of Europe in the world's research capacity (in terms of investments and researchers) and output (in terms of S&T publications and patents) is decreasing as the rest of the world, and in particular leading Asian economies, is emerging. In parallel with this long term trend, major societal challenges, such as climate change and the ageing of population, are creating new needs but also market opportunities which are global in nature. These challenges call for increasing the international scientific and technological cooperation in a focussed and strategic way, building on the excellent collaborative record and high scientific rating of European science but also addressing the issue of a comparatively much weaker technological cooperation.

The older and better established scientific and technological collaborative networks in the world (as measured by co-publications and co-patenting) are between the United States and the EU. The future prospect for the transatlantic cooperation looks as good as ever, as evidenced in particular by the growing number of European students accomplishing their doctoral studies in the United States. **Over the last decade, the number of European citizens receiving their doctoral degree in the United States increased by more than 38 %**.

Both regions are at the same time adapting to the new geography of knowledge production and market opportunities, by increasing their bilateral cooperation with emerging economies in Asia. In terms of students, both economies have a significant one-way inflow of Asian doctoral students. Over the period 2000–2009, the scientific cooperation (measured by number of co-publications) of the United States with the research-intensive Asian countries (Japan, South Korea and China) was higher than between the EU and the same countries. Nevertheless, over the same period, the EU increased its scientific cooperation with these Asian countries at a higher pace (average annual growth rate of 12.8 %) than the United States (10.6 %). The same applies to technological cooperation, with a higher absolute number of co-patents between the United States and the above mentioned Asian countries compared to the EU.

Finally, the share of participants in the Framework Programme from countries outside Europe is slowly growing - from 5.3 % in 2002 to 6.0 % in 2010 – as a result of its full international opening up. **Russia and China have the highest number of participants in FP projects, followed by the United States**. Among the European countries, it is mainly the five largest countries – Germany, the United Kingdom, France, Italy and Spain - which have collaborative links with Russia, China and the United States. In addition, the Netherlands and Sweden have also, relative to their size, a high proportion of collaborative links with these countries.

*Further increasing the international cooperation in research and technology should be facilitated by a focussed strategy covering both the scientific and technological dimensions; by the use of a common framework for international collaboration; by further effort to attract students from outside the ERA countries.*

### 8. The gender balance in the European research population is improving, but major research institutions continue to be predominantly led and managed by men

Reforms for a more efficient and creative research and innovation system also include measures for a better gender balance. In 2007, **women represented on average** in the EU 37 % of total researchers in higher education institutions, 39 % of researchers in public research organisations and **only 19 % of researchers in the business sector**. Since 2002, the average annual growth rate in the number of female researchers has been higher than that of male researchers. Moreover, the gender gap has been closing more markedly among scientists than in the labour market in general. However, **only 13 % of higher education institutions were headed by women in 2007**, and the proportion of female staff in research institutions having reached the position of full professor or equivalent remains very low: 7.2 % in engineering and technology, 17 % in medical sciences and 27 % in humanities. Over the period 2004-2007, there was a slight increase in the proportion of women having reached that level.

*In principle, advancement in gender equality is the result of the combined effect of reforms in the R&I systems, the features of the labour market and the equity policies in place. To provide a diversified view on what constitutes a good life for Europeans and what enhances innovation, the capacities and creativeness of both men and women have to be used in a balanced way in the research and innovation context. Focused actions with clear objectives, targets, deadlines and monitoring for gender equality should be included in sound national R&I strategies.*

## *Research and Innovation for a sustainable economy and a better life*

### 9. European SMEs are innovative but they do not grow sufficiently. The United States has shown a much better capacity to create and grow new companies in research-intensive sectors over the last 35 years

European SMEs are innovative. Out of those with innovation activities, **27 % introduced new or improved products to the market in 2008** according to the CIS survey. This figure even reaches 41 % in Sweden.

Relative to the size of the economy, **SMEs perform more R&D in the United States than in the EU**: in 2007, SMEs' R&D expenditure amounted to 0.25 % of GDP in the EU against 0.30 % in the United States, with a high concentration in certain States such as California. However, in a number of European countries (Denmark, Finland, Belgium, Austria and Sweden), SMEs perform much more R&D (above 0.5 % GDP).

More worrying, however, is the fact that in terms of patenting activity, young (less than five years old) firms in the EU are less innovative than their counterparts in the United States, except in Norway and Denmark where more than 30 % of young firms filed a PCT patent application between 2005 and 2007.

As a result, **innovative SMEs and enterprises of intermediate size do not grow sufficiently** to become large R&D-investing and innovative companies. The share of companies created after 1975 is three times higher among the top R&D-investing US companies (54.4 %) than among the top R&D-investing EU companies (17.8 %). This is symptomatic of a consistently lower capacity of the EU over the last 35 years to create and grow new companies in research-intensive sectors as compared to the United States. As a result the EU's industrial structure is not oriented enough towards fast-growing economic sectors.

*All types of SMEs can innovate and should be encouraged to invest in R&I. Also important is the fact that fast-growing enterprises in the most innovative sectors of the economy are key actors for the development of emerging industries and for the acceleration of the structural changes that Europe requires in order to become a knowledge based economy with sustained economic growth and high quality jobs. This is why the European Commission's proposal for a new single innovation headline indicator focuses on the share in the economy of the fast-growing enterprises in the most innovative sectors. The growth resulting of such a development will benefit the whole economy, including SMEs in low and medium-high tech sectors and in services that depend heavily of the overall development of demand.*

### 10. Weaker framework conditions for business R&D and a fragmented European market for innovation are hampering private R&D investments and affecting the attractiveness of Europe

The attractiveness of Europe for foreign firms depends in particular on the existence of a single market of 500 million consumers with transparent business environment, sound and enforceable competition rules and the availability of a large pool of skilled human resources. This economic openness is characterised by the intensity of intra-EU competition and the openness to foreign investments and products. Within the EU, economic competition is perceived to be more intense in old Member States compared to new Member States and particularly strong in Germany, Austria and the Netherlands.

An important element in identifying the markets where companies prefer to innovate is the level of customer and consumer demand for new products and in particular the presence of lead users who may provide feedback and have a high propensity to take up innovations. The EU is the largest market in the world and should take full advantage of this by attracting investors to develop innovations that respond to the needs of consumers worldwide. This potential is, however, hampered by a lack of appropriate framework conditions at EU and national level for facilitating access to market of innovative goods and service, and promoting R&D and innovation investment by firms.

At national level, evidence shows that **framework conditions for business R&I vary considerably between EU Member States**. Northern European countries are systematically in the top positions for many indicators; while new Member States are generally in less attractive positions.

A typical example of the major obstacles to innovation concerns the protection and management of intellectual property. While there is a political will at European level to facilitate the transfer of knowledge from research to technology and towards the market, further efforts are needed to create a genuine marketplace for research results and for patents and licensing. **In particular, the total cost of patenting and of maintaining a patent is around twenty times higher in Europe than in the United States**[9] (40 times higher in the case of SMEs). Most of this difference is due to the cost of fees for maintaining a patent over the period which is needed for a firm to expand its activities and get resources to develop a new generation of innovative products.

When it comes to access to private finance by firms, Europe lags well behind the United States regarding venture capital. **Early stage venture capital funds in the EU are at less than half of the level in the US** (respectively 1.9 and 4.5 EUR billion in 2009) and are only prominent in Norway, the Netherlands, Denmark, Portugal, Finland, Belgium and France. There are only three European countries that stand out regarding venture capital investments at the expansion phase: the United Kingdom, Sweden and Switzerland. New Member States have low levels of venture capital and generally still insufficiently attractive framework conditions for private R&D in spite of recent progress. As a result, the interest and demand for domestic R&D and innovation is low with no sufficient prospect for high return on investment.

**At EU level, current initiatives mostly provide incentives stimulating the supply of innovation in fast-growing sectors** (including the SET Plan, Joint Technology Initiatives, European Technology Platforms, and Joint Programming) whereas there have been fewer and less intensive efforts to stimulate the demand side (e.g. the Lead Market Initiative).

The **Innovation Union flagship aims, therefore, to create a genuine single market for knowledge and set in place framework conditions** to attract entrepreneurs and business investment and to provide European citizens with better public services and working opportunities.

*In complement to current incentive schemes, the Innovation Union flagship aims to set in place a business environment more favourable for business R&D and innovation by improving key framework conditions. EU initiatives are being launched to modernise European standardisation, promote innovative procurement, create an EU-wide market for IPR and facilitate access to private finance.*

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[9] Costs are computed over 20 years in order to make the comparison valid: maintenance fees in the USA disappear after 7 years, whilst steeping up in Europe.

## 11. Sustainable economic competitiveness in high knowledge-intensive sectors requires faster structural change in Europe

In the last 15 years, the EU economy has become ever more service oriented with the weight of manufacturing sectors shrinking to 20 % of the total Value Added.

This structural change has important consequences for the EU research and innovation system as the growing weight of the services sectors, which have a lower R&D intensity, offsets in most EU Member States recent increases in the research-intensity of manufacturing sectors. At the same time business R&D concentrates in high-tech and medium-high tech sectors which become ever more research intensive as more economies around the world move closer to the technological frontier. The net result of this complex evolution is that, while the EU economy has become slightly more knowledge-intensive since 2000, the gap with the United States has widened due to the higher share of high-tech sectors in the US economy and higher research intensities in individual sectors including services.

The increasing level of education and skills in the workforce is also an indicator of ongoing structural change. In 2009 **knowledge-intensive activities** (KIAs), where more than one third of the employees have a tertiary education degree, **represented 35 % of total employment in the EU** with generally no large variation around this rate among EU Member States. Between 2008 and 2009 there was a slight increase in KIAs at EU level.

Compared with the United States, there is room for further increases in the research intensity of the high-tech and medium high-tech industries and of services. Structural change is facilitated by the development of lead markets and addressing obstacles to the growth of new technology-based firms. Structural change from the perspective of R&D intensity can also be analysed at the level of firms. The 2010 European Industrial R&D Investment Scoreboard, covering the 1000 EU top firms in terms of R&D investments in a range of sectors, shows that in 2009 the R&D intensity of the EU companies slightly increased to reach 2.4 %.

Worldwide, the Industrial Scoreboard shows that, despite the impact of the crisis, the world's R&D landscape has maintained its sectoral specialisation, with the United States dominating in high R&D intensive sectors, which concentrate 69 % of the total BERD, and the EU in medium-high ones, which account for 48 % of the total BERD. R&D is a main competitiveness factor for key sectors such as Semiconductors, Software and Biotechnology: in these sectors, the United States' companies dominate in terms of number of companies and total investment. EU companies increased their share of R&D investment in Chemicals, Electronic & Electrical Equipment, Software & Computer Services, Automobiles & Parts and Pharmaceuticals & Biotechnology. The emergence of strong R&D investors from China and India is well visible through the Scoreboard: with one and zero companies in the 2004 edition to 21 and 17 companies respectively, in the 2010.

Finally, the trend in the contribution of innovation-related trade in manufactured goods to the balance of trade goods is an indicator of competitiveness. In the period 2000-2008, almost all EU Member States increased the knowledge-intensity in their manufacturing export as share of the trade balance. Between 2002 and 2007, countries like Denmark, Greece, Ireland, Germany, Luxembourg and the Netherlands had as well a very positive contribution of knowledge intensive services to trade balance; over the same period, the other Member States displayed a knowledge-intensive service trade deficit.

*Improving the EU innovative capacity and competitiveness calls for increases in the research intensity of the high-tech and medium high-tech industries, together with a more even distribution of the competitive factors among different regions. A faster structural change in Europe requires ensuring that framework conditions, in particular availability of personnel with appropriate skills and incentives on both the supply and demand side to facilitate and encourage investment in product-markets which are growing.*

### 12. Europe has a strong potential in technological inventions for societal challenges and new global growth areas, which could be successfully brought to the market by implementing the comprehensive and integrated approach set out in Innovation Union

Major societal challenges require developing innovative solutions which in turn will provide major opportunities in future high-growth markets around the world. **The percentage of European citizens that trust science and technology to improve their quality of life decreased over the last five years from 78 % to 66 %**. There is, therefore, a genuine expectation for science to reorient its efforts to contribute to addressing the societal challenges of our time.

Amongst the global societal challenges currently addressed, patenting activity shows that the emphasis in the EU has been on **climate change mitigation: the number of PCT patent applications filed in the EU relative to GDP has more than doubled between 2000 and 2007** in this area. Europe thus has a strong research and innovation capacity for the development of technologies for climate change mitigation and the environment. As a result of the rapidly increasing European patenting activity in this area, the EU had in 2007 a positive technological specialisation in environmental technologies, whereas it suffered from a negative specialisation in health technologies and other fast-growing technology fields.

In 2007, the EU accounted for 40 % of all patents related to climate change technologies in the world, with Germany, Denmark and Spain accounting for nearly half of world wind energy production in 2009. In contrast, the photovoltaic industry is dominated by Asian and US firms, with only two out of the ten largest companies in the world based in Europe.

In the field of health technologies, Europe is lagging behind **the United States**, which **accounts for almost half of all health-related patents in the world**, for both pharmaceutical products and medical technologies. EU patenting in health technologies has fallen slightly since 2000. However, individual Member States such as Denmark, the Netherlands, Sweden and Germany are at the forefront of technology in health-related technologies.

*Targeted research and demonstration Investments in key areas, combined with measures to support market development at EU and national level, can lead to new technologies and innovations capable of addressing major societal challenges. This new, integrated approach which will be supported notably through European Innovation partnerships constitutes a new source for future economic growth in Europe.*

# Table of contents

# OVERALL PICTURE

## Europe's competitive position in research and innovation - Acting in the new geography of knowledge

This first section of the Innovation Union Competitiveness Report presents the overall picture of European Research and Innovation (R&I). It benchmarks Europe's efforts to maintain its scientific, technological and innovation competitiveness in the new multi-polar world, and reveals some strengths and weaknesses of the European system. In addition, the analysis helps to monitor the progress towards an Innovation Union that contributes to smart, sustainable and inclusive growth in Europe. New threads and opportunities are identified in a rapidly changing world and the need for a long-term and global vision for Europe is put forward.

In order to depict this general picture, the analysis identifies some key indicators on (1) the investments done and the performance achieved by the European R&I system, (2) the progress to build an efficient system that maximises the results accruing from these investments, with a special emphasis on the construction of the European Research Area and the free movement of knowledge across Europe and beyond, and finally, (3) the framework conditions to boost business R&D and innovation in view of enhancing economic competitiveness and addressing societal challenges.

# CHAPTER 1

# Europe's competitive position in research and innovation

## HIGHLIGHTS

The EU's Research and Innovation (R&I) remains relatively competitive, even in a changing multi-polar world. The EU has one of the highest numbers of researchers in the world and in terms of research funding, scientific production and patenting of technologies, the EU remains the second major R&I centre after the United States of America. However, in many areas, the EU is still behind its main world competitors and its overall competitive position is declining.

The EU has made progress in some areas to increase its R&I capacity and performance and has managed to build some distinctive **strengths**. More precisely, the EU benefits from a number of researchers and a sizable and increasing share of the population graduating from academic tertiary education every year. Moreover, the EU is also advancing in its scientific and technological integration, thanks to closer collaborations between European researchers - albeit not at a desirable speed. Progress is also being made towards higher scientific excellence. Finally, the EU is well positioned in some upcoming technologies aimed at addressing societal global challenges, such as climate change technologies, that can yield significant economic results and become new growth areas. However, despite these encouraging signals, the overall R&I competitive position of the EU has been progressively declining in the last decade. This decline is mainly due to the sharp rise of Asia, a trend likely to continue given the ambitious R&D targets of South Korea, Japan or China; and the inability of the EU to address some important **weaknesses** of its R&I system, which are:

1. A severe underinvestment in Research and Education vis-à-vis the United States and major Asian economies. The underinvestment in R&D is particularly worrying in the private sector, as firms face unfavourable framework conditions that deter them from investing or accessing the necessary resources to invest.
2. Weak knowledge exchanges between Science and Industry hamper the diffusion and use of existing knowledge and its commercialisation.
3. Poorer scientific and technological excellence in comparison to the United States — as evidenced by a lower percentage of scientific publications among the most cited publications worldwide and much lower licence and patent revenues — affects the EU's capacity to lead groundbreaking innovations.
4. Unfavourable framework conditions for innovation in terms of access to financing (including venture capital), the much higher cost of patenting in Europe and business conditions that would enhance entrepreneurship activity.

The persistence of these weaknesses **threatens** the capacity of the EU to enhance its future R&I competitive position and its capacity to accelerate its currently sluggish progress towards a knowledge-intensive economy. Without this structural change to the EU economy, its future economic competitiveness in high-value-added products and services may be at risk. The EU needs to react opportunely, addressing the weaknesses and continuing to build on its strengths in order to grasp the new **opportunities** that a changing R&I multi-polar environment offers. In particular, closer cooperation with Asian economies can multiply and accelerate the generation and use of new, valuable knowledge, while the rise of new areas of economic growth closely associated with the increasing demand for R&I to address societal challenges can offer important opportunities for future economic growth and social progress.

## 1.1. Is the EU improving its performance in research and innovation?

Each Research and Innovation (R&I) System has its own characteristics which depend on the socio-economic realm in which it is embedded. However, it is generally accepted that well-functioning systems share a number of common features[10], (European Commission 2010[11]). The European Commission, after a broad consultation with stakeholders, has identified 10 of these features, which range from governance and design of R&I policies, to adequate and sufficient support for R&I, availability of the right mix of skills, support for effective knowledge flows, and the improvement of framework conditions that will promote private investment[12].

This section provides an overview of how the EU performs on a series of indicators that capture some of these features. An analysis of 25 indicators[13] of the Innovation Union Scoreboard[14] (IUS) is used. The 25 indicators of the scoreboard are grouped into 8 dimensions and were selected for their capacity to describe the competitive position of a system, both in terms of research and innovation performance, and of the factors affecting its capacity to achieve this performance.

The IUS, therefore, provides an appropriate framework to overview the R&I competitiveness of the EU *vis-à-vis* its main trading competitors, namely the United States and Japan, and the new rising scientific and technological economies in Asia, e.g. South Korea and China. International comparison of the EU with non-EU countries is already possible for 14 out of the 25 indicators proposed by IUS, although with different geographical coverage. For the remaining 11 indicators (mainly indicators on innovation), the absence of the necessary data in many non-EU countries prevents any international comparison. Nevertheless, the available indicators cover most of the relevant dimensions fairly well, and the IUS remains a suitable framework for our analysis. The two figures below present (1) an overview of the gap between the EU, the United States and Japan in the key dimensions of the IUS where data are available (Figure 1), and (2) a comparative analysis of the current state of play and the recent evolution of the EU, the United States, Japan and also China and South Korea, two countries rapidly gaining in scientific, technological and economic fields (Figure 2). From this overview, two overall conclusions can be drawn:

1. **R&I performance in the EU keeps lagging behind that of the United States and Japan. The much weaker R&I activity of EU private firms, coupled with a less favourable environment in terms of accessing funding (including venture capital) and the much higher cost of patenting, are major competitive challenges for the EU.**
2. **New competitors are swiftly growing. In particular, South Korea and China have emerged as important science, technology and innovation centres, in some areas outperforming Europe and the United States.**

The United States remains the world R&I leader, although in some areas such as business R&D investments or technological production measured by PCT[15] patents, some Asian countries, e.g. Japan and South Korea, have taken the lead. As figure 2 shows, the EU tends to lag behind the United States, Japan and South Korea particularly in terms of business R&I-related activities. The strengths of the EU lie in its production of new doctoral graduates and in the role of the export of knowledge-intensive services. Similar findings can be found in the recently published European Innovation Scoreboard.

In dynamic terms, the Asian economies, especially China, South Korea and Japan, have increased their R&D investments and scientific and technological performance more sharply than the EU or the United States. This trend is likely to continue given the ambitious R&D targets that they have set for the next decade. South Korea will aim to achieve an R&D intensity of 5 %, Japan of 4 %, Singapore of 3.5 % and China of 2.5 %, compared to the EU's 3 % target for 2020.[16] Moreover, the United States plans to launch a very ambitious R&I investment policy which could aid them in *'maintaining their leadership in research and technology as a crucial policy to support Amercia's success'*[17].

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[10] OECD (2009): 'The OECD Innovation Strategy: Getting a head start on tomorrow' (http://www.oecd.org/document/15/0,3343,en_2649_34273_45154895_1_1_1_1,00.html).

[11] European Commission (2010): 'Europe 2020 Flagship Initiative: Innovation Union' (http://ec.europa.eu/research/innovation-union/pdf/innovation-union-communication_en.pdf).

[12] A detailed description of these 10 features can be found in Annex 1 of the Innovation Union initiative.

[13] While 25 indicators comprise the Innovation Union Scoreboard, only 24 indicators are currently computed, as the indicator on "high-growth innovative enterprises as a percentage of all enterprises" is not sufficiently available yet.

[14] The 25 indicators can be found in "Performance Scoreboard for research and innovation", Annex II of the Innovation Union initiative.

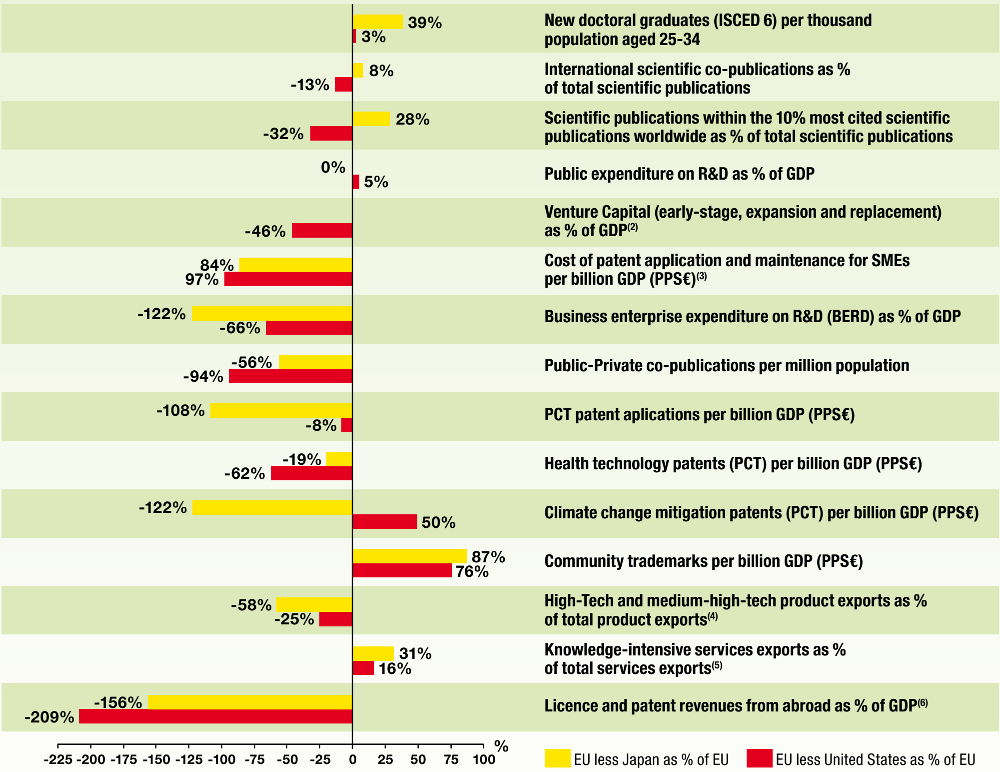
[15] Patent Cooperation Treaty.

[16] A detailed analysis of the EU's 3 % R&D intensity target is presented in Part I, chapter 1.

[17] President Barack Obama's speech on the State of the Union, 25 January 2011.

FIGURE 1

## Performance Scoreboard for Research and Innovation indicators - The gap between the EU and the United States and Japan, 2009(1)



*Source*: DG Research and Innovation

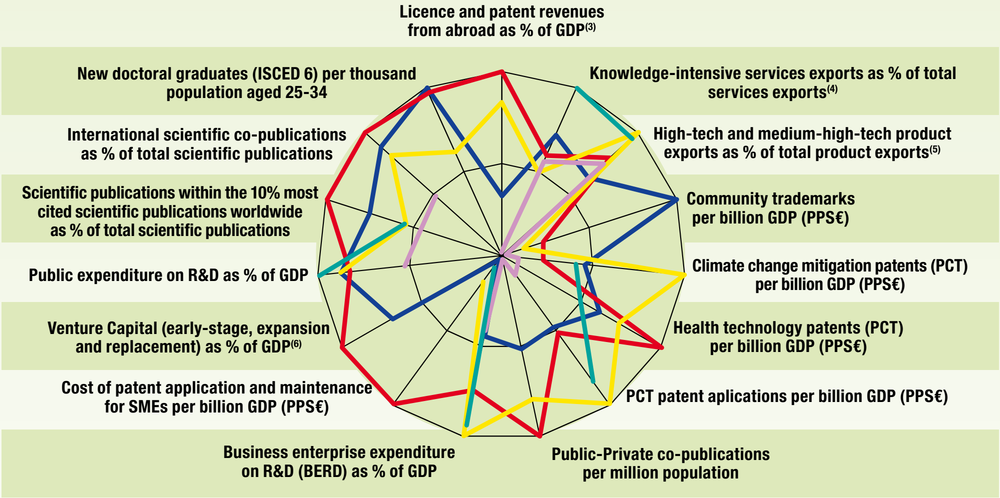
**Innovation Union Competitiveness Report 2011**

*Data*: Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard 2010

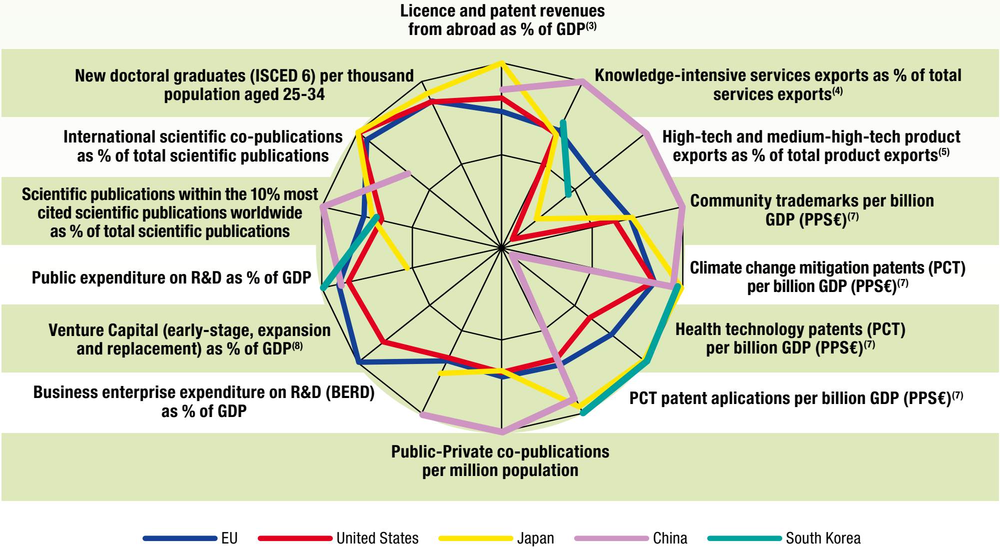
*Notes*: (1) The values refer to 2009 or to the latest available year.
(2) EU does not include EE, CY, LV, LT, MT, SI, SK.
(3) The values are on the left side of the graph because they express higher costs.
(4) EU includes intra-EU exports and was calculated from the uweighted average of the values for the Member States.
(5) EU includes intra-EU exports.
(6) EU refers to extra-EU.
(7) Elements of estimation were involved in the compilation of the data.

## FIGURE 2 Performance Scoreboard for Research and Innovation indicators

### 2009(1)



### Average annual growth (%), 2000-2009(2)



*Source*: DG Research and Innovation **Innovation Union Competitiveness Report 2011**

*Data*: Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard 2010

*Notes*: (1) The values refer to 2009 or to the latest available year.

(2) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2009.

(3) EU refers to extra-EU.

(4) EU includes intra-EU exports.

(5) EU includes intra-EU exports and was calculated from the uweighted average of the values for the Member States.

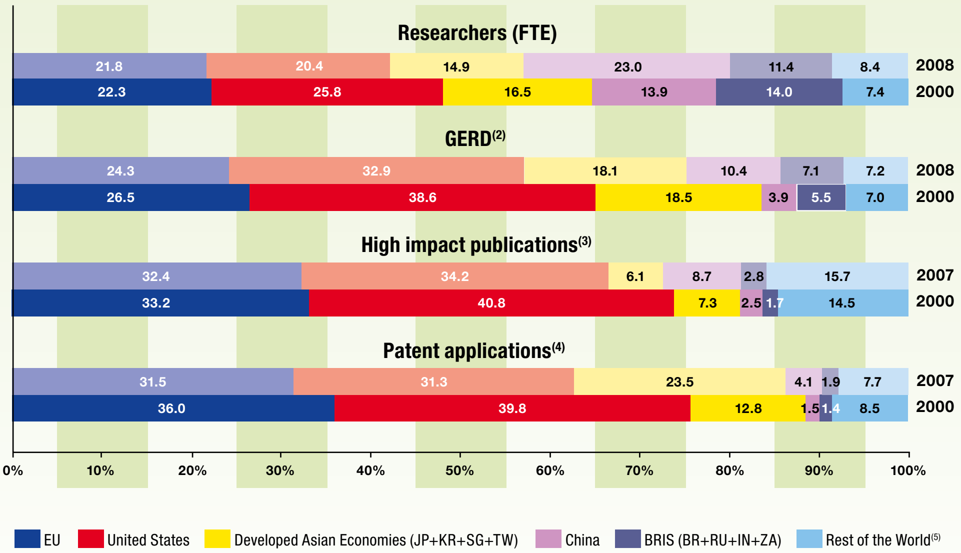
(6) EU does not include EE, CY, LV, LT, MT, SI, SK.

(7) Average annual growth refers to real growth.

(8) EU does not include BG, EE, CY, LV, LT, LU, MT, SI, SK.

(9) Elements of estimation were involved in the compilation of the data.

FIGURE 3 **Participation in global R&D – % shares**



*Source*: DG Research and Innovation
*Data*: Eurostat, OECD, UNESCO, Science Metrix / Scopus (Elsevier)
*Notes*: (1) Elements of estimation were involved in the compilation of the data.
(2) GERD : Shares were calculated from values in current PPS€.
(3) (i) The 10% most cited scientific publications - fractional counting method;
(ii) Developed Asian Economies does not include SG and TW.
(4) Patent applications under the PCT (Patent Cooperation Treaty), at international phase, designating the EPO by country of residence of the inventor(s).
(5) The coverage of the Rest of the World is not uniform for all indicators.

**Innovation Union Competitiveness Report 2011**

## 1.2. How big a player is the EU in the multi-polar world of science and technology?

***Overall, the EU's R&I competitiveness remains strong, but the world's centre of gravity for research and technological activity is shifting. If recent trends continue, Asia will become the new main pole of science and technology by 2020***

Figure 3 shows that the EU's R&I competitiveness remains strong. The EU accounts for 24.3 % of the total research investment in the world, almost 22 % of the researchers, 32.4 % of all the high impact publications and 31.5 % of all PCT patents. However, the EU's relative position has declined because of the rise of five Asian economies: Japan, South Korea, Singapore, Taiwan and especially China. Since 2000, the share of China in global R&D investment has increased from 3.9 % to above 10 %. Perhaps, more surprising is the translation of these increasing research investments into new knowledge and technology. In 2007, China authored 8.7 % of all high impact publications and filed 4.1 % of all PCT patents, compared to 2.5 % and 1.5 % respectively in 2000. This rapid growth of China has raised the scientific and technological profile of Asia. If these recent trends continued[18], in 2020 Asia would become the world research leader[19], accounting for more than half of the world patents and researchers, 28.6 % of all the high-impact publications and 43 % of the research investment. To a certain extent, given the sharp population increases in Asia and the stagnation in Europe, this trend is normal and should not necessarily be interpreted as a sign of weakness of European R&I, but rather as a shift in the centre of gravity of scientific and economic activity for which Europe needs to be prepared.

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[18] It is important to note that the rapid growth rates experienced by the 5 Asian economies, notably China, in the last seven or eight years are likely to slow down as the catching-up effect is likely to continue at a more moderate pace. Also, high growth rates are expected to be more difficult to maintain as the absolute levels of these quantities grow.

[19] The recent "UNESCO Science Report 2010" highlights that "given the size of Asia's population, one would expect it to become the dominant scientific continent in the coming years" (p.9) - http://www.unesco.org/science/psd/publications/sc_rp_10.shtml-

# CHAPTER 2

# Investments in knowledge and human resources

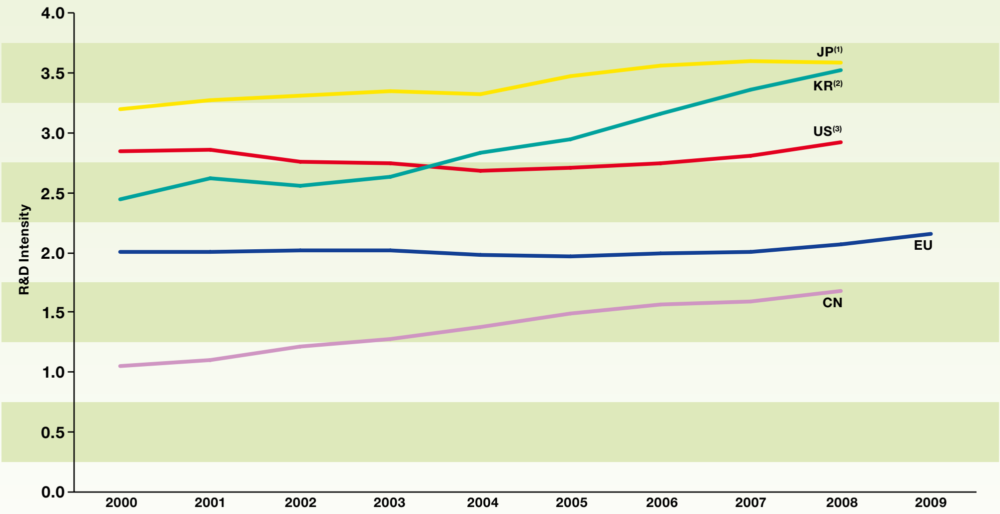
Investment in knowledge generation, diffusion and use is crucial for R&I. High investments in research, innovation and human resources are one of the key features of all well-functioning R&I systems. Research investment, both public and private, is crucial for the development of new scientific and technological knowledge and for building the capacity to absorb and use this knowledge. Moreover, non-scientific knowledge is important for innovation, and non-R&D investments, e.g. ICT investments, are also important for innovation activities. Finally, knowledge is produced, diffused and used by people, who need to have the right skills. This section analyses the EU's investment in knowledge generation in comparison to its main trading competitors.

## 2.1. Is the EU investing sufficiently in research, education and innovation?

***Research intensity in the EU has increased only marginally, in contrast with the remarkable growth in the major research-intensive Asian countries***[20]

Despite a more than 20 % real-terms increase in research expenditure over the period 2000–2009, R&D intensity in EU-27 has stagnated at around 1.85 % of GDP since 2000, with a slight increase to 2.01 % of GDP in 2009 (Figure 4), mainly as a result of the fall in GDP due to the economic downturn that year. In 2008, the year with the highest GERD investment of the decade, R&D

FIGURE 4 **Evolution of R&D Intensity, 2000-2009**



*Source*: DG Research and Innovation
*Data*: Eurostat, OECD
*Notes*: (1) JP: There is a break in series between 2008 and the previous years.
(2) KR: (i) GERD for 2000-2006 (inclusive) does not include R&D in the social sciences and humanities.
(ii) There is a break in series between 2007 and the previous years.
(3) US: GERD does not include most or all capital expenditure.

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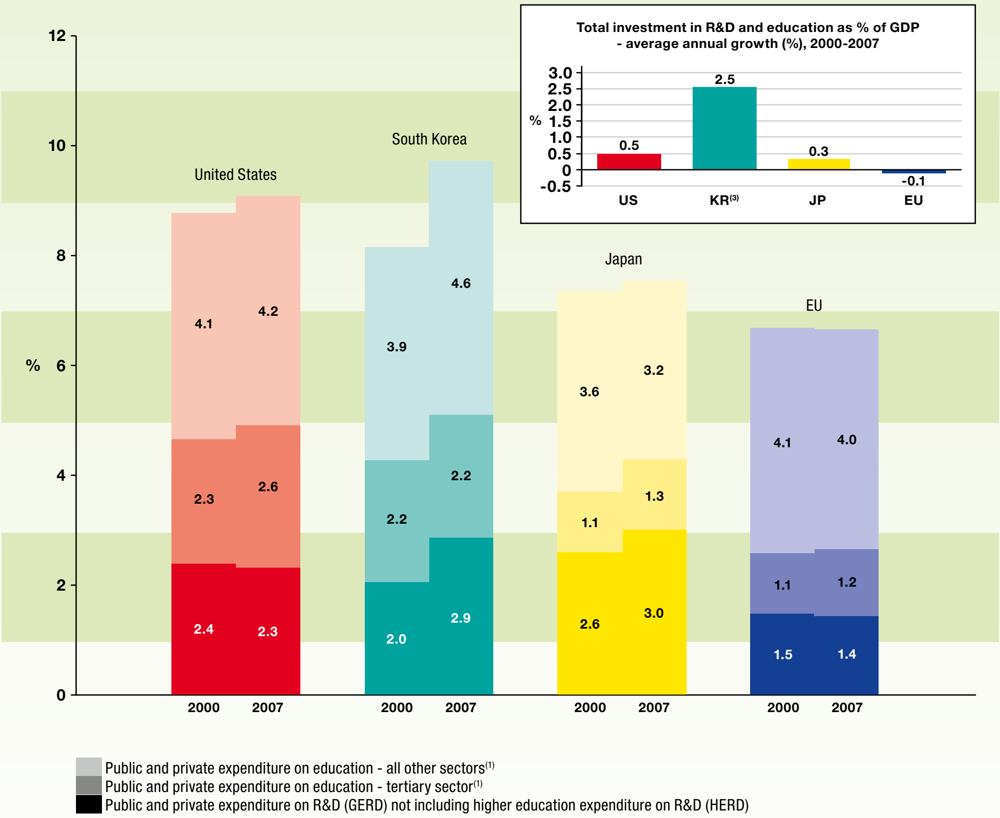
[20] For a more comprehensive analysis of the EU's progress towards its 3 % target on R&D investments, see Part I, chapter 1.

FIGURE 5 **Investment in R&D and education as % of GDP, 2000 and 2007**



*Source*: DG Research and Innovation
*Data*: Eurostat, OECD
**Innovation Union Competitiveness Report 2011**
*Notes*: (1) Public and private expenditure on education: Funds from international agencies and other sources are not included.
(2) US: GERD not including HERD does not include most or all capital expenditure.
(3) KR: (i) HERD does not include R&D in the social sciences and humanities;
(ii) There is a break in series between 2007 and 2000;
(iii) Average annual growth refers to 2000-2006.

intensity remained at 1.9%. In the United States, after a continuous decline during the first half of the decade, R&D intensity started to pick up again in 2005, rising to up to 2.76% of GDP in 2008, slightly above its 2000 value (2.69% of GDP). This quasi-stagnation of R&D intensity in the EU and the United States contrasts with the strong increases observed in Japan, South Korea and China during this period, of up to 3.44%, 3.21% and 1.54% of GDP respectively.

In absolute terms, GERD investment in the EU rose up to EUR 225 billion[21] in 2009, slightly below the almost EUR 230 billion invested in 2008. In 2008, in the United States the total R&D investment rose to EUR 310 billion[22], i.e. almost 40% more than in the EU; while Japan, China and South Korea invested EUR 116 billion, almost EUR 100 billion and EUR 34 billion more than the EU respectively.

### *The gap between the EU's knowledge investment and that of other advanced economies is even broader and has grown in the last decade*[23]

Investment in research and education are crucial for the generation, use and diffusion of new knowledge in an economy. The EU has traditionally invested less than other advanced economies both in research and

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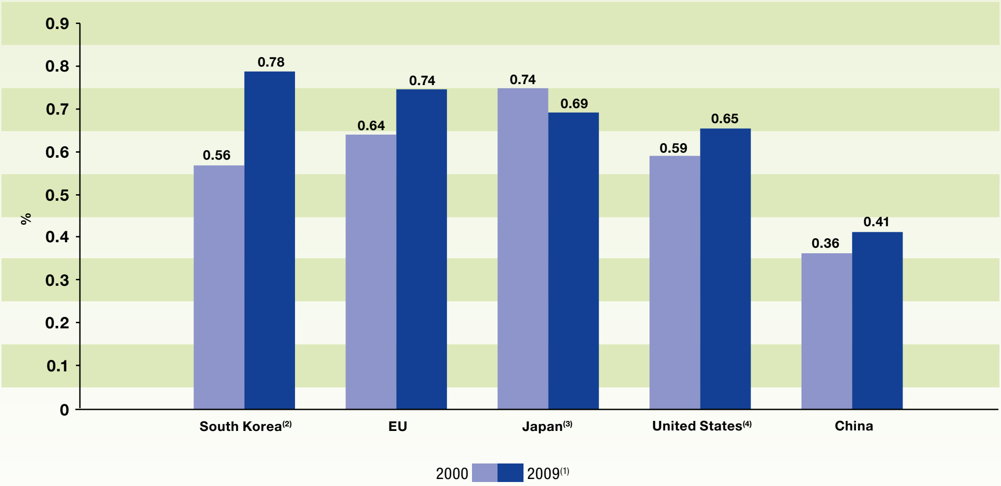
[21] Values in current prices in PPS.

[22] This figure does not include most of the capital investment.

[23] For a more comprehensive presentation of public investment in research and education, see Part I, chapter 3.

FIGURE 6 Public R&D expenditure as % of GDP, 2000 and 2009(1)



*Source*: DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data*: Eurostat, OECD

*Notes*: (1) US, JP, CN, KR: 2008.
(2) KR: (i) There is a break in series between 2008 and the previous years;
(ii) R&D in the social sciences and humanities is not included in 2000.
(3) JP: There is a break in series between 2008 and the previous years.
(4) US: (i) Most or all capital expenditure is not included
(ii) Government expenditure on R&D refers to federal or central government only.

education. In recent years, this gap has broadened, which may jeopardise the EU's current and future economic competitiveness. More precisely, the EU's investment intensity in research, higher education and other educational sectors amounted to 6.6 % of GDP in 2007, while the United States invested 9.2 %, Korea 9.7 % and Japan almost 7.5 % of their wealth (Figure 5). In evolutionary terms, South Korea increased its investment intensities by an average annual growth rate of 2.5 % between 2000 and 2007, while the United States and Japan experienced very low annual growth rates over this period (0.4 % and 0.1 % respectively). In contrast, the EU suffered a decrease in the same period.

### *Public R&D intensity has increased in the EU, although it remains far from the 1 % target set for 2010 by the Lisbon Agenda*[24]

The EU's R&D expenditure in the public sector amounted to 0.67 % of GDP in 2008 — a slight increase since 2000 (0.64 %) — and rose to 0.74 % of GDP in 2009 due to the fall in GDP and the resilience of public R&D investments (Figure 6). R&D intensity in the EU public sector is slightly above that of the United States (0.65 %) and Japan (0.69 %) and well above China (0.4 %), but below South Korea, where public R&D expenditure amounted to 0.78 % in 2008. These values show that some progress to foster the role of research in the public sector has been made in the EU. However, this progress has not been enough to meet the 1 % target[25] set by the Lisbon Agenda.

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[24] It should be noted that the Lisbon Agenda established a 1% target for publicly funded R&D. In this point, we are referring to publicly performed R&D. While there tends to exist a strong correlation between the two variables, some differences in specific countries may also exist. A specific analysis of publicly funded R&D is covered in the next session of this report.

[25] The Lisbon Agenda set the objective of raising public R&D funding to 1 % of GDP by 2010. While the public expenditure indicator refers to publicly performed R&D, in general there is a high correlation between the two variables and the differences between public R&D funding and publicly performed R&D tend to be small in most countries, perhaps with the notable exception of Japan, where public funding of R&D is 0.55 %.

## 2.2. Can the EU count on a growing number of human resources and researchers?

### *The EU lags behind other advanced economies in numbers of tertiary education graduates, hampering progress towards a knowledge-based economy*[26]

Highly skilled people are crucial for the generation, diffusion and use of knowledge which is at the core of innovation in an economy. In the EU, more than 30 % of the population aged 25–34 counted on a university degree in 2009. Although this percentage has increased in recent years, it is still much lower than in other advanced economies, especially South Korea or Japan, where more than half of the population in this age cohort have attained a university education (Figure 7). The Europe 2020[27] strategy has set a target of increasing the percentage of the population aged 30–34 with a university degree to 40 %, which will help bridge the current gap. Data for this age group was 32.3% in 2009.

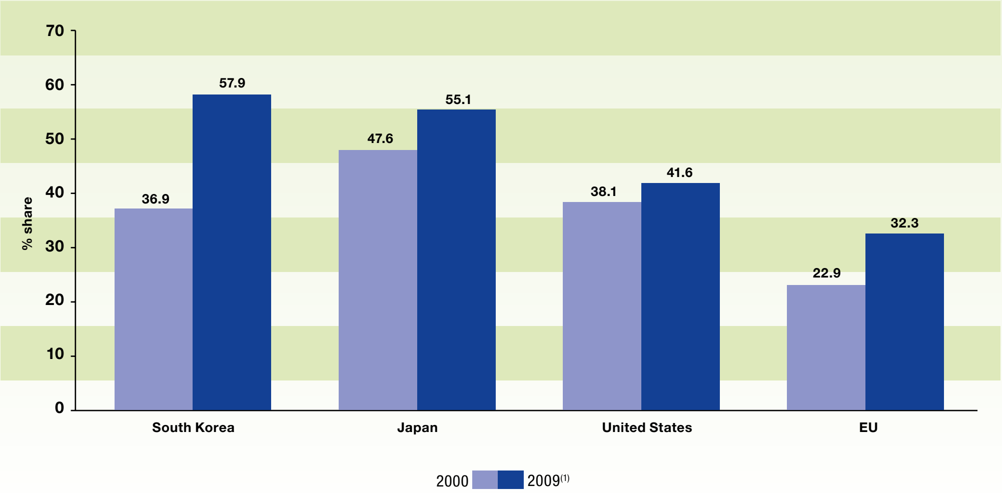
### *The EU has increased the number of new PhD graduates in the last few decades. These new cohorts of doctoral students increase the pool of researchers needed in Europe*

In the last decade, the number of new doctoral graduates per thousand population aged 25–34 has steadily increased by an average annual growth rate of 3.5 –5 % in the EU, the United States and Japan. In total, in 2008 the number of new doctoral graduates in the EU aged 25–34 was 110 073, in the United States 63 712, and 16 296 and 9 369 in Japan and South Korea respectively[28].

It is important to note that in 2008 the positive trend in the EU changed sign and the number of doctoral graduates per thousand population aged 25–34 fell to 2004 levels, probably due to the economic crisis and the lower employment expectations of the new doctoral graduates. As a result, fourteen people in every ten thousand aged 25–34 in the EU have a doctoral degree[29].

FIGURE 7

**Share of population aged 25-34 having completed tertiary education, 2000 and 2009(1)**



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD
*Note:* (1) US, JP, KR: 2008.

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[26] For a more comprehensive analysis of human resources and researchers, see Part I, chapter 4.

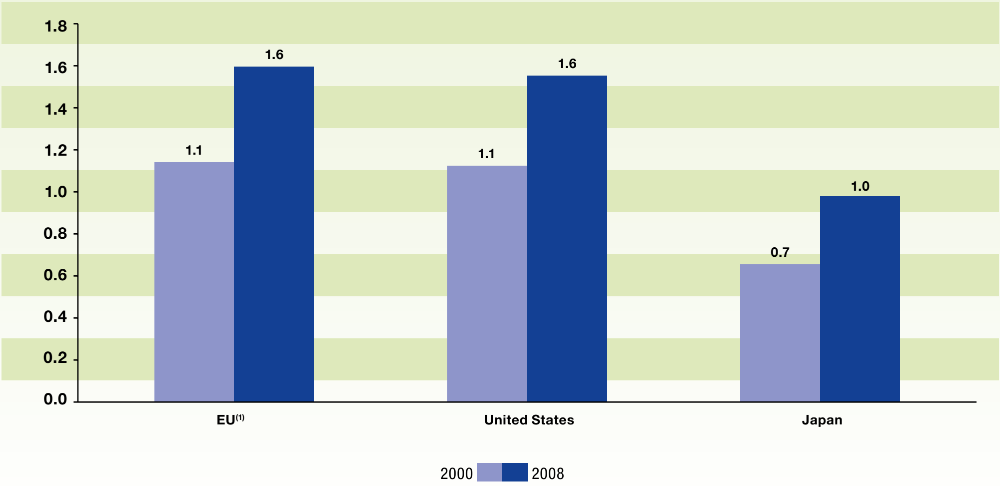
[27] http://ec.europa.eu/europe2020/index_en.htm.

[28] Source: Eurostat. The EU aggregate was calculated by DG Research and Innovation.

[29] All new doctoral graduates of the year are counted, including those aged below 25 (rare) or above 34 (more frequent). The population aged 25–34 is only a normalisation figure and does not constitute the sole population considered to count as new doctoral graduates.

FIGURE 8

## New doctoral graduates (ISCED 6) per thousand population aged 25-34, 2000 and 2008



*Source:* DG Research and Innovation

*Data:* Eurostat, OECD

*Note:* (1) EU aggregate does not include LU.

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This ratio is slightly below that of the United States (sixteen people in every ten thousand in the same age band) and significantly higher than that of Japan (nine people in every ten thousand).

This increasing number of doctoral graduates signals the increasing interest of students in continuing further research education and the capacity of the system to train them. An interpretation of these data must also consider the size of the total population of doctoral graduates along with the demographic prospects for each country.[30]

### *The EU has also managed to mobilise more women to undertake doctoral studies, so that 45 % of all doctoral graduates in 2008 were women — almost bridging the gender gap*

In 2008, 45 % of all PhD graduates on average across the EU were women who were joining the research community, which increased the still very low share of female researchers[31] in Europe (Figure 9). Since 2002, the proportion of new female doctoral holders has increased by an annual average rate of 6.8 %, outperforming the growth rate of male doctoral graduates, at 3.2 %. If this trend continues, gender parity in doctoral graduates will shortly be achieved, as in the United States at present.

### *The EU now has one of the highest numbers of researchers in the world, but in comparison to other developed economies and China, the EU engages fewer researchers in the private sector*

In terms of researchers, the EU has overtaken the United States and now has more researchers in absolute terms than almost any other system in the world, with the exception of China (Figure 10). There were almost 1.5 million researchers in the EU in 2008. This front-runner position has been due to a good growth rate in the number of researchers in the last decade, at almost 4 % on an annual average. Only China and South Korea, with very strong research investment increases, grew at a faster pace.

It is important to note that European researchers are mainly employed by the public sector. More than half of the researchers in EU are employed in public laboratories, while in the United States, almost 80 % and in Japan and South Korea 60 % of the researchers work in private firms. This structural difference in the sector of employment raises some questions about the role of the researchers in the EU and the involvement of the private sector in research activities.

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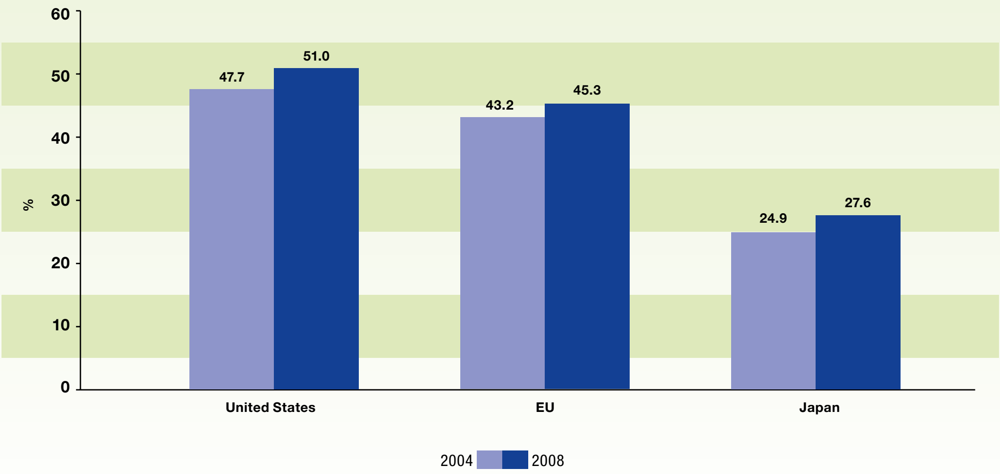
[30] See Part I, chapter 4.

[31] In 2006, women represented only 30 % of the total number of researchers in the EU (Source: DG Research, 'She figures 2009').

## FIGURE 9

### Female PhD / doctoral graduates as % of total PhD / doctoral graduates, 2004 and 2008



*Source:* DG Research and Innovation
*Data:* Eurostat

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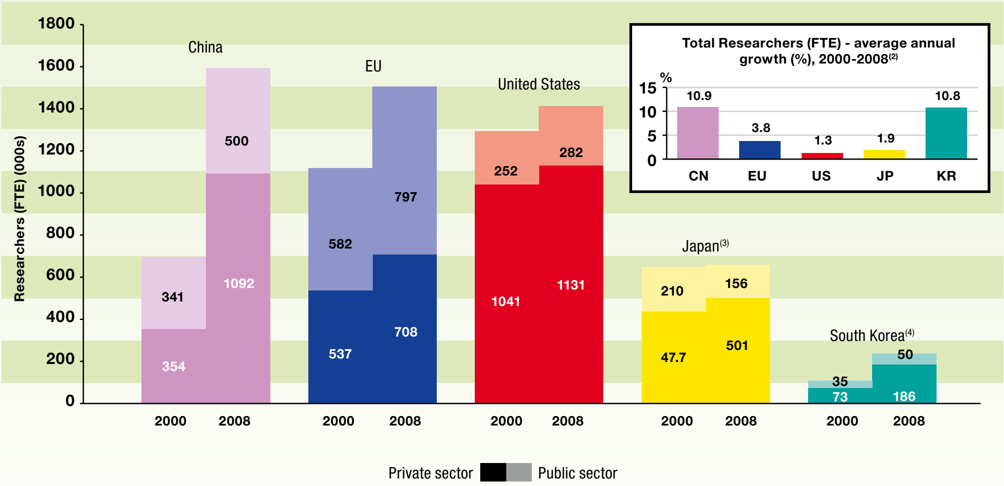
## FIGURE 10

### Researchers (FTE) broken down by public and private sector, 2000 and 2008[(1)]



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD
*Notes:* (1) US: 2007.
(2) KR: 2000-2006; US: 2000-2007; JP: 2002-2007.
(3) JP: There is a break in series between 2002 and the previous years and between 2008 and the previous years.
(4) KR: (i) There is a break in series between 2008 and the previous years; (ii) R&D in the social sciences and humanities is not included in 2000.

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## 2.3. Are EU firms increasing their R&D investments in order to generate and absorb new knowledge and boost innovation?

### *EU firms have not increased their research efforts in the last decade. In contrast, Japanese, South Korean, and above all, Chinese firms have made good progress*

EU firms have maintained their research efforts at a value of around 1.2 % of the European GDP (Figure 11). This stagnation in the private research effort contrasts with the rapid growth in other developed economies, especially Japan and South Korea, who in 2008 already doubled this intensity effort, or the United States, where the research carried out by firms accounted for 2 % of the national GDP. Moreover, Chinese firms are increasingly becoming technology-familiar, and since the year 2000, they increased their R&D efforts at an average annual growth rate of 10 %. As a result, China's private R&D intensity has surpassed the 1 % barrier and is quickly approaching the EU values.

Several factors could explain the remarkable difference in private research intensity between the EU and other developed economies. The EU's economic structure[32], or more precisely, the absence of change in an economic structure geared towards a more research-oriented, high-added-value economy, ranks high in this list.[33]

### *Small and Medium- size firms in the EU are less research oriented than those in other major countries[34]*

Research and technological development requires an entrepreneurial spur to trigger innovation and economic competitiveness. Small and Medium-size Enterprises (SMEs) are crucial players in the EU, contributing to a large part of the economy and employment. Moreover, successful economies worldwide are characterised by the emergence of new and fast-growing firms, mainly SMEs, that allow the economy to become more dynamic and in many cases contribute to the technological and structural change of the economies. As such, the research investment performed by SMEs reflects entrepreneurial innovative dynamism. As figure 12 shows below, despite the larger role of SMEs in the EU's economy, they are investing less than SMEs in the EU's main trading competitors, with the exception of Japan, whose economy is dominated by large conglomerates and has a lower presence of SMEs[35]. These data confirm some preliminary findings, showing that on average European research-intensive SMEs spent less on R&D as a proportion of their turnover than SMEs in the United States[36]. Moreover, while in recent years SMEs in the EU have increased their R&D investments, these increases have been lower than those of their international competitors.

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[32] It is important to note that changes in the economic structure are also the consequence of the research investments that affect the global competitiveness of specific sectors, and therefore it should not be regarded as a static constant that influences R&D investment.

[33] For a more comprehensive analysis on private R&D investments, see Part I, chapter 5 of this report.

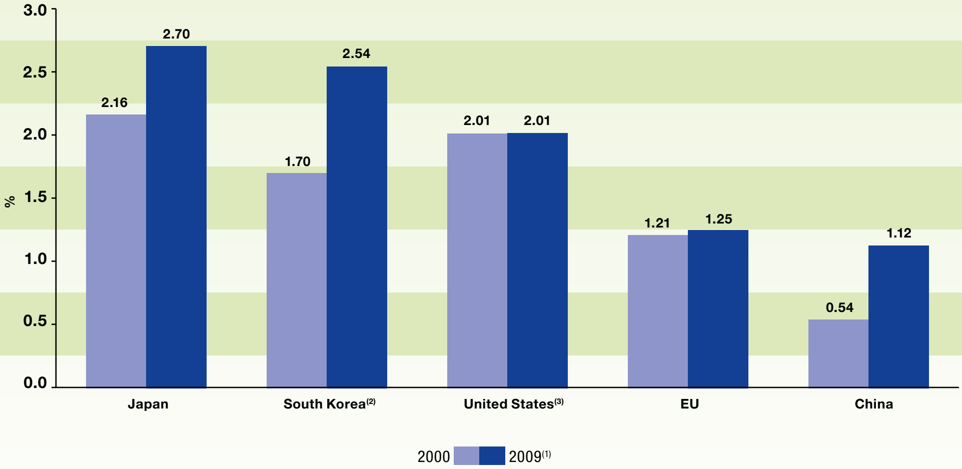
[34] For a more comprehensive analysis of knowledge-intensive SMEs, see Part III chapter 1.

[35] 99 % of all firms in Europe can be considered SMEs. European Commission (2010):'Interim evaluation of the seventh Framework Programme. Report of the expert group'.

[36] Ortega-Argilés R and Brandsma A (2009): 'EU–US differences in the size of R&D intensive firms', IPTS working papers on corporate R&D and Innovation, DG JRC.

FIGURE 11

**BERD Intensity (Business enterprise expenditure on R&D (BERD) as % of GDP), 2000 and 2009(1)**



Source: DG Research and Innovation

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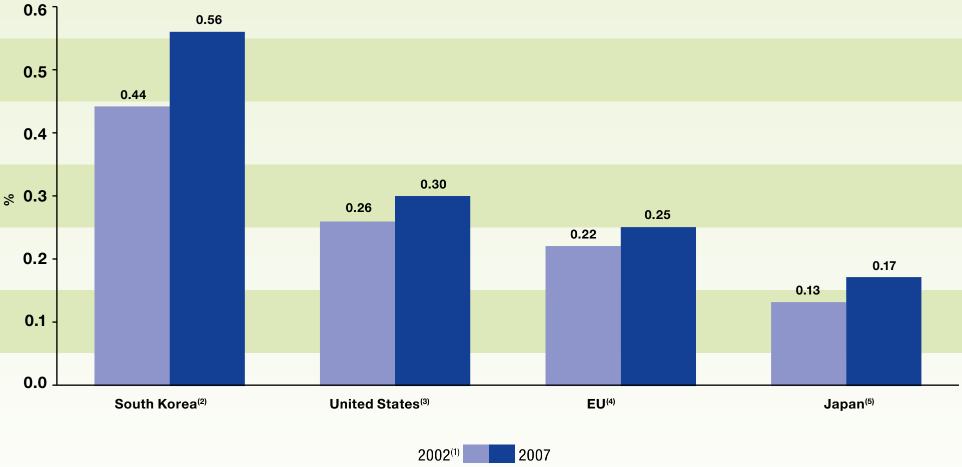
*Data:* Eurostat, OECD

*Notes:* (1) US, JP, CN, KR: 2008.
(2) KR: (i) There is a break in series between 2008 and the previous years; (ii) BERD for 2000 does not include R&D in the social sciences and humanities.
(3) US: BERD does not include most or all capital expenditure.

FIGURE 12

**BERD performed by SMEs as % of GDP, 2002(1) and 2007**



*Source:* DG Research and Innovation

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*Data:* Eurostat, OECD

*Notes:* (1) EU: 2003.
(2) KR: (i) There is a break in series between 2007 and the previous years; (ii) BERD for 2002 does not include R&D in the social sciences and humanities.
(3) US: BERD does not include most or all capital expenditure.
(4) EU does not include BE, IE, EL, IT, LU.
(5) JP: BERD by size class is underestimated.

# CHAPTER 3

# Towards the construction of a European Research Area (ERA) open to the world

Europe needs to build an efficient research system that resolves the fragmentation of European research and helps to build sufficient critical mass to compete globally. Moreover, a well-functioning single market for knowledge needs to be sufficiently developed to maximise research synergies and speed the development and use of new knowledge within Europe.[37]

In order to measure progress in the construction of a European Research Area, the European Commission has, in dialogue with Member States and Associated Countries, proposed a draft list of core indicators for the monitoring of the ERA (provisionally named 'ERAM indicators'). Several of these indicators are presented in this overview part of the RIC report, e.g. indicators measuring investments, human resources, innovation and technologies for societal challenges. This chapter presents some of the other ERAM indicators, with a specific focus on the integration of the European research system.

## 3.1. What is the overall progress towards the European Research Area?

***Since the launch of the ERA in 2000, Europe has made some progress towards the coordination of research investments and there has been an increase in internal scientific collaboration. However, further work is needed***

Data on some key indicators on the European Research Area covered in Figure 13 below, show that some progress towards the construction of the ERA has been achieved in the last decade, but also that further work is still needed to construct a true, well-functioning ERA.

According to experimental data, in 2008 around 4.5 % of EU Member States' R&D budget is directed to 'trans-nationally coordinated research' on average — only slightly up from 4.3 % in 2007. There is scope to augment the amount of national funds used to support R&D programmes coordinated between countries.

It is not possible yet to measure the share of national public funding directed to the *construction* and *operation* of national public research infrastructures[38], nor to calculate the share of national public funding for multi-national public research infrastructures. The annual total capital R&D expenditure[39] in the public sector is currently measured by country, and is much broader than investment in the construction of national research infrastructures. On average in the EU-27, capital expenditure has been stable at around 12.5 % of total R&D expenditure in the public sector. The share of capital expenditure in R&D expenditure is lower, and tends to decrease, in countries with higher labour cost. In many catching-up countries, the share of capital expenditure has considerably increased since 2000, which may reflect intensive investments in upgrading and constructing infrastructures for research in the public sector.

Scientific collaboration between Member States has been intensifying since 2000: the number of scientific publications involving at least two Member States in total EU scientific publications has increased by 36 % between 2000 and 2009. In most Member States, between 30 % and 50 % of their scientific publications are co-authored with one or more other Member States. To a large extent, this may be due to an increased mobility of researchers across Europe. The number of doctoral holders who studied or carried out research in another European country for at least 3 months was around 17 % of the total in 2006. Although there is no comparative data for previous years, this figure is likely to have increased thanks to the different programmes incentivising the mobility of researchers.

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[37] Europe 2020 Flagship Initiative Innovation Union, SEC (2010) 1161.

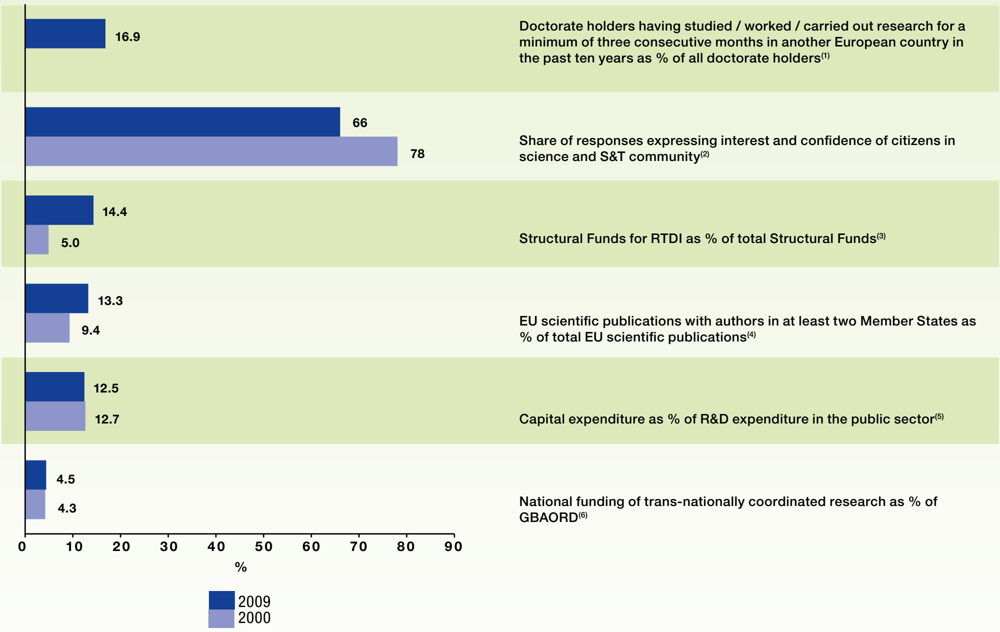
[38] Research infrastructures are defined as medium or large-scale, single-sited, distributed or virtual facilities or joint resources that provide unique access and services to research communities in both academic and technological domains.

[39] Expenditure on land, buildings, instruments and equipment for the performance of R&D activities.

Moreover, in order to benefit from an efficient internal market for knowledge, all regions and Member States should be able to contribute and benefit from the circulation of new knowledge. This requires that those regions of Europe whose scientific and technological capacity currently lags behind make an effort to enhance their research and innovation capacity supported by national research and innovation policies. In this respect, the EU's Structural Funds are playing a crucial role as 14.4 % of all the Structural Funds are and will be devoted to research and innovation activities for the 2007–2013 programme. In the previous 2000–2006 programme, these activities accounted for only 5 % of all Structural Funds[40].

Finally, European research and innovation can only advance and gain credibility if there is a strong social acceptance and confidence. In the last five years, i.e. from 2005 to 2010, this confidence in the capacity of science and technology to improve our quality of life has decreased from 78 % to 66 % of the population[41]. This indicates both the need for a reorientation towards societal benefits and for a better communication of the potential and achieved benefits accruing from scientific and technological research.

FIGURE 13 **EU - selected ERAM indicators, 2000 and 2009**



*Source:* DG Research and Innovation

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*Data:* Eurostat, DG REGIO, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) (i) 2006; (ii) EU includes BG, DK, ES, LT, AT, PL.
(2) 2005 and 2010.
(3) 2000-2006 and 2007-2013.
(4) 2000 (citation window 2000-2003) and 2007 (citation window 2007-2009).
(5) 2008 and 2009.
(6) 2007 and 2008.

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[40] These figures include actions related to research, development, technology and innovation (RDTI). On top of this, the Structural Funds also support entrepreneurship, human capital and ICT. This would increase the total amount from EUR 50 billion to EUR 86 billion (24.5% of cohesion funding).

[41] More detailed information can be found in section 3 'New Perspectives', Chapter 3.

## 3.2. Is Europe advancing towards a single market for knowledge?

In addition to the scientific knowledge flows analysed in the previous section, a single market for knowledge also needs to foster stronger knowledge flows between the public and the private sectors in order to bring the ideas to the market.

### *The linkages between public and private research actors in the EU are increasing, but remain much weaker than those in the United States and Japan*[42]

R&I seldom works in isolation. The linkages between research actors are crucial to expand the knowledge base. The linkages created between public and private research agents represent, to a certain degree, the cohesion of a system and its capacity to maximise the use of the local knowledge.

As Figure 14 shows, these interactions in the EU are relatively weak when compared to the United States or Japan. More precisely, Japan has almost twice as many public–private co-publications per million population (56) as the EU (36). The United States is well ahead with 70 public-private co-publications per million population.

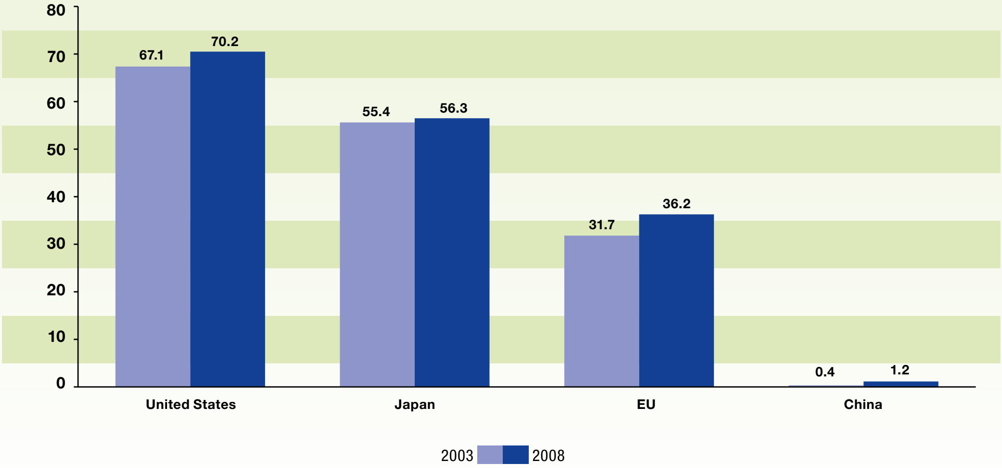
Since 2000, the EU has slightly improved this ratio with an average annual growth rate of almost 3 % that has helped to slightly bridge the gap between the EU and the United States and Japan. However, the sharp increase of almost 12 % in China's average annual growth is more remarkable, although it starts from a very low position.

### *The EU is increasingly becoming an open system, tapping into global sources of knowledge*[43]

The rise of a multi-polar scientific and technological world opens the door to an increased collaboration with foreign research agents in order to tap into knowledge developed abroad.

In terms of technological collaboration with co-inventors located abroad, China is the most open country, ahead of the United States and the EU (Figure 15). Over the period 2006–2008, almost 12 % of all PCT patent applications

FIGURE 14 **Public-private co-publications per million population, 2003 and 2008**



*Source:* DG Research and Innovation
*Data:* European Innovation Scoreboard, 2010

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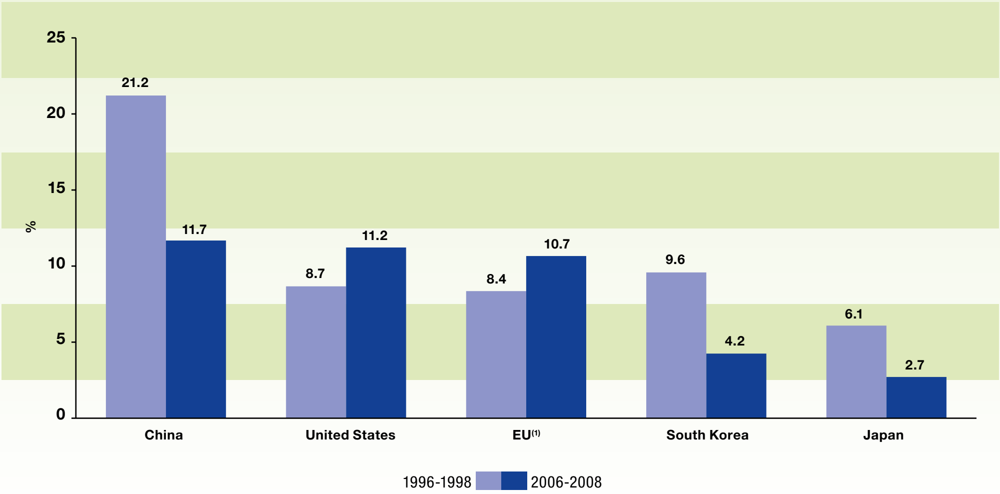
[42] For a more comprehensive analysis of public–private cooperation, see Part II, chapter 2.

[43] For a more comprehensive analysis of transnational knowledge spill-overs and technology cooperation, see Part II, chapter 6.

FIGURE 15 **PCT patent applications with at least one foreign co-inventor as % of total PCT patent applications, 1996-1998 and 2006-2008**



*Source:* DG Research and Innovation
*Data:* OECD
*Note:* (1) The EU is treated as one country; intra-EU co-operation is excluded.

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made by an inventor based in China involved at least one foreign-based co-inventor. This was the case in 10.7 % of the PCT patent applications with an inventor based in the EU and 11.2 % for the United States. Only 4.2 % and 2.7 % of the PCT patents with inventors based in South Korea and Japan respectively had co-inventors based in other countries.

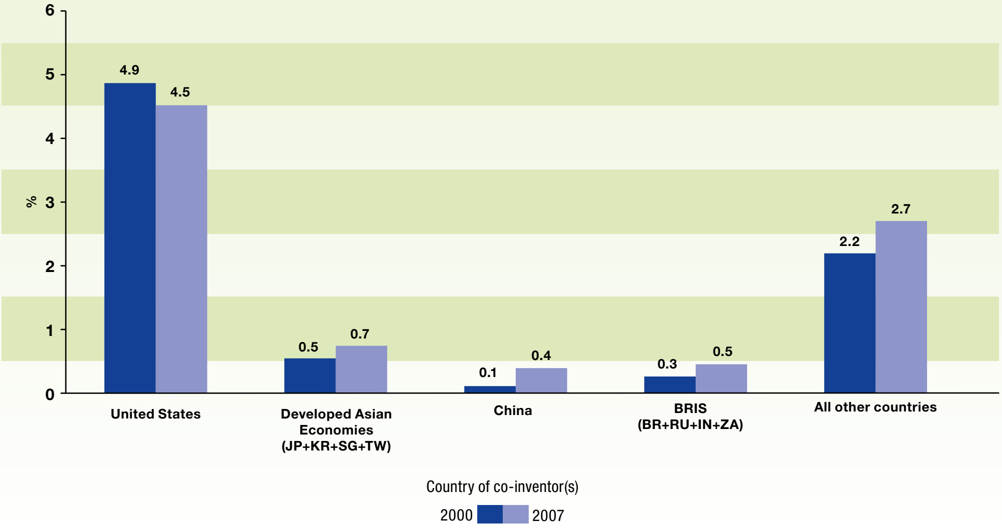
Over time, both the United States and the EU have increased the share of co-patents, suggesting that both systems are increasingly open to foreign technological collaborations, while the Asian economies on the other hand show a decrease of this ratio, largely due to the sharper increase in the total number of patents, and also the rise of their technological capacity, which allows them to develop new technological inventions with local partners.

### *The United States remains the main technological partner for the EU, although closer links are being established with countries in Asia and in other parts of the world*

In terms of nationality of collaborators in technology development, the EU's traditional cultural, scientific and technological ties to the United States make this country the main technological partner for European inventors. Almost half of all co-patents are filed with an American counterpart.

However, it is worth noting that over time there has been a shift in the selection of technological co-partners. As Asia and the rest of the world become more technology-intensive, the role of these world regions in technological cooperation grows. The share of EU patent applications with a co-inventor from the developed Asian economies has grown from 0.7 % to 1.1 % since the year 2000, and EU patent applications with a co-inventor from a country other than the United States or the developed Asian economies, have risen from 2.6 % to 3.6 % (Figure 16).

FIGURE 16 **EU patent applications to the EPO with at least one foreign co-inventor as % of total EU patent applications to the EPO, 2000 and 2007**



*Source:* DG Research
*Data:* OECD

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## 3.3. Has Europe achieved world excellence in science and technology?

### *The EU's scientific excellence improved in the last decade although it still lags behind the United States*[44]

Scientific excellence is measured here with an indicator relating the total number of publications in a country (or in the EU) to the number of those publications which are among the 10 % most cited publications worldwide. According to this indicator, the United States remains the world leader in producing high quality, high impact scientific publications (Figure 17). The United States ratio is close to 1.5, meaning that 15 % of their publications are among the 10 % most cited scientific publications worldwide.

In contrast, the EU's share is 11.6%, i.e. slightly above the world average, and above the share of the major Asian countries. Over the last decade, the EU has progressed in terms of improving the quality of its scientific production. However, this progress has not been as sharp as that of China, which has significantly increased the share of its national publications ranking in the top 10 % most cited publications.

### *However, the economic returns on the EU's technologies are relatively stagnant and lag behind those of the United States and Japan*

EU firms, universities and public research-performing organisations sell the results of their technological activity to other research agents in the world. The amount of revenue obtained can, to a certain extent, be interpreted as an indication of the quality and competitiveness of the technologies and innovations. In 2009, the economic revenues obtained by EU research agents amounted to 0.21 % of the total GDP (0.20 % in 2008). In comparison, the economic impact of the patents and licence rights sold by United States agents rose to more than 0.6 % of the national GDP, a value slightly above Japan's 0.5 % share in 2008.

Moreover, this performance gap between the EU and its main trading competitors is broadening over time, as both the United States and Japan have increased their license and patent revenues at a much faster pace than the EU (with annual growth rates of 5.8 % and 13.4 % respectively compared to 2 % for the EU).

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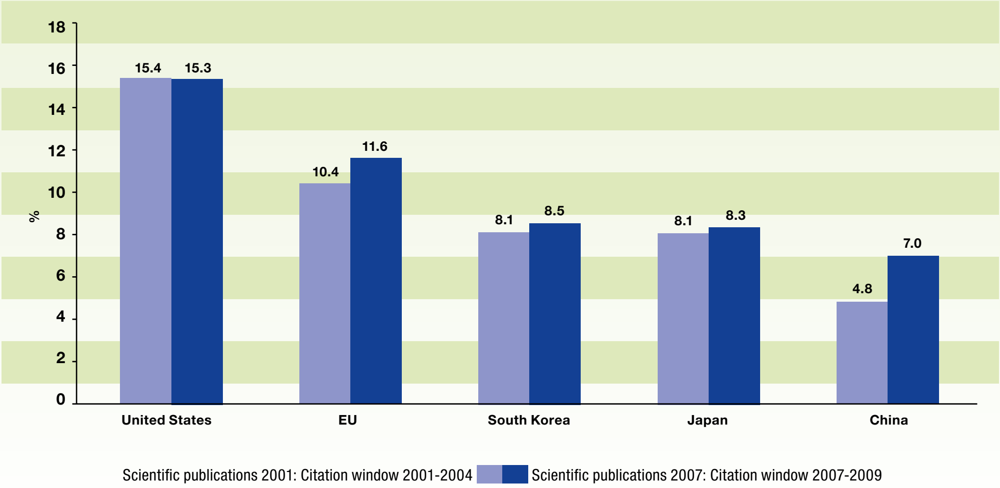
[44] For a more comprehensive analysis of scientific and technological output, see Part I, chapter 6.

FIGURE 17

## Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country(1), 2001 and 2007



*Source:* DG Research and Innovation
*Data:* Science Metrix / Scopus (Elsevier)
*Note:* (1) Full counting method.

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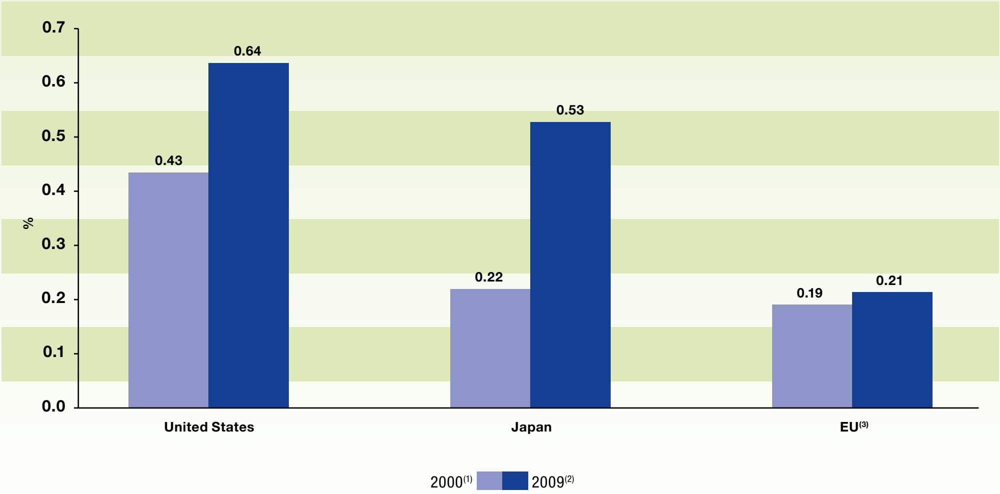
FIGURE 18

## Licence and patent revenues from abroad as % of GDP, 2000(1) and 2009(2)



*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) EU: 2004.
(2) US, JP: 2008.
(3) Extra-EU.

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# CHAPTER 4

# Innovation for a knowledge economy and societal challenges

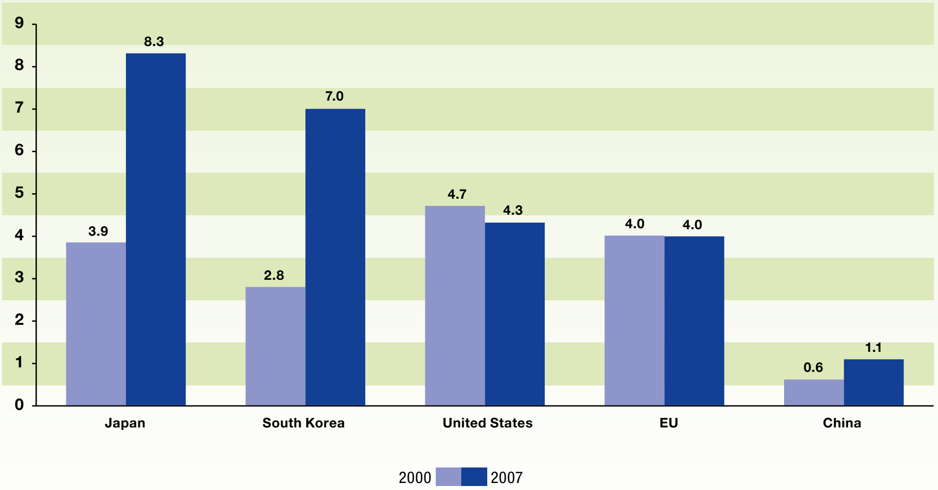
Smart, sustainable and inclusive growth that secures the economic competitiveness of the EU in high-value-added, high-wage activities will require a structural change of the EU economy towards higher knowledge intensity. In order to ensure this structural change, the EU needs to improve its framework conditions for business R&D by reducing the costs of Intellectual Property Rights (especially the cost of patenting), enhancing access to finance, and facilitating a more entrepreneurial environment for technology-based innovation. In parallel, research and innovation policies need to address global societal challenges by responding to both citizens' demands and expanding global markets.[45]

## 4.1. Are European firms/companies achieving technology-based innovation?

***The EU is catching up with the United States in terms of PCT patent applications per billion GDP ratio, but is falling further behind the leading countries in Asia[46]***

The EU's technological output reflects the intensity of research investment by private firms. The number of PCT patents per billion GDP (PPS €) gives an indication of the technological performance of a country and the technological intensity of an economy (Figure 19). In 2007, the EU had four PCT patent applications per

FIGURE 19 **PCT patent applications(1) per billion GDP (PPS€), 2000 and 2007**



*Source:* DG Research and Innovation

*Data:* OECD

*Note:* (1) Patent applications under the PCT (Patent Cooperation Treaty), at international phase, designating the EPO by country of residence of the inventor(s).

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[45] Europe 2020 Flagship Initiative Innovation Union, SEC (2010) 1161.

[46] For a more comprehensive analysis of technology output, see Part I, chapter 6.

billion GDP, which is slightly below the United States and much lower than Japan and South Korea. In the latter two countries, the number of PCT patent applications per billion GDP was seven or above, almost double the EU average. China has one patent per billion GDP leaving a large technological gap between China and more advanced economies.

This indicator shows that the relative stagnation in private research efforts in both the United States and the EU since 2000 has resulted in a decrease in technological output: both the EU and the United States had slight negative average annual growth rates in PCT patent applications. In contrast, South Korea and Japan benefited from sharp increases, with average annual growth rates approaching 14 % for South Korea, and 9 % for Japan. China, with its sharp increase in private R&D investment in the last decade, has also benefited from a remarkable annual growth rate of 9 % in its PCT patent application rate.

## 4.2. Can the EU count on the right framework conditions to boost innovation?

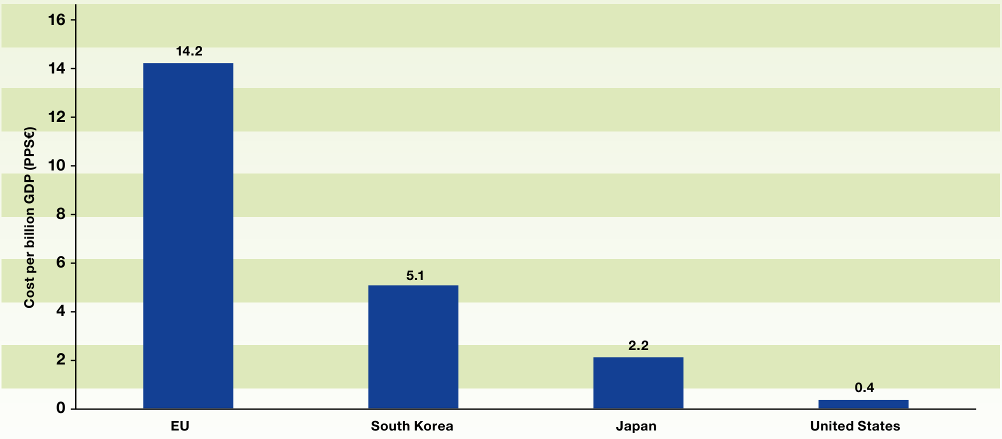
### *The cost of protecting intellectual property through patents is much higher for EU firms than for their competitors*[47]

Patents are one of the main means that firms use to protect the technological results of their research activity. They allow firms to exploit their technological production commercially and, as such, they provide an incentive for firms to invest further in R&D activities. However, the cost of applying for and maintaining a patent can discourage firms, especially SMEs, from engaging in the process and finally getting involved in R&D activities.

As figure 20 shows, the cost of applying for a patent and maintaining it is much higher in particular for SMEs in the EU than for their international competitors. The lack of a European Patent imposes high costs on EU companies that need to designate different patent offices in order to have their patent protected in the EU.

FIGURE 20

**The cost in 2009 of patent application and maintenenance for SMEs, per billion GDP**



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, EPO, USPTO, JPO, KIPO

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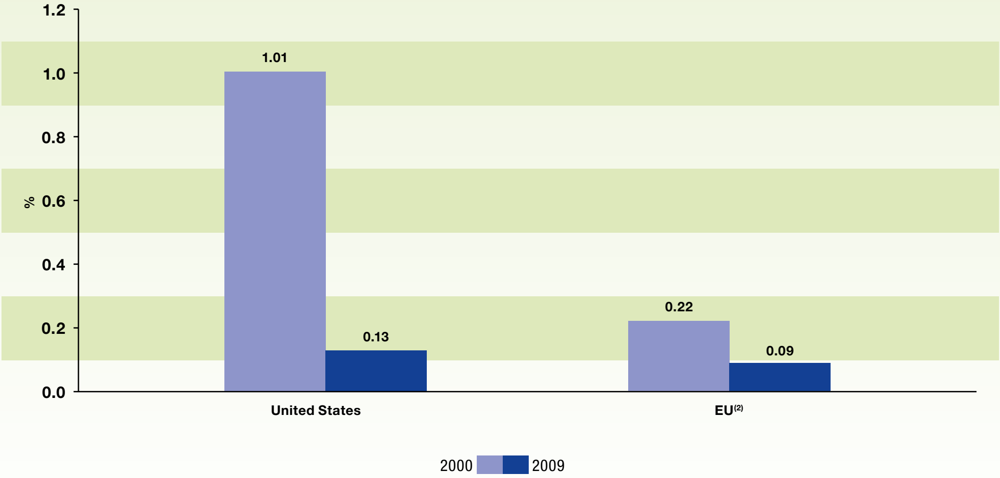
[47] For a more comprehensive analysis of the framework conditions for business research and innovation, including cost of patenting, venture capital and entrepreneurship, see Part III, chapter 2.

## FIGURE 21 Venture Capital[(1)] as % of GDP, 2000 and 2009



*Source:* DG Research and Innovation

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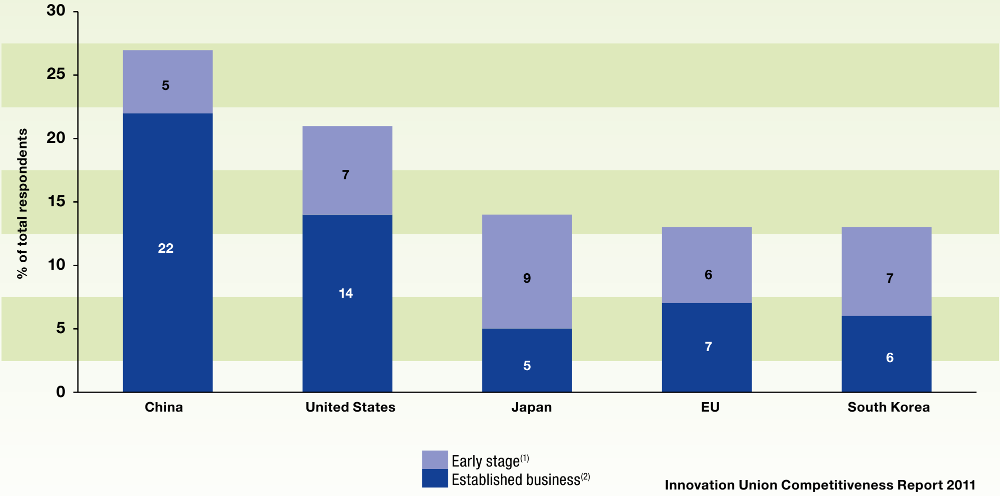
*Data:* Eurostat

*Notes:* (1) Early stage, expansion and replacement.

(2) EU does not include BG, EE, CY, LV, LT, LU, MT, SI, SK.

## FIGURE 22 Entrepreneurial activity, 2009



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*Source:* DG Research and Innovation

*Data:* Eurobarometer, Entepreneurship in Europe and beyond, 2010. Q: Have you ever started a business or are you taking steps to start one?

*Notes:* (1) Early stage comprises embryonic entrepreneurship (respondents who were taking the necessary steps to start a business at the time of the survey) and new businesses (respondents who had started or had taken over a business in the last three years and which was still active at the time of the survey).

(2) Established business refers to still active businesses established by respondents three or more years before the time of the survey.

### *The share of venture capital is lower in the EU than in the United States, but the gap has decreased over the last decade*

The EU lags behind in the availability of venture capital funding, which is crucial for new technology-based firms and for promoting radical innovation. In 2009, the EU's venture capital investment amounted to less than 0.1 % of GDP, while in the United States, it is 0.13 % (Figure 21).

Venture capital is particularly important in the EU due to the large presence of SMEs in Europe, and these enterprises have difficulties in auto-financing their expansion and R&I plans.

Venture capital markets have proportionally decreased since 2000 both in the EU and the United States. The burst of the dot.com bubble in the early years of the 1990s and the financial crisis from the end of 2007 onwards brought about severe reductions of funding for venture capital, especially in the United States. Since then, venture capital has been growing, but it still remains below 2000 values.

### *The EU has lower entrepreneurial activity than the United States and China*

The unfavourable framework conditions for R&I also affect entrepreneurial activity in the EU. While the entrepreneurial spirit is, to a large extent, the result of deeply embedded cultural factors, Europe seems to face higher barriers to starting new economic activities (Figure 22). As mentioned earlier, an entrepreneurial spur is the basis of innovation, and it is mainly the entrepreneurs who are bringing the ideas to the market.

## 4.3. Is the EU shifting towards a more knowledge-intensive economy?

### *European Young Innovators face difficulties in becoming leading innovators and contributing to economic growth and employment creation*

Yollies or 'young leading innovators' are R&D intensive firms that have, in a relatively short period, grown into world leaders on the basis of their substantial R&D efforts, while still remaining 'independent'[48]. As such, they are crucial players in the development of new technologies and in bringing innovations in the market, and they contribute to transforming the economy towards more research- and knowledge-intensive activities.

As Figure 23 shows, EU-based yollies play a smaller role in the economy than in the United States. Only one out of five leading innovators based in the EU was born after 1975. On the other hand, this was the case for more than half of leading American innovators, and, moreover, the share of EU yollies in total leading firms' R&D expenditure is around 7 % in contrast to the 35 % in the United States. This shows the dynamism of the American economy and the sluggishness of the European, and once again hints at the existence of important barriers in terms of framework conditions, such as access to finance, fragmentation of the market or sophistication of users, but also to the 'eco-innovation system' that does not manage to effectively link the institutions and organisations that are active in innovation.

### *Moreover, Europe's technological profile seems to depict a relative negative specialisation in developing key enabling technologies such as ICT or biotechnology, whose use can spread across many technology fields and contribute to boost the overall innovation capacity and productivity of an economy*

Enabling technologies, such as ICT, biotechnology or nanotechnology, have the potential to interact with a large set of established technologies and generate breakthrough innovations in products, services and processes and offer effective solutions which help address major societal challenges, such as healthy aging, climate change or energy dependency.

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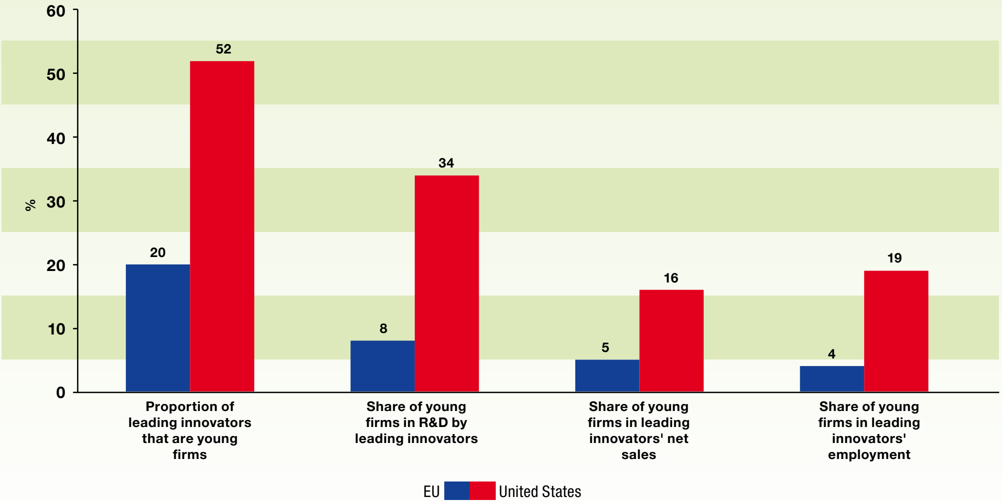
[48] Veugelers R and Cincera M (2010): 'Europe's mission yollies', *Bruegel Policy Brief.*

FIGURE 23 **Share of 'yollies'(1) in number of firms, R&D, sales and employment, 2007**



*Source*: DG Research and Innovation

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*Data:* Bruegel 2010 (calculations based on data from IRMA)

*Note:* (1) 'Yollies' or Young Leading Innovators are post-1975 born R&D intensive enterprises, as covered in the EU Industrial R&D Investment Scoreboard.

It is expected that a significant number of the goods and services that will be available in the market by 2020 are yet unknown, but the driving force behind their development will be the deployment of key enabling technologies[49], and where first movers' benefits will be substantial. The nations mastering these technologies will count on an important competitive advantage to secure future economic growth. In the past, as previously presented, the United States benefited from larger productivity gains thanks to the mastering and extensive deployment of ICT across the national economy, especially in service sectors. In the future, further innovations could rely on ICT, but also on the use of biotechnology in, for example, industries such as agriculture and food processing, or nanotechnology in healthcare, energy, environment or manufacturing.

At present, Europe's relative specialisation[50] in these technologies is less pronounced than that of the United States. More precisely, while the United States (Figure 24) presents a consistent positive specialisation in all three key enabling technologies, Europe presents a mixed picture. It lags behind in ICT and biotechnology, although it has managed to offset its relative lag in nanotechnology in the last decade. Given the large potential benefits associated with the first movers in these technologies, it would be important to boost Europe's capacity to develop and deploy these technologies.

### *Despite these difficulties, the EU's economy, like the Japanese and US economy, has slowly shifted towards higher knowledge intensity[51]*

The availability of a well-educated working population is a key asset favouring innovation and an indication of the injection of knowledge into the economy in both high and low technology sectors. The size of knowledge-intensive activities in an economy in this sense is linked to its capacity to produce innovation outputs. Knowledge-intensive activities are defined as those activities where at least 25 % of the workforce has a tertiary education. This new indicator provides

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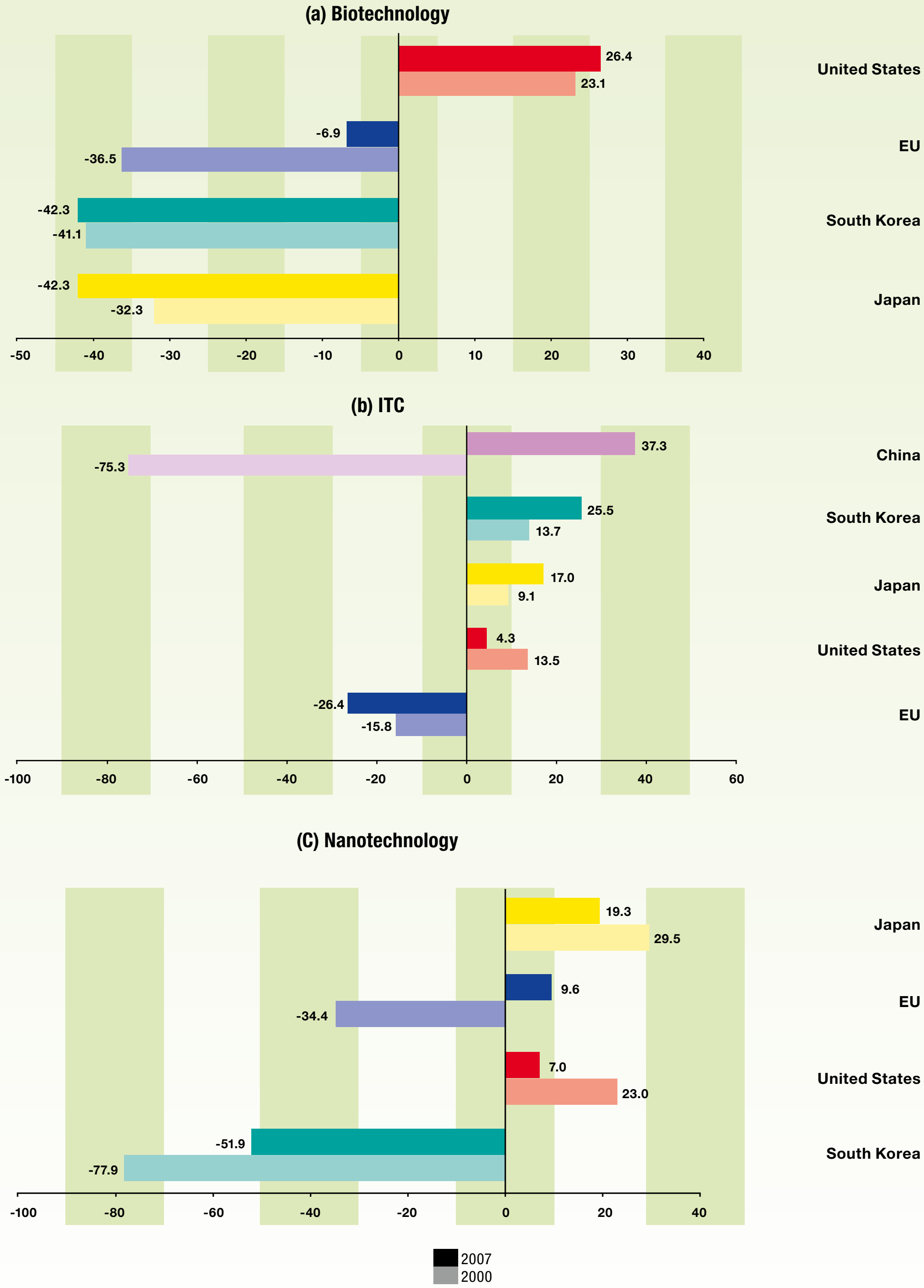
[49] European Commission (2009): 'Preparing for our future: Developing a common strategy for key enabling technologies in the EU'.

[50] The relative specialisation of a country is based on the specialisation index. This index is a Balassa index that measures the relative importance of a technology field in one country in comparison to the importance of that technology in the world. If the value is zero, the country is not specialised in that technology. If the value is positive, the country is then positively specialised in that technology, and conversely if the value is negative, the country is negatively specialised. The higher or lower the value, the more positively or negatively specialised it is. Europe's relative specialisation is analysed in the section "New Perspectives", chapter 2.

[51] For a more comprehensive analysis of structural change towards a more knowledge-intensive economy, see Part III, chapter 3, and for change in each country, see the section on the overall review of the EU Member States and Associated countries in the end of the report.

## FIGURE 24 Specialisation indices[(1)]



*Source:* DG Research and Innovation
*Data:* JRC-IPTS (calculations based on data from OECD)
*Note:* (1) Patent applications by inventor's country of residence.

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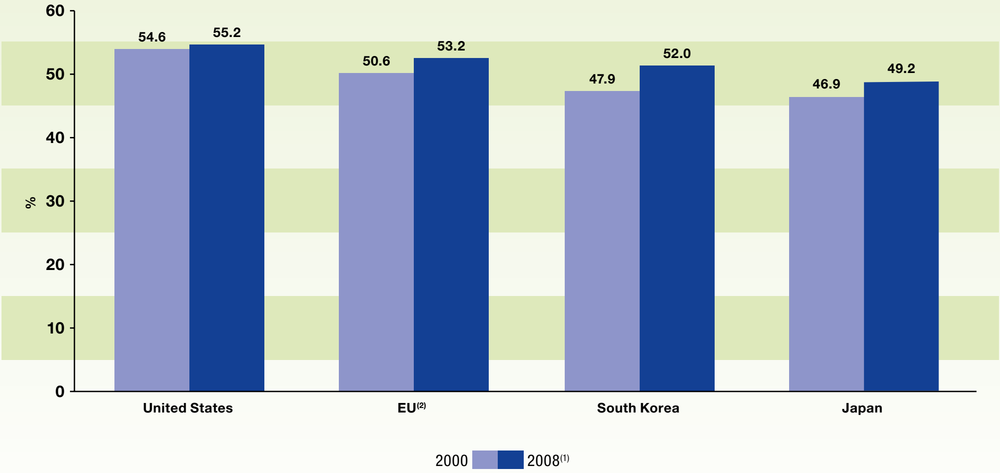
FIGURE 25

**Value added for knowledge-intensive services (KIS) and high-tech and medium-high-tech industries as % of total value added, 2000 and 2008(1)**



*Source:* DG Research and Innovation

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*Data:* OECD

*Notes:* (1) US: 2007; JP: 2005.
(2) (i) EU does not include BG, CY, LV, LT, MT, AT, RO
(ii) Elements of estimation were involved in the calculation of the EU aggregate.

an indication of the knowledge intensity of the entire economy, also covering services and other sectors beyond manufacturing.[52]

The EU's economy has slowly become more knowledge intensive. More precisely, in the EU, the percentage of the value added by knowledge-intensive services and high-tech and medium high-tech industries has increased in the last decade from 50.6 % of the total to 53.2 % (Figure 25). The United States, one of the most knowledge-intensive economies, has followed a similar path as the value added by these activities has moved up from 54.6 % in 2000 to 55.2 % in 2007. Finally, Japan and above all South Korea have also experienced a positive shift towards more knowledge-intensive activities, moving from 46.9 and 47.9 % in 2000 to 49.2 % and 52 % respectively in 2008. Based on these findings, the EU still falls behind the United States but, surprisingly, scores higher than Japan and South Korea, two highly technology-based countries, although both of them are closing the gap with the EU.

### *The share of the total EU product export given over to medium- and high-technology manufacturing has remained stable over time, but is lower than that of its main competitors*

The quality of research and technological production should contribute to the economic competitiveness of a country.[53] The share of the exports in knowledge-intensive sectors, both in manufacturing and services, provides an indication of the capacity of a country to compete internationally in high-value-added knowledge-based sectors. Changes in these shares would also reflect the impacts of a country's science, technology and innovation on their overall competitiveness.

In this context, as Figure 26 shows, Europe's share of medium and high-technology manufacturing exports is below 50 % of the total manufacturing exports. This value is well below that of China, the United States and especially Japan, where almost 75 % of the exports fall under this category. To a certain extent this finding reflects the economic structure of the EU, which is less technologically advanced than the United States and Japan. However, in an increasingly knowledge-intensive world economy, this threatens the EU's long-term economic competitiveness.

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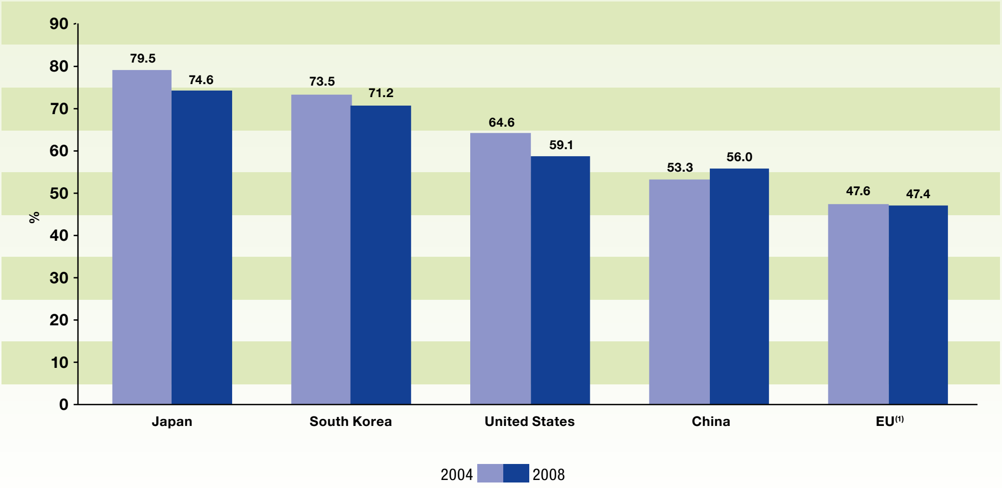
[52] Tertiary education in this context is defined as ISCED 5 and ISCED 6. This is a new key indicator developed by Eurostat after advice from the expert group on ERA indicators and monitoring, financed by the European Commission, 2009. This new indicator is presented in Part III, chapter 3. However, since data for the United States and Japan are not yet available, this comparative Overall Picture uses the current OECD classification in knowledge-intensive services, high-tech and medium-high-tech industries.

[53] For a more comprehensive analysis of competitiveness in Europe, see Part III, chapter 4.

FIGURE 26 **High-tech and medium-high-tech product exports as % of total product exports, 2004 and 2008**



*Source:* DG Research and Innovation **Innovation Union Competitiveness Report 2011**
*Data:* European Innovation Scoreboard 2010
*Note:* (1) EU includes intra-EU exports and was calculated from the unweighted average of the values of the Member States.

In evolutionary terms, it is worth noting that the EU's share has remained relatively stable over time. In contrast, both the United States and Japan suffered clear decreases, while China benefited from the sharpest average annual growth rates (approaching 1 %), which reflects once again its scientific and technological rise.

***However, the EU is competitive in knowledge-intensive services, although the United States, Japan and China are catching up***

Almost half of the service exports from the EU fall under the category of knowledge-intensive service exports. This share is higher than that of other competitors, which once again may reflect the economic structure of the countries (Figure 27). It is also important to highlight that even if the EU has showed better progress than the United States and Japan, the most remarkable increase has occurred in China, indicating a strong injection of knowledge in its services too.

## 4.4. Is European R&D addressing societal challenges?

***The EU's research contributes to address some of the most pressing societal challenges, although its technological production stills lags behind the United States and Japan[54]***

The EU invests in research oriented to the production of new technologies that help address some of the most pressing challenges our society faces. The EU produces more than one PCT patent in health-related technologies for every EUR 2 billion GDP and almost one PCT patent in climate-change mitigation for every EUR 10 billion GDP. However, the EU still lags far behind the United States in producing health-related patents, and it lags behind Japan in producing both health-related and climate-change mitigation patents (Figure 28).

This relative European lag in the production of new technologies to improve the quality of life of citizens[55] can also have important economic implications, as these technologies can rapidly become new areas of future economic growth. This is especially true in a context of an ageing and a more environmentally aware population.

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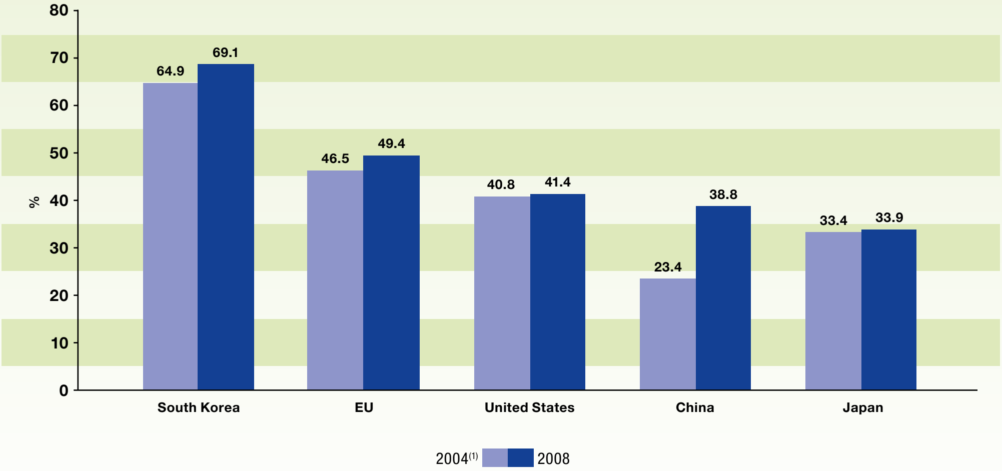
[54] For a more comprehensive analysis of the role of research and technology in addressing societal challenges, see Part III, chapter 5.

[55] This finding can be interrelated to the decline of European citizens' confidence in science and technology which will improve their quality of life (see section 'New Perspectives', chapter 3).

## FIGURE 27 Knowledge-intensive services (KIS) exports as % of total services exports, 2004(1) and 2008



*Source:* DG Research and Innovation

*Data:* European Innovation Scoreboard 2010

*Notes:* (1) US, KR: 2006.

(2) EU includes intra-EU exports.

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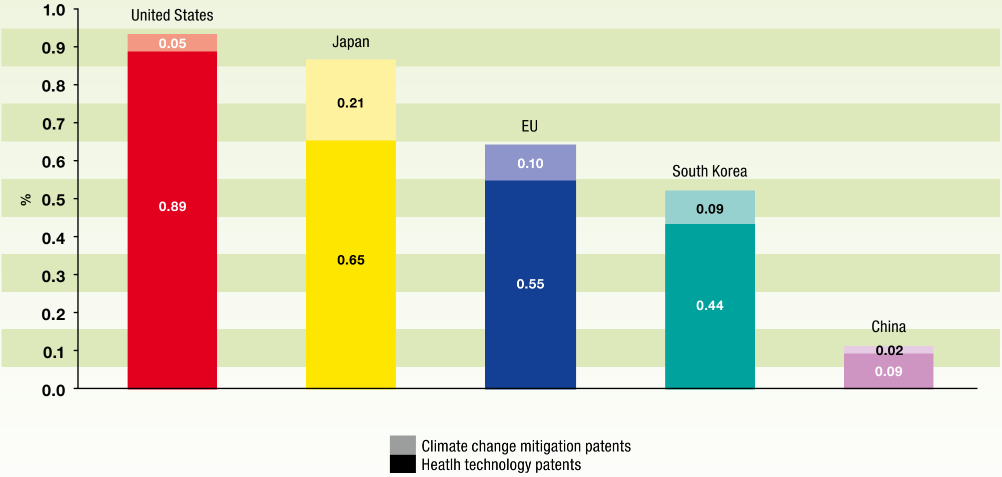
## FIGURE 28 PCT patent applications in societal challenges per billion GDP (PPS€), 2007



*Source:* DG Research and Innovation

*Data:* Eurostat, OECD

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# Table of contents

# ANALYSIS

## Part I: Investment and performance in R&D - Investing for the future

This is the first part of the more analytical section of the IUC report. It reviews a large range of indicators and data on investment and performance in Research and Innovation in Europe. From the perspective of progress towards a higher knowledge capacity in Europe, findings are presented on progress towards the EU and national R&D targets in the context of the Europe 2020 strategy, on the effect of the economic crisis on R&D investment using the most recent data, on public investment in research as well as education, on the dynamics of human resources for R&D, and on business-sector investment in R&I. In contrast with this public and private input, the section ends with evidence concerning scientific and technological output in Europe, including reflections on the efficiency of the relationship between investment and output performance.

# CHAPTER 1

# Progress towards the EU and national R&D intensity targets

## HIGHLIGHTS

Over the last ten years, the European Union has only slightly progressed towards the objective of investing 3 % of GDP in research and development, which contrasts with the remarkable R&D intensity growth in the major Asian research-intensive countries. In real terms, total R&D investment in the EU has increased by 50 % between 1995 and 2008, but this is a much lower growth rate than that in other parts of the world: 75 % in developed Asian economies (Japan, South Korea, Singapore, Taiwan), 855 % in China, 145 % in BRIS countries (Brazil, Russia, India, South-Africa) and almost 100 % in the rest of the world. As a result, the EU share of world R&D expenditures has shrunk from 29 % in 1995 to about 24 % in 2008.

There has been progress in R&D intensity in 24 Member States, and in a majority of Member States, R&D intensity grew at a faster pace in 2006–2009 than in 2000–2006. Despite this progress, in 2009 most Member States remained far from the national 2010 targets they set for themselves in 2005. The overall EU aggregate R&D intensity is largely determined by the four largest member states.

Investment in research and development is highly concentrated in some parts of the European Union. Half of the total EU–27 R&D expenditure is located in approximately 60 NUTS 2 regions, i.e. one fifth of the regions in the EU. Conversely, half of all the regions contribute to only 6 % of the total EU R&D expenditure. The regional concentration of R&D expenditures is larger than that of GDP in the EU.

The EU 3 % target and further national targets have mobilised increasing resources for R&D. The national 2020 R&D targets set up by member states in 2010 are ambitious but achievable and would bring the EU R&D intensity to 2.7–2.8 % of GDP in 2020, close to 3 % in 2020.

In the 2002 Lisbon Strategy, the EU set the objective of devoting 3 % of its GDP to R&D activities by 2010. In 2005, with the re-launch of the Lisbon Strategy, Member States set their own national R&D intensity targets to be met in 2010. In the Europe 2020 Strategy adopted in 2010, the EU maintained the 3 % objective for 2020 and in the following months, Member States adopted their 2020 national R&D intensity targets.

This chapter analyses the progress made by the EU and individual Member States towards their respective R&D objectives. It, therefore, focuses on the evolution of total R&D expenditure in countries.

## 1.1. Has the EU made progress since the year 2000 to meet the R&D intensity target?

***Overall research investment in the EU has increased in recent years, although at a lower growth rate than in other parts of the world***

Between 1995 and 2008 the world's gross domestic expenditure on R&D (GERD) almost doubled in real terms (Figure I.1.1). Over this period real GERD increased by about 50 % in the EU, 60 % in the United States, 75 % in developed Asian economies, 855 % in China, 145 % in BRIS countries (Brazil, Russia, India, South-Africa) and almost 100 % in the rest of the world. As a result, less than 24 % of R&D expenditure in the world was located in the EU in 2008, compared to almost 29 % in 1995. The share of the United States and Japan also decreased substantially from almost 38 % to 33 % in the United States and from 16 % to 13 % in Japan. Moreover, this global trend has been accelerating since 2004, which marked the beginning of a steeper increase in R&D expenditure in China and developed Asian economies.

This evolution is expected since rapid economic growth in China and a number of other countries in the world allows for rapid increases in R&D expenditures in these countries. Also, high growth rates are more easily reached when the initial level is relatively low. In that context, the share of the EU and other advanced economies is bound to shrink and the figure below quantifies this shrinkage. This re-balancing in knowledge production has important consequences for the EU in terms of international scientific and technological cooperation and knowledge flows in the world.

## *Research intensity in the EU has increased only marginally since 2000, which contrasts with the remarkable growth in the major Asian research-intensive countries*

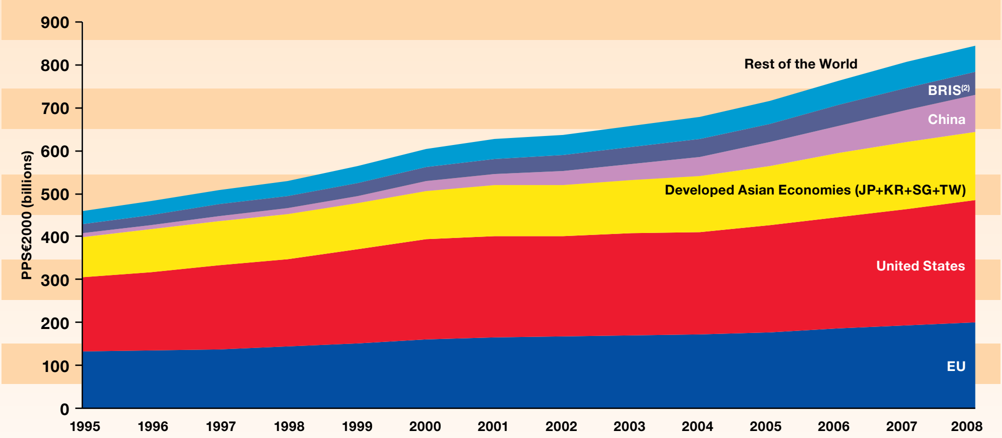
Despite a 25 % real-terms increase in research expenditure over the period 2000–2008, R&D intensity in the EU has stagnated at around 1.85 % of GDP between 2000 and 2007 with a slight increase in 2008 and 2009 to 2.01 % of GDP (Figure I.1.2). This late increase in R&D intensity is, however, due to a more rapid decrease in GDP than in R&D expenditure.

In the United States, after a continuous decline during the first half of the decade, R&D intensity started to increase from 2005 to 2.77 % of GDP in 2008, slightly above its 2000 value (2.69 % of GDP). This quasi-stagnation of R&D intensity in the EU and the United States contrasts with the strong increases observed in Japan, South Korea and China during this period, up to 3.44 %, 3.37 % and 1.54 % of GDP respectively. Part of the very high R&D intensity growth observed in China is due to its low initial position. It is to be noted that this increase slowed down in 2007–2008 in Japan.

Of the largest contributors to R&D expenditure in the EU, France and the United Kingdom have followed a similar path to the EU average, while Germany is closer to the US level.

FIGURE I.1.1

**Evolution of World GERD in real terms (PPS€ at 2000 prices and exchange rates), 1995-2008**



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, UNESCO
*Notes:* (1) Elements of estimation were involved in the compilation of the data.
(2) BR+RU+IN+ZA.

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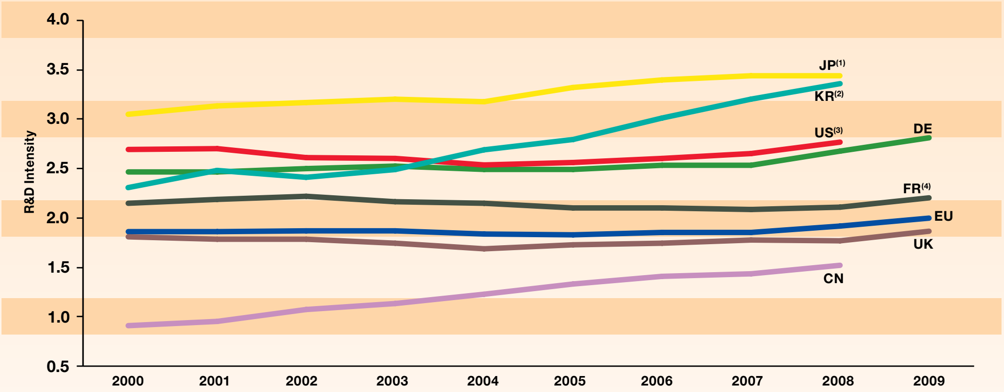
FIGURE I.1.2 **Evolution of R&D Intensity, 2000-2009**



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*Source:* DG Research and Innovation
*Data:* Eurostat, OECD
*Notes:* (1) JP: There is a break in series between 2008 and the previous years.
(2) KR: (i) GERD for 2000-2006 (inclusive) does not include R&D in the social sciences and humanities.
(ii) There is a break in series between 2007 and the previous years.
(3) US: GERD does not include most or all capital expenditure.
(4) FR: There is a break in series between 2004 and the previous years.

### *R&D intensity progressed in 24 Member States over the period 2000–2009[56]*

The pace of progress in R&D intensity has been very different across Member States (Figure I.1.4):

- Two Member States (Estonia and Portugal, representing about 1.5 % of EU-27 GDP[57]) have increased their R&D intensities by more than **100 %**.
- Three Member States (Cyprus, Ireland and Spain, representing about 10.4 % of EU-27 GDP[58]) have had R&D intensity increases of between **50 % and 100 %**. Of the Associated Countries, Turkey has experienced a comparable increase in R&D intensity.
- Ten Member States (Hungary, Austria, Lithuania, Denmark, Slovenia, Romania, Czech Republic, Italy, Finland and Germany, representing about 42.4 % of EU-27 GDP[59]) have had R&D intensity increases of between **15 % and 50 %**. Of the Associated Countries, Switzerland has experienced a comparable increase in R&D intensity.
- Nine Member States (Malta, Bulgaria, Latvia, Luxembourg, the United Kingdom, the Netherlands, France, Sweden and Poland representing about 40.2 % of EU-27 GDP[60]) have increased their R&D intensity by **less than 15 %**. Of the Associated Countries, Norway has experienced a comparable increase in R&D intensity.

In contrast, three Member States (Greece, Belgium and Slovakia, representing about 5.4 % of EU-27 GDP[61]) have seen their R&D intensity remain at the same level or decrease over the period 2000–2009. With the exception of Belgium, these are Member States with low R&D intensity, which, therefore, have fallen further behind. Among the Associated Countries, R&D intensity also decreased in Israel and Croatia.

The GDP fall of 2009 is responsible for part of the progress in R&D intensity in all countries. However, a good part of this progress is still due to an increase in R&D expenditure, in particular in countries of the first three groups with the highest R&D intensity growth (over 15 %). A particular focus on the evolution of R&D expenditure in 2009 during the economic crisis is to be found in Chapter 2 of this Part.

### *In a majority of Member States, R&D intensity grew at a faster pace in 2006–2009 than in 2000–2006[62]*

In 2005, the Lisbon Strategy was re-launched and Member States set national R&D intensity targets to be reached in 2010.

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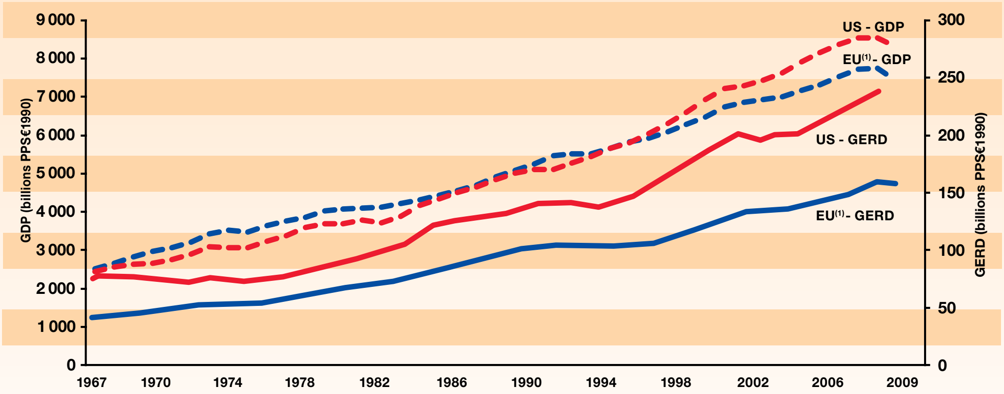
[56] For data availability reasons, the actual period covered differs across countries, see footnote to Figure I.1.4.
[57] In 2009
[58] In 2009
[59] In 2009
[60] In 2009
[61] In 2009
[62] For data availability reasons, the actual periods covered differ across countries, see footnote to Table I.1.1.

## Box I.1.1 – A persistent, historical R&D intensity gap

The R&D intensity gap between the EU and the US has always existed since measurement started (Figure I.1.3). It, therefore, reflects a deep structural difference between both countries that is relatively robust throughout time.

FIGURE I.1.3 **EU[(1)] and the United States - Evolution (in real terms[(2)]) of GDP and Gross Domestic Expenditure on R&D (GERD), 1967-2009**



*Source:* DG Research and Innovation
*Data:* Eurostat, DG ECFIN,OECD
*Notes:* (1) EU: BE, DK, DE, ES, FR, IE, IT, NL, AT, PT, FI, SE, UK.
(2) PPS€ at constant 1990 prices and exchange rates.

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In a majority of Member States, progress in R&D intensity occurred at a faster pace (on an annual average) in the period 2006–2009 than in the period 2000–2006 (highlighted in green in Table I.1.1 below). This observation is also valid when comparing 2006–2008 to 2000–2006 to exclude the effect due to the fall in GDP in 2009.

However, several Member States (Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Austria and Romania) that experienced a rapid increase in R&D intensity over 2000–2006 saw their pace of progress slow down or even reverse after 2006.

### *In real terms, R&D expenditure grew in all Member States between 2000 and 2009[63]*

In real terms, R&D expenditure grew in all 27 Member States, candidate countries and Associated Countries over the period 2000–2009 (Figure I.1.5). In some cases the growth has been considerable: real growth of R&D expenditure over the period 2000–2009 exceeded 100% in Estonia (236% over 2000–2009), Cyprus, Portugal, Lithuania and Ireland; it exceeded 60% in Romania, Spain, Czech Republic and Austria. On average for the EU, the total real growth of R&D expenditure between 2000 and 2009 reached 25%.

### *Despite clear progress in real R&D expenditure and R&D intensity, in 2008 most Member States remained far from their national 2010 targets*

Figure I.1.6 shows the difference between R&D intensity for the latest available year[64] and R&D intensity in 2000 for each Member State in blue. For instance, R&D intensity in Portugal was 0.93 percentage points higher in 2009 (at 1.66% of GDP, shown in brackets on the graph) than in 2000 (at 0.73%).

The blue bars show for each Member State the distance separating its latest[65] R&D intensity value and its R&D intensity target for 2010. Portugal's R&D intensity target for 2010 of 1.8% of GDP is 0.14 percentage points higher than its 2009 R&D intensity of 1.66%. In other words, in the period 2000–2009, Portugal has made about 87% of its way towards its 2010 target.

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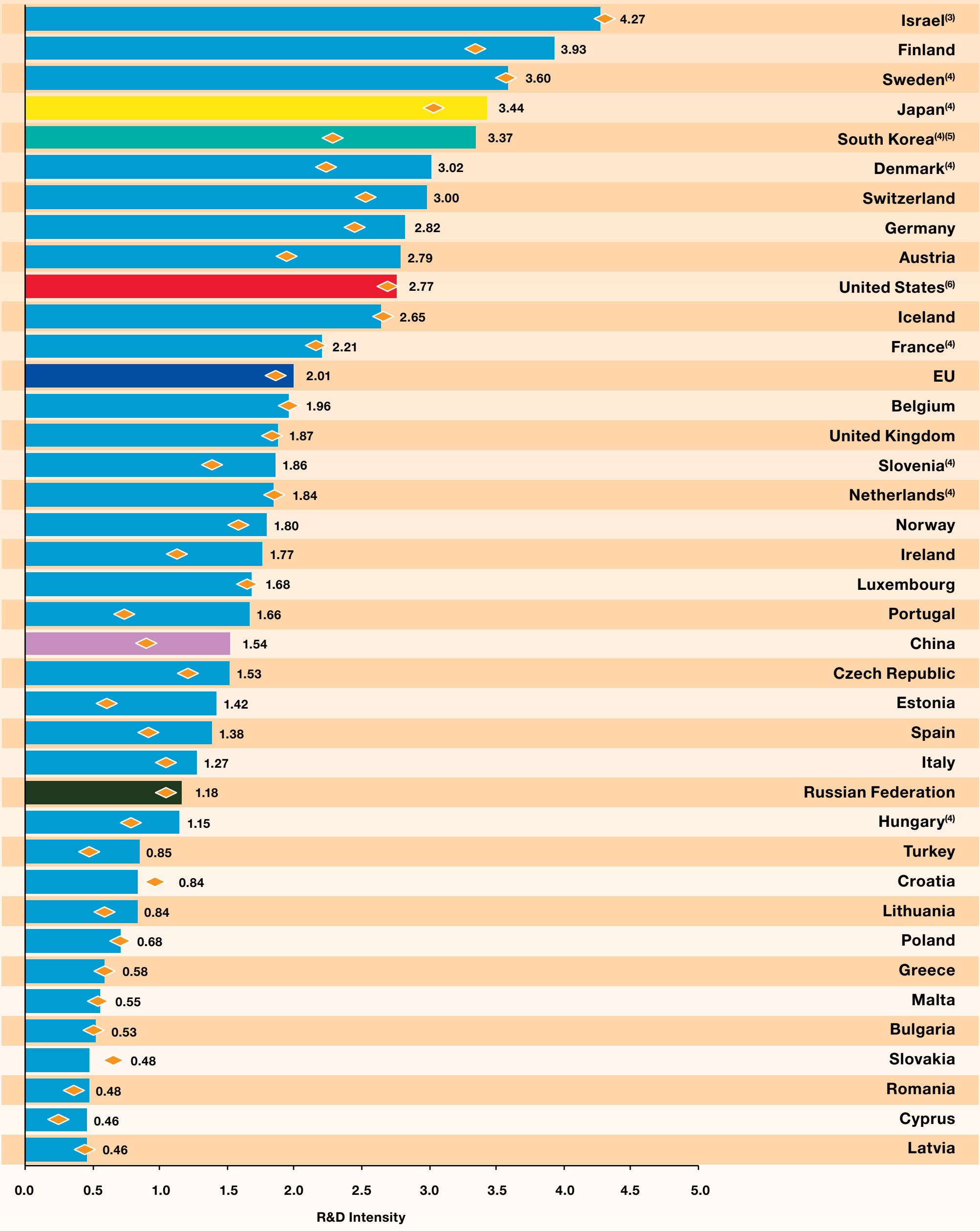
[63] For data availability reasons, the actual period covered differs across countries, see footnote to Figure I.1.5.

[64] 2009 or 2010 according to the latest data available for each country, see footnote to Figure I.1.6 (2007 for Greece).

[65] Idem previous footnote.

## FIGURE I.1.4 R&D Intensity 2000(1) and 2009(2)



*Source:* DG Research and Innovation

*Data:* Eurostat, OECD

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*Notes:* (1) SE: 1999; EL, NO: 2001; HR: 2002; MT: 2004.
(2) EL: 2007; IS, CH, US, JP, CN, KR: 2008; AT, FI: 2010.
(3) IL: GERD does not include defence.
(4) DK, FR, HU, NL, SI; SE, JP, KR: Breaks in series occur between 2000 and 2009.
(5) KR: GERD for 2000-2006 (inclusive) does not include R&D in the social sciences and humanities.
(6) US: GERD does not include most or all capital expenditure.

TABLE I.1.1

### R&D Intensity - Average annual growth (%), 2000-2006(1) and 2006-2009(2) (A green background indicates a higher rate of growth in 2006-2009(2) than in 2000-2006(1))

| | Average annual growth (%) | |
|---|---|---|
| | 2000-2006(1) | 2006-2009(2) |
| Belgium | -0.91 | *1.74* |
| Bulgaria | -1.73 | *4.80* |
| Czech Republic | 4.20 | -0.48 |
| Denmark | 1.68 | *8.84* |
| Germany | 0.48 | *3.76* |
| Estonia | 11.05 | *8.08* |
| Ireland | 1.85 | *12.20* |
| Greece | *0.03* | *-0.17* |
| Spain | 4.77 | 4.85 |
| France | -1.21 | *1.69* |
| Italy | 1.34 | *3.80* |
| Cyprus | 9.75 | *2.65* |
| Latvia | 7.97 | -13.19 |
| Lithuania | 5.08 | 1.70 |
| Luxembourg | 0.07 | *0.37* |
| Hungary | 7.25 | 4.62 |
| Malta | 6.95 | -3.20 |
| Netherlands | -0.60 | *-0.72* |
| Austria | *4.02* | *3.22* |
| Poland | -2.43 | 6.69 |
| Portugal | *5.22* | *18.81* |
| Romania | 3.68 | 1.83 |
| Slovenia | 1.95 | 12.25 |
| Slovakia | -4.68 | -0.37 |
| Finland | 0.64 | *3.12* |
| Sweden | *-4.70* | *-0.76* |
| United Kingdom | -0.63 | *2.34* |
| EU | -0.10 | *2.78* |

*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) SE: 2001-2004; EL: 2001-2006; NL: 2003-2006; FR, HU, MT: 2004-2006.
(2) EL: 2006-2007; AT, FI: 2006-2010; DK: 2007-2009; SI: 2008-2009.
(3) Values in italics are estimated or provisional or forecasts.

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The distance between the right end of the blue bar and the y-axis, measures the distance in percentage points of GDP from the initial value of R&D intensity in 2000 to the 2010 target fixed by the Member State. For some countries, this distance between the initial position and the target was greater (even two or three times greater in some cases) than the initial position, which made the target very difficult to reach.

Denmark and Ireland have reached their 2010 targets. Portugal, Austria, Finland and Germany have achieved substantial progress towards their respective targets. Estonia and Spain have made good progress as well but remain far from their targets. In 15 other Member States, progress made is only a fraction of what was required to meet their respective targets[66]. In three Member States, R&D intensity was higher in 2000 than in 2009 (negative grey bars). These Member States are, therefore, further away from their national R&D intensity targets in 2009 than in 2000.

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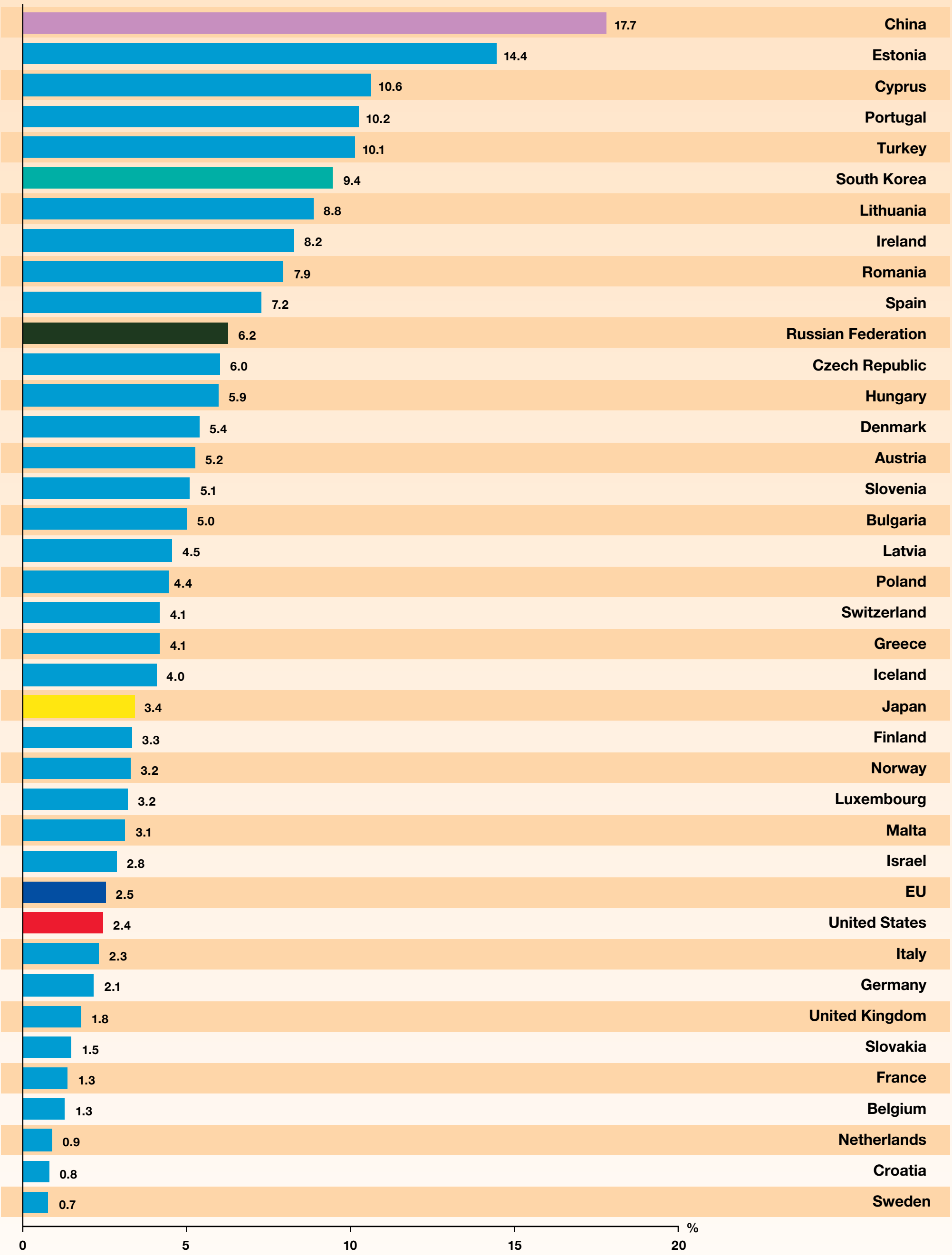
[66] Bulgaria had no target for 2010.

FIGURE I.1.5

## Gross Domestic Expenditure on R&D (GERD) - Average annual real growth (%), 2000-2009(1)



*Source:* DG Research and Innovation

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*Data:* Eurostat, OECD

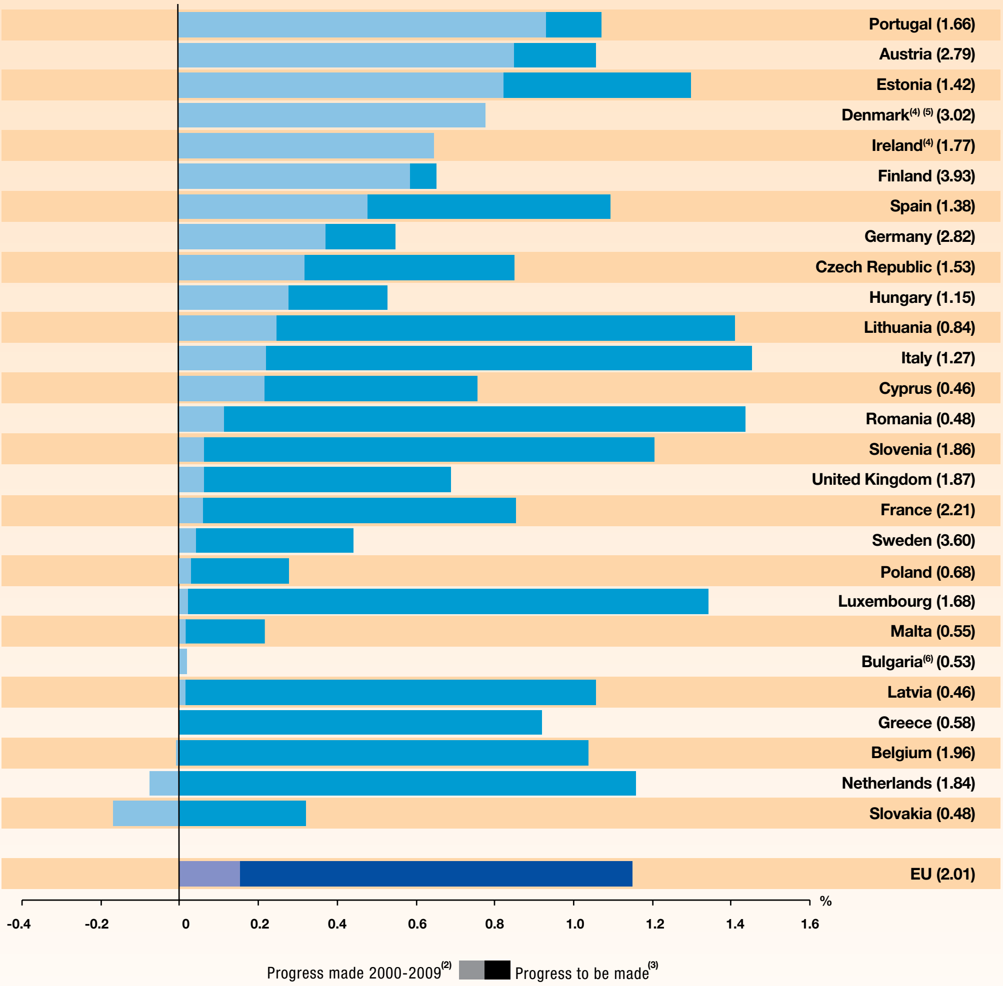
*Notes:* (1) KR: 2000-2006; SI, JP: 2000-2007; IS, CH, US, JP, CN: 2000-2008; AT, FI: 2000-2010; EL: 2001-2007; NO: 2001-2009; HR: 2002-2009; NL: 2003-2009; FR, HU, MT: 2004-2009; SE: 2005-2009; DK: 2007-2009.

(2) KR: R&D in the social sciences and humanities is not included.

(3) IL: Defence is not included.

(4) US: Most or all capital expenditure is not included.

## FIGURE I.1.6 R&D Intensity - Progress towards the 2010 targets (in percentage points); in brackets: R&D Intensity, 2009[(1)]



*Source:* DG Research and Innovation

*Data:* Eurostat, Member States

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*Notes:* (1) EL: 2007; AT, FI: 2010.
(2) SI: 2000-2007; AT, FI: 2000-2010; EL: 2001-2007; NL: 2003-2009; FR, HU, MT: 2004-2009; SE: 2005-2009.
(3) EL : 2007-2015; FI: 2010-2011; FR: 2009-2012; UK: 2009-2014.
(4) DK, IE: The R&D Intensity targets for 2010 were achieved in 2009.
(5) DK: There is a break in series between 2007 and the previous years.
(6) BG has not set an R&D intensity target.

## Box I.1.2 – Austria: R&D intensity increased by 44 % between 2000 and 2009, advancing towards the national R&D target

Austria, together with Portugal, is the Member State that has achieved the most substantial progress towards its R&D intensity target of 3 % of GDP by 2010.

### Sources of funds responsible for the R&D intensity growth

In terms of financing, 47 % of the increase in R&D intensity in Austria is due to the business sector, 48 % to the government sector and 5 % to investors from abroad. A very large part of business R&D in Austria is financed by business abroad (0.42 % of GDP, i.e. 15 % of total R&D investment).

TABLE I.1.2 **Austria: R&D Intensities for the four sources of funds**

| Source of funds | 2000 | 2010 |
|---|---|---|
| Business enterprise | *0.81* | *1.21* |
| Government | *0.74* | *1.15* |
| Other national sources | *0.01* | *0.01* |
| Abroad | *0.39* | *0.42* |
| Total | *1.94* | *2.79* |

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*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) Values in italics are estimated or provisional or forecasts.

### Economic sectors responsible for business R&D growth

Four economic sectors account for almost 50 % of total BERD in Austria over the period 2001–2006:

- Radio, TV and communication equipment (22 %)
- Machinery and equipment (11 %)
- R&D services (10 %)
- Motor vehicles (9 %)

Seven additional economic sectors account for more than 30 % of total Business Expenditure on R&D (BERD) in Austria. These eleven main economic sectors performing R&D in Austria have seen their **R&D intensity grow between 1998 and 2006**, with the exception of ‘Chemicals less Pharmaceuticals’ which very slightly diminished. In addition, these sectors all **grew in terms of their share in total value added** in Austria, except ‘Radio, TV and communication equipment’, which hardly diminished, and ‘Wholesale and Retail trade’. The increase in business R&D intensity in Austria is, therefore, due both to increased research intensity in the R&D performing sectors in Austria and to a gain in weight of these sectors in the economy. ‘R&D services’, ‘computer services’ and ‘machinery and equipment’ are the three sectors which made the largest contributions to the increase of business R&D.

### Research policy

Since the mid-1990s, Austria has considerably increased public funding for R&D. R&D has become and remained a policy priority supported by all political parties in Austria. During the last decade, the Austrian research and innovation system has gone through a catching-up phase and many recurring weaknesses have been overcome, e.g. mobilisation of resources for R&D, science–industry cooperation, international R&D collaboration, institutional funding and governance. In December 2007, the Federal Budget Act (‘*Bundeshaushaltsgesetz*’) was changed fundamentally, providing the basis for long-term planning in any field of government spending including R&D. The federal government has also launched a number of initiatives in the field of research and technology which have received additional funding (*Sondermittel*) on top of the regular budget. The R&D funding agencies have undergone structural reforms which provided an institutional basis for the efficient implementation of funding measures in the context of increased public funding.

Indirect research funding through R&D tax incentives has been largely expanded; in 2007, indirect research support represented almost half of total government support to business R&D (see Figure I.3.4).

The governance of Austrian universities has undergone a drastic change following the University Act of 2002. Universities have been given both a new organisational structure and full decision-making power and responsibility. Performance contracts between each university and the Ministry of Science and Research were signed in 2007 in order to define the services that are to be provided by each university. These include: teaching, research, mobility of researchers and students, cooperation, strategy, specialisation etc. Institutional funding is provided through three-year global budgets: 80% is allocated as a basic budget and 20% depends on the achievement of performance indicators ('formula-based budget'). Of particular importance in this context, evaluations of research and teaching have become compulsory, and intellectual capital reports will be used as the main tool for monitoring each university's performance and the achievement of their goals.

The strong commitment by the government which resulted in increased public funding also stimulated private R&D investment. A large number of measures are aimed at stimulating private R&D spending. The more recent ones are: JITU[67] (a programme promoting the creation and development of innovative and technology-oriented companies), ProTRANS (supporting SMEs to better use their innovation potential) or '*Innovationsscheck*' (supporting SMEs to establish research and innovation activities). Over the past 15 years external evaluations which analyse the impact of different funding measures have become an integral part of Austrian R&I policies, and action is taken accordingly. In addition to the continuous efforts of the federal government, the *Provinces* have contributed with their own activities in R&I.

The Austrian National Reform Programme 2008–2010 has emphasised strengthening and fostering knowledge and innovation. R&D policy is seen as crucial to safeguarding the location of businesses and jobs and a comprehensive policy is in place. The country will be positioned as a dynamic partner and an attractive business location within the European Research Area.

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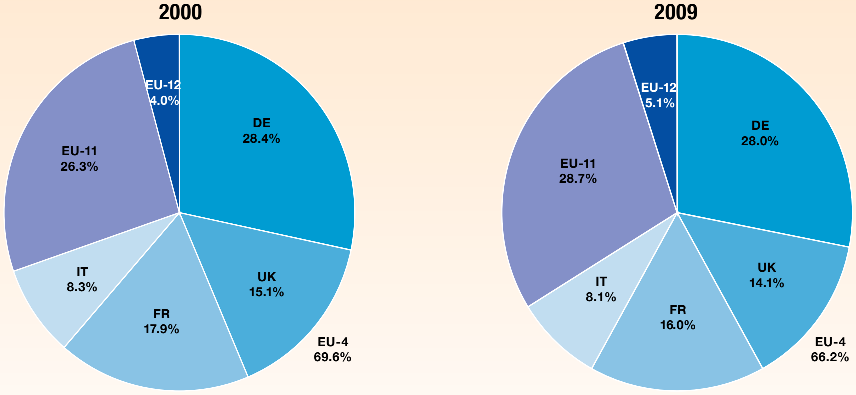
[67] *Junge Innovative Technolgieorientierte Unternehmen.*

FIGURE I.1.7 **Distribution of GERD(1) within the EU, 2000 and 2009**



*Source:* DG Research and Innovation

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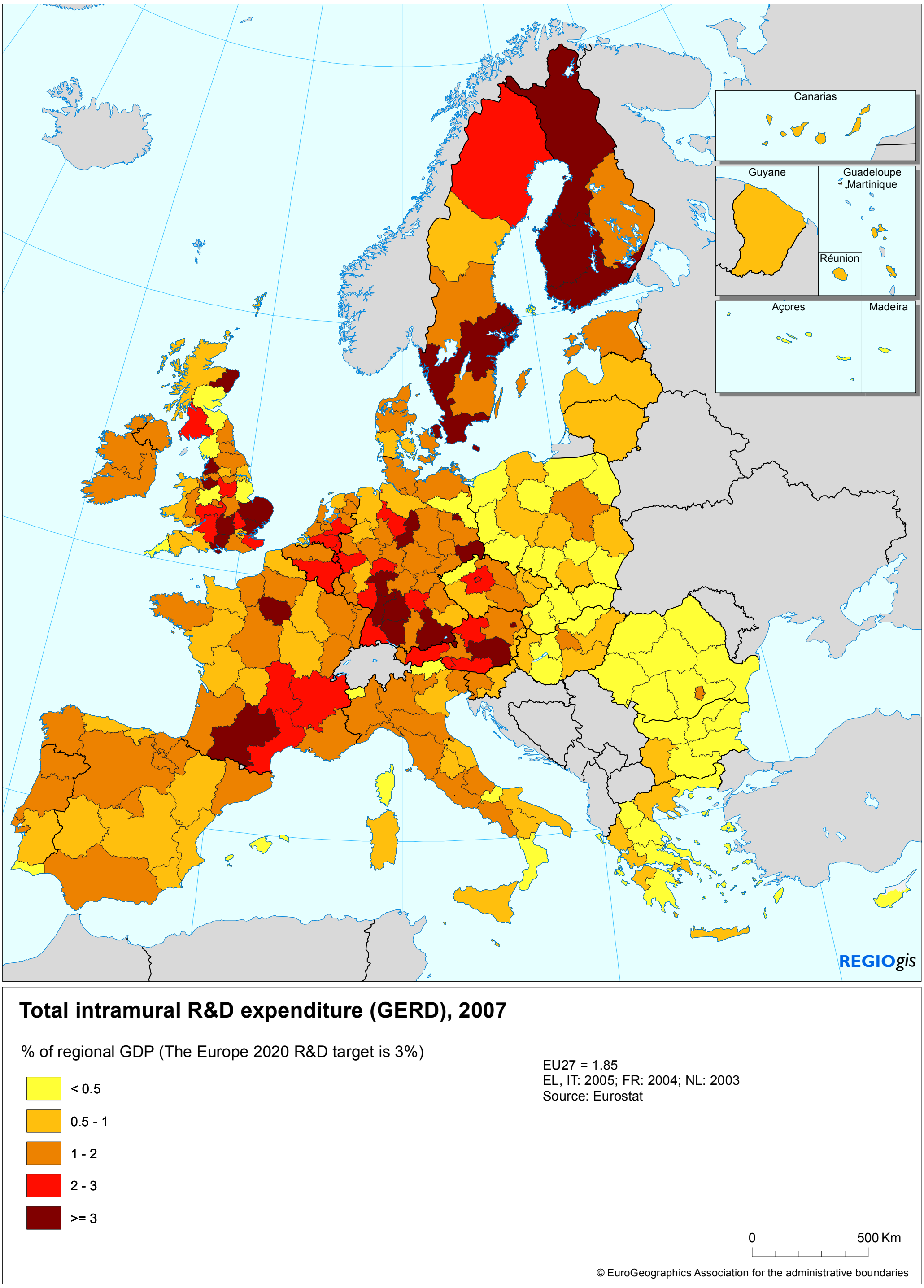
*Data:* Eurostat

*Notes:* (1) GERD in the EU increased by 25% in real terms between 2000 and 2009 (from 160 billion PPS€2000 in 2000 to 201 billion PPS€2000 in 2009).
(2) EU-4: DE, FR, IT, UK.
(3) EU-11: BE, DK, IE, EL, ES, LU, NL, AT, PT, FI, SE.
(4) EU-12: The twelve new Member States (BG, CZ, EE, CY, LV, LT, HU, MT, PL, RO, SI, SK).

## FIGURE I.1.8 Gross Domestic Expenditure on R&D (GERD) as % of regional GDP, 2007



EU27 = 1.85
EL, IT: 2005; FR: 2004; NL: 2003
Source: Eurostat

© EuroGeographics Association for the administrative boundaries

### *Two thirds of R&D expenditure in EU-27 is performed in the four largest Member States*

Expenditure on R&D is very much concentrated in a few countries of the EU: two thirds (in Purchasing Power Parity or PPP) is performed in four countries: Germany, France, the United Kingdom and Italy (Figure I.1.7). The 11 other Member States of EU-15 combined represented 29 % of EU-27 expenditure on R&D in PPP in 2009 — barely more than Germany alone. With 5.3 % of EU-27 expenditure on R&D in PPP in 2009, EU-12 weights five times less than Germany. However, the share of the four large Member States slightly decreased between 2000 and 2009.

GDP is less concentrated than R&D expenditures but the four largest Member States still account for more than half of the EU-27 GDP (not shown). As a consequence, the overall EU-27 R&D intensity is very much determined by its value in these four countries.

### *R&D expenditure is more concentrated in fewer regions of Europe than GDP*

The realisation of the full research potential of the enlarged ERA necessarily comes through unlocking and developing the research potential in the EU´s 'Convergence objective regions' and outermost regions, and strengthening the capacities of their researchers to successfully participate in research activities at EU and international level.

So far R&D expenditure is very much concentrated in a few regions in the EU (Figure I.1.8). Out of the 268 EU NUTS 2 regions, only about 35 (i.e. about 13 %) had an R&D intensity above 2 % of GDP in 2007[68]. These regions form an 'S'-shape, located in three of the Nordic countries, in France, and in a central band from Austria to the South East of the United Kingdom, through southern Germany, the Netherlands and Belgium. The R&D intensity in eastern and southern regions of the EU is low — often below 1 % or 0.5 % of GDP.

In absolute terms, half of the total EU-27 R&D expenditure is located in about 60 NUTS 2 regions in the EU, i.e. one fifth of the regions. Conversely, half of all the regions contribute to only 6 % of the total EU-27 R&D expenditure. The concentration of R&D expenditures is larger than that of GDP in the EU, indicating that disparities in the research systems are larger than disparities in the economic system. Within the research system, disparities are more pronounced in the business sector than in the public sector.

However, a slight de-concentration of R&D expenditure was observed between 2000 and 2005, as many of the very low R&D intensive regions, in particular in Central and Eastern Europe, have had a higher growth rate of R&D expenditures than the more R&D intensive regions over that period.

## 1.2. Which targets have been set for 2020 at EU level and at national level?

### *The EU 3 % target responds to the EU funding gap in R&D*

Between 2000 and 2008, R&D intensity increased by more than 70 % in China. It also increased considerably in Korea and Japan[69]. In view of this massive increase in R&D resources in Asia and the persisting gap between itself and the United States, the European Union cannot give up its objective of substantially increasing resources devoted to R&D to comparable levels.

The table I.1.3 also shows that in the United States and the three Asian countries, private sector R&D represents about three quarters to four fifths of total R&D in terms of expenditure, while in the EU it is slightly less than two thirds. In the three Asian countries, the main motor of the rapid growth in R&D intensity has been the private sector, although public sector R&D intensity also substantially increased in South Korea and to a lesser extent in China.

This smaller private-sector share in total R&D in the EU is even more striking in terms of researchers, since the private sector hosts less than half of the researchers in the EU, i.e. substantially less than its two-thirds share in R&D expenditure. In the United States and the three Asian countries, the share of researchers in the private sector is more aligned with the share of the private sector in total R&D expenditure.

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[68] There are in fact 271 NUTS2 regions, but for analytical purposes, Inner and Outer London as well as the region of Brussels capital, provins of Vlaams-Brabant and provins of Brabant Wallon have been merged.

[69] However, due to a break in series between 2000 and 2008 in Korea and Japan, it is not possible to calculate a growth rate between these two years in these countries.

## TABLE I.1.3 Private sector(1) and public sector(2) R&D Intensities and private sector share of total researchers (FTE)

| | EU | | | US(3) | | |
|---|---|---|---|---|---|---|
| | 2000 | 2009 | % change | 2000 | 2009 | % change |
| R&D Intensity - private sector | 1.22 | 1.27 | 3.5 | 2.11 | 2.12 | 0.6 |
| R&D Intensity - public sector | 0.64 | 0.74 | 16.5 | 0.59 | 0.65 | 10.8 |
| R&D Intensity - total | 1.86 | 2.01 | 7.9 | 2.69 | 2.77 | 2.9 |
| R&D Intensity - private sector as % of total | 65.8 | 63.1 | -4.1 | 78.2 | 76.5 | -2.1 |
| Researchers (FTE) - private sector as % of total | 48.0 | 47.0 | -2.0 | 80.5 | 80.0(6) | -0.6(7) |

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD
*Notes:* (1) Private sector: Business enterprise and private non-profit sectors.
(2) Public sector: Government and higher education sectors.
(3) US: R&D Intensity does not include most or all capital expenditure on R&D.
(4) JP: There is a break in series between 2008 and 2000 for public sector R&D Intensity and researchers (FTE).
(5) KR: There is a break in series between 2008 and 2000 for R&D Intensity and researchers (FTE).
(6) 2007.
(7) 2000-2007.

### *The national 2020 R&D targets set up by Member States are ambitious but achievable and would bring the EU R&D intensity close to, but below, 3 % in 2020*

In 2009, the EU R&D intensity gap to the 3 % target is 1 % GDP, i.e. about EUR 118 billion, half the total amount of EU R&D expenditures (EUR 236 billion).

In 2010, the EU decided to maintain the 3 % objective for 2020. If the 2000–2009 trend continued another decade, the EU's R&D intensity would reach 2.2 % of GDP by 2020 (Figure I.1.9). In other words, based on the last decade's trend, the EU as a whole would fall short of the 3 % target by 0.8 percentage points (i.e. 27 % of the target). With respect to 2009 EU's GDP, this represents EUR 94 billion. Under the hypothesis that the EU's GDP will grow on average by 2 % annually, if the 2000–2009 R&D intensity trend continues, the gap to the 3 % will amount to about EUR 117 billion, as in 2009.

Member States set their own national 2020 targets (Table I.1.4 below). If Member States were to reach these national 2020 targets, the overall EU R&D intensity would be between 2.7 and 2.8 % of GDP in 2020. In other words, based on present national R&D targets, the EU as a whole would fall short of the 3 % target by 0.2 to 0.3 percentage points (i.e. 7–10 % of the target). With respect to the EU's 2009 GDP, this represents EUR 24–35 billion. Under the hypothesis that the EU's GDP will grow on average by 2 % annually until 2020, the gap to all Member States reaching their target of 3 % will amount to EUR 29–44 billion.

The 2020 targets set by Member States for themselves are both realistic and ambitious. The targets are realistic because for each Member State the chosen target is compatible with the range of 2020 values obtained with two complementary projection methods based on (1) the current sectoral composition of the country's economy and (2) the potential growth of R&D intensity based on the country's 2006–2008 R&D intensity trend or that of comparable countries. The targets are ambitious because the hypotheses underlying each projection method are ambitious.

The first method estimates potential future intensity of Business Expenditure on R&D (BERD) in a country, by assuming that in each sector R&D intensity will, in the next 10 years, approach the corresponding sectoral intensity in 2006 of the best five EU performers in that sector. These five best sectoral intensities are then applied to the present sectoral composition of the country to compute its overall BERD intensity[70]. According to this model and with the additional hypothesis that all the Member States will have achieved by 2020 the Lisbon target on the public R&D component set by themselves in 2005 for 2010, the expected EU intensity may reach 2.79 % in 2020.

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[70] Note, however, that within a given sector an increase in intensity is likely to result both from favourable changes in composition of its sub-sectors and from increased R&D intensity of each sub-sector moving closer to the technological frontier.

| Japan[4] | | | South Korea[5] | | | China | | |
|---|---|---|---|---|---|---|---|---|
| 2000 | 2008 | % change | 2000 | 2008 | % change | 2000 | 2008 | % change |
| 2.30 | 2.75 | 19.7 | 1.73 | 2.59 | :[5] | 0.54 | 1.12 | 107.8 |
| 0.74 | 0.69 | :[4] | 0.56 | 0.78 | :[5] | 0.36 | 0.41 | 13.6 |
| 3.04 | 3.44 | :[4] | 2.30 | 3.37 | :[5] | 0.90 | 1.54 | 70.1 |
| 75.6 | 80.0 | 5.9 | 75.4 | 76.8 | :[5] | 60.0 | 73.3 | 22.2 |
| 67.5 | 76.3 | :[4] | 67.5 | 78.7 | :[5] | 50.9 | 68.6 | 34.7 |

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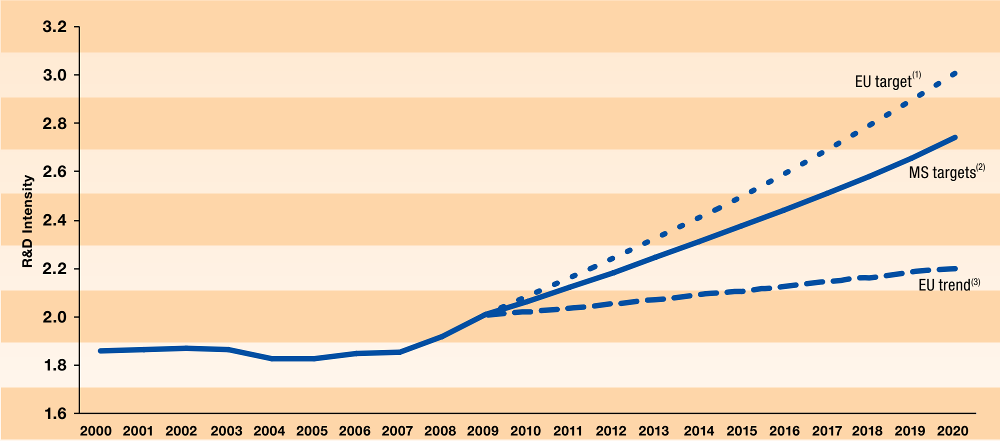
The second method estimates the value that a Member State's R&D intensity would reach in 2020 using (i) its average annual growth rate between 2006 and 2008 if the latter was high, and, if it was not, using as potential benchmarks (ii) the average annual growth rate between 2006 and 2008 of the best performing countries in Europe and its main trading partners. In other words, for those countries that have had a limited or negative growth rate in 2006–2008, this method applies the average growth rate of a basket of better-performing countries with similar initial research intensities, level of economic development and economic structures[71]. With this method, the projected value for EU R&D intensity in 2020 is 3.02 %.

FIGURE I.1.9 **EU - R&D Intensity projections**



*Source:* DG Research and Innovation

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*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The EU target projection is based on the R&D Intensity target of 3.0% for 2020.
(2) The EU target projection is based on the R&D Intensity targets of Member States.
(3) The EU trend projection is derived from the average annual growth in R&D Intensity 2000-2009.

Unsurprisingly, according to these national objectives, the greatest progression will have to be achieved by the countries whose initial level of R&D intensity is the lowest, while countries with the highest initial R&D intensity will achieve more modest progress. The average progression of the groups of countries with a current average R&D intensity of 1.1 % and 1.9 % would be to the order of 110 % and 50 % respectively, while the progression of medium-high (2.7 %) and high (3.8 %) R&D intensity groups would be around 15 % and 10 %. The target averages of the low and medium groups of countries are, therefore, very ambitious and root themselves in the need to increase international competitiveness in the knowledge-economy and to respond to global and societal challenges.

## TABLE I.1.4 R&D Intensity, 2009⁽¹⁾ and R&D Intensity target for 2020

| | Public sector(2) | Private sector(3) | Total | Target 2020 |
|---|---|---|---|---|
| Belgium | *0.62* | *1.35* | *1.96* | 2.60 - 3.00 |
| Bulgaria | *0.36* | *0.16* | *0.53* | 1.50 |
| Czech Republic | 0.60 | 0.92 | 1.53 | 2.70 |
| Denmark | *0.99* | *2.03* | *3.02* | 3.00 |
| Germany | *0.90* | *1.92* | *2.82* | 3.00 |
| Estonia | 0.76 | *0.67* | *1.42* | 3.00 |
| Ireland | *0.60* | *1.17* | *1.77* | : |
| Greece | *0.42* | *0.16* | *0.58* | 2.00 |
| Spain | 0.66 | *0.72* | 1.38 | 3.00 |
| France | *0.81* | *1.39* | *2.21* | 3.00 |
| Italy | *0.57* | *0.69* | *1.27* | 1.53 |
| Cyprus | *0.29* | *0.17* | *0.46* | 0.50 |
| Latvia | 0.29 | 0.17 | 0.46 | 1.50 |
| Lithuania | 0.64 | 0.20 | 0.84 | 1.90 |
| Luxembourg | *0.44* | *1.24* | *1.68* | 2.60 |
| Hungary(4) | 0.47 | 0.66 | 1.15 | 1.80 |
| Malta | *0.21* | *0.34* | 0.55 | 0.67 |
| Netherlands | *0.96* | *0.88* | *1.84* | : |
| Austria | *0.80* | *1.95* | *2.75* | 3.76 |
| Poland | 0.48 | 0.19 | 0.68 | 1.70 |
| Portugal | *0.71* | *0.95* | *1.66* | 2.70 - 3.30 |
| Romania | 0.29 | 0.19 | 0.48 | 2.00 |
| Slovenia | 0.66 | 1.20 | 1.86 | 3.00 |
| Slovakia | 0.28 | 0.20 | 0.48 | 0.90 - 1.10 |
| Finland | *1.14* | *2.79* | *3.93* | 4.00 |
| Sweden | *1.06* | *2.54* | *3.60* | 4.00 |
| United Kingdom | *0.67* | *1.20* | *1.87* | : |
| EU | 0.74 | 1.27 | 2.01 | 3.00 |

*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) EL: 2007; FI: 2010.
(2) Public sector: Government and higher education sectors.
(3) Private sector: Business enterprise and private non-profit sectors.
(4) HU: The sum of the public and private sectors is not equal to the total.
(5) Values in italics are estimated or provisional.

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# CHAPTER 2

# Effect of the economic crisis on R&D investment

## HIGHLIGHTS

In 2008–2009, R&D expenditure was more resilient to the financial crisis than overall economic activity. Due to a more rapid drop in GDP than in R&D expenditure, the net effect of the crisis has been an increase in EU's R&D intensity from 1.85 % of GDP in 2007 to 1.92 % in 2008 and 2.01 % in 2009.

Overall, in 2008–2009 there was good continuity in national public R&D investment trends in the EU, with sustained R&D investment in the majority of Member States. In 2009, nominal R&D budgets grew or were maintained in 17 Member States. In terms of execution, nominal R&D expenditure in the public sector grew by 1.8 % in the EU in 2009. As % of GDP, both total R&D budget and public R&D expenditure increased in the EU by 0.03 and 0.05 percentage points, up to 0.74 and 0.75 % of GDP respectively. Altogether, the data shows that governments in the EU have considered R&D as a priority in times of crisis.

However, the result of the economic crisis might be a further widening of the gap between Member States with high R&D intensities and some Member States with lower R&D intensities, the latter having more difficulty in avoiding cuts in R&D spending.

In addition, first GBAORD[72] data for 2010 indicates that R&D budgets may decrease as % of GDP in more EU countries than in 2009. In the medium term, the need for fiscal consolidation may place further pressure on the ability of some European governments to maintain their investment in R&D.

Business investment in R&D was more affected than public investment in 2009. In the EU's business sector, R&D expenditure decreased by -3.1 % in nominal terms in 2009. This relatively limited decrease, however, shows that business R&D expenditure has been relatively resilient to the economic crisis in 2009. As % of GDP, business R&D expenditure even progressed by 0.03 percentage point, up to 1.25 % of GDP, due to a sharper drop in GDP.

The relative resilience of business R&D in 2009 is confirmed by the 2010 EU Industrial R&D Investment Scoreboard (hereafter the Scoreboard) which analyses the information from the world's top 1 400 R&D investing companies' latest published accounts covering fiscal year 2009. Despite large decreases in sales and profits, nominal R&D investment by these companies decreased by only 1.9 % in 2009 — a decrease unevenly distributed across industrial sectors. A substantial decrease occurred in the Automobiles and IT hardware sectors, while the Pharmaceutical sector continued to rise and consolidate its position as top investor in R&D. The decrease in R&D investment was sharper in US companies than in EU companies, but Asian companies continue their high R&D growth. The observed increase in business R&D expenditure in a number of catching-up Member States indicates that they have probably benefited from this strategic R&D persistency in large companies.

Smaller companies investing in R&D are likely to have had much more difficulty in maintaining their level of R&D investment. A rough comparison of the R&D behaviour of large Scoreboard companies with the evolution of domestic business R&D expenditure indicates that smaller companies investing in R&D (not covered in the Scoreboard) considerably reduced their R&D investment in 2009 in a number of Member States.

Besides, the evolution of business investment in R&D after 2009 remains uncertain. Past observations show that fluctuations in business R&D growth are larger than fluctuations in GDP growth with a time lag of 1–2 years. Lessons from the past, therefore, indicate that the negative trend in business R&D started in 2009 might worsen in 2010 and in following years.

Finally, it must be noted that all official 2009 data on total R&D expenditure and on R&D expenditure in the public and business sectors shown in this chapter is still provisional data, subject to revision by mid-2011. 2009 GBAORD data is also still provisional in a number of Member States.

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[72] Government Budget Appropriations or Outlays on R&D.

Research and Innovation are widely accepted to be the centrepiece for long-term sustainable economic growth in Europe. However, despite this recognition, the strong financial and economic crisis that Europe has gone through since 2007 can deeply affect R&D investments.

In general, historical data shows that private R&D investments follow economic downturns to some extent. Liquidity pressure, difficulties in finding appropriate financing, credit constraint, falls in sales and available cash-flows, and difficulties facing shorter-term payments are just some of the factors which can lead some private firms to decrease their investments in R&D. Moreover, the large public budget deficits that several European governments have run in recent years as a consequence of the stimulus packages and the lower tax revenues, have called for a need for fiscal consolidation in order to regain macroeconomic stability.

As a result, the economic crisis exposes many risks that can lead to a general drop in both public and private R&D investments in Europe, potentially jeopardising Europe's future economic growth. Therefore, it is important to gain evidence of its effects on both public and private R&D investments.

This chapter presents some of the latest available data on both public and private R&D and thus depicts an initial overview of the short-term effects that the financial and economic crisis has brought about in terms of R&D investments. Longer-term effects are more difficult to foresee and will largely depend on the strategy of both private firms and governments. It is structured around five main sections that analyse (1) the historical relationship between R&D and the business cycle, (2) the effects of the economic crisis on overall R&D, (3) on public R&D and on (4) private R&D. Finally, section (5) summarises the main preliminary findings and alerts about the unknown medium- and long-terms effects.

## 2.1. How is R&D growth related to the business cycle?

It is widely recognised that R&D and innovation are major drivers of productivity and growth. It is also commonly accepted that the positive relationship between R&D and growth is mainly driven by business R&D. This is logical to the extent that public R&D is more focused on fundamental research than business R&D. As a result, public R&D creates a positive externality for business R&D, thus increasing the capability of the business sector to undertake R&D. However, it also means that public R&D is a step further away from the market, and therefore the relationship with growth is less direct than for business R&D.

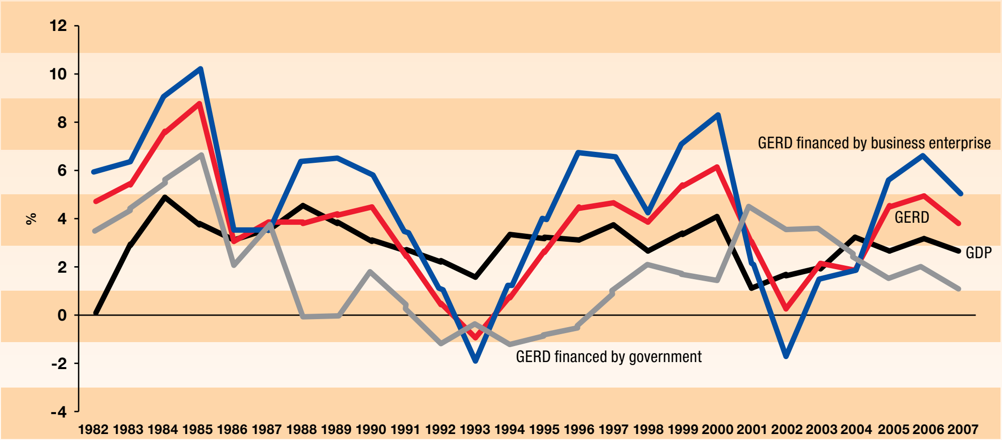
### *There is a strong correlation between business R&D investment and economic growth, while publicly financed R&D has a countercyclical effect*

GDP and R&D expenditure (GERD) are closely correlated over time in the OECD area: Figure I.2.1 shows that R&D expenditure growth tends to follow the business cycle, with larger fluctuations than for GDP growth and a time lag of one to two years. The fluctuations are the biggest for business-financed R&D, showing that R&D financed by the business sector is the component most affected by the business cycle. In contrast, government-financed R&D growth shows smaller, often countercyclical, fluctuations like, for instance, during the economic downturn of the early 2000s.

### *In the short- to medium-term the relationship between R&D and economic growth depends on the underlying sector dynamics of a national economy*

The development patterns of GDP and R&D differ between countries both in terms of timing and impact. In countries such as Austria, Latvia, the Netherlands, Slovenia and Spain, the lag occurs after just one year, indicating a rather immediate relationship between GDP and R&D, whereas in countries such as Denmark, Finland and the United States, it only occurs after 3–5 years. This could indicate that it often takes some time before R&D expenditure has an impact on GDP. In general business, R&D expenditure has shorter lag intervals with GDP, confirming a more direct relationship between business R&D expenditure and GDP growth, than between public R&D expenditure and GDP growth.

FIGURE I.2.1 **R&D growth(1) over the business cycle, OECD area, 1982-2007**



*Source:* DG Research and Innovation
*Data:* OECD STI Scoreboard, 2009
*Note:* (1) Real growth per annum (%).

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## Box I.2.1 – Time-series analysis of the co-evolution of GDP and R&D expenditure

The main findings of a time-series analysis of GDP and R&D expenditure are:

The levels of R&D spending are interrelated to the levels of economic growth, but growing R&D expenditure levels might not always be completely reflected in the R&D investment intensities, since R&D intensities are temporarily influenced by the levels of GDP growth. In other words, high levels of GDP (growth) may temporarily push the R&D intensity downwards, whereas in periods of an economic downturn R&D intensities could also move upwards for a certain period of time

The evolution of GDP versus R&D expenditure and R&D personnel depends on several structural characteristics like governance structure, policy priorities, and systemic features like industry and academic structures. An understanding of R&D expenditure patterns and performance requires in-depth knowledge of these characteristics.

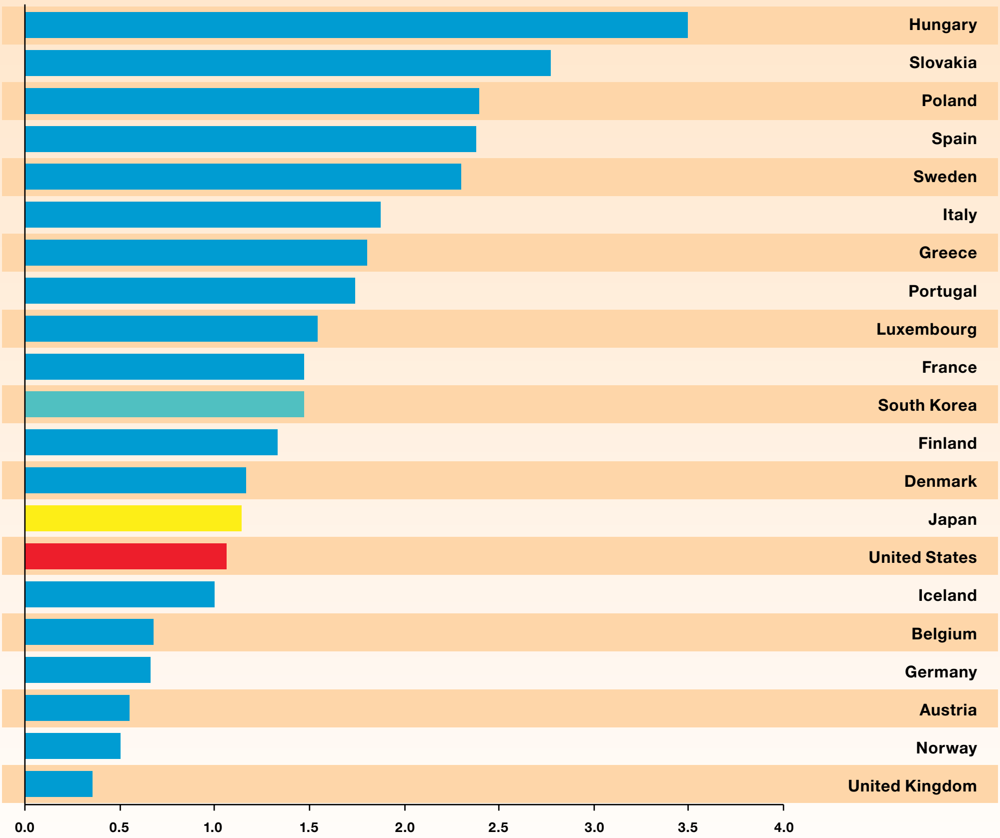
The effect of government-performed R&D is significant and positive on the number of publications and patent applications (the output side). With a time lag of 1–2 years. R&D performed by the business sector positively influences the number of patent applications, which could be expected, as the proximity to patent in the business sector is, in general, higher than for the public sector.

The wide differences in co-evolution of GDP and R&D expenditure between countries could be the result of specific sector developments. GDP may, for example, be growing much faster in a particular country than R&D expenditure, due to a temporary boom in certain sectors such as construction. As a result, otherwise positive developments for R&D may not result in higher R&D intensities. Similarly, in periods of declining GDP growth, R&D intensities may increase for a certain period of time. This is what happened in 2009 (see below).

## *The responsiveness of R&D to GDP varies widely between countries over the business cycle*

Figure I.2.2 below shows the responsiveness of R&D to the business cycle (elasticity of R&D expenditure with respect to GDP). It is seen that in countries such as Hungary, Slovakia, Poland, Spain, Sweden, Italy, Greece, Portugal, Luxembourg and France, the response in R&D expenditure is 1.5 to 3.5 times the change in GDP — meaning that, based on past experience, the current crisis could lead to significant drops in R&D intensity in these countries after 2009.

FIGURE I.2.2 **Responsiveness of R&D to the business cycle, 1981-2007**



*Source:* DG Research and Innovation
*Data:* OECD STI Scoreboard, 2009

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## 2.2. How did the economic crisis affect total R&D intensity?

### *In 2009, GDP decreased faster than R&D expenditure in the EU, resulting in an increase in R&D intensity*

In nominal terms, gross domestic R&D expenditure (GERD) decreased in 12 Member States in 2009 with respect to 2008 (Table I.2.1). However, GDP decreased even more sharply, so that: (i) R&D intensity decreased in 2009 in only five Member States and (ii) in these Member States the decrease in R&D intensity is less marked than in nominal GERD. For the EU as a whole, the decrease in nominal R&D expenditure amounts to about EUR 3 billion (-1.3 %, from EUR 239.7 billion in 2008 to EUR 236.5 billion in 2009). Despite this loss, EU-27's R&D intensity gained 0.09 percentage points of GDP at 2.01 % of GDP, compared to 1.92 % in 2008.

Despite the economic crisis, total R&D expenditure increased in nominal terms in 14 Member States[73] in 2009. This gave rise to relatively important increases in R&D intensity in these countries, above 0.1 percentage points of GDP in most cases.

Total R&D expenditure in Japan suffered much more from the economic crisis; it decreased by 8.3 % in 2009 compared to 2008 nominally. This caused a sharp decrease in R&D intensity from 3.8 % in 2008 to 3.62 % of GDP in 2009[74]. Due to the unavailability of 2009 data for the United States, South Korea and China, no other international comparison is possible.

In the long term, R&D expenditure growth tends to show larger variations than GDP growth in the OECD area, with a time lag of about one to two years (see section 2.1 above). This suggests that the recent drop in GDP may still result in a larger decrease in total R&D expenditure only after 2009.

TABLE I.2.1

**GERD and R&D Intensity - Change between 2008 and 2009**

| | GERD (nominal) % change | R&D Intensity change in percentage points |
|---|---|---|
| Poland | 17.7 | 0.07 |
| Turkey | 17.3 | 0.12 |
| Russian Federation | 12.7 | 0.15 |
| Hungary | 12.3 | 0.15 |
| Bulgaria | *10.8* | *0.06* |
| Portugal | *8.0* | *0.16* |
| Ireland | *7.7* | *0.31* |
| Slovenia | 6.5 | 0.20 |
| Cyprus | *6.2* | *0.03* |
| Norway | *4.0* | *0.16* |
| Luxembourg | *3.3* | *0.12* |
| France | *2.5* | *0.10* |
| Czech Republic | 2.3 | 0.06 |
| United Kingdom | *1.7* | *0.10* |
| Germany | *1.7* | *0.14* |
| Netherlands | *0.4* | *0.08* |
| Denmark | *0.1* | *0.15* |
| Austria | *-0.1* | *0.08* |
| Italy | *-0.1* | *0.04* |
| Slovakia | -0.6 | 0.01 |
| Spain | -0.8 | 0.03 |
| Finland | -1.2 | 0.24 |
| EU | -1.3 | 0.09 |
| Belgium | *-1.6* | *0.00* |
| Israel(2) | *-2.9* | *-0.39* |
| Malta | -3.7 | -0.02 |
| Estonia | *-5.2* | *0.13* |
| Sweden | *-5.5* | *-0.08* |
| Croatia | -9.1 | -0.06 |
| Lithuania | -14.1 | 0.04 |
| Romania | -20.9 | -0.10 |
| Latvia | -39.8 | -0.16 |

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*Source:* DG Research and Innovation
*Data:* Eurostat, OECD
*Notes:* (1) EL: Data are not available for 2008 and 2009.
(2) IL: GERD does not include defence.
(3) Values in italics are estimated or provisional.

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[73] At the time of writing, 2009 data was not available for Greece.

[74] Statistics Bureau of the Minister of International Affairs and Communication in Japan.

## 2.3. Has the economic crisis led to cuts in public R&D investment?

***In nominal terms, R&D budgets increased or were maintained in 17 Member States and decreased in 7 Member States in 2009[75], but they decreased relative to GDP in only 2 Member States in the same year***

Seventeen Member States were able to maintain or increase their nominal R&D budgets in 2009, a sign that Member States regard R&D as a priority to ensure a better and more rapid economic recovery and economic growth in the longer term (Table I.2.2). Seven Member States could, however, not maintain their R&D budgets at the same level as in the year before[76]. Severe cuts occurred in Lithuania already in 2008, and lighter ones in Spain[77]. In 2009, the most severe cuts occurred in Latvia, Romania and Lithuania; Latvia and Romania are the only countries where the fall in R&D budget was larger than the fall in GDP, leading to a decrease in the ratio of R&D budget to GDP that year.

According to a survey of research ministries in Member States conducted by the European Commission in 2010, 16 Member States planned to increase their R&D budget in 2010, while 4 Member States planned to decrease it[78]. However, the first data available shows that relative to GDP, R&D budgets will be decreasing in more countries in 2010 than in 2009 due to the return to positive GDP growth in most countries.

In the medium term, the need for fiscal consolidation may place further pressure on the ability of some European governments to maintain their investment in R&D. According to the above-mentioned survey, nine Member States intend to increase their R&D budget in 2011, four to stabilise it and four to decrease it[79].

Keeping increasing public investment in R&D during the economic downturn and slow recovery — as in the OECD area in the early 2000s (Figure I.2.1 above) — is key to ensuring a more rapid return to sustained economic growth[80].

***The GDP fall of 2009 allowed for a slight increase of the R&D budget to GDP ratio in the EU and Japan, while progress of this ratio over 2007–2009 reaches almost 20 % in South Korea***

Outside Europe, the US R&D budget stayed roughly at the same nominal level in dollars in 2008 compared to 2007, but decreased sharply when measured in euros (from EUR 103.5 to EUR 96.8 billion, not shown in Table I.2.2). In Japan, the R&D budget experienced a limited rebound in 2008 but has been on a declining trend since 2004 in nominal terms. South Korea continued substantially increasing its R&D budget in 2008–2009 (+13.7 %), although when converted into euros this corresponds to a 9 % decrease (from 6.4 in 2007 to EUR 5.8 billion in 2008, not shown in the table).

Relative to GDP, the R&D budget in the EU and Japan followed exactly the same path in 2008–2009 and could increase from 0.71 % to about 0.75 % of GDP thanks to the GDP fall. The US R&D budget slightly decreased relative to GDP in 2008, but is likely to have increased in 2009, as in the EU and Japan, due to the GDP fall. The 20 % increase in the R&D budget to GDP ratio over 2007–2009 in South Korea outperforms all countries.

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[75] Data is not available for Greece; break in series in Spain and Poland in 2009 prevents a direct comparison of 2009 with 2008 for these two countries.

[76] See preceding footnote.

[77] The appreciation of the euro compared to the British pound caused an important decrease of the United Kingdom's nominal R&D budgets in 2008 and 2009 in euro (-12.4 % and -3.6 % respectively), despite the increase in pounds. This has, however, an an important impact on the EU-27 total which is expressed in euro and decreased in 2009. The same consideration holds for Sweden where the increase of R&D budgets in nominal terms vanishes almost entirely when expressed in euro.

[78] Not available in 7 Member states.

[79] Not available in 10 Member States.

[80] See also Science, Technology and Competitiveness report 2008/2009, page 7.

## TABLE I.2.2

## Government budget appropriations or outlays for R&D (GBAORD) - Growth and as % of GDP, 2007-2010(1)

| | GBAORD (nominal) - % change | | | GBAORD as % of GDP | | | |
|---|---|---|---|---|---|---|---|
| | 2007-2008 | 2008-2009 | 2009-2010 | 2007 | 2008 | 2009 | 2010 |
| Belgium | 15.8 | *-2.3* | : | 0.60 | 0.68 | *0.68* | : |
| Bulgaria | 36.5 | 8.4 | : | 0.26 | 0.31 | 0.34 | : |
| Czech Republic | 0.1 | *21.2* | *0.0* | 0.58 | 0.56 | *0.68* | *0.67* |
| Denmark | 10.6 | 10.4 | *5.1* | 0.79 | 0.85 | 0.99 | *1.01* |
| Germany | 5.3 | 5.8 | *8.3* | 0.77 | 0.79 | 0.87 | *0.93* |
| Estonia | *34.3* | *-7.4* | : | *0.49* | *0.65* | *0.70* | : |
| Ireland | *1.3* | *-1.8* | : | 0.49 | 0.53 | *0.58* | : |
| Greece | : | : | : | *0.30* | : | : | : |
| Spain | -4.0 | : | : | 1.07 | 1.00 | 0.74 | : |
| France | 1.7 | 4.0 | *1.9* | 0.74 | 0.74 | 0.78 | 0.78 |
| Italy | 0.0 | -1.6 | -6.1 | 0.64 | 0.63 | 0.64 | 0.59 |
| Cyprus | 7.6 | 12.1 | : | 0.42 | 0.42 | 0.48 | : |
| Latvia | 7.5 | -43.2 | : | 0.30 | 0.29 | 0.20 | : |
| Lithuania | -11.3 | -17.7 | : | 0.33 | 0.26 | 0.26 | : |
| Luxembourg | 31.3 | 8.6 | 25.0 | 0.37 | 0.46 | 0.52 | *0.61* |
| Hungary | *16.1* | 5.6 | : | *0.39* | 0.43 | 0.46 | : |
| Malta | 4.4 | 4.4 | : | 0.20 | 0.20 | *0.21* | : |
| Netherlands | 5.1 | *9.2* | *-0.2* | 0.69 | 0.70 | *0.79* | *0.77* |
| Austria(2) | 12.2 | *10.9* | 9.5 | 0.65 | 0.70 | *0.80* | *0.86* |
| Poland | 4.1 | : | : | 0.32 | 0.30 | 0.34 | *:* |
| Portugal | 16.6 | *4.6* | *13.8* | 0.75 | 0.86 | *0.92* | *1.03* |
| Romania | 33.0 | -25.4 | *-4.4* | 0.37 | 0.40 | 0.31 | *0.28* |
| Slovenia | 5.2 | 46.0 | : | 0.52 | 0.51 | 0.78 | : |
| Slovakia | 54.0 | 6.5 | *4.2* | 0.21 | 0.28 | 0.30 | *0.30* |
| Finland | 4.3 | *6.3* | *6.6* | 0.97 | 0.98 | *1.13* | *1.17* |
| Sweden | 3.6 | *10.5* | : | 0.79 | 0.80 | *0.91* | : |
| United Kingdom | 2.0 | *7.8* | : | 0.65 | 0.65 | *0.73* | : |
| EU | 1.0 | -1.2 | : | 0.71 | 0.71 | 0.74 | : |
| Iceland | 20.9 | 21.0 | : | 0.82 | 0.88 | 1.05 | : |
| Norway | 6.5 | 9.1 | *5.0* | 0.76 | 0.74 | 0.85 | *0.85* |
| Switzerland | : | : | : | : | 0.76 | : | : |
| Croatia | : | *1.5* | : | : | 0.66 | *0.69* | : |
| Russian Federation | 15.9 | 37.5 | : | 0.40 | 0.37 | 0.51 | : |
| United States(2) (3) | 1.8 | : | : | 1.01 | 1.00 | 1.17 | : |
| Japan(2) | 1.7 | -0.2 | 0.7 | 0.68 | 0.71 | 0.75 | 0.75 |
| South Korea | *14.8* | *13.7* | *12.5* | 0.83 | *0.91* | *1.02* | *1.09* |
| Israel(4) | 8.6 | *9.8* | : | 0.60 | 0.62 | *0.64* | : |

*Source:* DG Research and Innovation

*Data:* Eurostat, OECD

*Notes:* (1) ES, PL, US: There is a break in series between 2009 and the previous years - nominal growth between 2008 and 2009 cannot be calculated.
(2) AT, US, JP: GBAORD refers to federal or central government only.
(3) US: GBAORD excludes data for the R&D content of general payment to the Higher Education sector for combined education and research.
(4) IL: GBAORD does not include defence.
(5) Values in italics are estimated or provisional.

**In terms of execution, nominal R&D expenditure continued to increase in the public sector in 2009 on average in the EU, but EU-12 Member States had more difficulty in avoiding important cuts in public R&D, which may widen the gap between high and low R&D intensity countries in Europe**

In most European countries R&D expenditure (Table I.2.1 and Table I.2.4) in the public sector resisted better than in the business sector (Table I.2.3 and Table I.2.4). In the majority of Member States (20), it increased in nominal terms in 2009 with respect to 2008 (Table I.2.3). On average in the EU, the 2009 increase amounts to 1.8 %. As a % of GDP, R&D expenditure in the public sector decreased only in Latvia, Romania and Poland and progressed in all other Member States.

Since governments are the main funders of public R&D expenditure, these observations show that a majority of European countries did not cut R&D spending and maintained R&D activities among their priorities, as observed with R&D budget data above. Member States which already had higher public R&D intensities were more often able to maintain it. The four Member States with the sharpest decrease in nominal public R&D expenditure are all EU-12 Member States. Despite support from the Structural Funds, this shows that the result of the economic crisis could be a further widening of the gap between Member States with high R&D intensities and some Member States with lower R&D intensities.

## 2.4. Has the economic crisis led to cuts in business R&D investment?

**On average in the EU, the 2009 decrease in nominal R&D expenditure was more marked in the business sector than overall, but catching-up Member States have probably benefited from strategic R&D persistency in large companies**

In most countries, the evolution of R&D expenditure in the business sector (BERD) in nominal terms in 2009 was worse than that of total R&D expenditure (Table I.2.1 and Table I.2.4): (i) nominal BERD decreased in three more Member States (15) than nominal GERD (12), (ii) when BERD decreased it did so more sharply than GERD (except in Latvia, Romania, Estonia) and (iii) when it increased it did so less strongly than GERD (except in Hungary and Ireland). In some countries however, nominal BERD

TABLE I.2.3

### Public expenditure on R&D (GOVERD plus HERD) and Public sector R&D Intensity change between 2008 and 2009

| | Public expenditure on R&D (nominal) % change | Public sector R&D Intensity change in percentage points |
|---|---|---|
| Turkey | 26.2 | 0.10 |
| Luxembourg | *22.9* | *0.10* |
| Poland | 21.8 | 0.07 |
| Russian Federation | 14.4 | 0.06 |
| Bulgaria | *13.0* | *0.05* |
| Portugal | *10.5* | *0.08* |
| Denmark | *10.3* | *0.14* |
| Finland | 9.7 | 0.17 |
| Sweden | *7.8* | *0.11* |
| Czech Republic | 7.1 | 0.05 |
| Norway | *7.0* | *0.10* |
| Slovenia | 6.4 | 0.07 |
| Spain | 5.8 | 0.06 |
| Germany | *5.3* | *0.07* |
| France | *5.1* | *0.06* |
| Netherlands | *4.9* | *0.08* |
| Malta | *4.6* | *0.01* |
| Slovakia | 2.6 | 0.01 |
| Italy | *2.5* | *0.03* |
| Israel(2) | *2.3* | *-0.03* |
| Ireland | *2.3* | *0.08* |
| Cyprus | *1.9* | *0.01* |
| EU | 1.8 | 0.05 |
| United Kingdom | *1.7* | *0.04* |
| Hungary | 1.3 | 0.02 |
| Austria | *-0.2* | *0.02* |
| Belgium | *-0.7* | *0.01* |
| Croatia | -2.8 | 0.00 |
| Estonia | -7.8 | 0.05 |
| Lithuania | -14.0 | 0.03 |
| Romania | -32.4 | -0.12 |
| Latvia | -48.9 | -0.17 |

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*Source:* DG Research and Innovation
*Data:* Eurostat, OECD
*Notes:* (1) EL: Data are not available for 2008 and 2009.
(2) IL: GOVERD does not include defence.
(3) Values in italics are estimated or provisional.

and GERD behaved the same way (Austria, Slovenia, United Kingdom and Lithuania). On average in the EU, the 2009 decrease in nominal R&D expenditure was more marked in the business sector than overall (-3.1 % vs -1.3 % respectively). As % of GDP, business R&D expenditure progressed slightly (+0.03 percentage point, up to 1.25 % of GDP) due to a larger drop in GDP.

Interestingly, business R&D expenditure has increased in a number of catching-up countries, like Hungary, Bulgaria, Slovenia, Turkey, Romania, Cyprus and Poland (Table I.2.4). This indicates that large foreign R&D investors — which are responsible for most of business R&D in these countries — have increased their R&D investment in these countries. As shown below, in total, R&D investment by large R&D investing companies in the world has indeed proved relatively resilient to the crisis in 2009. Catching-up countries would, therefore, have benefited from this strategic R&D persistency in large companies.

In contrast, business R&D expenditure decreased sharply in some of the frontrunners in Europe, namely Sweden, Finland and Denmark. Business R&D expenditure in Sweden and Finland has probably been dragged downwards by the large Swedish and Finnish companies whose R&D investment decreased in 2009 by -6.6 % and -6 % respectively[81] — much more than for large companies in other countries. In the case of Denmark, large Danish companies have slightly increased their R&D investment, so that smaller R&D investing companies, in particular SMEs, are probably responsible for the downward trend (see Figure I.2.3 below).

## *Worldwide, despite large decreases in sales and profits, the overall decrease in large companies' R&D investment remained relatively limited in 2009*

The *EU Industrial R&D Investment Scoreboard* (referred to as the Scoreboard in this section) presents information on the world's top 1 400 companies (1 000 non-EU and 400 EU) ranked by their investment in R&D. The 2010 edition is based on data from companies' published accounts intended to be their fiscal year 2009 accounts[82]. Therefore, the effect of the economic and financial crisis that began in 2008 is reflected in this data.

TABLE I.2.4

**BERD and BERD Intensity - Change between 2008 and 2009**

| | BERD (nominal) % change | BERD Intensity change in percentage points |
|---|---|---|
| Hungary | 22.3 | 0.13 |
| Russian Federation | 11.7 | 0.09 |
| Ireland | *10.8* | *0.23* |
| Poland | 8.4 | 0.01 |
| Bulgaria | *7.0* | *0.01* |
| Slovenia | 6.6 | 0.13 |
| Turkey | 6.1 | 0.02 |
| Romania | 6.1 | 0.02 |
| Cyprus | *2.8* | *0.00* |
| United Kingdom | *1.7* | *0.06* |
| Norway | *1.4* | *0.06* |
| France | *1.1* | *0.04* |
| Portugal | *0.6* | *0.02* |
| Germany | *0.1* | *0.07* |
| Austria | *-0.1* | *0.06* |
| Czech Republic | -0.8 | 0.01 |
| Estonia | *-1.9* | *0.08* |
| Belgium | *-2.0* | *0.00* |
| Luxembourg | *-2.3* | *0.02* |
| Italy | *-2.4* | *0.00* |
| EU | -3.1 | 0.03 |
| Netherlands | *-4.1* | *0.00* |
| Israel(2) | *-4.3* | *-0.36* |
| Denmark | *-4.3* | *0.01* |
| Slovakia | -4.9 | -0.01 |
| Finland | -5.0 | 0.07 |
| Spain | -6.3 | -0.02 |
| Malta | *-8.2* | *-0.03* |
| Sweden | *-10.0* | *-0.19* |
| Latvia | -12.4 | 0.01 |
| Lithuania | -14.1 | 0.01 |
| Croatia | -17.1 | -0.06 |

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*Source:* DG Research and Innovation
*Data:* Eurostat, OECD
*Notes:* (1) EL: Data are not available for 2008 and 2009.
(2) IL: BERD does not include defence.
(3) Values in italics are estimated or provisional.

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[81] *2010 EU Industrial R&D Investment Scoreboard.*

[82] However, due to different accounting practices, it includes accounts ending from a range of date from late 2008 to early 2010.

According to the Scoreboard, this crisis has had a stronger impact on companies' R&D investment than the 2002/2003 one. However, globally, overall companies' R&D investment turned out to be relatively resilient to the recession, with a decrease of only 1.9 % in nominal terms[83], compared to -10.1 % for sales and -21.0 % for profits. This shows the strategic importance that large R&D investing companies attach to R&D, which they regard as a top priority. A number of companies have continued to increase R&D investment in order to strengthen their competitiveness in preparation for the recovery.

### *In most Member States, SMEs' R&D investment has been more affected than that of larger companies'*

The Scoreboard covers the largest R&D investors in the world. The situation is likely to be different for smaller companies investing in R&D. Liquidity pressure, difficulties in finding financing, credit constraint, falls in sales and available cash-flows, and difficulties in facing shorter-term payments have affected SMEs' R&D activities very strongly.

There are, as yet. no official statistics on R&D investment by SMEs. However, a first insight can be obtained by comparing the 2009 evolution of BERD to the 2009 evolution of R&D investment by large companies from the Scoreboard. Due to a number of differences in the two data collections' methodologies[84], BERD data and Scoreboard data are not directly comparable. In particular, R&D investment by EU companies of the Scoreboard is not necessarily located in the EU, while BERD data records R&D expenditure executed in a country whatever the nationality of the company. However, this comparison still provides a general indication on the behaviour of smaller firms in a country, since a good part of the difference between BERD data and Scoreboard data is accounted for by them[85].

In a number of Member States (Czech Republic, Portugal, Spain, Austria, Denmark and Malta), the BERD/Scoreboard comparison in Figure I.2.3 below indicates that smaller companies have considerably reduced their R&D investment — despite the increase in total nominal R&D investment by the top R&D investing companies of these countries, BERD has still decreased in nominal terms. The reduction of R&D investment by smaller firms has, therefore, more than compensated the increase in R&D investment made by larger firms[86]. This phenomenon is particularly marked in the Czech Republic, Portugal, Spain and Austria. In Ireland, BERD increased as well, but less than R&D investment by large Irish firms, suggesting also that smaller firms had more difficulty than large firms in maintaining their R&D investment in this country. In Sweden, the Netherlands — and in EU-27 on average — BERD declined more than Scoreboard's companies, which indicates that R&D investment by smaller companies in these countries declined more than that of large firms.

In a number of countries however, (Slovenia, Poland, United Kingdom, France, Germany, Belgium and Finland), the opposite phenomenon is observed: BERD resisted better than R&D investment by large Scoreboard companies. In some others (Hungary and Italy), both behaved the same way. This tends to indicate that smaller firms' R&D investment has been relatively resilient in these countries.

### *The effects of the economic crisis were felt differently across industrial sectors*

The impact of the crisis was very different across industrial sectors. R&D investment decreased substantially in the Automobiles and IT hardware sectors (-11.6 % and -6.4 % respectively), while it rose further in the Pharmaceutical sector (+5.3 %). The latter thereby consolidates its position as top R&D investor. This is also one of the few sectors that managed to increase sales during the crisis (+6.4 %). Moreover, large pharmaceutical companies are reinforcing their position by increasing their R&D capacity through mergers and acquisitions, often involving biotech firms. The growth in R&D investment in the Alternative Energy sector continued in the *Scoreboard* (+28.7 %), in particular with 9 more companies entering the Scoreboard list of the world's top 1 400 R&D investors than in the previous edition[87]. Thirteen out of the fifteen companies included in the Scoreboard in this sector are based in the EU.

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[83] All growth rates are nominal in the EU Industrial R&D Investment Scoreboard.

[84] For an overview of the differences, *see Science*, *Technology and Competitiveness key figures Report 2008/2009*, p 39.

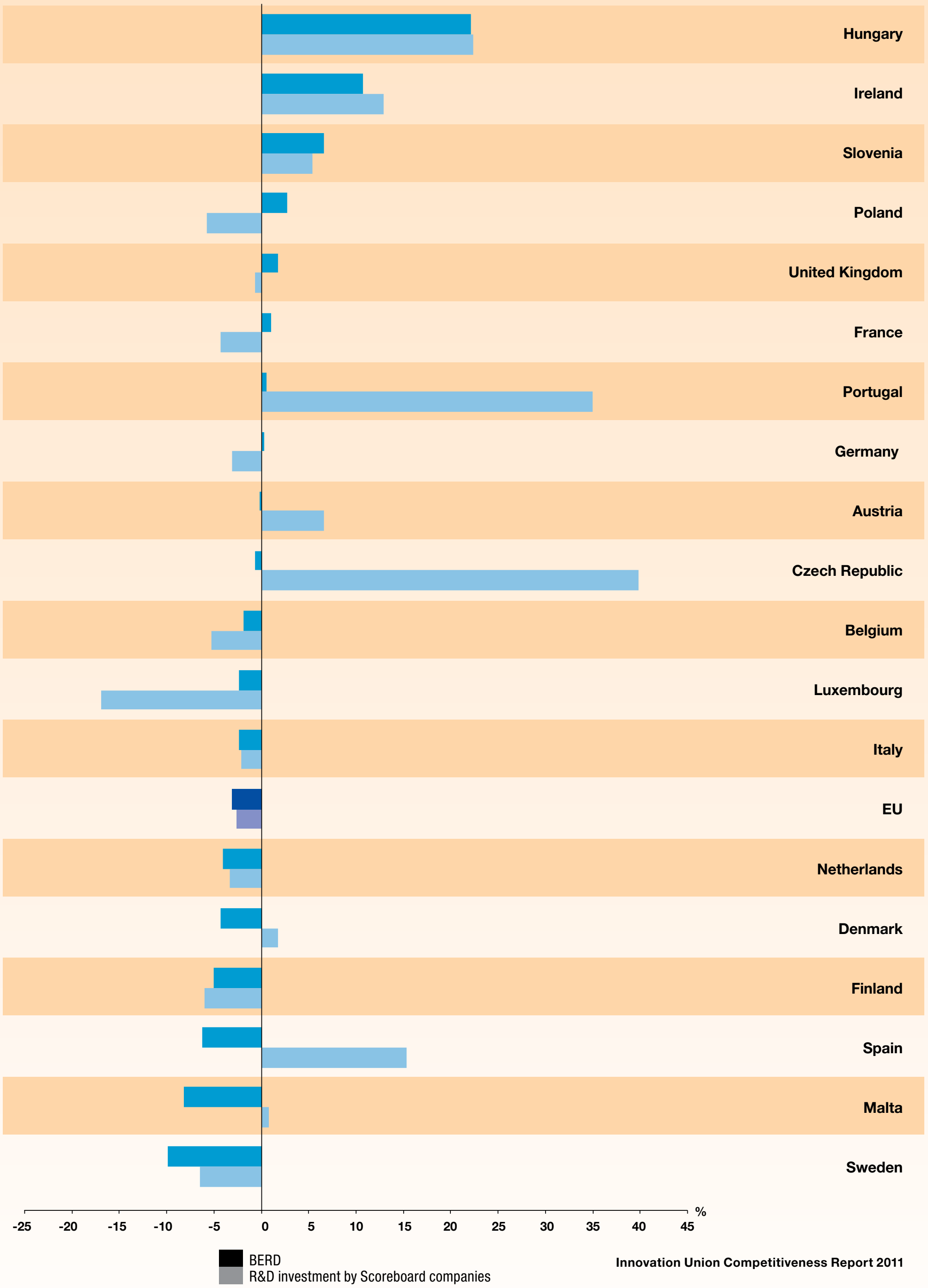
[85] Smaller firms not included in the *Scoreboard*, in particular most SMEs, have their R&D expenditure recorded in BERD.

[86] As noted above, (part of) this increase in R&D investment by the country's large companies shown by the *Scoreboard* may have taken place in other countries, so that one cannot exclude the chance that large companies too have reduced their R&D investment in their own country.

[87] It should be noted that important R&D investment in alternative energy is also made by companies classified in other sectors in the Scoreboard, like Oil & Gas, General Industrials and Industrial Machinery.

FIGURE I.2.3

**BERD and R&D investment by *Scoreboard* companies - Percentage change between 2008 and 2009[1]**



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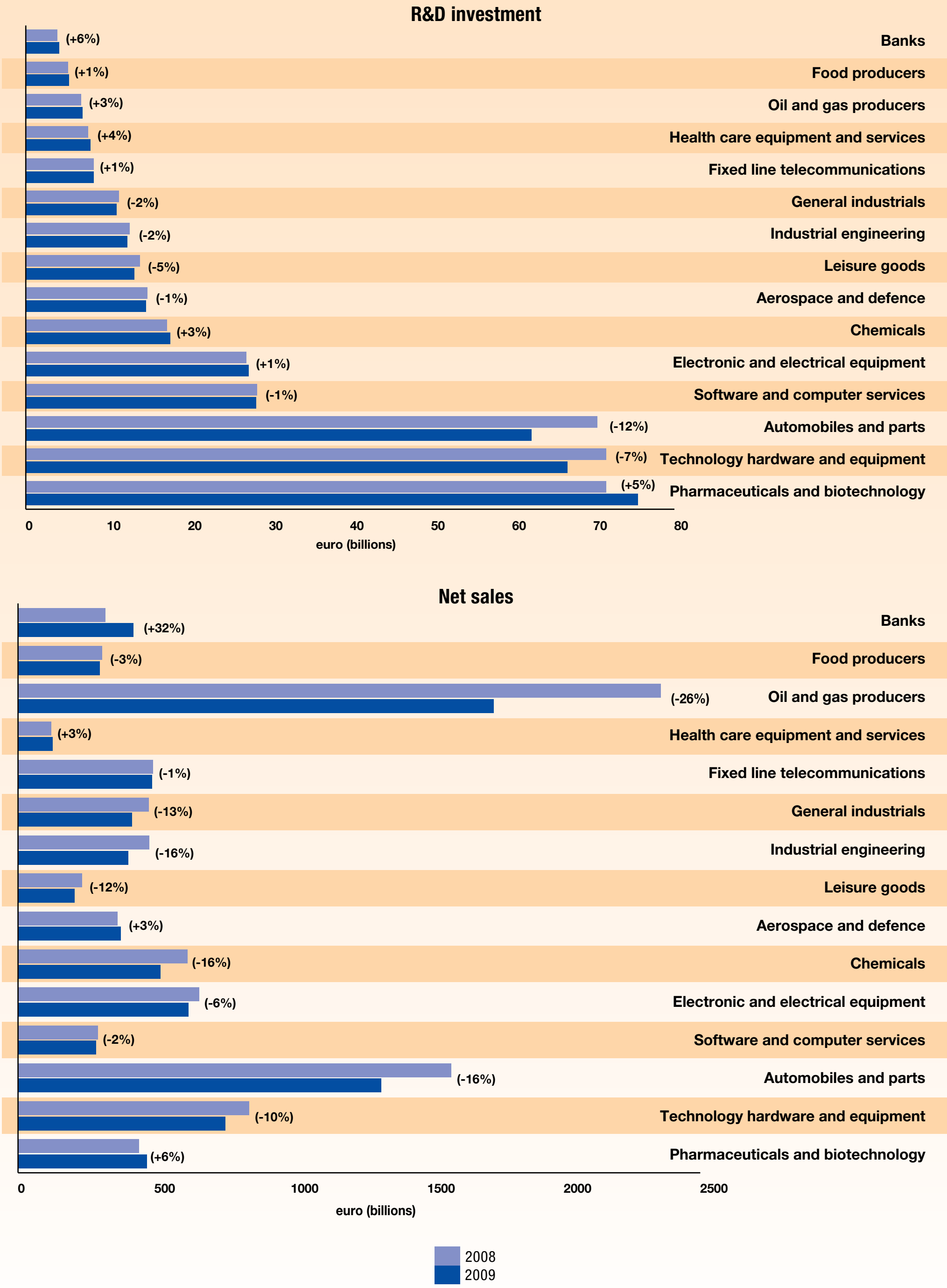
*Source:* DG Research and Innovation, JRC-IPTS

*Data:* The 2010 EU Industrial R&D Investment Scoreboard

*Note:* (1) Only Member States with companies in the 2009 and 2010 Scoreboards and with BERD available for 2008 and 2009 are included.

FIGURE I.2.4

R&D investment and net sales of the top 10 sectors for *Scoreboard* companies, 2008 and 2009; in brackets the percentage change between 2008 and 2009



*Source:* DG Research and Innovation, JRC-IPTS
*Data:* The 2010 EU Industrial R&D Investment Scoreboard

### *The decrease in R&D investment was sharper in US companies than in EU companies, but Asian companies continued their high R&D growth*

EU companies have reduced their R&D investment less than their US counterparts (-2.6 % versus -5.1 %, respectively), despite similar drops in sales (around -10 %). More remarkable is the performance of the Japanese companies, which held the level of R&D investment of the previous year despite strong drops in sales (around -10 %) and dramatic drops in profits (-88.2 %).

Companies based in China, India and South Korea continued to rapidly increase their investment in R&D on the Scoreboard: +40.0 %, +27.3 % and +9.1 % respectively. This high R&D growth is partly due to new firms based in these countries entering the Scoreboard list of top 1 400 R&D investors worldwide, to the detriment of US and EU firms dropping out of the Scoreboard.

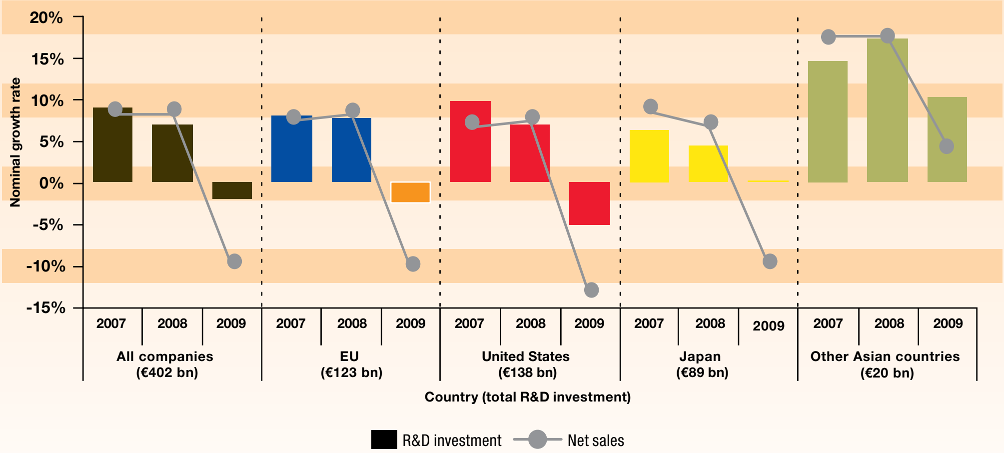
However, the world's R&D landscape has maintained its characteristic sector composition with US companies dominating in high R&D-intensive sectors and the EU companies in medium-high ones.

### *The evolution of business investment in R&D after 2009 remains uncertain*

Business R&D investment proved to be relatively resilient to the recession in 2009. However, the situation might still worsen in 2010. As observed in section 2.1, fluctuations in business-financed R&D growth are usually larger than fluctuations in GDP growth and have a time lag of one to two years. The limited decrease in business R&D investment observed in 2009 might therefore be only the beginning of a negative trend.

Moreover, a recently conducted 'Business R&D Investment Trends'[88] survey on the 1 000 most R&D intensive companies in the EU[89], showed that (1) business R&D is expected to grow by 2 % per year over the 2010–12 period (i.e. half the expectations of the previous survey), (2) almost half of the surveyed companies expected a contraction of their research agenda, (3) 25 % of their R&D was carried out outside the EU and (4) business R&D investment is expected to grow faster outside the EU, particularly in the United States, China and India.

FIGURE I.2.5 **Growth rates of R&D investment and net sales for *Scoreboard* companies**



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*Source:* DG Research and Innovation, JRC-IPTS
*Data:* The EU Industrial R&D Investment Scoreboards (2008, 2009, 2010)

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[88] The 2009 EU Survey on R&D Investment Business Trends is part of the Industrial Research Investment Monitoring Activity (IRMA) of DG Research and Innovation and the Joint Research Centre.

[89] The surveyed companies account for almost EUR 48 billion, i.e; over one third of total R&D investment.

# CHAPTER 3

# Public investment in research and education

## HIGHLIGHTS

Public funding of R&D and education is under the direct control of governments. Consequently, policymakers are directly accountable for its evolution. Evidence shows that the share of the R&D budget (GBAORD) in total government expenditure has progressed in 20 Member States between 2000 and 2008[90]. However, at 1.5 % on average in the EU in 2008, the share of R&D budget in total government expenditure has not progressed since 2000.

The share of domestic R&D expenditure financed by the public sector is larger in less research-intensive countries. In the most research-intensive countries, the business sector is the predominant source of funds (around 75 % of R&D funds). Altogether in the EU, the public sector finances slightly more than one third of R&D expenditure and the private sector slightly less than two thirds.

Progress of government-financed R&D expenditure as % of GDP is observed in countries with low levels of government-financed R&D intensity, while decline and stagnation in those with higher levels prevail. In EU-27, on average, government-financed R&D expenditure has stagnated at around 0.65 % of GDP since 2000.

In many Member States, a substantial part of government support to business R&D is now indirect through R&D tax incentives which represent up to 0.13 % of GDP in Belgium. A more complete view of total government R&D support is, therefore, given by adding this indirect support to government-financed R&D expenditure and to the GBAORD. A full quantification of public R&D support should also include the funding from the EU budget.

An increase of investment in research and innovation is mainly visible in the EU budget. In nominal terms, the annual EU funding of RTDI has been multiplied by 18 over the last 25 years. More than 11 % of the total EU budget was devoted to RTDI in 2009, compared to less than 3 % in 1985. In 2009, EU RTDI funding represented about 16 % of the sum of Member States' civil R&D budgets (civil GBAORDs), compared to 3 % in 1985.

In the EU, public funding in education is eight times higher than public funding in R&D. The Member States with the highest R&D intensity are, in general, also those with the highest education expenditure to GDP ratio. Governments of the Nordic countries invest most in both education and research.

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[90] GBAORD data is available for 2009 and, for some countries, 2010 (see Chapter 2 of this Part); however, GBAORD as % of total government expenditure is available up to 2008 only.

## 3.1. How much are governments investing in R&D at national and at European level?

In the Europe 2020 Strategy, the EU has maintained its objective of devoting 3 % of its GDP to R&D without specifying the relative efforts of the public and private sectors to reach this objective.

The 2002 Barcelona Objectives targeted an increase in both the overall expenditure on R&D (to approach 3 % of EU GDP allocated to R&D by 2010) and the share of R&D expenditure funded by the public and private sectors. According to the Barcelona Objectives, one third of total R&D expenditure should be funded by the public sector and two thirds by the private sector. Public funding of R&D is under the direct control of policymakers, so that they are directly accountable for its evolution.

***Altogether, the public sector finances slightly more than one third of R&D expenditure in the EU and the private sector slightly less than two thirds***

In 2008, the government sector financed 33.9 % of total R&D expenditure in EU-27, while (domestic) business enterprise financed 54.8 % of it (Figure I.3.1). The third important source of funds (almost 9 %) is 'abroad' (both private and public sources), which includes cross-border intra-EU funding, as well as funding from the European Commission (through the Framework Programme and Structural Funds for R&D). For the countries that provide an up-to-date breakdown public/private of this 'abroad' source of funds, this breakdown is shown on Figure I.3.1, and is to be added respectively to the government and (domestic) business sources of funds. Government financed RD as described in this chapter does not include state aid for research and innovation, which is described in chapter 2 of the part III of the report.

Altogether, the public sector, therefore, finances slightly more than one third of R&D expenditure in the EU and the private sector slightly less than two thirds. The government sector accounts for a large share of R&D funding in most of the EU-12 Member States[91] and in the Southern European countries. More than 50 % of

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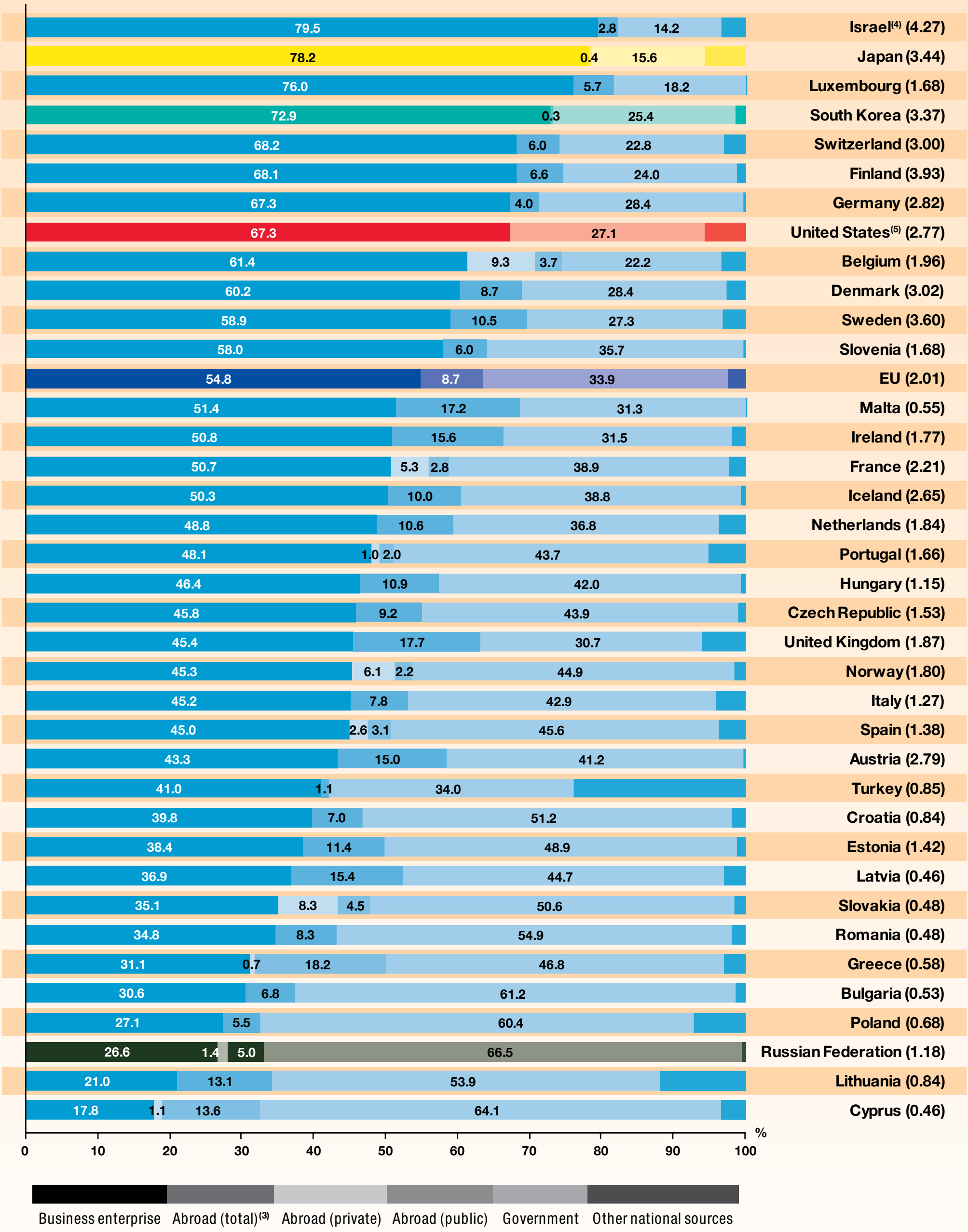
[91] The EU-12 Member States are the 12 countries which joined the European Union in 2004 and 2007.

FIGURE I.3.1

## R&D expenditure by main sources of funds, 2009[1]; in brackets R&D Intensity, 2009[2]



*Source:* DG Research and Innovation

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*Data:* Eurostat, OECD

*Notes:* (1) EL: 2005; BE, LU, NL, NO, IL: 2007; EU, BG, DE, ES, FR, IT, CY, PT, IS, CH, US, JP, CN, KR: 2008; AT: 2010.

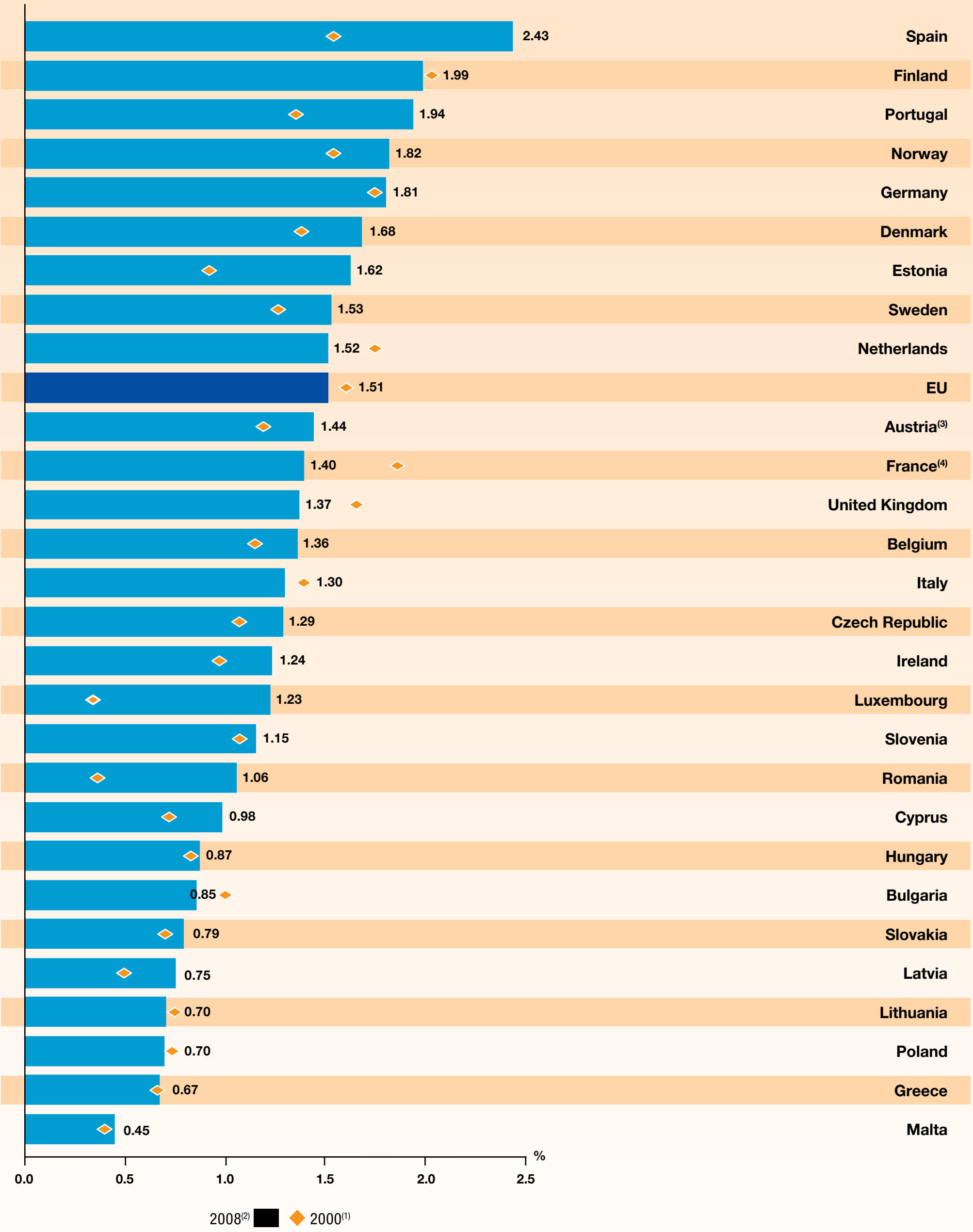
(2) EL: 2007; IS, CH, US, JP, CN, KR: 2008; AT, FI: 2010.

(3) Abroad has been broken down by public and private sector for those countries for which this breakdown is available and up-to-date.

(4) IL: Defence is not included.

(5) US: Most or all capital expenditure is not included; Abroad is included in business enterprise.

## FIGURE I.3.2 GBAORD as % of general government expenditure 2000[(1)] and 2008[(2)]



*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) DK, UK: 2001; EU, CZ, SK: 2002; CY, MT, PL: 2004; HU: 2005.
(2) EL: 2007; DK, LU: 2009.
(3) AT: GBAORD refers to federal or central government expenditure only.
(4) FR: There is a break in series between 2006 and the previous years.

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R&D expenditure in Cyprus, Lithuania, Romania, Poland, Bulgaria and Slovakia is funded by the government sector. Conversely, high R&D-intensive Member States such as Germany, Finland, Sweden and Denmark are characterised by a high involvement of the private sector in the financing of domestic R&D activities.

### *The share of R&D budget in total government expenditure has progressed in 20 Member States between 2000 and 2008*[92]

Between 2000 and 2008, the countries that have considerably increased (by more than 50 %) the share of R&D budget in total government expenditure are Luxembourg, Romania, Estonia, Spain, Latvia and Portugal, all countries with a relatively low intensity (as % of GDP) of public funding for R&D in 2000. Substantial increases also occurred in Cyprus, Ireland, Denmark, Sweden, Austria, Czech Republic and Belgium (Figure I.3.2).

On average in the EU, the R&D budget (GBAORD) represented a slightly smaller share in total government expenditure in 2008 (1.5 %) than in 2000 (1.6 %). This is to a large extent due to the sharp decrease observed in France, the United Kingdom and the Netherlands which is counterbalancing the progress observed in the above-mentioned countries. However, the break in series in 2006 in France prevents any comparison of this indicator between 2008 and 2000. In addition, in these countries, government support to R&D is increasingly provided through R&D tax incentives (see Figure I.3.4 below) which are not included in GBAORD.

### *Progress of government funding is observed in countries with low levels of government-financed R&D intensity, while decline and stagnation prevail in those with higher levels*

Between 2000 and 2009[93], R&D expenditures financed by government as % of GDP increased in 20 Member States (Figure I.3.3). It grew by more than 100 % in Luxembourg and Ireland, by 50 % to 80 % in Estonia, Romania, Spain, Cyprus and Austria, and by 7 % to 30 % in Denmark, Czech Republic, Lithuania, Hungary, Slovenia, Malta, Latvia, Finland and Sweden. In total over this period, 15 Member States managed to increase by more than 10 % their government-financed R&D intensity which shows their commitment towards higher levels of research intensity. In contrast, decreases of R&D expenditure financed by government are observed in Belgium, Italy, Bulgaria, Poland and Slovakia.

With the exception of Austria and Denmark, R&D expenditure financed by government in proportion of GDP tended to decrease or remain stable in the Member States where it was above 0.6 % of GDP in 2000. In contrast, it tended to increase in those Member States where it was low or very low (below 0.4 % of GDP), except in Bulgaria, Poland and Slovakia. Although the dispersion of government-financed R&D intensities across Member States remains large, it has, therefore, been reduced since 2000.

At EU aggregate level, R&D expenditures financed by government have remained stable around 0.65 % of GDP since 2000. Additional public sources from abroad (European Commission, International Organisations, other governments, see Box I.3.2) can be estimated at around 0.05 % of GDP[94] in Member States, which brings R&D expenditures financed by public sources up to 0.7 % of GDP at EU-27 aggregate level. Austria is the only Member State to have reached (and even gone beyond) the 1 % target for public sources. The other Member States whose public financing of R&D are very close to this level are Sweden and Finland.

In order to account for all public R&D support, one needs to add the indirect public support (through R&D tax incentives) to government and public sources from abroad.

A particular focus on the evolution of publicly financed R&D expenditure in 2009 during the economic crisis is to be found in Chapter 2 of this Part.

### *Indicators on government-financed R&D do not include indirect public support of business R&D through R&D tax incentives*

Government-financed R&D includes only direct funding of R&D through grants, loans and procurements that governments give to private firms (Figure I.3.4). Indirect government funding through R&D tax incentives (R&D tax credits, R&D allowances, reduction in R&D workers' wage taxes and social security and accelerated depreciation of R&D capital) is not recorded in government-financed R&D.

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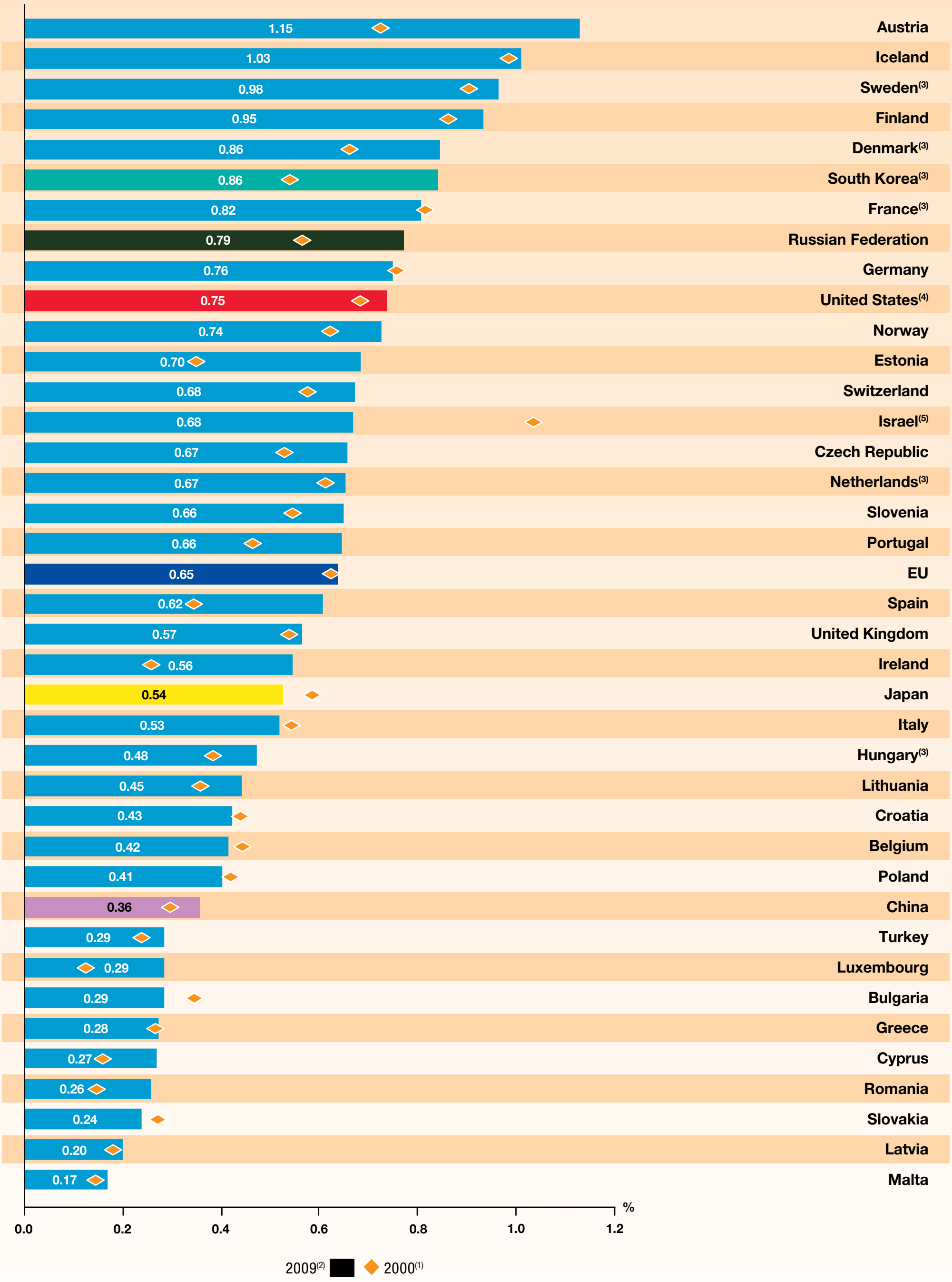
[92] GBAORD data is available for 2009 and, for some countries, 2010 (see Chapter 2 of this Part); however, GBAORD as % of total government expenditure is available up to 2008 only.

[93] For data availability reasons, the actual period covered differs across countries, see footnote to Figure I.3.3.

[94] The breakdown between the different sources of funds from 'abroad' is not provided by all Member States, therefore a precise EU-27 aggregate of these sources cannot be calculated. The estimate of 0.05 % of GDP for public sources from abroad is based on 2007 data from 20 Member States (see Box I.3.2).

FIGURE I.3.3

## GERD financed by government as % of GDP, 2000(1) and 2009(2)



*Source:* DG Research and Innovation

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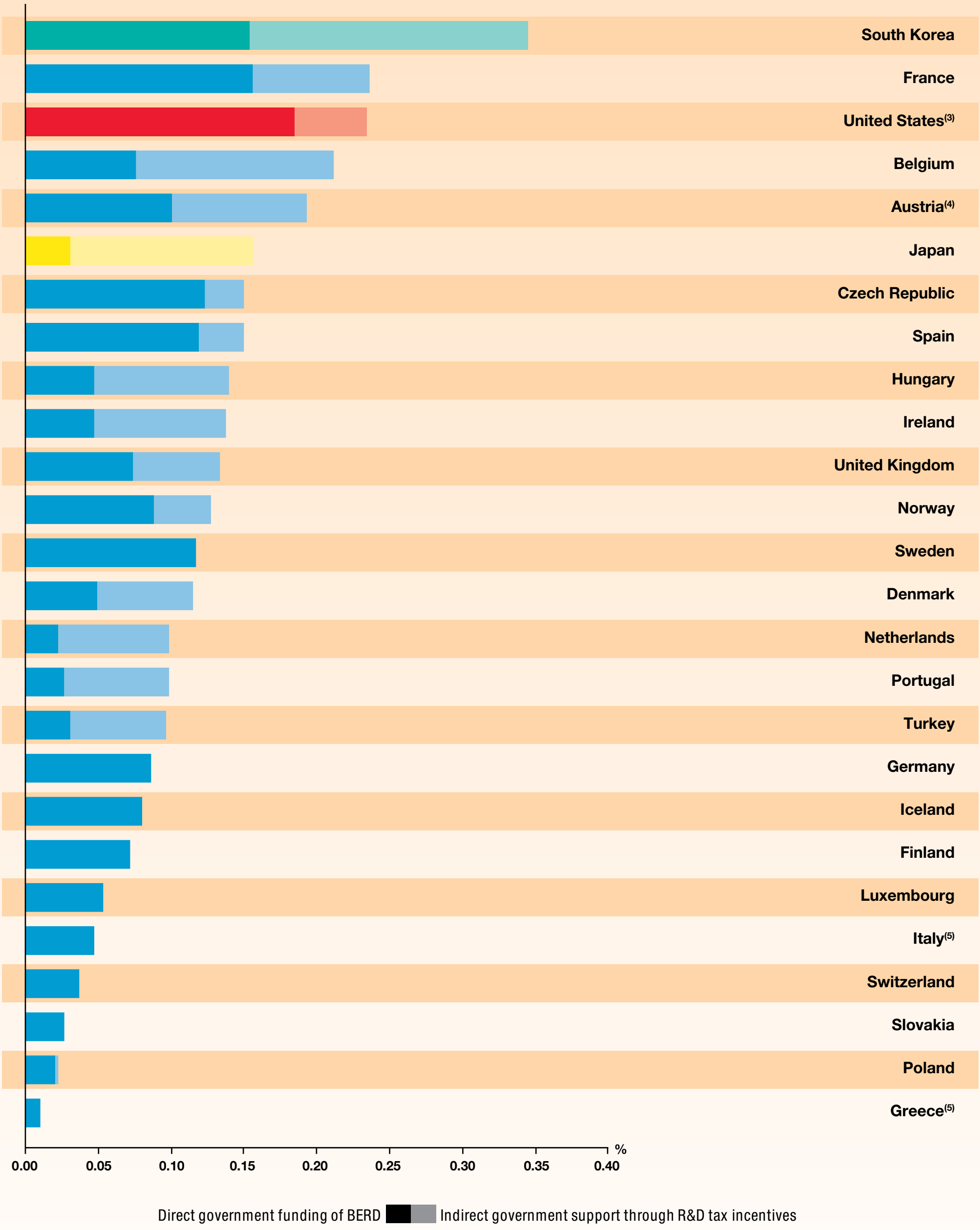
*Data:* Eurostat, OECD

*Notes:* (1) DK, EL, SE, IS, NO: 2001; HR: 2002; IT, MT: 2005.
(2) EL: 2005; BE, LU, NL, NO, IL: 2007; EU, BG, DE, ES, FR, IT, CY, PT, IS, CH, US, JP, CN, KR : 2008, AT: 2010.
(3) DK, FR, HU, NL, SI, SE, KR: Breaks in series occur between 2000 and 2009.
(4) US: GERD does not include most or all capital expenditure.
(5) IL: GERD does not include defence.

FIGURE I.3.4

**Direct and indirect government funding of business R&D and tax incentives for R&D(1) as % of GDP, 2008(2)**



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*Source:* DG Research and Innovation

*Data:* OECD (based on national estimates from the Working Party of National Experts in Science and Technology (NESTI) R&D tax incentives questionnaire, January 2010 and OECD, Main Science and Technology Indicators database).

*Notes:* (1) The R&D tax expenditures estimates do not cover sub-national R&D tax incentives.
(2) EL: 2005; IE, ES, LU, NL, AT, PL, SE, JP: 2007; EL: 2005.
(3) US: The R&D tax expenditure estimate covers the research tax credit but excludes the expensing of R&D.
(4) AT: The R&D tax expenditure estimate covers the refundable research premium but excludes other R&D allowances.
(5) IT (volume tax credit of 10%) and EL (tax credit of 50% for incremental R&D) provided R&D tax incentives but the cost of those incentives was not available.

The omission of the tax expenditures from the measurement of government-financed R&D leads to incomplete indicators on public R&D support. To get a more exhaustive view of government R&D support, it is necessary to estimate the cost of R&D tax-incentive schemes in countries that have put them in place.

### *In many Member States, a substantial part of public support of R&D is indirect through R&D tax incentives*

Figure I.3.4 shows the government's foregone revenue due to R&D tax incentives as a % of GDP along with the direct government funding of business R&D[95]. In certain countries, most of the government support of business R&D is done through R&D tax incentives. In the EU, this is the case of Belgium, Denmark, Hungary, Ireland, the Netherlands and Portugal. Other EU Member States (France, Austria, the United Kingdom, Czech Republic and Spain) provide a substantial share of their public support to business R&D through R&D tax incentives, while others have no R&D tax incentives at all.

### Box I.3.1 – R&D tax incentives in Belgium

More than half of public support to business R&D in Belgium is done through R&D tax incentives. As in most countries, Belgium's fiscal incentives are tax credits or allowances and capital expensing. In Belgium, they cover R&D expenditures but also include a deduction for patent income. Additional fiscal incentives are provided through reductions in R&D workers' wage taxes and social security contributions[96].

### *A major increase in public funding to R&D has taken place in the EU budget*

In nominal terms, the annual EU funding of R&D[97] has been multiplied by 18 over the last 25 years (Figure I.3.5), thanks to a considerable increase in FP funding (annual funding multiplied by more than 9) and to a dramatic increase of Structural Funds for R&D after 2007. Structural Funds now represent slightly more than half of EU funding to R&D and innovation.

### *EU R&D funding now represents about 16 % of the sum of Member States' civil R&D budgets*

This considerable increase of EU funding for R&D in absolute terms is also remarkable relative to the total civil R&D budget of Member States (total EU civil GBAORD, Figure I.3.6): in 2009, EU R&D funding (Framework Programme and Structural funds) represented 16 % of the sum of Member States' civil R&D budgets, compared to 3 % in 1985[98]. About 11 % of the total EU budget[99] was devoted to R&D in 2009, compared to less than 3 % in 1985.

The increase in the share of EU R&D funding in total EU funding and in Member States' civil R&D budgets was steadily sustained during the period 1988–1994 with FP2, FP3 and the beginning of Structural Funds. The year 2007 marked another important and more radical step forward with the beginning of FP7 and the new Structural Funds period[100].

### *Total public R&D support includes direct and indirect government funding of R&D as well as European Commission funding of R&D*

In terms of GDP, R&D tax incentives in Member States range from 0 (Spain and Czech Republic) to 0.13 % of GDP (Belgium). Adding this amount of indirect government funding to the direct public (government and abroad-public) funding displayed in Figure I.3.7 provides a more complete quantification of total government R&D support (Figure I.3.8[101]). The European Commission's direct funding of R&D[102] completes the picture of total public support to R&D in each Member State. In some cases, the addition of R&D tax incentives and European Commission funds brings public support substantially closer to the 1 % objective fixed by many Member States. Total public support to R&D amounts to 0.6 % of GDP in Belgium for instance, against 0.42 % of GDP with the sole direct government funding.

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[95] Data is available for OECD countries only.

[96] *Measuring Innovation*, OECD, 2010; see also Part II, chapter 1.

[97] Structural Funds for R&D include innovation activities: Research, Technology Development and Innovation (RTDI).

[98] The sum of Member States' civil R&D budgets for a given year is calculated from the Member States composing the EU that year.

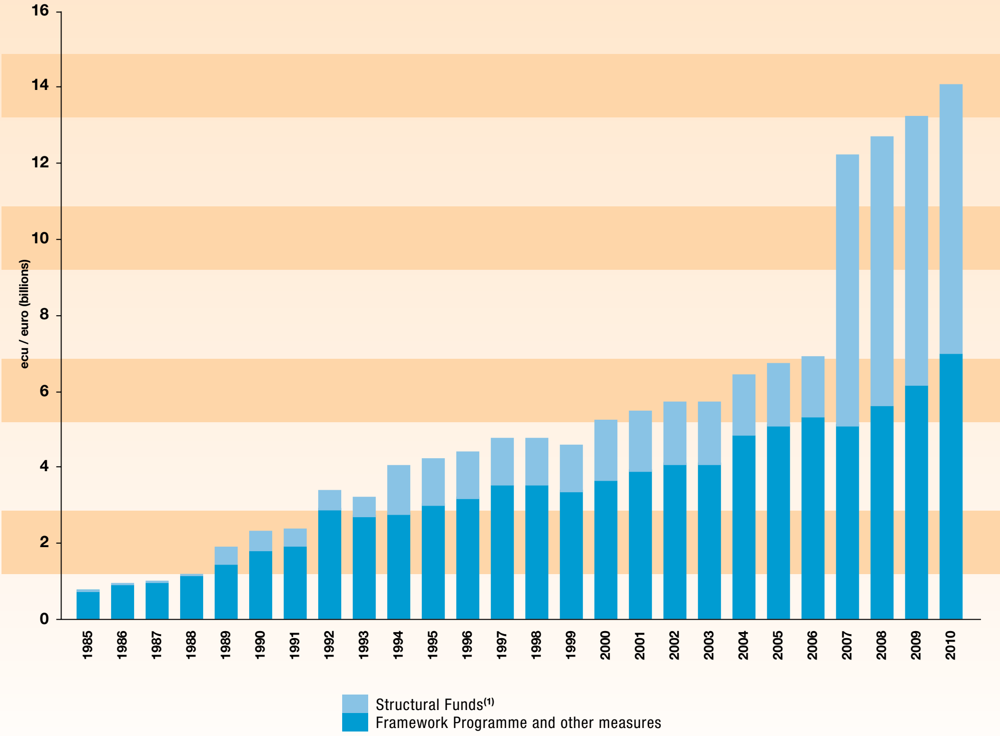
[99] European Commission's budget.

[100] Both lines in Figure I.3.6 represent the evolution of the same quantity, namely European Commission funding of RTDI, over the years. The fact that both lines evolve similarly over time indicates that the rates of growth of both denominators, namely total EU-27 civil GBAORD and total European Commission expenditure, have been of similar magnitude.

[101] As in Figure I.3.7, due to the unavailability of R&D tax incentives data in non-OECD countries, only European Countries that are also members of the OECD are included in this figure.

[102] Through EU Framework Programmes for Research, Technology and Development (RTD) and Structural Funds for RTD.

## FIGURE I.3.5 Evolution of European Commission funding of RTDI, 1985-2010



*Source:* DG Research and Innovation
*Data:* Eurostat, DG REGIO
*Note:* (1) Estimated average annual funding.

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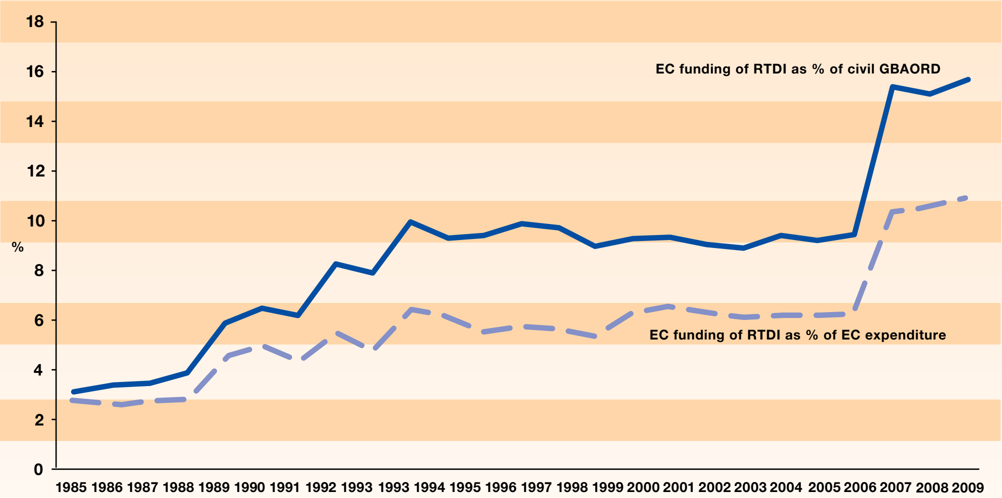
FIGURE I.3.6 Evolution of European Commission fundng of RTDI[(1)] as % of total European Commission expenditure and as % of total EU[(2)] civil GBAORD, 1985-2009



*Source:* DG Research and Innovation

*Data:* Eurostat, DG REGIO, DG Budget

*Notes:* (1) European Commission funding of RTDI was estimated by DG Research.
(2) 1985: EU-10; 1986-1994: EU-12; 1995-2003: EU-15; 2004-2006: EU-25; 2007-2009: EU-27.

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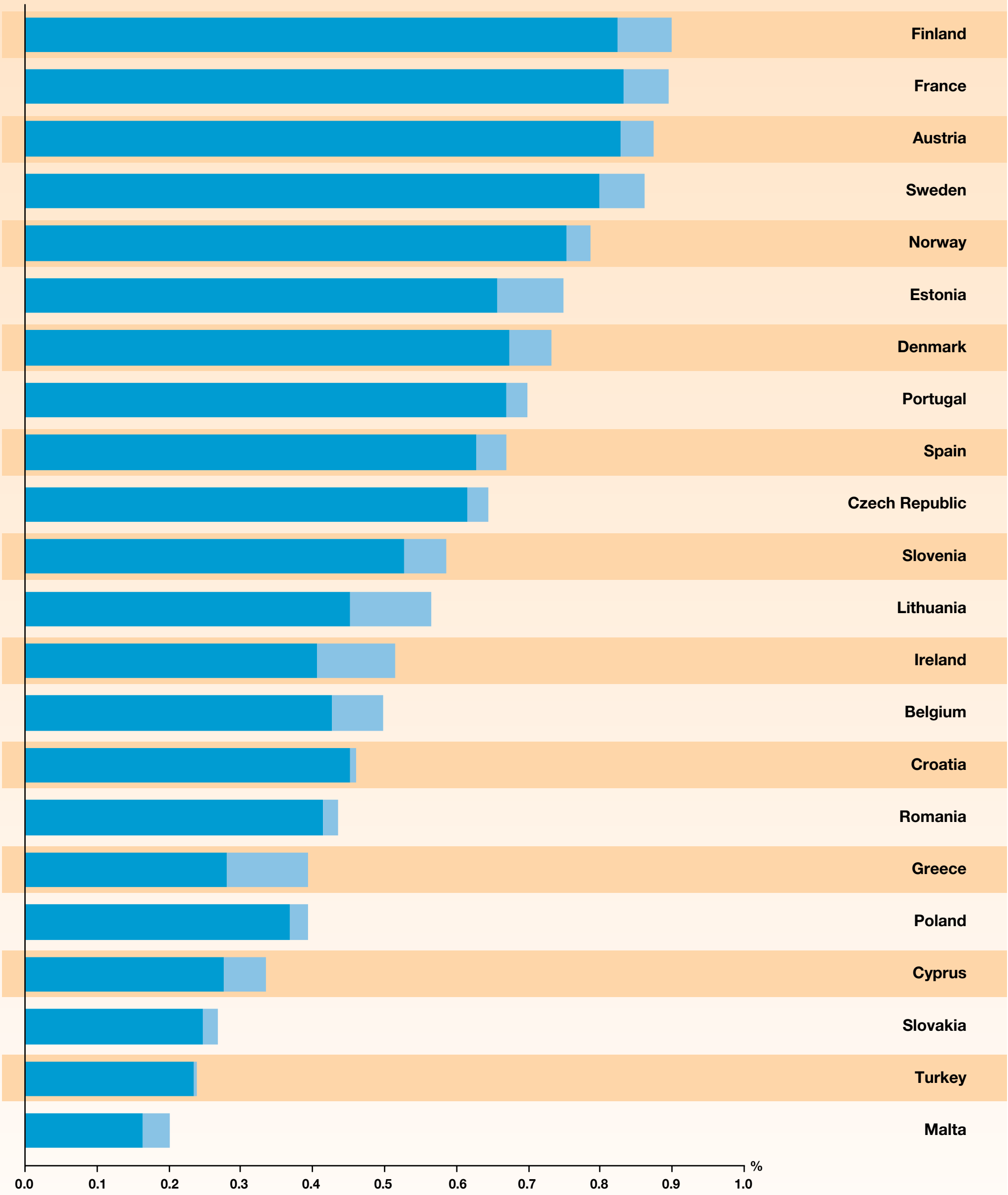
## Box I.3.2 – Public sources of funds for GERD: adding public funding from abroad to government funding

When monitoring progress towards the EU 1 % Barcelona Objective for public sources of funds for R&D, government funding is used as a proxy for all public funding of R&D in a Member State. However, government is not the sole public source of funds for R&D. There are public sources from abroad: the European Commission, other governments and international organisations. The European Commission in particular is a significant additional public source of funds for R&D in Member States, through the Research Framework Programme and Structural Funds used for R&D activities. Adding the public funding from abroad to government funding gives a better account of the intensity of public funding for R&D in a Member State (Figure I.3.7). However, this data is not available in all Member States. Besides, the latest year available for the further breakdown of the abroad source of funds is 2008 for most Member States, while data on government funding is available for 2009 (Figure I.3.3).

In government funding, only direct funding of R&D is recorded. To give a more exhaustive measure of total public support to R&D, indirect government support through R&D tax incentives has to be added (Figure I.3.8). However, this data is not available in all Member States. The evolution of the sum of direct and indirect government funding with direct public funding from abroad is to be compared to the public objective that Member States had fixed for themselves in 2005 (1 % of GDP in the majority of the cases).

FIGURE I.3.7 **GERD financed by the public sector as % of GDP, 2008**(1)



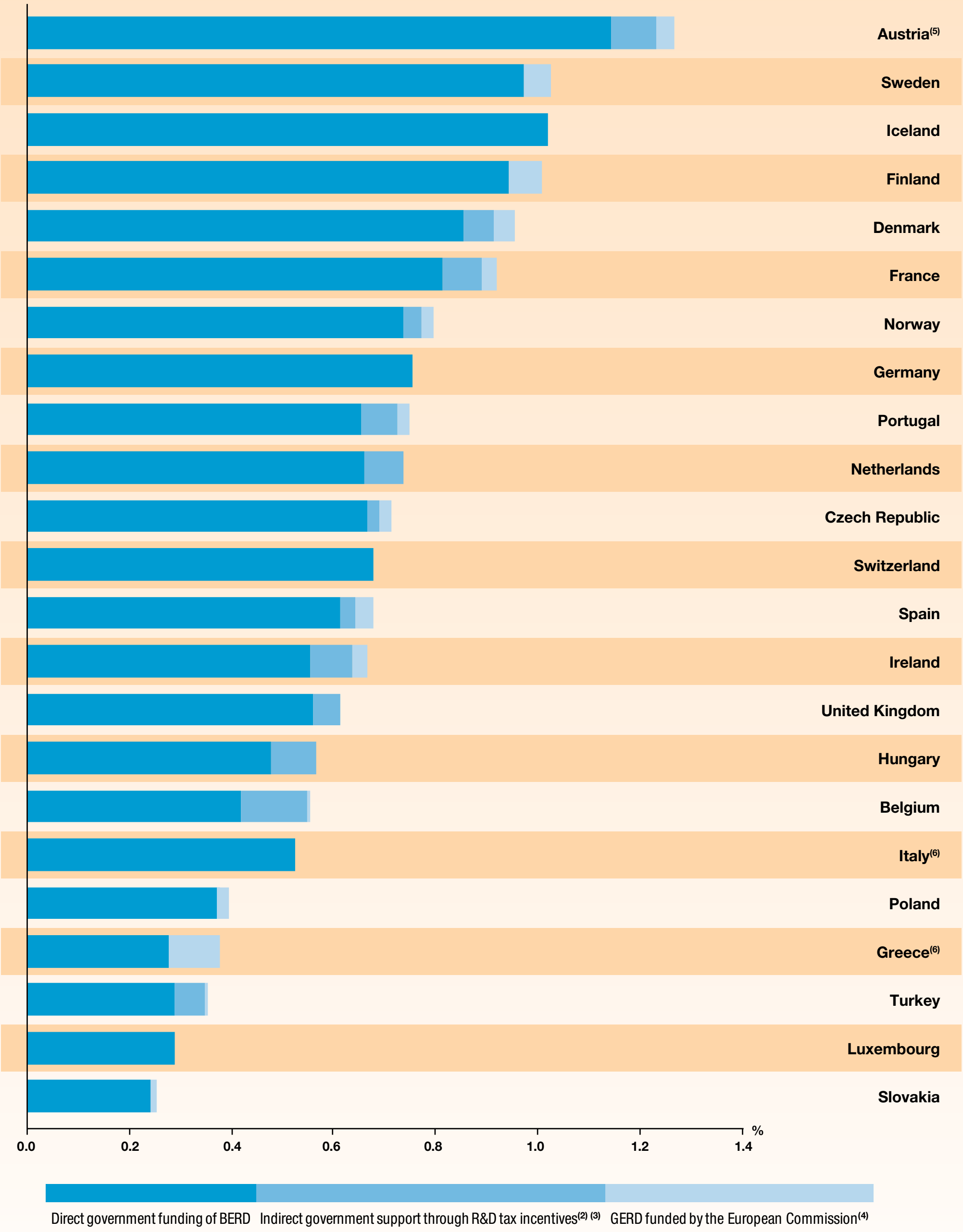
*Source:* DG Research and Innovation

*Data:* Eurostat

*Notes:* (1) EL, IE: 2005; BE, DK, AT, SE, NO: 2007; SK: 2009.
(2) Abroad (public sector) includes the European Commission, international organisations and other national governments.
(3) BG, DE, IT, LV, LU, HU, NL and UK are not included on the graph because GERD financed by abroad (public sector) is not available for these Member States.

## FIGURE I.3.8

## GERD funded by public sources (direct and indirect support) as % of GDP, 2008(1)



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*Source:* DG Research and Innovation

*Data:* Eurostat, OECD (based on national estimates from the Working Party of National Experts in Science and Technology (NESTI) R&D tax incentives questionnaire, January 2010).

*Notes:* (1) The latest year available was used for each indicator.
(2) DE, IT, LU, PL, SK, FI, SE, IS, CH have no R&D tax incentives.
(3) The R&D tax expenditures estimates do not cover sub-national R&D tax incentives.
(4) GERD funded by the European Commission is not available for: DE, IT, LU, HU, NL, UK, IS, CH.
(5) AT: The R&D tax expenditure estimate covers the refundable research premium but excludes other R&D allowances.
(6) IT (volume tax credit of 10%) and EL (tax credit of 50% for incremental R&D) provided R&D tax incentives but the cost of those incentives was not available.

## 3.2. Is overall public funding for knowledge creation growing?

Besides R&D, the public sector invests massively in education and financially supports innovation activities in firms. Together with R&D, education and innovation form the three edges of the Knowledge Triangle. While it is possible to measure public funding in education and in R&D, there is currently no reliable measure of public funding of innovation.

### *The European governments which invest most in knowledge are reaching funding levels above 7 % of GDP*

At EU-27 aggregate level, Member States' governments invested about eight times more in education (5.06 % of GDP) than in R&D (0.63 % of GDP) in 2007. Governments of the Nordic countries invest most in these two areas (between 7 % and 8 % of GDP (Figure I.3.9)).

Private funding of education represented 0.7 % of GDP on average in the EU in 2007, with most Member States contributing between 0.5 % and 0.8 % of GDP[103]. The United Kingdom and Cyprus are notable exceptions with 1.7 % and 1.3 % of GDP respectively. Private funding of education is even much more important in Japan and above all in the United States, where it amounted respectively to 1.6 % and 2.6 % of GDP in 2007. In total, public and private investment in education relative to GDP was one third higher in the United States (7.77 % of GDP) than in the EU (5.76 % of GDP) in 2007.

The evolution of total public funding to education and R&D is mainly driven by public funding to education since it is almost one order of magnitude higher than public funding to R&D. Iceland, Cyprus, Ireland, Malta and Romania are the countries in which the increase has been most important, followed by Belgium, the United Kingdom, Hungary, Spain, Croatia, Bulgaria, Spain and Luxembourg. In all other countries, public funding to education and R&D barely changed or decreased.

### *In the EU on average, more than three quarters of public expenditure on education concern pre-primary, primary and secondary education and about one quarter concerns tertiary education*

Public expenditure on tertiary education as % of GDP is by far the highest in the Nordic countries, followed by Austria, the Netherlands and Greece (Figure I.3.10). The public sector in the United States invests about 12.6 % more than the EU in tertiary education. The main difference between the EU and the United States, however, comes from the private sector, which is a major source of funds for tertiary education in the United States, while it is much more limited in the EU.

### *In a majority of European countries, between 15 % and 30 % of innovative enterprises received public funding between 2006 and 2008*

Public funding also supports innovation activities in enterprises. In a majority of the European countries providing this data, between 15 % and 30 % of innovative enterprises had received some public funding in 2008, i.e. funding from central and/or government and/or from the EU (Figure I.3.11). In a few cases, this share goes beyond 30 %. The amount of public funding that this support to innovative enterprises represents is not known.

In Member States, the share of innovative enterprises that received EU funding ranges from 1.7 % (in Spain) to 13 % (in Hungary). Unsurprisingly, this share is higher in Member States that receive large amounts of Structural Funds.

### *12 % of EU budget supports Research, Education and Innovation*

In 2009, the Framework Programme and Structural Funds supporting RTDI activities represented about 11 % of the EU budget (Figure I.3.6). Adding the Community Innovation Programme (0.37 % of EU budget over 2007–2013) and the Life-Long-Learning Programme[104] (0.71 % of EU budget over 2007–2013) brings the total EU support to Research, Innovation and Education to about 12 % of EU budget (Figure I.3.11).

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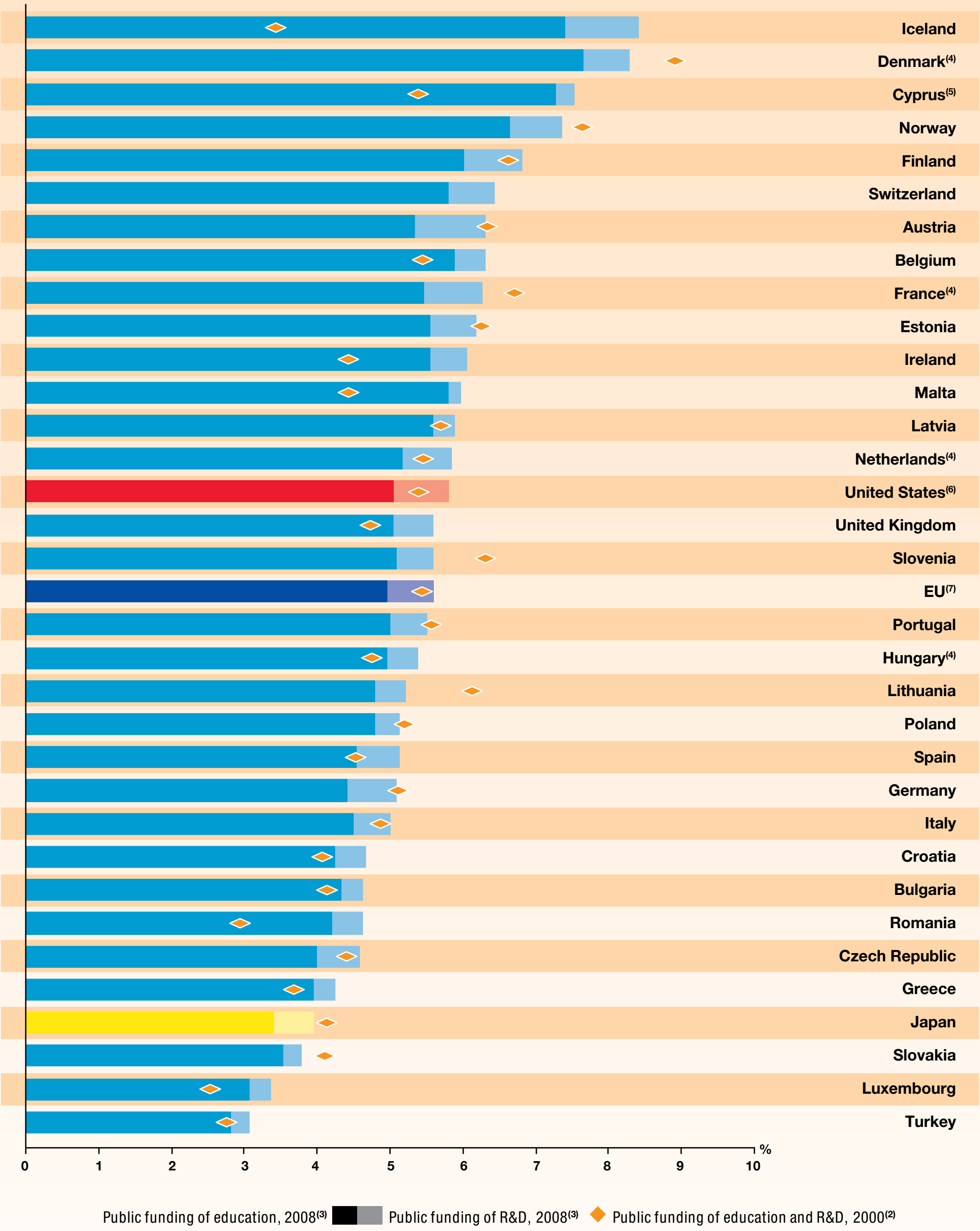
[103] This private part of education funding is not included in Figure I.3.9.

[104] The Lifelong Learning Programme includes the school education (Comenius), higher education (Erasmus), vocational training (Leonardo da Vinci) and adult education (Grundtvig).

## FIGURE I.3.9

## Public funding of education and R&D(1) as % of GDP, 2000(2) and 2008(3)



*Source:* DG Research and Innovation

*Data:* Eurostat, OECD

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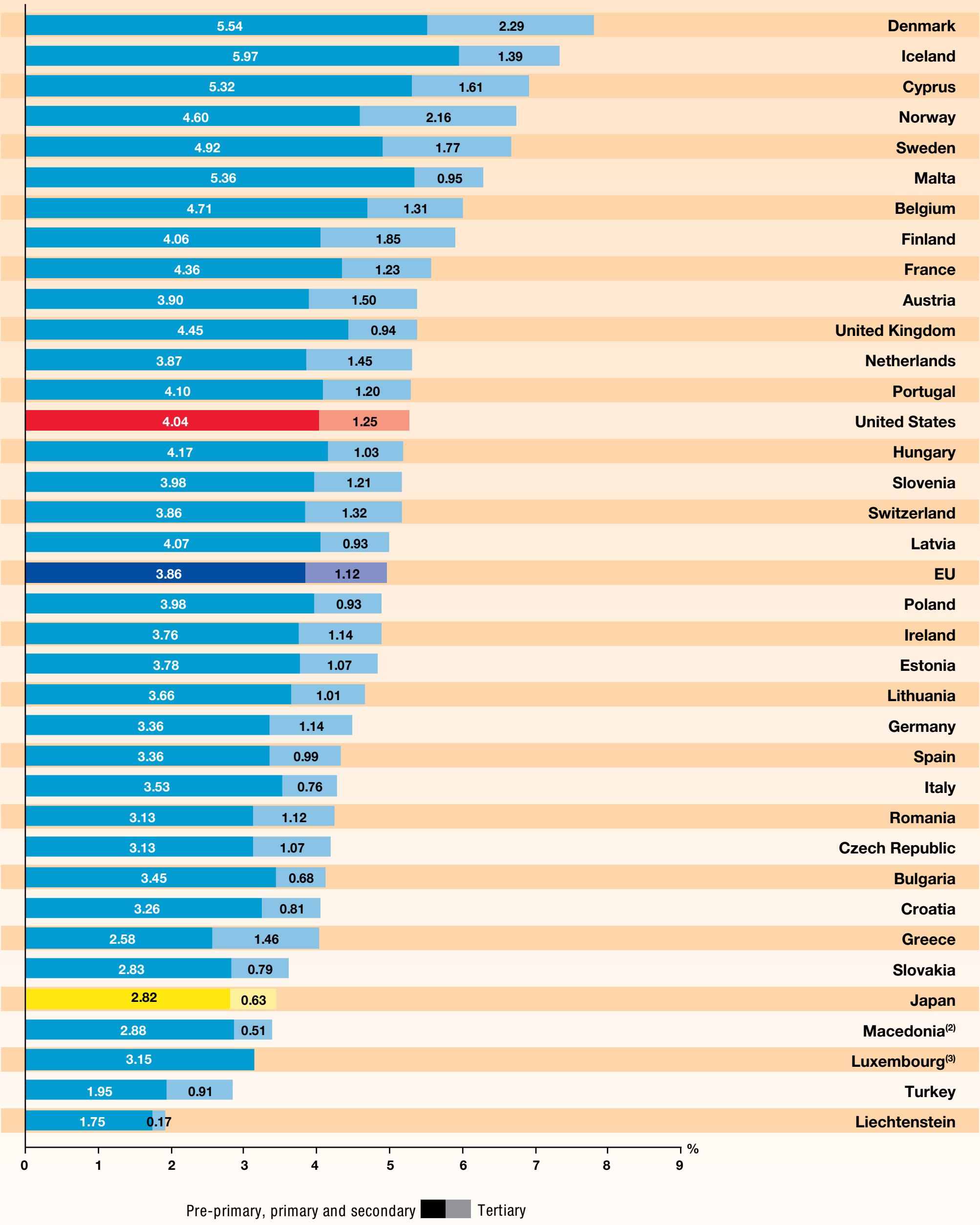
*Notes:* (1) Public funding of R&D from abroad is not included.
(2) DK, EL, SI, IS, NO: 2001; MT, HR: 2002, LU: 2003; IT: 2005.
(3) CH: 2004; EL: 2005; TR: 2006; EU, BE, DK, DE, LU, NL, PL, PT, SI, UK, NO, US: 2007.
(4) DK, FR, HU, NL: Breaks in series occur between 2000 and 2008.
(5) CY: Funding for students studying abroad is included.
(6) US: Public funding of R&D does not include most or all capital expenditure.
(7) EU does not include EL, IT, LU, SI, SE.
(8) SE: Data are not available.

## FIGURE I.3.10 Public expenditure on education as % of GDP, 2007[1]



*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) MK: 2003; EL: 2005; TR: 2006.
(2) The former Yugoslav Republic of Macedonia.
(3) LU: Data are not available for tertiary education.

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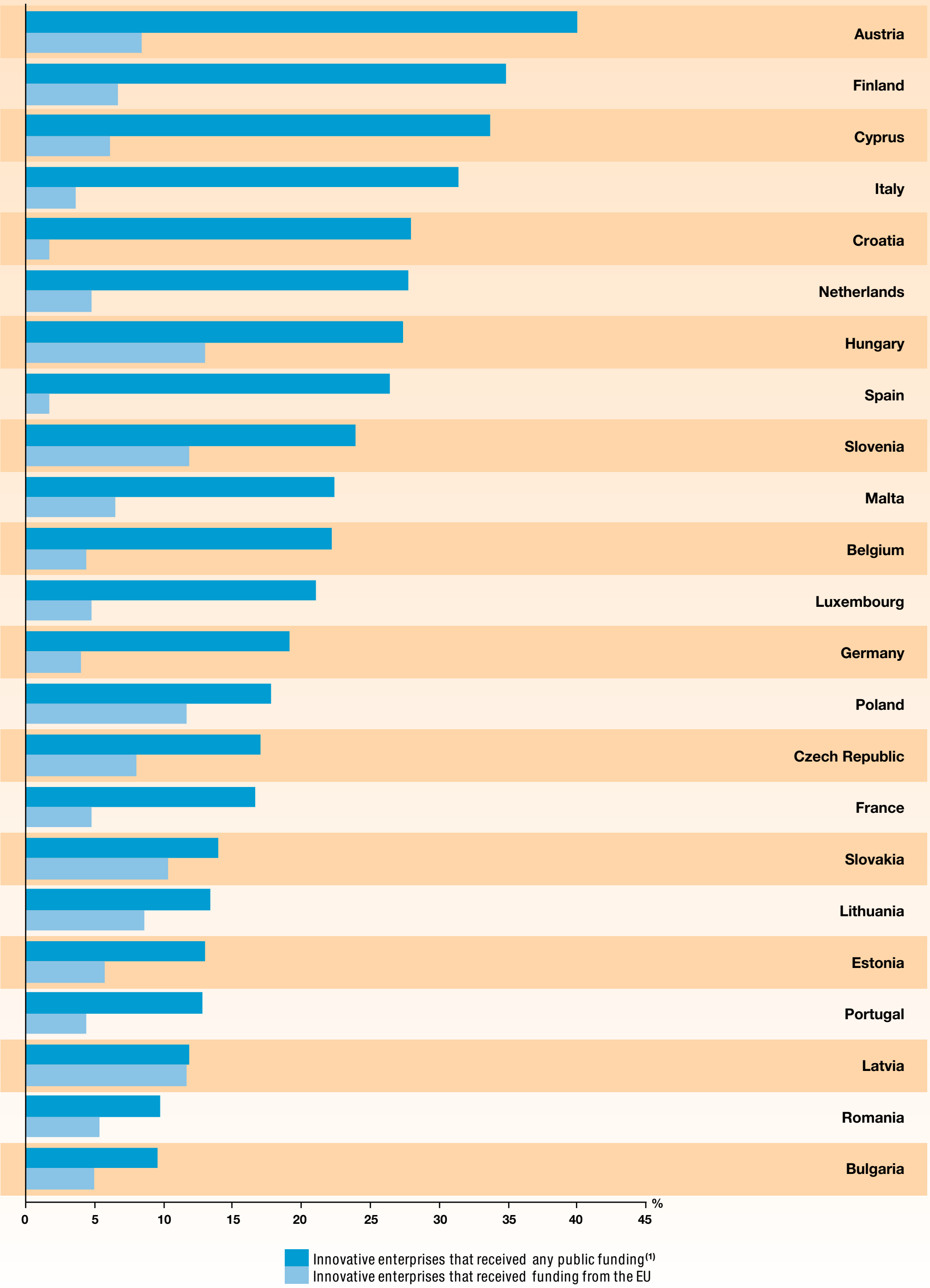
## FIGURE I.3.11 Shares of innovative enterprises that received public funding, 2006-2008



*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) Funding from central government, local or regional authorities or the EU.

# CHAPTER 4

# Investing in human resources for R&D

## HIGHLIGHTS

Europe is ageing, and so is its population of researchers. In view of 2020, it is crucial to increase the knowledge-intensity of its labour force to counteract EU's loss of productivity, and in particular increase the share of researchers in the business sector. Over one million additional researchers are needed, in particular in the private sector.

There are promising signs in the considerable increase of new tertiary education and doctoral graduates in the EU, but the large stock of researchers are not being employed in the business sector to the same extent as in its major competitors in the world economy.

With more than 895 000 students receiving a tertiary degree in Science and Engineering in 2008, the European Union produces an impressive resource in human capital for R&D - more than twice as much as in the United States. The number of tertiary degrees in the EU has increased at an average annual rate of nearly 5.0 % per year over the period 2000–2008.

The number of doctorates awarded in 2008, at 111 000, is more than twice the number awarded in the United States, mirroring the impressive potential of EU's human resources for a knowledge-based economy. The number of doctorates in Science and Engineering follows the same pattern with respectively 47 000 for the EU and 23 000 for the United States.

The EU, the United States and China have almost the same number of researchers in absolute terms. In 2008, there were 1.5 million FTE researchers in the EU compared to 1.6 million in China and – in 2007 – 1.4 million in the United States. Compared to 2007, China has now passed the EU and the United States in total number of researchers. However, the employment pattern of these researchers is not similar. The number of researchers in the public sector in the EU is more than twice the number of researchers in public sector in the United States.

Despite these impressive resources, both in terms of stock of researchers and in terms of in-flow, the EU is lagging behind where the human resources employed by business for R&D are concerned. Only 690 000 researchers work in the private sector of the EU compared to 1 113 000 in the United States and more than 490 000 in Japan. In the EU less than one out of two researchers are employed in the private sector; in the United States this accounts for four out of five researchers and in Japan and China approximately two out of three researchers are employed in the business sector. The EU is catching up, albeit slowly, in terms of researchers employed in the business sector.

## 4.1. What are the demographic prospects for the coming decades?

In the face of the economic challenge of a massive increase in the number of elderly while the number of young people is decreasing, massive investment into education and research is needed to ensure sufficient competitiveness over the next decades. According to the Eurostat population projections Europop2010, in 2011, the EU's population of working age is due to peak, and from 2011 onwards the size of the potential labour force is expected to decrease[105] (Figure I.4.1).

The resulting challenges ahead of the EU are twofold: a decreasing number of young Europeans will have to create the wealth to finance living expenditures for the increasing number of elderly Europeans in an increasingly competitive world[106]. Highly skilled human resources are the necessary pre-requisite for Europe to rise to this challenge.

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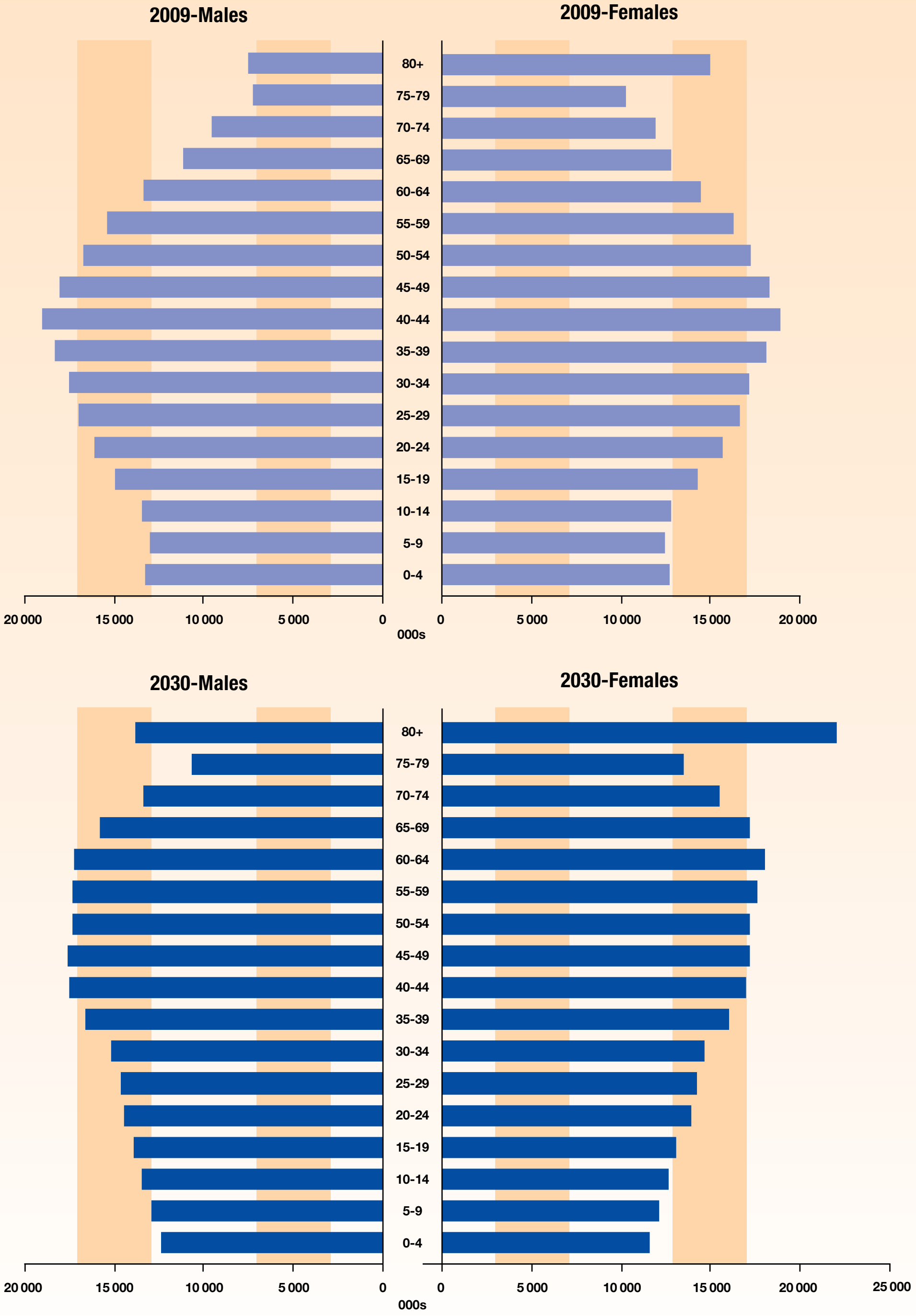
[105] http://ec.europa.eu/social/main.jsp?langId=en&catId=103&newsId=434&furtherNews=yes.

[106] For an up to date overview of the increase in world competitiveness in research and innovation, see the Overview section in the beginning of this report and the Competitiveness chapter in Part III, chapter 4. See also the European Competitiveness report 2010, COM(2010) 614.

FIGURE I.4.1 **EU - Population by age group, 2009 and 2030 (projections)**



*Source:* DG Research and Innovation
*Data:* Eurostat

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Achieving the 3 % R&D intensity target will require changes beyond the mere research and innovation actors, and will have broader implications for both the economy and the educational and labour systems, that will be required to provide and utilise increasing numbers of new skills, including research skills. An increasing number of researchers will have to be trained or attracted if rises in R&D (private and public) budgets are to be absorbed efficiently. Beyond this quantitative challenge, there is also a qualitative dimension that will need to be taken into account, as many of the new researchers will be needed in different scientific fields and will have to be employed in the private sector.

In order to avoid any bottlenecks in the scientific, technological and economic transformation of the European Union, it is important to assess and estimate (quantify) the needs for new skills, and especially the needs for new researchers.

### *Almost 40 % of the human resources in science and technology in the EU are 45 years or older*

Overall the core of human resources in science and technology (HRSTC) in Europe are rather mature. 37 % of HRST core is more than 45 years old (Figure I.4.2). In Member States with high or medium-high R&D intensities (Austria, Denmark, Germany, Finland and Sweden), the share of individuals younger than 34 is very low. The human resources in science and technologies are on average younger in countries with medium and low R&D intensities: in Poland, Malta, Ireland, Portugal and Turkey the share of individuals younger than 35 is above 40 %, indicating a relatively young population of human resources in science and technology.

### *Over one million additional researchers are needed, in particular in the private sector*

The growth rate in the number of researchers is somehow consistent with the increase in the absolute R&D budgets in the EU, but they are much higher than the R&D intensity growth in the European Union. For 2020, the combination of an increase in R&D intensity and of economic growth will require a very sharp increase in the number of HRST staff.

The estimation of the number of researchers needed is complex because many of the variables affecting this estimate co-evolve[107] over time and, therefore, the accuracy of any estimate based on past data can only be tentative and needs to be handled with caution. The number of researchers, however, is directly linked to the absolute level of research investment available in one economy. As such, research funding can happen in two ways:

1. **Increases in GDP with a constant evolution of R&D intensity**

2. **Increases in Research intensity with a flat GDP growth**

In the case of the EU, the total research investment is expected to grow thanks to (1) an increase of GDP in the economy, and (2) an increase in Research intensity that may pass from 1.9 % in 2008 to 3 % in 2020. An estimation based on these assumptions ends up with the need of additional one million researchers by 2020[108]. This estimation does not include the additional need of researchers to substitute those leaving their employment for retirement.

### *The quality of the future human resources is of crucial importance*

Public expenditures in education (all levels) is below the EU average of around 5 % of GDP in 13 Member States, in particular in Southern and Eastern European countries[109]. Those Member States that have a relatively low public investments in primary, secondary and tertiary education also (with some exceptions) have a relatively weaker performance by high school students in the PISA study of OECD (Figure I.4.3), raising potential concerns about the quality of the future labour force. Only 8 European countries have a score which is above OECD average.

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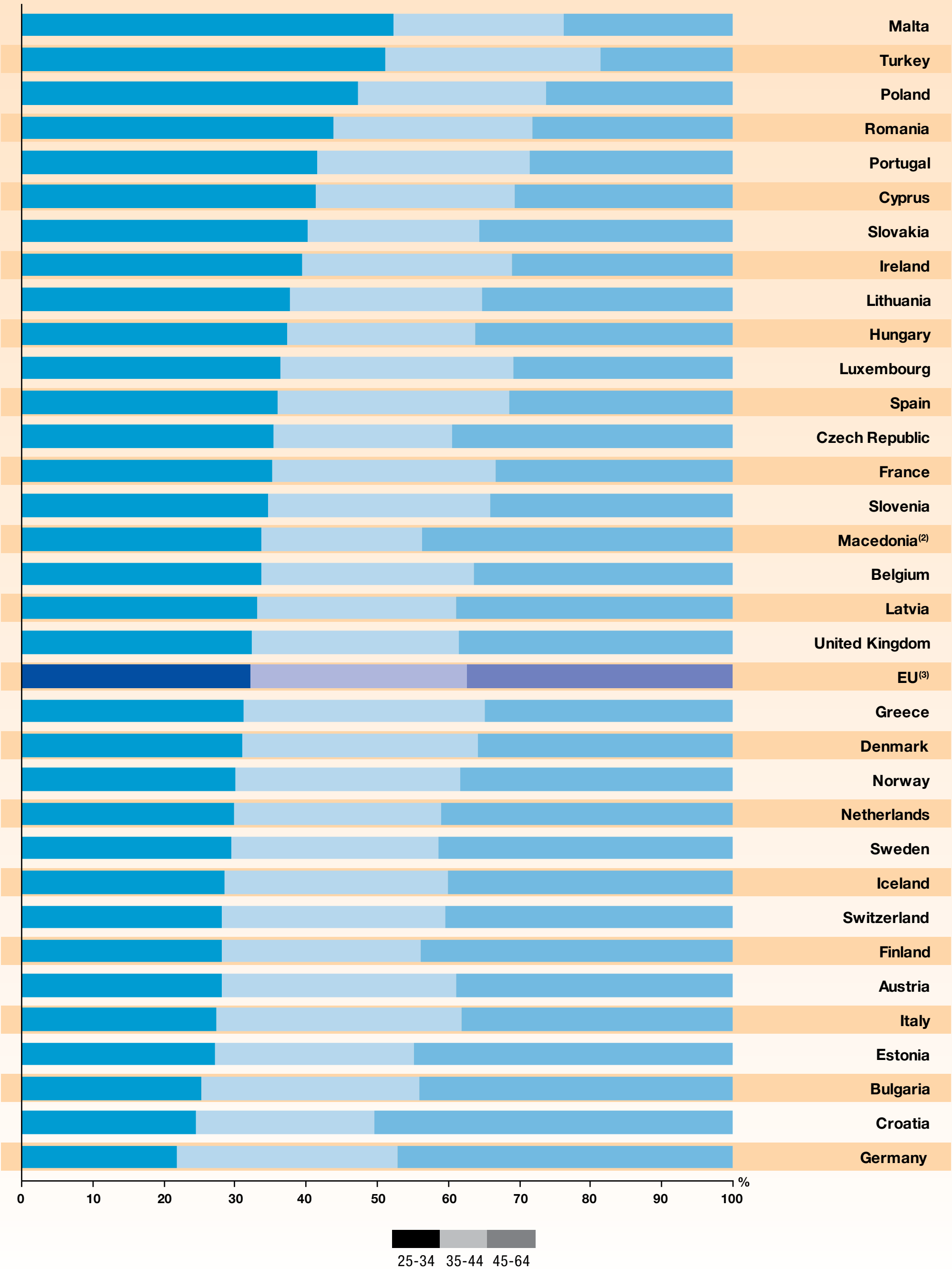
[107] The rate of economic growth, the economic structure or the scientific and technological specialisation of an economy are variables that are closely interrelated with research investments and the number of HRST staff needed, and their changes affect each other.

[108] For the specific calculations, see the Methodological annex to this report.

[109] See figure I.3.9. in Part I, chapter 3.2 on public investments in knowledge.

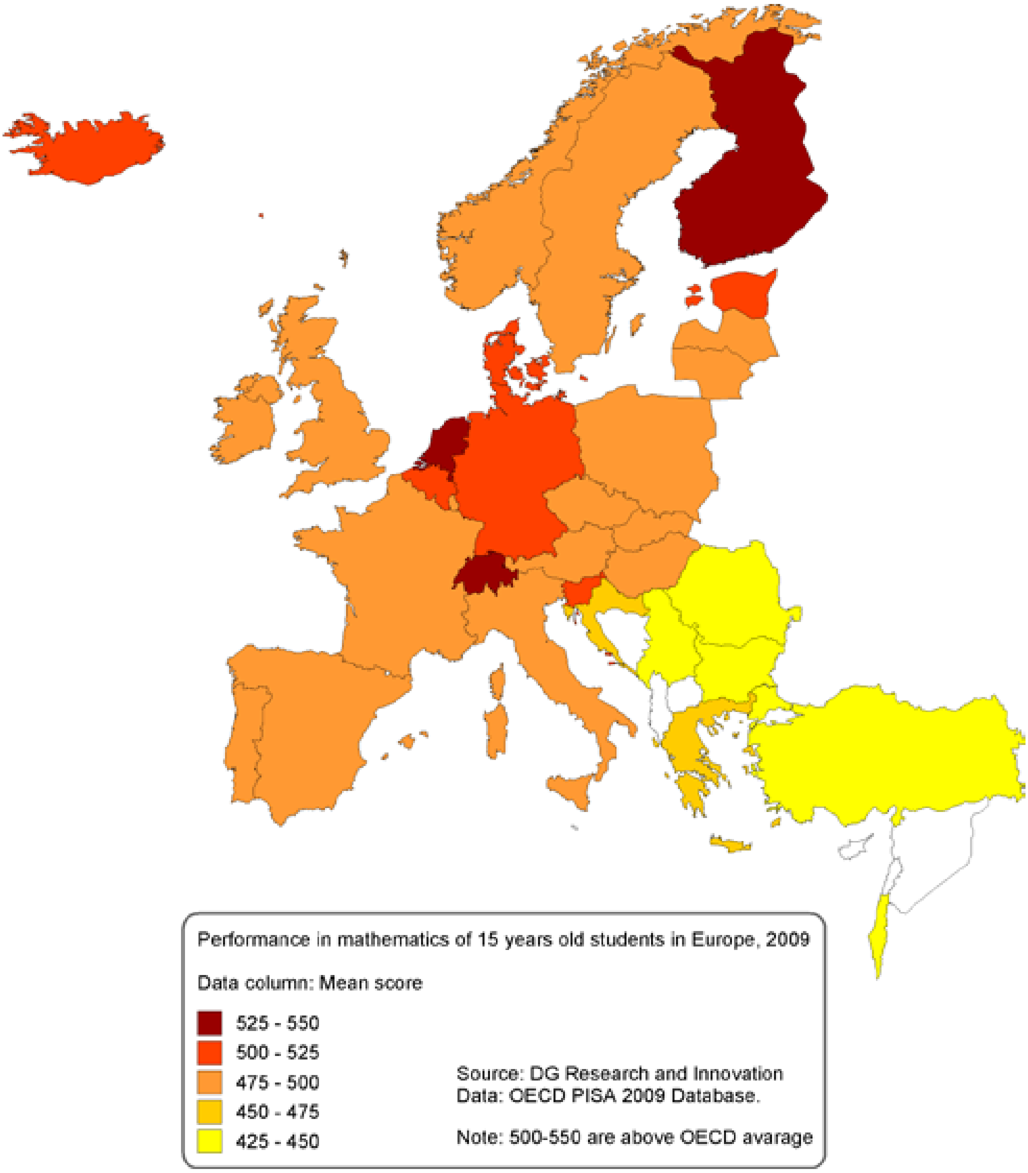
FIGURE I.4.2

## Human Resources in Science and Technology - Core (HRSTC) - % distribution by age group, 2009(1)



*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) LU: 2008.
(2) The former Yugoslav Republic of Macedonia.
(3) EU does not include LU.

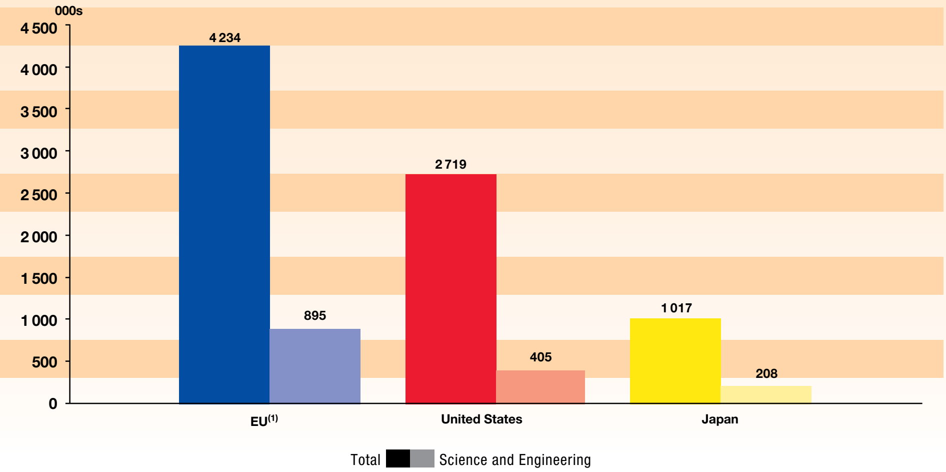
FIGURE I.4.3 **Performance in mathematics of 15 years old students in Europe, 2009**



Source: DG Research and Innovation
Data: OECD PISA 2009 Database.

Note: 500-550 are above OECD avarage

FIGURE I.4.4 **Tertiary graduates, ISCED 5, 2008**



*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) EU: Total science and engineering was estimated by DG Research and Innovation.

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## 4.2. Is Europe training sufficient researchers and skilled human resources?

Today's students are the future human resources in research and development. Therefore, this section presents the current picture on the number of tertiary degrees in the EU in the period 2000–2008. In particular, the focus lies on the analysis of tertiary degrees (ISCED 5) and of doctoral degrees (ISCED 6), given that these graduates provide the main 'pool' of potential employees which meets the demand for scientists and researchers.

Based on the International Standard Classification of Education (ISCED 97) terminology, the first stage of tertiary education (ISCED level 5) programmes include ISCED 5A programmes which are 'largely theoretically based and are intended to provide sufficient qualifications for gaining entry into advanced research programmes and professions with high skills requirements,' and ISCED 5B are programmes which are 'practical/technical/occupationally specific'. The ISCED 6 level, 'second stage of tertiary education leading to an advanced research qualification', is reserved for tertiary programmes which 'are devoted to advanced study and original research and are not based on course-work only.'[110]

### *The EU has a higher number of graduates from the first stage of tertiary education than the United States and Japan, as well as a higher share of graduates in Science and Engineering*

These graduates provide the bulk of Human Resources in Science and Technology for industry as well as a talent pool for doctoral students (and future researchers). Figure I.4.4 provides a comparison between the EU, the United States and Japan for the number of tertiary degrees and the share of Science and Engineering tertiary degrees awarded in 2008. 4.2 million degrees were awarded in the EU compared with 2.7 million in the United States and about 1 million in Japan. Expressed in percentage of the number of tertiary graduates, the figures are respectively of 21 % (EU), 15 % (United States) and 20 % (Japan).

The number of Science and Engineering degrees (ISCED 5) awarded in the EU increased from about 784000 in 2004 to 895000 in 2008. In 2008, the EU exhibits a considerably larger production of Science and Engineering degrees compared to the United States (405000) and Japan (208000). Together with the 47 000 doctorate graduates (ISCED 6) in Science and Engineering, the EU produced 940 000 S.E graduates in 2008.

The trends are very different between countries (Table I.4.1). A number of countries have dramatically

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[110] For a documentation of ISCED 1997, see the following document: http://www.uis.unesco.org/TEMPLATE/pdf/isced/ISCED_A.pdf.

## TABLE I.4.1 Tertiary graduates - Total ISCED 5 and Science and Engineering, 2000 and 2008

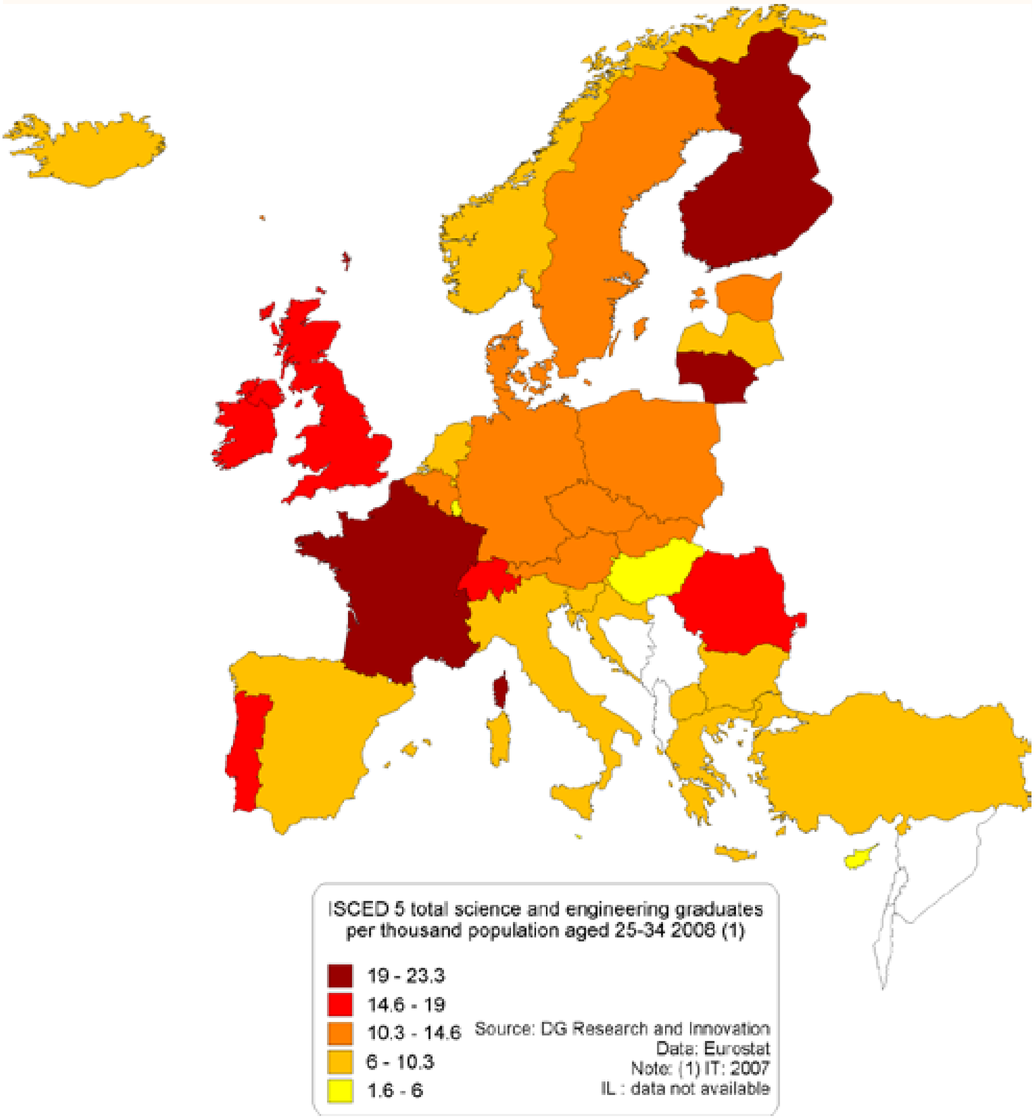
| | Total ISCED 5 | | | Science and Engineering | | |
|---|---|---|---|---|---|---|
| | 2000(1) | 2008 | Average annual growth 2000-2008(2) | 2000(1) | 2008(3) | Average annual growth 2000-2008(4) |
| Belgium | 67 078 | 95 368 | 4.5 | 12 287 | 14 451 | 2.0 |
| Bulgaria | 46 319 | 54 309 | 2.0 | 7947 | 9613 | 2.4 |
| Czech Republic | 37 481 | 86 593 | 11.0 | 8848 | 21 341 | 11.6 |
| Denmark | 38 222 | 48 652 | 3.1 | 8059 | 9216 | 1.7 |
| Germany | 276 314 | 441 731 | 6.0 | 70 225 | 113 408 | 6.2 |
| Estonia | 7626 | 11 184 | 4.9 | 1441 | 2241 | 5.7 |
| Ireland | 41 508 | 58 984 | 4.5 | 14 190 | 14 037 | -0.1 |
| Greece | 46 840 | 65 550 | 8.8 | 12 326 | 16 120 | 6.9 |
| Spain | 254 218 | 283 734 | 1.4 | 62 911 | 71 825 | 1.7 |
| France | 497 785 | 610 135 | 2.6 | 148 811 | 156 474 | 0.6 |
| Italy | 198 265 | 385 603 | 8.7 | 44 961 | 77 579 | 8.1 |
| Cyprus | 2800 | 4200 | 5.2 | 333 | 517 | 5.7 |
| Latvia | 15 220 | 24 031 | 5.9 | 2405 | 3005 | 2.8 |
| Lithuania | 24 799 | 42 178 | 6.9 | 6403 | 8802 | 4.1 |
| Luxembourg | 680 | 330 | -8.6 | 99 | 110 | 1.3 |
| Hungary | 59 166 | 62 190 | 0.6 | 6902 | 8303 | 2.3 |
| Malta | 1997 | 2781 | 4.2 | 185 | 354 | 8.4 |
| Netherlands | 76 927 | 121 014 | 5.8 | 11 630 | 16 320 | 4.3 |
| Austria | 23 191 | 41 439 | 7.5 | 6754 | 11 560 | 6.9 |
| Poland | 426 704 | 552 407 | 3.8 | 43 454 | 87 782 | 10.6 |
| Portugal | 51 751 | 79 146 | 5.5 | 9261 | 27 383 | 14.5 |
| Romania | 134 000 | 308 204 | 18.1 | 31 836 | 50 534 | 9.7 |
| Slovenia | 11 201 | 16 816 | 5.2 | 2500 | 2838 | 1.6 |
| Slovakia | 22 253 | 63 371 | 14.0 | 4555 | 12 928 | 13.9 |
| Finland | 34 344 | 58 124 | 6.8 | 9438 | 15 319 | 6.2 |
| Sweden | 39 342 | 56 809 | 4.7 | 11 440 | 12 892 | 1.5 |
| United Kingdom | 492 513 | 659 594 | 3.7 | 134 401 | 136 749 | 0.2 |
| EU(5) | 3500 154 | 4234 477 | 4.9 | 784 711 | 894 583 | 3.3 |
| Iceland | 1777 | 3604 | 9.2 | 351 | 480 | 4.0 |
| Liechtenstein | 61 | 141 | 18.2 | 25 | 31 | 4.4 |
| Norway | 29 277 | 33 983 | 1.9 | 4736 | 4817 | 0.2 |
| Switzerland | 54 899 | 76 089 | 5.6 | 12 316 | 14 949 | 3.3 |
| Croatia | 16 570 | 26 444 | 9.8 | 3262 | 5989 | 12.9 |
| Macedonia(6) | 3841 | 11 110 | 14.2 | 1161 | 1961 | 6.8 |
| Turkey | 187 956 | 441 004 | 11.2 | 56 450 | 96 381 | 6.9 |
| United States | 2106 146 | 2718 558 | 3.2 | 353 104 | 405 110 | 1.7 |
| Japan | 1069 243 | 1017 478 | -0.6 | 231 926 | 208 074 | -1.3 |

*Source:* DG Research and Innovation

*Data:* Eurostat

*Notes:* (1) PL: 2001; CH: 2002; RO, LI, HR: 2003; EU, EL: 2004.
(2) PL: 2001-2008; CH: 2002-2008; RO, LI, HR: 2003-2008; EU, EL: 2004-2008.
(3) IT: 2007.
(4) IT: 2000-2007; PL: 2001-2008; CH: 2002-2008; RO, LI, HR: 2003-2008; EU, EL: 2004-2008.
(5) EU: The value for Science and Engineering for 2008 was estimated by DG Research and Innovation.
(6) The former Yugoslav Republic of Macedonia.

FIGURE I.4.5 **New graduates in Science and Engineering per thousand population aged 25-34, 2008**



Source: DG Research and Innovation
Data: Eurostat
Note: (1) IT: 2007
IL : data not available

stepped up their efforts in the training of Science and Engineering graduates, such as Croatia, the Czech Republic, Poland, Portugal, Romania and Slovakia. Strong innovation performers such as Austria, Finland and Germany have also maintained a significant growth of S&E graduates, whereas France and the United Kingdom remain nearly static, although they still produce the largest number of S&E graduates. In growth terms, the EU as a whole is outperforming the United States and Japan with the latter, in particular, experiencing a decrease in the number of Science and Engineering graduates.

Figure I.4.5 illustrates the share of new graduates in Science and Engineering in the population aged 25-34 reflecting the addition of Science and Engineering graduates to the working population. France, Finland and Lithuania are the leading Member States in that respect.

### The EU produces almost twice as many Science and Engineering doctoral degrees as the United States - 47 000 Science and Engineering doctoral degrees were awarded in the EU in 2008 compared with 23 000 in the United States

Figure I.4.6 provides a comparison between the EU, the United States and Japan for the number of doctoral degrees awarded in 2008 (tertiary graduates at level ISCED 6), as well as for the share of Science and Engineering doctoral degrees awarded. In 2008, around 111 000 doctoral degrees were awarded in the EU compared with 64 000 in the United States and 16 000 in Japan.

Relative to the population aged 25–34, the number of new doctoral graduates is the highest in Sweden, Finland, Germany and Portugal (Figure I.4.7). On the contrary, several Eastern European countries, as well as Spain and Greece, show a very low intensity of new doctoral graduates in their population.

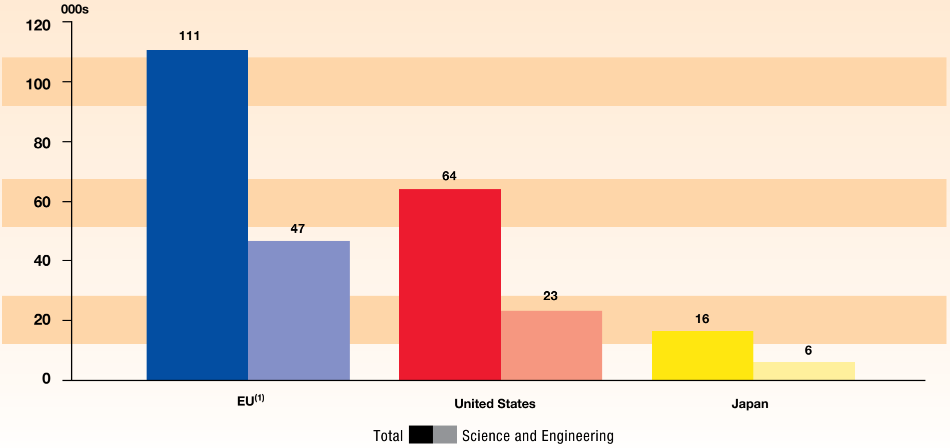
Figure I.4.7 below, seen in relation with figure I.4.5 above, highlights some interesting differences between countries. The leading countries in the overall production of Science and Engineering graduates were Finland, France and Estonia while the leading ones in terms of doctoral graduates in Science and Engineering are Sweden, Switzerland and Portugal. Secondly, despite their recent efforts a number of EU-12 Member States and Associated countries have not managed to close the gap in terms of doctoral graduates. Some of them, however (e.g. the Czech Republic and Slovenia) are now on a par with countries such as Austria, France, the United Kingdom and Ireland.

Concerning the overall doctoral degrees in the EU, Germany, the United Kingdom, Italy and France have awarded the highest numbers of doctoral degrees — about 26 000, 17 000, 13 000 and 11 000, respectively. Spain follows with around 7 000 doctoral degrees each year. These six countries account for 70 % of the total number of doctoral degrees awarded in the EU in 2008 (Table I.4.2).

### The annual growth rate of tertiary degrees in Science and Engineering in the EU was similar to the average for all fields. This rate is similar to the trends observed in the Unites States and Japan.

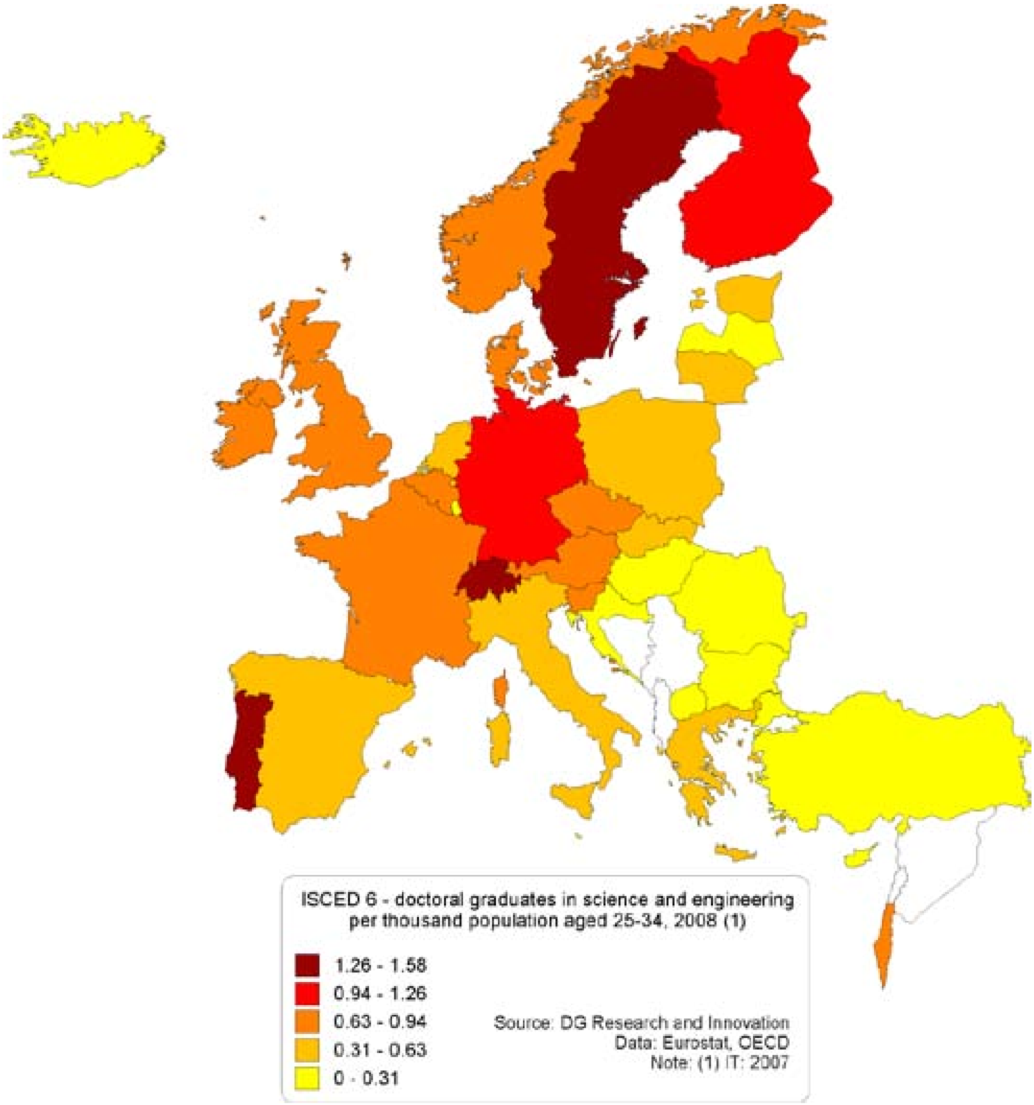
About 111 000 doctoral degrees were awarded in 2008, with 46 000 doctoral degrees in Science and Engineering (Table I.4.2). Between 2004 and 2008, the number of doctoral degrees in the EU increased at an average annual rate of 3.8 % per year. In Science and Engineering the annual growth rate (4.0 %) was slightly higher.

FIGURE I.4.6 **Tertiary graduates, ISCED 6, 2008**



*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) EU: Total science and engineering was estimated by DG Research and Innovation.

## FIGURE I.4.7 New doctoral graduates in Science and Engineering per thousand population aged 25-34, 2008



ISCED 6 - doctoral graduates in science and engineering per thousand population aged 25-34, 2008 (1)

Source: DG Research and Innovation
Data: Eurostat, OECD
Note: (1) IT: 2007

These global figures hide a number of important differences between countries. The number of doctoral degrees decreased both globally and in Science and Engineering in Germany, while it increased very slowly in France, Finland and Sweden. Countries such as Italy, the Czech Republic, Portugal, Slovakia, Cyprus and Malta have been catching up with double digit growths. Estonia, Ireland and Latvia are close in terms of growth.

## TABLE I.4.2

## Tertiary graduates - Total ISCED 6 and Science and Engineering, 2000 and 2008

| | Total ISCED 6 | | | Science and Engineering | | |
|---|---|---|---|---|---|---|
| | 2000(1) | 2008 | Average annual growth 2000-2008(2) | 2000(1) | 2008(3) | Average annual growth 2000-2008(4) |
| Belgium | 1147 | 1880 | 6.4 | 632 | 917 | 4.8 |
| Bulgaria | 399 | 601 | 5.3 | 129 | 223 | 7.1 |
| Czech Republic | 895 | 2382 | 13.0 | 510 | 1239 | 11.7 |
| Denmark | 795 | 1102 | 4.2 | 397 | 446 | 1.5 |
| Germany | 25 780 | 25 604 | -0.1 | 9820 | 9495 | -0.4 |
| Estonia | 117 | 161 | 4.1 | 42 | 89 | 9.8 |
| Ireland | 501 | 1090 | 10.2 | 282 | 584 | 9.5 |
| Greece | 1295 | 1406 | 2.1 | 830 | 526 | -10.8 |
| Spain | 6007 | 7302 | 2.5 | 2169 | 2855 | 3.5 |
| France | 10 404 | 11 309 | 1.0 | 5945 | 6644 | 1.4 |
| Italy | 4044 | 12 591 | 15.3 | 1629 | 4597 | 16.0 |
| Cyprus | 13 | 28 | 10.1 | 3 | 15 | 22.3 |
| Latvia | 40 | 139 | 16.8 | 26 | 54 | 9.6 |
| Lithuania | 442 | 369 | -2.2 | 161 | 151 | -0.8 |
| Luxembourg | : | 8 | : | : | : | : |
| Hungary | 717 | 1141 | 6.0 | 297 | 257 | -1.8 |
| Malta | 6 | 11 | 7.9 | 1 | 5 | 22.3 |
| Netherlands | 2489 | 3214 | 3.2 | 842 | 1052 | 2.8 |
| Austria | 1790 | 2205 | 2.6 | 752 | 927 | 2.6 |
| Poland | 4400 | 5616 | 3.5 | 1388 | 1895 | 4.5 |
| Portugal | 2504 | 4863 | 8.7 | 823 | 2184 | 13.0 |
| Romania | 2580 | 3271 | 4.9 | 708 | 913 | 5.2 |
| Slovenia | 296 | 405 | 4.0 | 119 | 199 | 6.6 |
| Slovakia | 446 | 1655 | 17.8 | 170 | 576 | 16.5 |
| Finland | 1797 | 1951 | 1.0 | 666 | 795 | 2.2 |
| Sweden | 3049 | 3625 | 2.2 | 1530 | 1804 | 2.1 |
| United Kingdom | 11 568 | 16 606 | 4.6 | 6157 | 7268 | 2.1 |
| EU(5) | 95 350 | 110 535 | 3.8 | 39 885 | 46 597 | 4.0 |
| Iceland | 2 | 23 | 35.7 | 0 | 11 | : |
| Liechtenstein | 0 | 0 | : | 0 | 0 | : |
| Norway | 658 | 1231 | 8.1 | 82 | 533 | 26.4 |
| Switzerland | 2800 | 3426 | 3.4 | 1146 | 1372 | 3.0 |
| Croatia | 321 | 494 | 9.0 | 131 | 175 | 6.0 |
| Macedonia(6) | 34 | 87 | 12.5 | 17 | 18 | 0.7 |
| Turkey | 2124 | 3754 | 7.4 | 636 | 1126 | 7.4 |
| Israel | 688 | 1427 | 9.5 | 406 | 716 | 7.3 |
| United States | 44 808 | 63 712 | 4.5 | 16 287 | 23 146 | 4.5 |
| Japan | 12 192 | 16 296 | 3.7 | 4744 | 6288 | 3.6 |

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD
*Notes:* (1) PL: 2001; CH: 2002; RO, LI, HR: 2003; EU, EL: 2004.
(2) PL: 2001-2008; CH: 2002-2008; RO, HR: 2003-2008; EU, EL: 2004-2008.
(3) IT: 2007.
(4) IT: 2000-2007; PL: 2001-2008; CH: 2002-2008; RO, HR: 2003-2008; EU, EL: 2004-2008.
(5) EU: The value for Science and Engineering for 2008 was estimated by DG Research and Innovation.
(6) The former Yugoslav Republic of Macedonia.

## 4.3. How large is the current stock of Human Resources for Science and Technology in Europe?

The following section will look more into detail into the current stock of human resources available in Europe. Table I.4.3 gives a general picture on the human resources in S&T in the EU. It provides data on HRST and its subgroups, Scientists and Engineers and Researchers.

The active population for the EU in 2009 (referring to the total labour force, which includes both employed and unemployed persons) was about 239 million. The total employment was about 218 million. Human resources in Science and Technology accounted for 43.9% of the active population. Those who have successfully completed a tertiary-level education in an S&T (Science and Technology) field of study (HRSTE) accounted for 32.7% of the active population and 36.0% of the total employment, while the share of the active population having both completed a tertiary level education and been employed in an S&T occupation (HRSTC) accounted for 16.7%. Therefore, only half of the tertiary education graduates in an S&T field of study were employed in S&T occupations.

Total R&D personnel accounted for 1.46% of the active population. Researchers were estimated to be more than 2.1 million or 0.91% of the active population in headcounts, while researchers in FTEs accounted for 1.5 million or 0.63% of the active population.

### TABLE I.4.3 EU - Human Resources in Science and Technology by sub-group, R&D personnel and researchers, 2009(1)

| | Total (000s) | as % of active population | as % of total employment |
|---|---|---|---|
| Total active population | 239281 | : | : |
| Total employment | 217813 | 91.0 | : |
| HRST - Human Resources in Science and Technology(2) | 104839 | 43.9 | 48.2 |
| HRSTE - Human Resources in Science and Technology - Education(2) | 78281 | 32.7 | 36.0 |
| HRSTO - Human Resources in Science and Technology - Occupation(2) | 66514 | 27.8 | 30.6 |
| HRSTC - Human Resources in Science and Technology - Core(2) | 39955 | 16.7 | 18.4 |
| SE- Scientists and Engineers(2) | 11778 | 4.9 | 5.4 |
| Total R&D personnel (Head Count) | *3438* | 1.46 | 1.57 |
| Total R&D personnel (FTE) | *2455* | 1.03 | 1.11 |
| Researchers (Head Count) | *2158* | 0.91 | 0.98 |
| Researchers (FTE) | *1505* | 0.63 | 0.68 |

*Source:* DG Research and Innovation

*Data:* Eurostat

*Notes:* (1) Total R&D personnel (Head Count) and researchers (Head Count) refer to 2007; Total R&D personnel (FTE) and researchers (FTE) refer to 2008.
(2) EU does not include LU.
(3) Values in italics are estimates.

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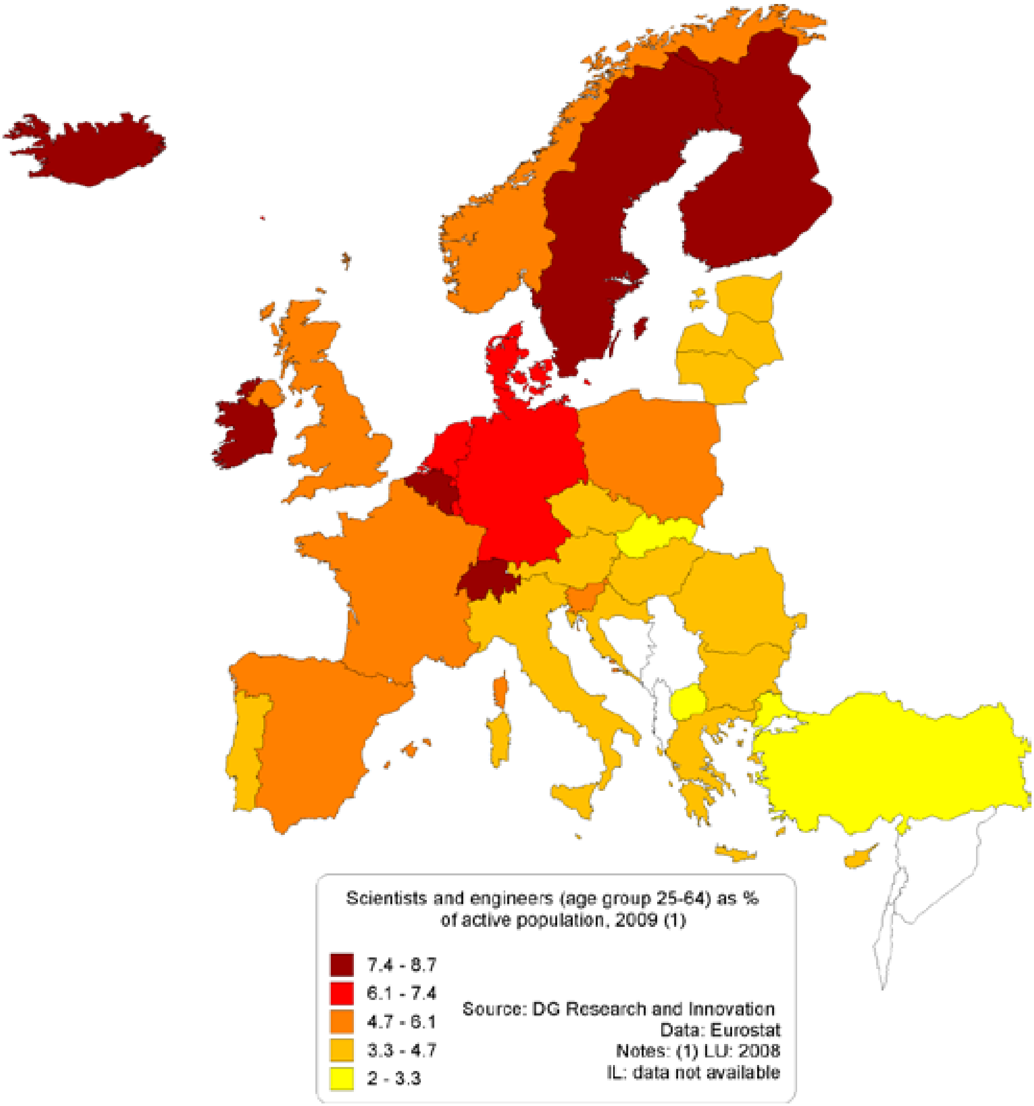
FIGURE I.4.8 **Scientists and engineers (age group 25-64) as % of active population, 2009**


Scientists and engineers (age group 25-64) as % of active population, 2009 (1)

Source: DG Research and Innovation
Data: Eurostat
Notes: (1) LU: 2008
IL: data not available

***The largest share of scientists and engineers are in Belgium, Iceland, Ireland and Switzerland***

Scientists and engineers account for 4.8 % of the active population and 5.1 % of total employment. Figure I.4.8 presents the share of scientists and engineers as a percentage of total labour force in 2009. Belgium, Iceland, Ireland and Switzerland have percentages of 8 % or more, while the share of scientists and engineers is lowest in Turkey, Slovakia and Maccedonia.

Concerning researchers, their number increased by almost 30 % at an average annual growth rate of 3.8 % between 2000 and 2008 in the EU, while R&D intensity stagnated. In 2008, there were 6.3 researcher FTEs per thousand labour force in the EU, versus 5.0 in 2000. Since 2000, the number of researchers in FTEs in the EU has increased from 1.1 million to 1.5 million in 2008. The respective increase in the United States was from 1.3 to 1.4 million (in 2007). In Japan, the number of researchers in FTEs increased approximately 1.3 % per year from 0.6 to 0.7 million. China experienced the largest increase in the number of researchers in FTEs, from 0.7 to almost 1.6 million (10.8 % p.a.)[111].

This growth was not homogeneous across sectors, as the average annual growth rate for researchers in higher education increased by 5 %, in the private sector by 3.5 %, and in government by just 1.2 %. The percentage of researchers in the total labour force is also growing, albeit at slightly lower speed (average annual growth of 2.9 % between 2000 and 2008).

### *The share of researchers per thousand labour force was highest in Finland and Denmark in 2008, and lowest in Italy, Poland, Romania, Bulgaria and Latvia*

Figure I.4.9 and Table I.4.4 illustrate the total numbers of researchers (FTEs) in 2008. Finland has the highest penetration of researchers in the workforce with 15 researchers per 1 000 labour force. Also, other Nordic countries (Iceland, Denmark, Norway and Sweden with around 10 researchers employed) have a high number of researchers per 1 000 employed. To complete the top five we find Luxembourg in second and the United Kingdom in fifth place. Romania, Cyprus, Malta, Bulgaria and Latvia have the lowest numbers, in a striking contrast between Romania's 2 and Finland's 15 researchers per 1 000 employed.

The share of researchers in the private sector to total researchers differs significantly between the EU and other major economies. In the EU, less than half of researchers (46 %) are employed in the private sector. This share is significantly higher in the United States (79.1 % data, 2007)) and Japan (68 %). In addition, 66 % of all Chinese researchers work in the business sector.

### *The number of researchers in the private sector has increased in the EU slightly more than in the United States and Japan*

In terms of growth, the number of researchers employed in the private sector increased by 3.5 % between 2000 and 2008 in the EU against 1.2 % in the United States and 2 % in Japan. The performance of major European economies has been patchy with respect to the growth of researchers in the private sector with countries such as France, Italy in the average or slightly above, the United Kingdom and Germany lagging behind. Finland, although starting from a very high level, has remained stable. The number of researchers in the private sector decreased sharply in three EU-12 Member States (Latvia, Slovakia and Romania) between 2000 and 2008 and decreased also to a lesser extent in Poland, illustrating the difficulties of industry in those three countries to remain in the competition. In contrast, some countries have been doing very well over the period (Cyprus, Estonia, Greece, Spain, Lithuania, Portugal, Slovenia and Turkey).

### *The main increase in the number of researchers (FTEs) in the business sector from 2000 to 2007 took place in the sector of Computer and related activities with growth of over 86 %*

The number of researchers in FTEs in the business sector by selected NACE Rev.1.1 sectors in 2000 and 2007 is presented in Figure I.4.10. The stock of researchers in the business enterprise sector grows unevenly between the various sectors of economic activity. Most sectors have experienced an increase in the number of researchers employed, except for Office machinery and computers, and for Radio, TV and communication equipment, reflecting the decrease in competitiveness of the European industry in those domains. Other sectors, however, have increased substantially the stock of researchers: in Computer and related activities, Research and development, and other business activities, the overall increase in the period 2000–2007, is substantial (86 %, 71 %, and 56 %).

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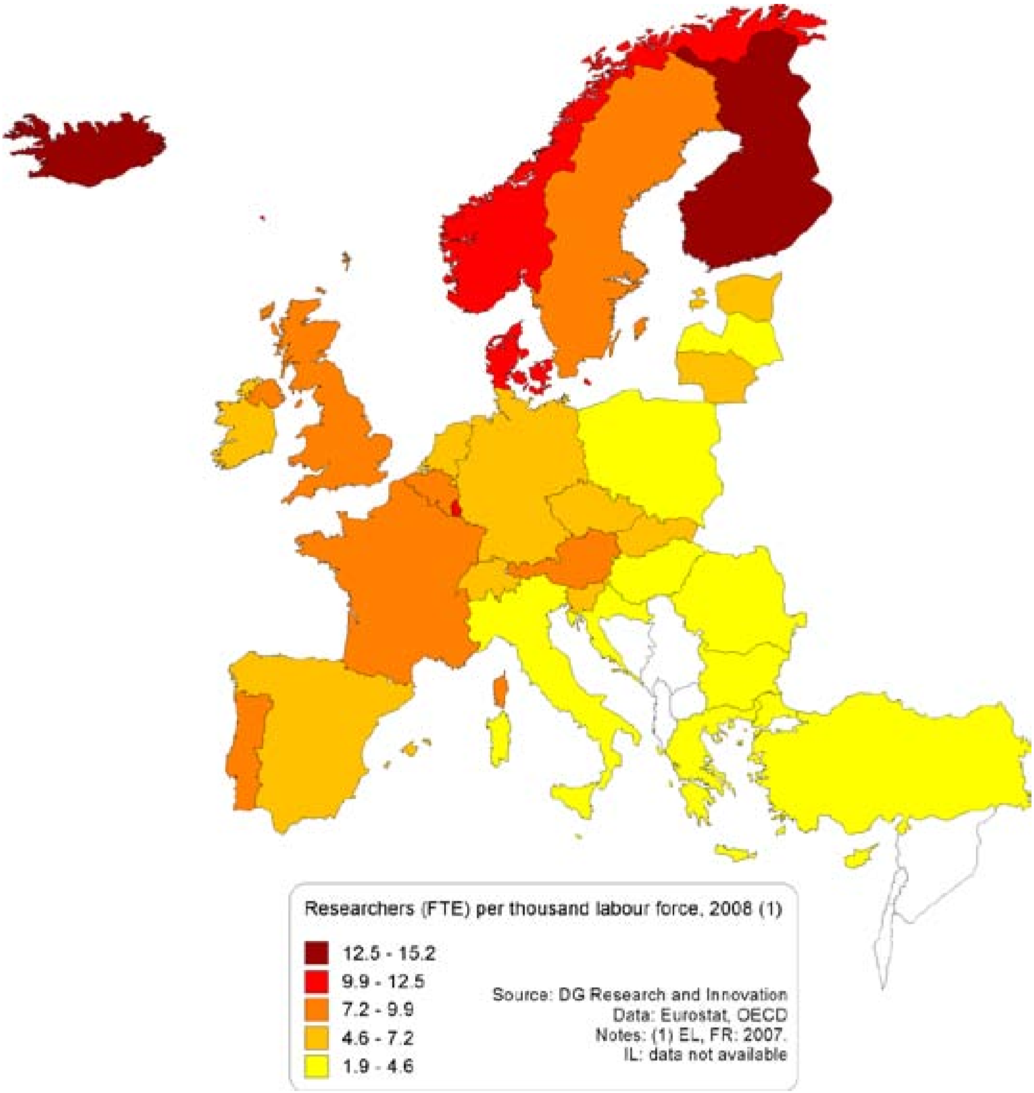
[111] For graphs benchmarking the EU with other major research-intensive countries in the world, see the first section of the report 'Overall picture', Chapter 2.2.

FIGURE I.4.9 **Researchers (FTE) per thousand labour force, 2008**



Source: DG Research and Innovation
Data: Eurostat, OECD
Notes: (1) EL, FR: 2007.
IL: data not available

## TABLE I.4.4

## Total researchers (FTE) and business enterprise researchers (FTE), 2000 and 2008

| | Total researchers (FTE) | | | Business enterprise researchers (FTE) | | |
|---|---|---|---|---|---|---|
| | 2000(1) | 2008(2) | Average annual growth 2000-2008(3) (4) | 2000(5) | 2008(6) | Average annual growth 2000-2008(7) (8) |
| Belgium | 30 540 | *36 382* | *2.2* | *16 684* | *17 838* | *0.8* |
| Bulgaria | 9 479 | *11 384* | *2.3* | *1 139* | *1 491* | *3.4* |
| Czech Republic | 13 852 | 29 785 | 7.2 | 5 533 | 13 253 | 9.3 |
| Denmark | 25 547 | *30 945* | *2.6* | 15 747 | *19 634* | *2.6* |
| Germany | 257 874 | *299 000* | *1.9* | *153 120* | *178 000* | *1.9* |
| Estonia | 2 666 | *3 979* | *5.1* | 274 | *1 233* | *20.7* |
| Ireland | 8 516 | 13 709 | 6.1 | 5 631 | *7 428* | *3.5* |
| Greece | 14 371 | *20 817* | *6.4* | 3 234 | *6 090* | *9.5* |
| Spain | 76 670 | 130 986 | 6.9 | 20 869 | 46 375 | 11.3 |
| France | 172 070 | 215 755 | 3.3 | 88 479 | 118 568 | 5.0 |
| Italy | 66 110 | *96 303* | *4.8* | 26 099 | *35 645* | *3.5* |
| Cyprus | 303 | *885* | *14.3* | 77 | *205* | *13.0* |
| Latvia | 3 814 | 4 370 | 1.7 | 995 | 487 | -8.5 |
| Lithuania | 7 777 | 8 458 | 1.1 | 288 | 1 168 | 19.1 |
| Luxembourg | 1 646 | *2 282* | *4.2* | 1 399 | *1 537* | *1.2* |
| Hungary | 14 406 | 18 504 | 5.6 | 3 901 | 7 912 | 9.2 |
| Malta | 436 | *524* | *4.7* | 199 | *249* | *5.8* |
| Netherlands | 42 088 | *51 052* | *2.4* | 20 022 | *26 578* | *3.6* |
| Austria | 24 124 | *34 377* | *6.1* | 16 001 | *21 769* | *5.3* |
| Poland | 55 174 | *61 831* | *1.4* | 9 821 | *8 934* | *-1.2* |
| Portugal | *16 738* | *40 563* | *11.7* | *2 358* | *10 589* | *20.7* |
| Romania | 20 476 | 19 394 | -0.7 | 12 690 | 6 309 | -8.4 |
| Slovenia | 4 336 | 7 032 | 6.2 | 1 380 | 3 058 | 10.5 |
| Slovakia | 9 955 | 12 587 | 3.0 | 2 420 | 1 649 | -4.7 |
| Finland | 41 004 | 40 879 | -0.1 | 23 397 | 24 132 | 0.8 |
| Sweden | 45 995 | *48 220* | *0.9* | *27 884* | *33 378* | *7.9* |
| United Kingdom | *170 554* | *261 406* | *1.7* | 91 145 | *94 279* | *0.5* |
| EU(5) | 1 118 988 | 1 504 575 | 3.8 | 524 844 | 689 867 | 3.5 |
| Iceland | 1 859 | 2 308 | 3.1 | 853 | 1 117 | 3.9 |
| Norway | 20 048 | 26 006 | 3.8 | 11 296 | 13 305 | 2.4 |
| Switzerland | 26 105 | 25 142 | -0.5 | 16 275 | 10 332 | -5.5 |
| Croatia | 8 572 | 6 697 | -4.0 | 1 253 | 1 098 | -2.2 |
| Turkey | 23 083 | 57 759 | 10.7 | 3 702 | 21 019 | 21.3 |
| United States | 1 293 582 | 1 412 639 | 1.3 | 1 041 300 | 1 130 500 | 1.2 |
| Japan | 647 572 | 656 676 | 1.9 | 421 363 | 492 805 | 2.0 |

*Source:* DG Research and Innovation

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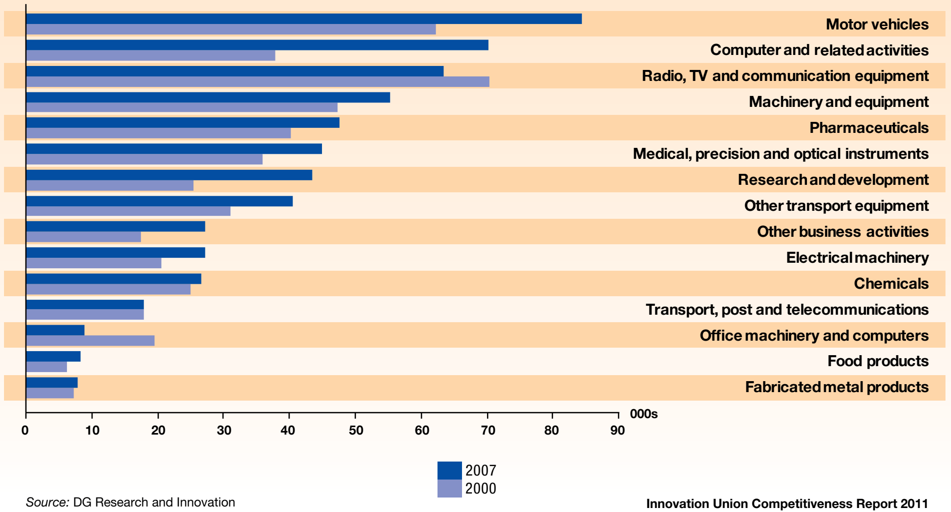
*Data:* Eurostat

*Notes:* (1) EL, SE, IS, NO: 2001; DK, AT, HR: 2002; MT, FI: 2004.
(2) EL, FR, US: 2007; TR: 2009.
(3) EL: 2001-2007; IS, NO: 2001-2008; JP: 2002-2007; AT, HR: 2002-2008; HU, MT, FI: 2004-2008; CZ, UK: 2005-2008; DK, SE: 2007-2008
(4) CZ, DK, HU, NL, SE, UK, JP: Breaks in series occur between 2000 and 2008.
(5) EL, FR, SE, UK, IS, NO: 2001; DK, AT, HR: 2002; MT, FI: 2004.
(6) EL, FR: 2007; IT, TR: 2009.
(7) EL: 2000-2007; FR: 2001-2007; UK, IS, NO: 2001-2008; ES: 2002-2007; AT, HR: 2002-2008; MT, FI: 2004-2008; CZ: 2005-2008; DK, SE: 2007-2008.
(8) CZ, DK, ES, SE: Breaks in series occur between 2000 and 2008.
(9) Values in italics are estimated or provisional.

FIGURE I.4.10

**EU - business enterprise researchers (FTE)(1) by selected NACE sector, 2000 and 2007**



*Source:* DG Research and Innovation
*Data:* MORE Study: NIFU STEP based on Eurostat data.
*Note:* (1) Estimated values.

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### *The rate of participation in Adult Lifelong Learning is highest in Sweden, Denmark, Switzerland, Iceland and Finland, with more than 20% of the population aged 25–64 participating in education and training*

Participation in measures of adult lifelong learning is crucial to keep the labour force skilled and up to date with progress in technology and innovation. This is particularly relevant with regard to the use of ICT-related innovations, as well as also to adaptation to new forms of organisations and innovation paradigms. Lifelong learning counters the depreciation of human capital, and might even increase the formation of skills and resources for innovation-related growth, as lifelong learning measures bring together the experience of trained people with new technologies and procedures. The overarching priority of the Lifelong Programme is to reinforce the contribution of education and training to the priorities and headline targets of the EU 2020 Strategy, which aims, amongst others, at enhancing creativity and innovation at all levels of education and training by promoting the acquisition of transversal key competences and by establishing partnerships with the wider world, in particular business. In 2009, the most performing countries in terms of innovation in the EU, Sweden, Denmark, Finland and the United Kingdom, together with Iceland and Switzerland[112] had more than 20% of population aged 25–64 participating in education and training (Figure I.4.11). In contrast, adult lifelong learning is lowest in low performing countries, where 5% or less of the population aged 25–64 participated in lifelong learning measures.

### *In an innovative economy there should be a shortage of Human Resources for Science and Technology. Albeit lower than global employment figures, the unemployment ratio in this category at European level remains significant*

Figure I.4.12 presents the unemployment ratios available concerning the wider population of Human Resources in Science and Technology (HRST) in Europe in 2009. Unemployment of Human Resources for Science and Technology as share of total unemployment is highest in Macedonia, Turkey, Spain, Greece, Ireland and the three Baltic states. On the contrary, the Czech Republic, Austria and Norway have achieved unemployment ratios below 1.5%.

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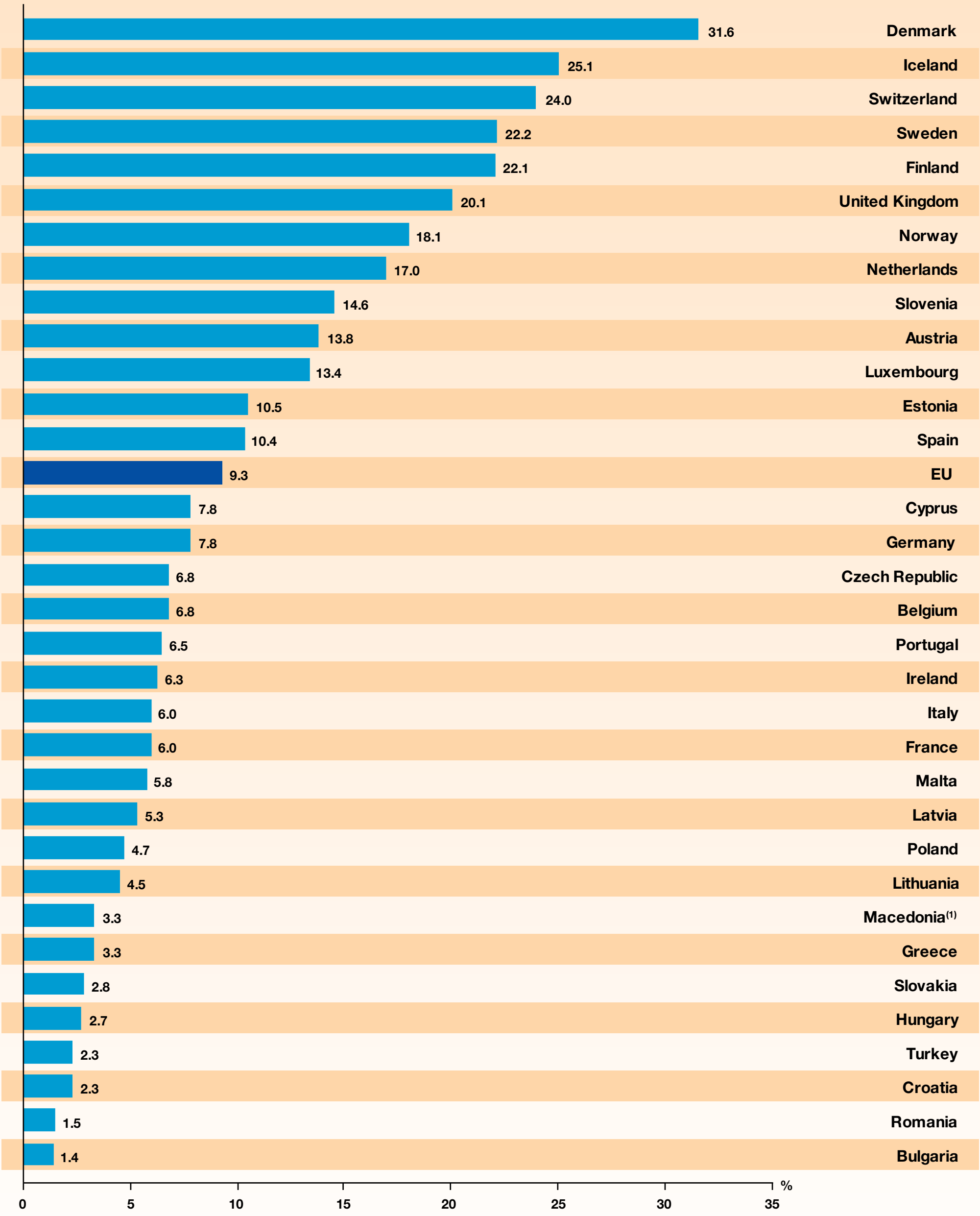
[112] See the Innovation Union Scoreboard, 2010.

FIGURE I.4.11

## Participation in Adult lifelong learning - % share of population aged 25-64 participating in education and training, 2009



*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) The former Yugoslav Republic of Macedonia.

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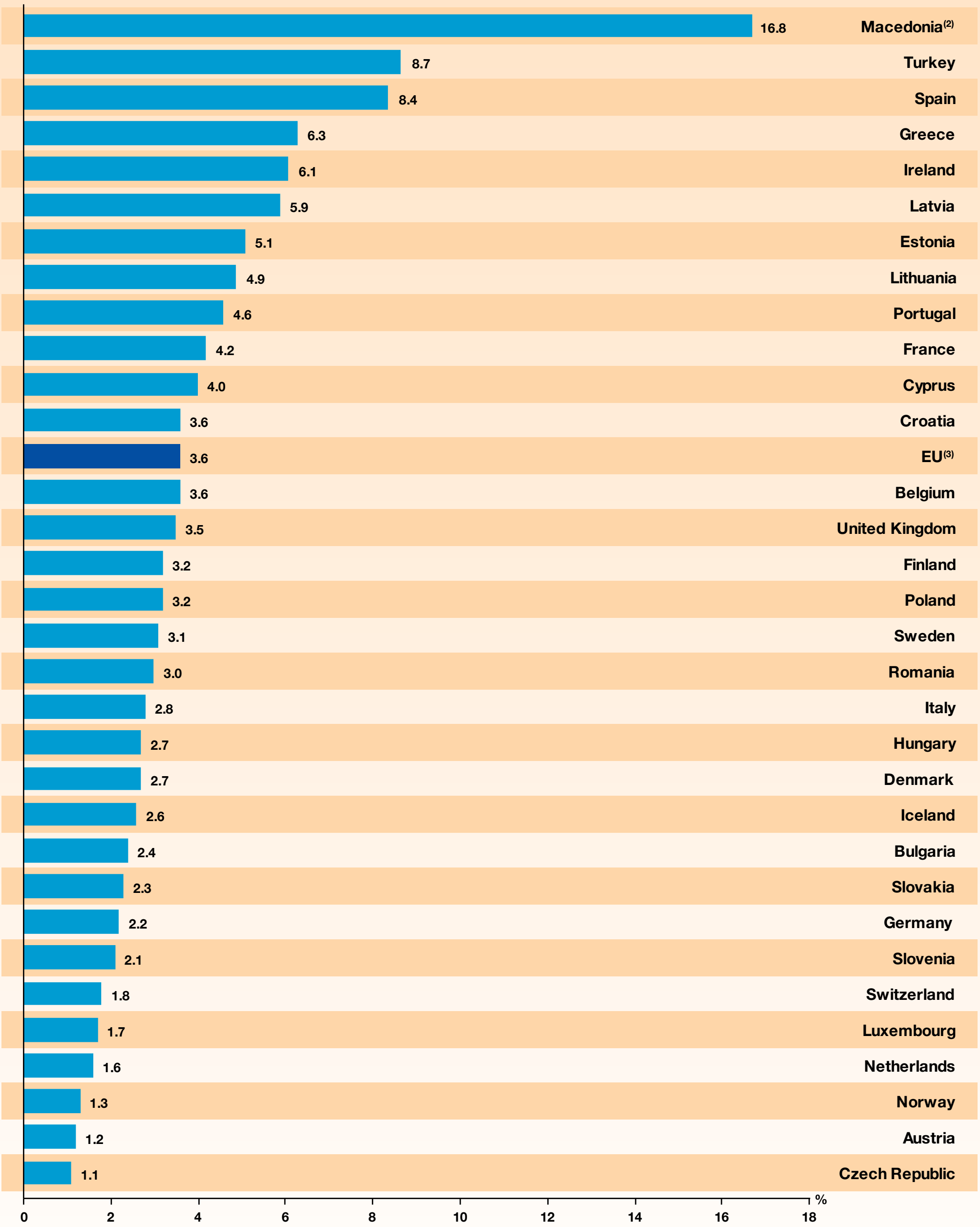
FIGURE I.4.12

## Unemployed Human Resources in Science and Technology as % of total unemployment, 2009(1)



*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) LU: 2008.
(2) The former Yugoslav Republic of Macedonia.
(3) EU does not include LU.

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# CHAPTER 5

# Business sector investment in R&D

## HIGHLIGHTS

At EU aggregate level, R&D expenditure financed by business enterprise has remained almost unchanged since 2000 at around 1.05 % of GDP. Additional business sources from abroad can be estimated at around 0.12 % of GDP, and private-non-profit funding of R&D amounts to 0.03 % of GDP in the EU, which brings R&D expenditure financed by private sources to 1.20 % of GDP at EU-27 aggregate level, far from the 2 % target.

Among Member States, with the exception of Austria and Slovenia, the sharpest increases between 2000 and 2009 are observed in countries that were at a very low level of business financed R&D (0.5 % of GDP and less). However, in addition to Austria and Slovenia, non-negligible increases also occurred in Denmark, Finland and Germany, which shows that further increases are still possible in Member States which already have high intensities of R&D financed by business.

Business R&D is more concentrated than GDP in Europe. Business R&D intensity is above 1 % of GDP in barely more than one quarter of NUTS 2 regions. However, innovation is more than R&D: other intangible assets create value. Different structures of intangibles investment — in particular the respective weights of R&D investment and organisational investment in total investment in intangibles — point to different innovation models across countries.

In 2007, R&D expenditure by affiliates of foreign parent companies represented between 20 % and 70 % of domestic business R&D expenditure in European countries[113]. In each of them, this share has not changed much since 2000, except in Poland, the Czech Republic and Slovakia where it increased substantially.

In the manufacturing sector, which performs most of total business R&D, foreign R&D expenditure is predominantly intra-European. In addition, despite a rising share of emerging countries in overseas R&D expenditures of US multinationals, Europe remains by far the most important location for US overseas R&D.

Altogether, in the four economies — the EU, the United States, South Korea and Japan — the main R&D performing sectors are manufacturing high-tech and medium high-tech sectors that make more than 70 % of total BERD in each economy. Manufacturing high-tech sectors, in particular, largely determine the overall level of business R&D intensity in a country.

In the EU, most of the sectors that perform the vast majority (80 %) of the EU BERD — in particular the manufacturing high-tech sectors — have become more research intensive since 1995. However, at the same time, the weight of these sectors in the EU economy has decreased, counterbalancing the research intensification observed at sector level. Overall, the result is a limited increase in the EU business R&D intensity since 1995 and stagnation since 2000.

Important conclusions can be drawn about the relationship between a country's R&D investment in the business sector and its economic structure, by comparison with countries outside the EU:

- The main reason for the R&D gap between the EU and the United States in manufacturing industry is the larger and more research intensive American high-tech industry;
- The very high business R&D intensity of South Korea is linked to the structure of its economy, clearly less dominated by services than the EU or the United States (the weight of the main high-tech and medium high-tech sectors in South Korea's economy is almost twice as large as in the EU or US economy).
- The very high business R&D intensity of Japan (and its growth) highlights an exceptionally high and growing research intensity in particular in the high-tech sector 'office machinery and computers', and in large, medium high-tech sectors that are more research-intensive than in the other economies. In addition, the weight of the high-tech sectors in Japan's economy is one third larger than in the EU's economy.

Within the high-tech industry, ICT sectors play a prominent role in business R&D. Worldwide, the ICT industry occupies and maintains its position as a leading R&D investing sector by R&D expenditure and patenting activity.

---

[113] A large part of R&D expenditure by foreign affiliates in a country is financed locally, i.e. without funds coming from abroad. This high share of domestic business R&D performed by foreign affiliates in Europe is therefore consistent with a much lower share of domestic business R&D funded by business abroad.

The chapter shows that:

- Europe has been, and is still, lagging behind its main competitors in terms of ICT R&D investment and ICT R&D patenting, with significant differences between the Member States. There are significant differences across ICT sub-sectors indicating regional specialisation and also differentiating dynamics between the EU, US and Asian countries.
- This lag is largely due to the share of the EU ICT sector in the economy, its industrial composition and the size of its companies. For example, large EU ICT companies are smaller than their US equivalents, and did not grow as quickly in the last few decades. This is a particular weakness in the most promising segments, for example in the 'computer services and software' sub-sector, where EU Internet companies have failed so far to achieve a truly global scale. A growing part of the R&D gap can be observed in this sector.
- Europe is an important location for foreign ICT R&D investment, but international cooperation in R&D is evolving from a dominant EU–US relationship to global networking where the US–Asia relationship is taking a growing share. Here too, it seems that US companies are grasping opportunities more rapidly than EU ones.

These findings point to the need for structural change in the EU's economy to ensure its competitiveness in an increasingly knowledge-based world economy. A broader analysis of the EU's structural change is presented in Part V.

## 5.1. Is the business sector increasing its funding to R&D?

In the Europe 2020 Strategy, the EU has maintained its objective to devote 3% of its GDP to R&D without specifying the relative efforts of the public and private sectors to reach this objective.

The 2002 Barcelona Objectives targeted an increase in both the overall expenditure on R&D (to approach 3% of EU GDP allocated to R&D by 2010) and the share of R&D expenditure funded by the public and private sectors. According to the Barcelona Objectives, one third of total R&D expenditure should be funded by the public sector, two thirds by the private sector. Chapter 3 focused on public funding of R&D. This chapter looks at private funding of R&D, i.e. funding by the business sector.

### *The evolution of R&D expenditure financed by business sector varies across Member States*

At EU aggregate level, R&D expenditure financed by business sector has remained stable at around 1.05% of GDP since 2000. Additional business sources from abroad can be estimated at around 0.12% of GDP, and private-non-profit funding of R&D amounts to 0.03% of GDP in the EU, which brings R&D expenditure financed by private sources to 1.20% of GDP at EU-27 aggregate level, far from the 2% target. In only two Member States, Finland and Sweden, business-financed R&D intensity is above 2% of GDP[114]. All other Member States are below 1.5% of GDP, except Denmark, Germany and Austria[115] (see Box I.5.1).

Between 2000 and 2009[116], R&D expenditure financed by business sector as % of GDP increased in 16 Member States (Figure I.5.1). It grew by more than 200% in Estonia and Portugal, by 50% to 80% in Cyprus, Hungary and Austria, and by 7% to 50% in Slovenia, Spain, Latvia, Italy, Denmark, Ireland, Bulgaria, Finland, Czech Republic, Germany and Malta. In contrast, the sharpest decreases (by 20% and more) of R&D expenditure financed by the business sector are observed in Luxembourg, Sweden and Slovakia.

With the exception of Austria and Slovenia (see Box I.1.2 on Austria in Chapter 1 of this Part), the sharpest increases between 2000 and 2009 are observed in countries that were at a very low level of business-financed R&D (0.5% of GDP and less). This is in part due to the simple statistical fact that absolute changes have different importance relative to the level of starting point, so that a very low starting point makes it possible to reach very high growth rates more easily. However, in addition to Austria and Slovenia, non-negligible increases also occurred in Denmark, Finland and Germany, which shows that further increases are still possible in Member States which already have high intensities of R&D financed by business.

A particular focus on the evolution of business-financed R&D expenditure in 2009 during the economic crisis is to be found in Chapter 2 of this Part.

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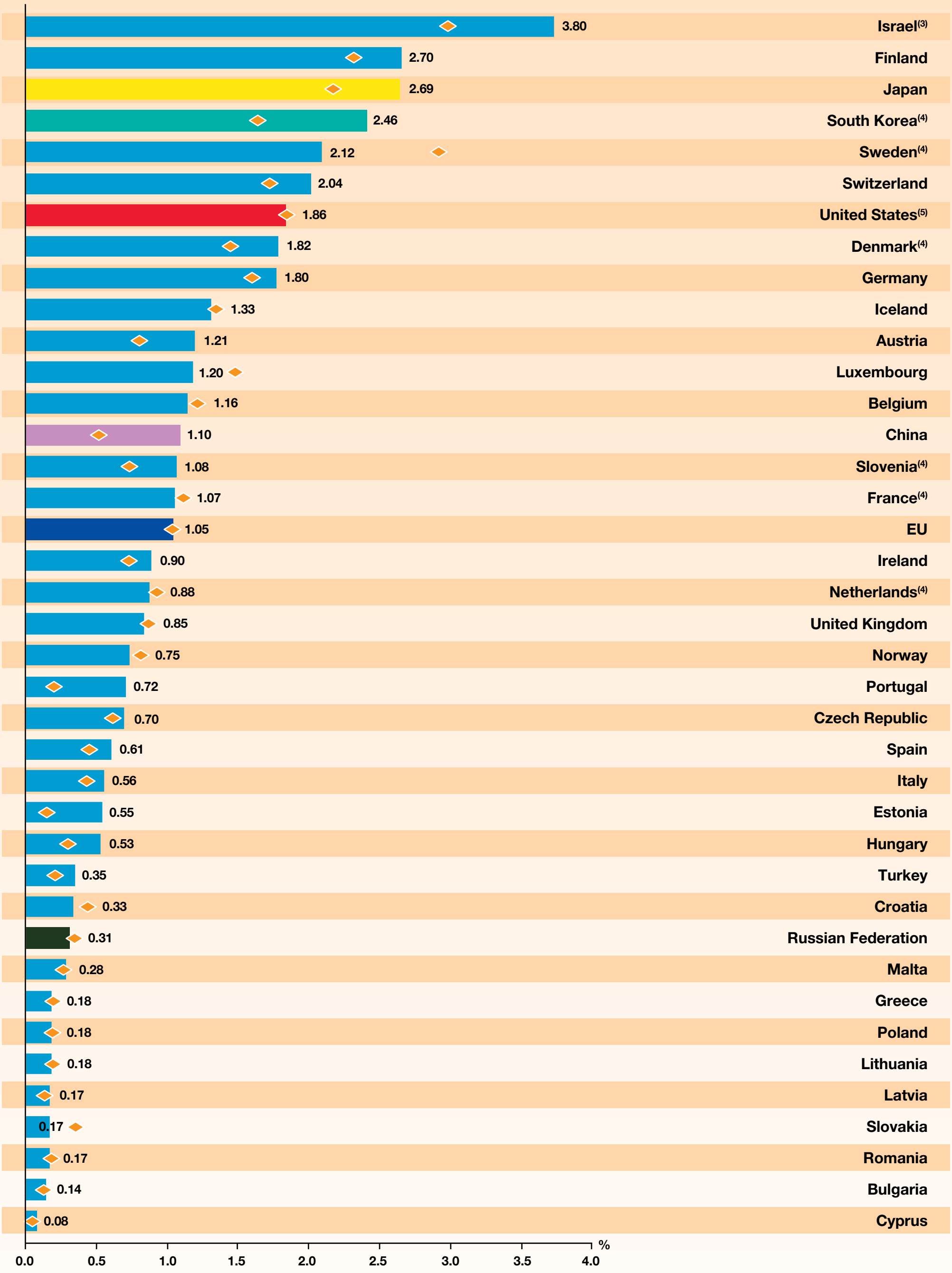
[114] Below the national private target of 3% set by each of these two countries.

[115] In Austria, abroad-business financed R&D expenditure at the level of 0.41% of GDP in 2007. If this value has been maintained until 2010, added to the 1.21% of GDP financed by business enterprise in 2010 (Figure I.5.1 and footnote (2) to this figure) and with the addition of 0.01% of GDP by private-non-profit sector, R&D financed by private sources amounted to 1.63% of GDP in 2010 in Austria.

[116] For data availability reasons, the actual period covered differs across countries, see footnote to Figure I.5.1.

## FIGURE I.5.1 GERD financed by business enterprise as % of GDP, 2000[1] and 2009[2]



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD
*Notes:* (1) DK, EL, SE, IS, NO: 2001; HR: 2002; IT, MT: 2005.
(2) EL: 2005; BE, LU, NL, NO, IL: 2007; EU, BG, DE, ES, FR, IT, CY, PT, IS, CH, US, JP, CN, KR : 2008; AT: 2010.
(3) IL: GERD does not include defence.
(4) DK, FR, NL, SI, SE, KR: Breaks in series occur between 2000 and 2009.
(5) US: GERD does not include most or all capital expenditure.

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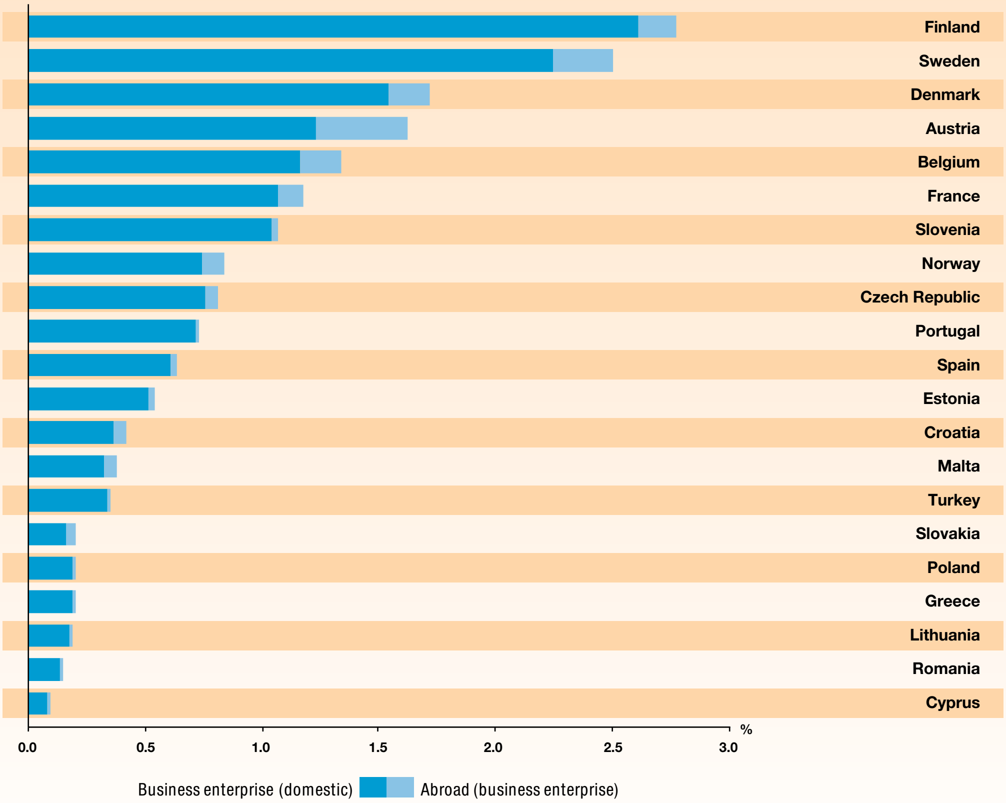
## Box I.5.1 – Business sources of funds for GERD: adding business funding from abroad to domestic business funding

When monitoring progress towards the EU 2 % target for private sources of funds for R&D, (domestic) business sector funding is used as a proxy for all private funding of R&D in a Member State. However, in any Member State, a 'business sector abroad' also finances R&D expenditure. Adding the business funding from abroad to domestic business funding gives a better account of the intensity of business funding for R&D in a Member State (Figure I.5.2). However, this data is not available in all Member States.

To exhaustively account for all private sources (beyond business sources), R&D financed by Private-Non-Profit (PNP) sector should also be added, to account for all private sources of funding for R&D. This source of funds is, however, very small on average in the EU (0.03 % of GDP) and not added in Figure I.5.2. Denmark, Sweden and the United Kingdom are the Member States with by far the largest amount of R&D financed by PNP, namely 0.08–0.09 % of GDP. Most Member States are around or below 0.03 % of GDP.

FIGURE I.5.2 **GERD financed by business enterprise (domestic and abroad) as % of GDP, 2008(1)**



*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) EL: 2005; BE, DK, AT, SE, NO: 2007; SK: 2009.
(2) BG, DE, IE, IT, LV, LU, HU, NL and UK are not included on the graph because GERD financed by abroad (business enterprise) is not available for these Member States.

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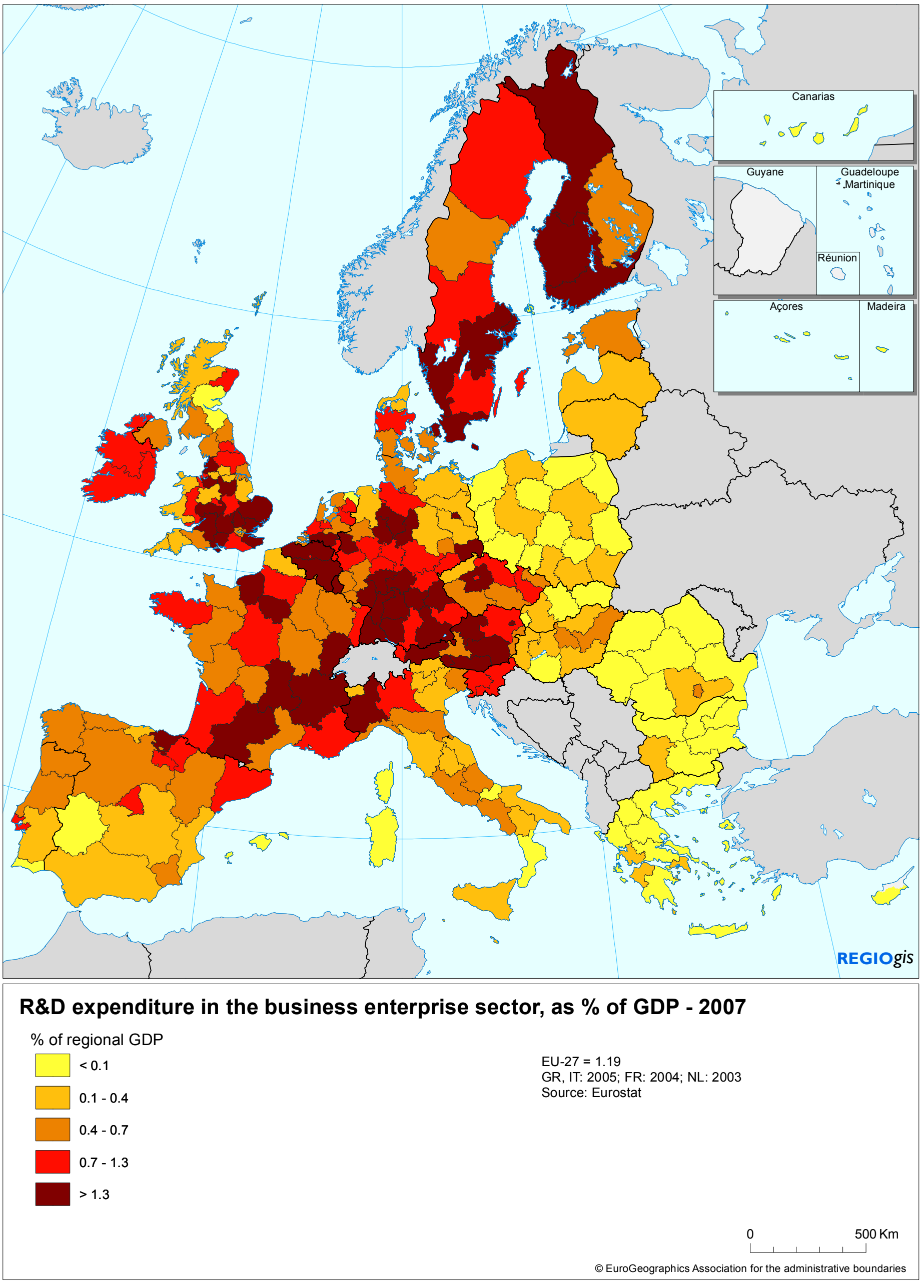
FIGURE I.5.3 **Business R&D expenditure as % of GDP by NUTS 2 regions, 2007**



EU-27 = 1.19
GR, IT: 2005; FR: 2004; NL: 2003
Source: Eurostat

© EuroGeographics Association for the administrative boundaries

### *Business R&D intensity is above 1 % of GDP in barely more than one quarter of NUTS 2 regions*

Out of the 268 EU NUTS 2 regions, only around 50 had in 2007 a business R&D intensity above 1.3 % of GDP, 32 had above 2% and 72 above 1%. These regions are located in Nordic countries, in France, and in a central band from Austria across the south of Germany, the Netherlands and Belgium to the South East of the United Kingdom. The business R&D intensity in most eastern and southern regions of the EU is below 0.4 % of GDP. R&D activities in these regions are often still dominated by public R&D activities.

However, a slight convergence was observed between 2000 and 2007, as many of the very low business R&D intensive regions, in particular in Southern, Central and Eastern Europe, have had a higher growth rate of business R&D intensity than the more business R&D intensive regions over that period.

### *Innovation is more than R&D: other intangibles matter in creating value*

Firms' efforts to create innovations require R&D, human capital (education) and skills (training), organisational capital, design and ICT along with tangible capital and adequate financial sources[117]. Investment in intangible assets is innovation-related investment.

The intensity of innovation efforts can be measured by investment in intangible assets (see Box I.5.2) in relation to GDP. Figure I.5.4 presents investment in intangibles (R&D, organisational competence, and other factors) as a share of conventional GDP in 2005, based on national accounts in Europe[118]. Investment in intangibles ranges from 9.1 % of GDP in Sweden and the United Kingdom to around 2 % of GDP in Greece. This is considerably higher than the scientific R&D investment (2.5 % of GDP in Sweden and 0.1 % of GDP in Greece, see Figure I.5.4)[119], which demonstrates the importance of intangibles for innovation and competitiveness in each country.

### Box I.5.2 – Measuring investment in intangibles: the INNODRIVE project[120]

The European political agenda recognises the importance of investment in innovation as a driver of 'smart growth'. A central theme for the smart-growth strategy is that intangible assets need to be considered as innovation-related investment creating future value. Presently, intangibles are considered as cost and have not been included as investment in National Accounts; they are imprecisely valued in company-level balance of accounts. This means that their contribution to growth and productivity is not measured adequately.

INNODRIVE-project produces new estimates of intangibles for EU-27 countries and Norway following the Corrado, Hulten and Sichel (2006) typology[121]: computerised information (mainly software); innovative property (mainly scientific and non-scientific R&D, mineral exploration, copyright and licence costs, spending for artistic originals); economic/firm competences (spending on reputation, advertising, firm specific training and organisational capital).

All R&D-intensive countries (Sweden, Finland, Germany) tend also to rank above average in terms of their investment in intangibles. However, some countries that are not particularly R&D-intensive rank very high on this broader measure of innovation intensity (Belgium 8.3 %; the Czech Republic 8 %; the Netherlands 7.7 %; France 7.6 %, Hungary 7.5 %). This result points to a type of innovation model which emphasises organisational competence as one of the key drivers of growth. Sweden, the United Kingdom and France are also intensive in other types of intangibles (training, non-scientific capital, and database and software)[122].

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[117] The chain-link model of innovation and the national-innovation approaches stress these elements and their interactions.

[118] In Luxembourg new financial product share is set at five times the EU27 average.

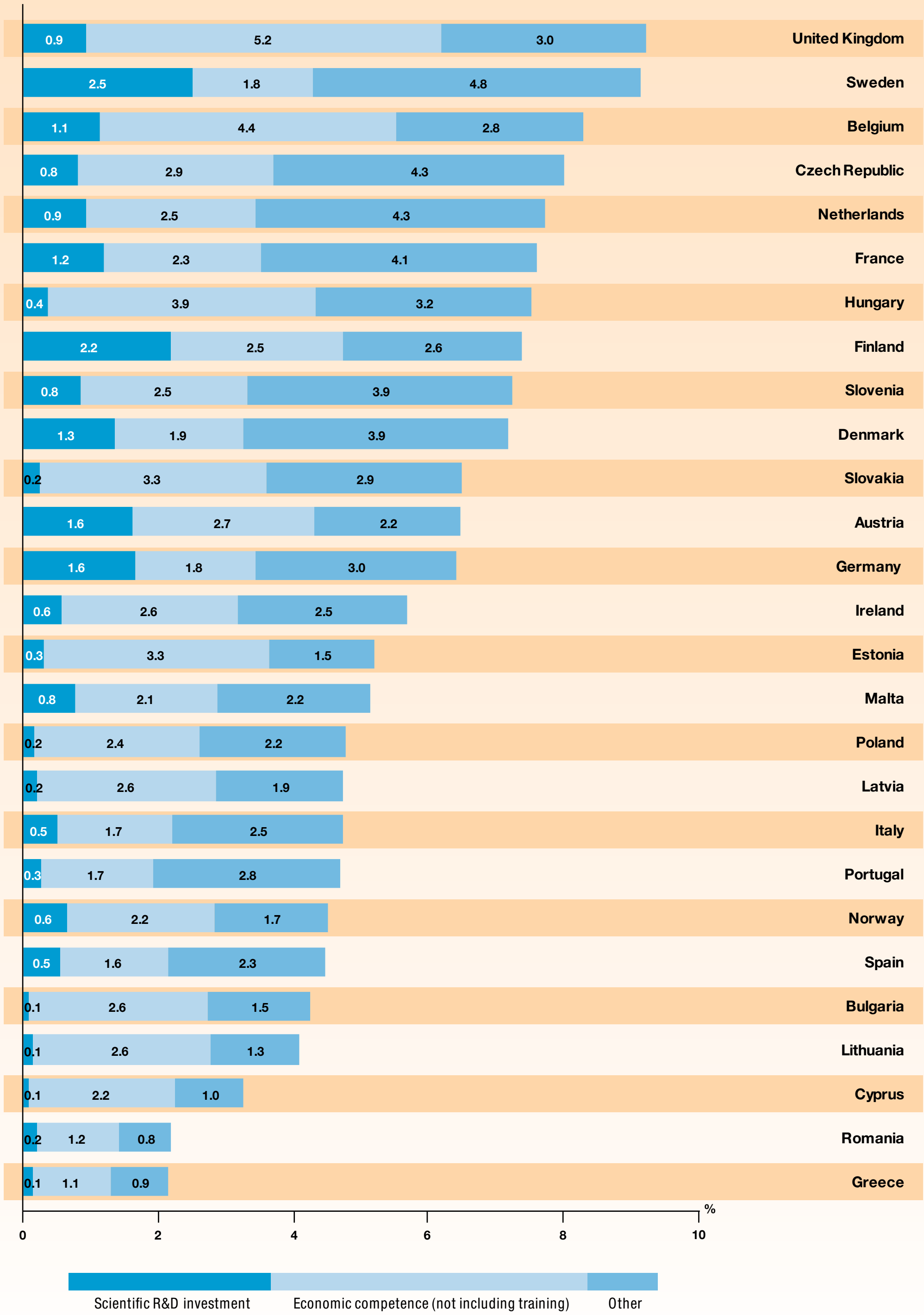
[119] GDP measures come from national accounts which do not include the new intangibles. The capitalisation of intangibles implies an average increase of 5.5 per cent of the GDP for the EU-27 over the period 1995-2005 (See INNODRIVE Policy Brief February 2011).

[120] Project funded by the FP7 SSH cooperation programme, Grant no. 214576.

[121] Corrado/Hulten/ Sichel (2006), Intangible Capital and Economic Growth, NBER Working Paper No 11948, National Bureau of Economic Research, Cambridge, MA.

[122] See INNODRIVE Policy Brief February 2011.

FIGURE I.5.4 **Investment in intangibles as % of GDP, 2005**



*Source:* DG Research and Innovation
*Data:* INNODRIVE project

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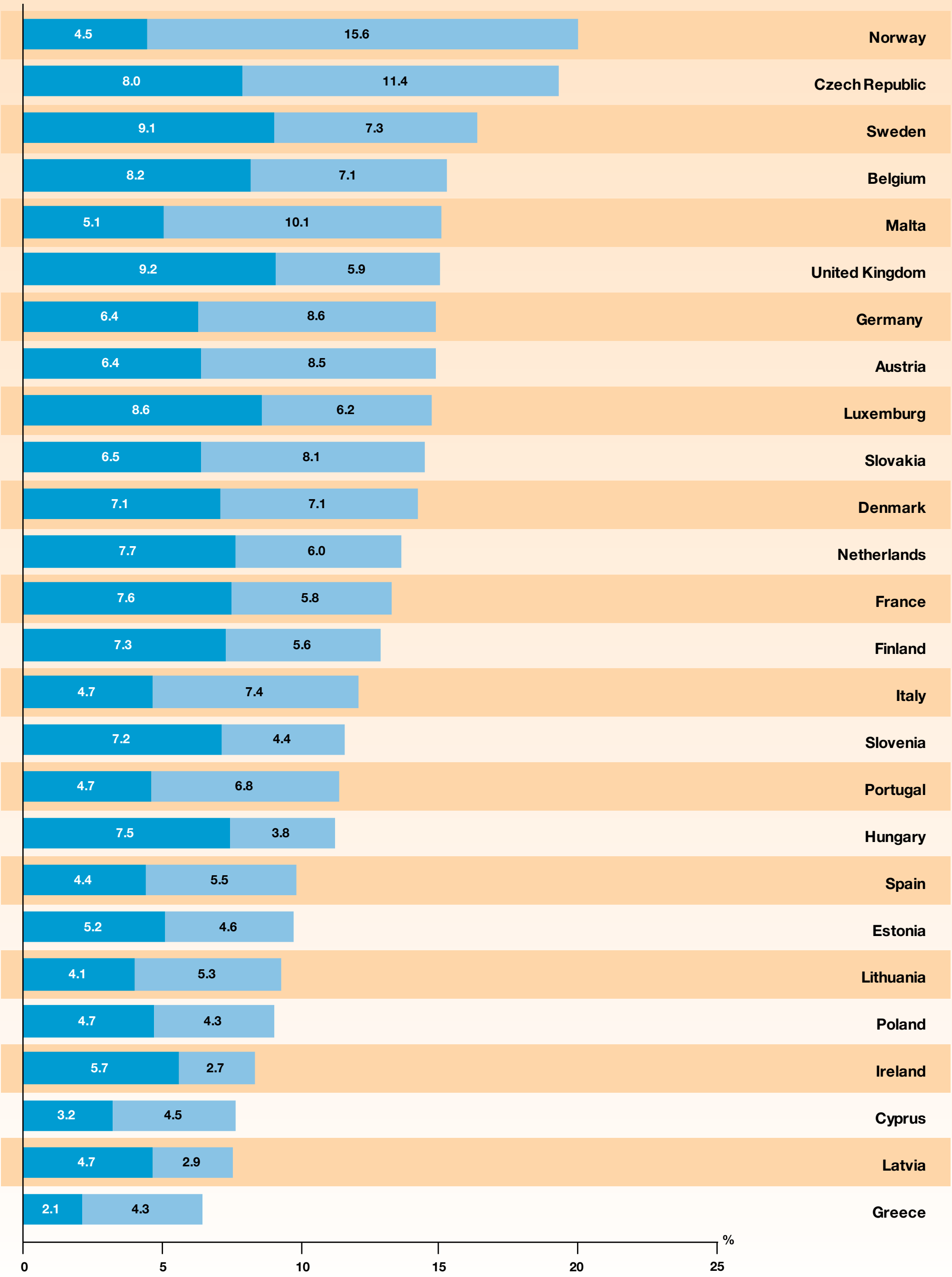
FIGURE I.5.5 **Intangible and tangible investment as % of GDP, 2005**



*Source:* DG Research and Innovation
*Data:* INNODRIVE project

Intangible investment ▮ ▮ Tangible investment

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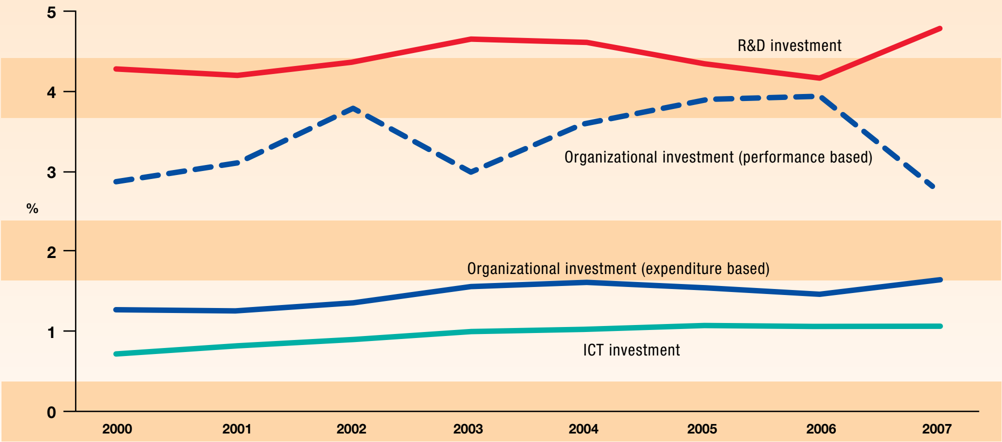
Figure I.5.5 shows the relative importance of intangibles in overall investment, which can be seen as an indication of the degree of transition towards a knowledge economy in 2005.

FIGURE I.5.6 **Finland - investment in intangibles as % of new value added, 2000-2007(1)**



*Source:* DG Research and Innovation
*Data:* INNODRIVE project, based on data from the Confederation of Finnish Industries, Asiakastieto company information database.
*Note:* (1) The data refer to the non-farm market sector. NACE 1.1 sections CA, DF, E, F, J are not included.

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### *Different structures of intangible investment point to different innovation models across countries*

The different structures of intangibles across countries point to different innovation models related to technological and non-technological innovations. The structure of intangibles differs considerably in the United Kingdom and Finland, which can be taken as two opposite examples of organisational-capital-driven and R&D-driven economies respectively[123].

Figures I.5.6 and I.5.7 show how the structure of intangible capital has evolved over the period 2000–2007 in Finland and 2000-2006 in the United Kingdom, based on firm-level data[124]. In Finland, according to the expenditure-based approach[125], the investment rate in all intangibles (R&D, ICT and organisational-capital investment) was around 6 % of the new value added[126] in 2000 and 8 % in 2007. The corresponding figures for the United Kingdom are 10 % (2000) and almost 11 % (2006). While the totals are close in these two countries, the composition is, however, very different: the total is dominated by organisational investment in the United Kingdom, but largely dominated by R&D investment in Finland.

When using a performance-based approach[127] the importance of organisational investment increases in both countries. This is explained by the widely observed gap between productivity and the wage costs of organisational workers. Using the performance-based approach, organisational investment is now closer to R&D investment in Finland. In the United Kingdom, organisational investment exceeds R&D investment regardless of the estimation method, although the difference seems to fade out in 2005–2006.

However, over the years 2000–2007, organisational investment (the largest component of organisational competence in the national estimates) decreased in both countries when the productivity of organisational-type work is used to construct these estimates. This decline may call for new types of innovation policy measures which go beyond R&D investment.

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[123] INNODRIVE project collects firm-level data on intangibles for six European countries: Czech Republic, Finland, Germany, Norway, Slovenia and the United Kingdom.

[124] The data collection methodology of INNODRIVE allows the aggregation of micro-level firms' data to national measures of intangible capital formation (expenditure-based approach to measure firms' investments). This methodology is a great advantage for various types of economic analysis.

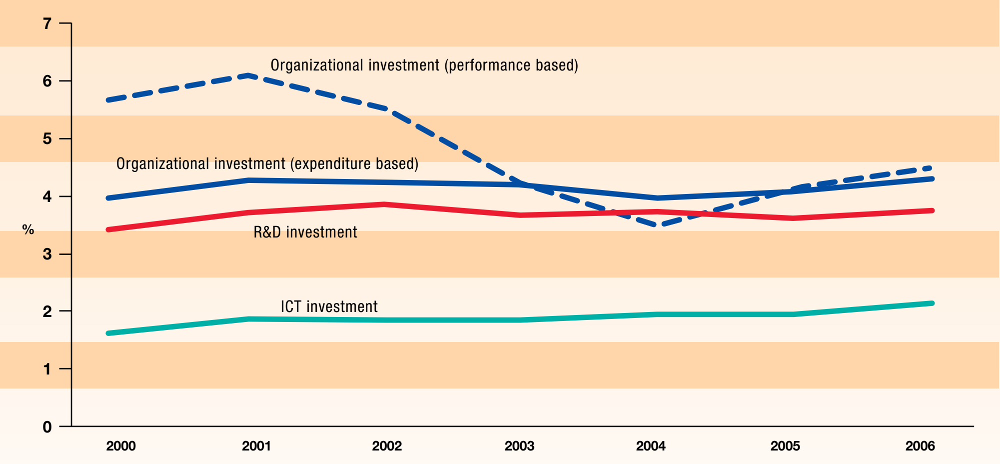
[125] The expenditure-based approach gives only part of the picture regarding the value of intangibles when they are owned by the firm and when employees are not fully compensated for the value of intangible production.

[126] New value-added figures are generated in the respective business sectors to include investment in intangibles.

[127] The performance-based approach with productivity estimate replacing wage costs gives a better understanding about the value of intangibles when they are owned by the firm and employees are not fully compensated for the value of intangible production. This is explained by the widely observed gap between productivity and wage costs of organisational workers.

FIGURE I.5.7

**United Kingdom - investment in intangibles as % of new value added, 2000-2006(1)**



*Source:* DG Research and Innovation
*Data:* INNODRIVE project, based on Annual Survey of Hours and Earnings, Labour Force Survey, Annual Business Inquiry.
*Note:* (1) The data refer to the non-farm market sector. NACE 1.1 sections CA, DF, E, F, J are not included.

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## 5.2. Is Europe attracting foreign funding to R&D?

A large part of business R&D in the world is performed by a small group of companies operating on a global scale. Multinational enterprises (MNEs) play a major role in the internationalisation of R&D and innovation with their growing investment in R&D abroad. While the majority of the R&D investment is still concentrated in the home countries, often close to the MNEs' headquarters, foreign affiliates of MNEs play an important role within the multinational network when organising their R&D and innovation activities on a global scale.

In this section, a foreign affiliate is an enterprise resident in a country over which an institutional unit *not resident* in this country has control[128].

### *In 2007, foreign R&D expenditure represented between 20 % and 70 % of domestic business R&D expenditure in European countries*

In five of the sixteen European countries that provide this data, more than 50 % of domestic business R&D expenditure is performed by affiliates of foreign companies (inward R&D, figure I.5.8). For the eleven other European countries, the share of foreign affiliates in domestic business R&D ranges from 20 % (slightly less in Finland) to 45 %, compared to 14.3 % and 5.1 % in the United States and Japan respectively. Except for Ireland, the higher values observed in European countries are due to the intra-European cross-border business R&D investment which prevails (see below).

In the majority of the European countries that provide the data, the share of foreign affiliates in domestic business R&D increased between 2000 and 2007. The increase in Poland, Czech Republic, Slovakia and the United Kingdom is particularly pronounced.

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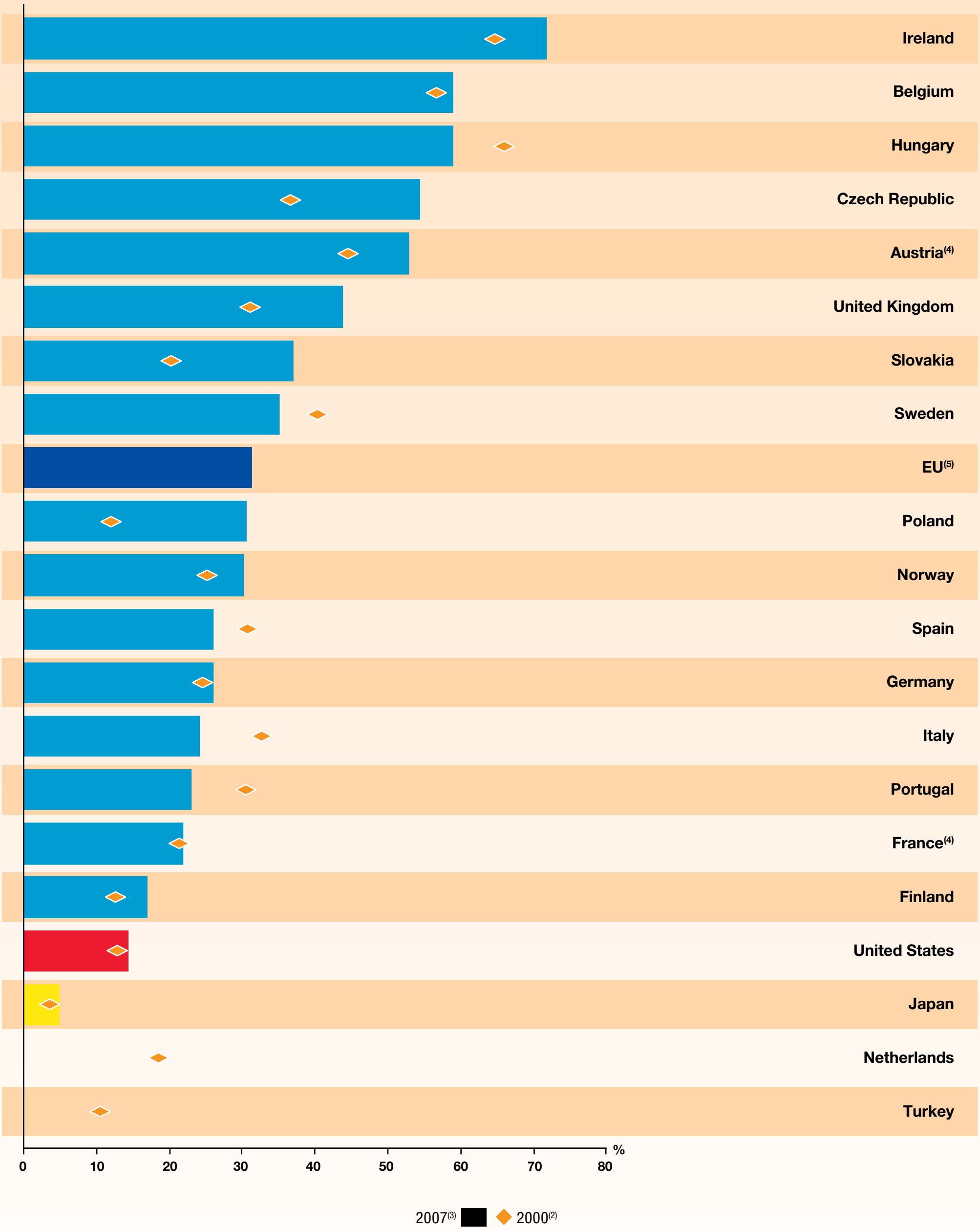
[128] Control is determined according to the concept of 'ultimate controlling institutional unit (UCI)'. The UCI is the institutional unit, proceeding up a foreign affiliate's chain of control, which is not controlled by another institutional unit. Foreign affiliates in a country can be created through greenfield investments of the parent foreign company or through acquisition of, or merger with, a domestic firm by a foreign firm. This definition includes affiliates of foreign affiliates.

FIGURE I.5.8

## Inward R&D expenditure[(1)] as % of R&D expenditure by business enterprise, 2000[(2)] and 2007[(3)]



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD
*Notes:* (1) R&D expenditure of foreign affiliates.
(2) DE, IE, ES, FR, IT, PT, SE: 2001; BE, HU, NO: 2003; AT: 2004.
(3) ES: 2005; FI: 2006; FR, IT, HU, UK, US: 2008; NL, TR: data are not available.
(4) FR, AT: Breaks in series occur between 2000 and 2008.
(5) EU does not include BG, DK, EE, EL, ES, CY, LV, LT, LU, MT, NL, RO, SI, FI.

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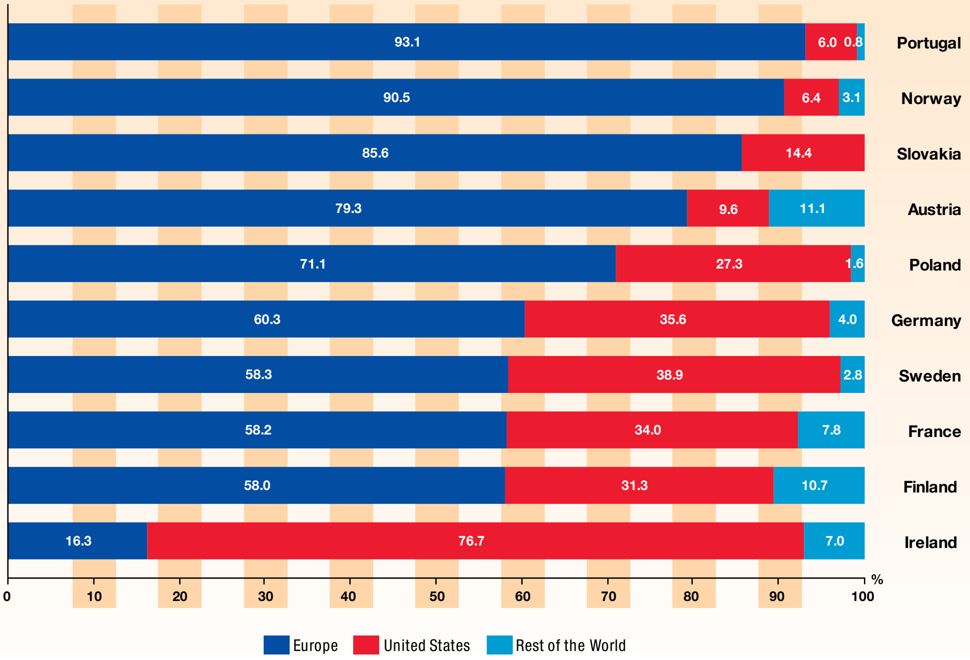
FIGURE I.5.9 **Inward R&D investment in manufacturing - % shares by investing region**(1)



*Source:* DG Research and Innovation
*Data:* OECD
*Note:* (1) IE: 2005; FI: 2006.

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### *Foreign R&D expenditure in the manufacturing sector is predominantly intra-European*

Intra-European foreign R&D expenditure contributes significantly to the high shares of foreign R&D investment in European countries (Figure I.5.9). With the exception of Ireland, in all European countries for which this data is available, more than 58 % (and up to 93 %) of R&D expenditure by foreign affiliates in the manufacturing sector is performed by affiliates of a European parent company. In contrast, in Ireland, US firms are by far the largest foreign R&D investors.

### *Although rising fast, R&D expenditure by affiliates of US companies in emerging countries is much smaller than their R&D expenditures in European countries*

Figure I.5.10 below shows that Europe is still a very attractive location for overseas R&D activities for US companies. In contrast to the period 1995–2001, when the EU share of foreign US R&D investment dropped by almost 10 percentage points (from 70.4 % to 61 %)[129], the EU share remained stable between 2000 and 2007. In 2007, more than 60 % of US companies' overseas R&D expenditures were still located in EU-27.

The share of emerging countries (Brazil, Russia, India and China) and South Korea is rising, but the gap between the EU and these countries remains large. In absolute terms, inflows of US R&D expenditures to the EU are increasing. Therefore, despite having a slightly decreasing share in overseas R&D expenditures of US multinationals, Europe remains by far the most important location for US overseas R&D.

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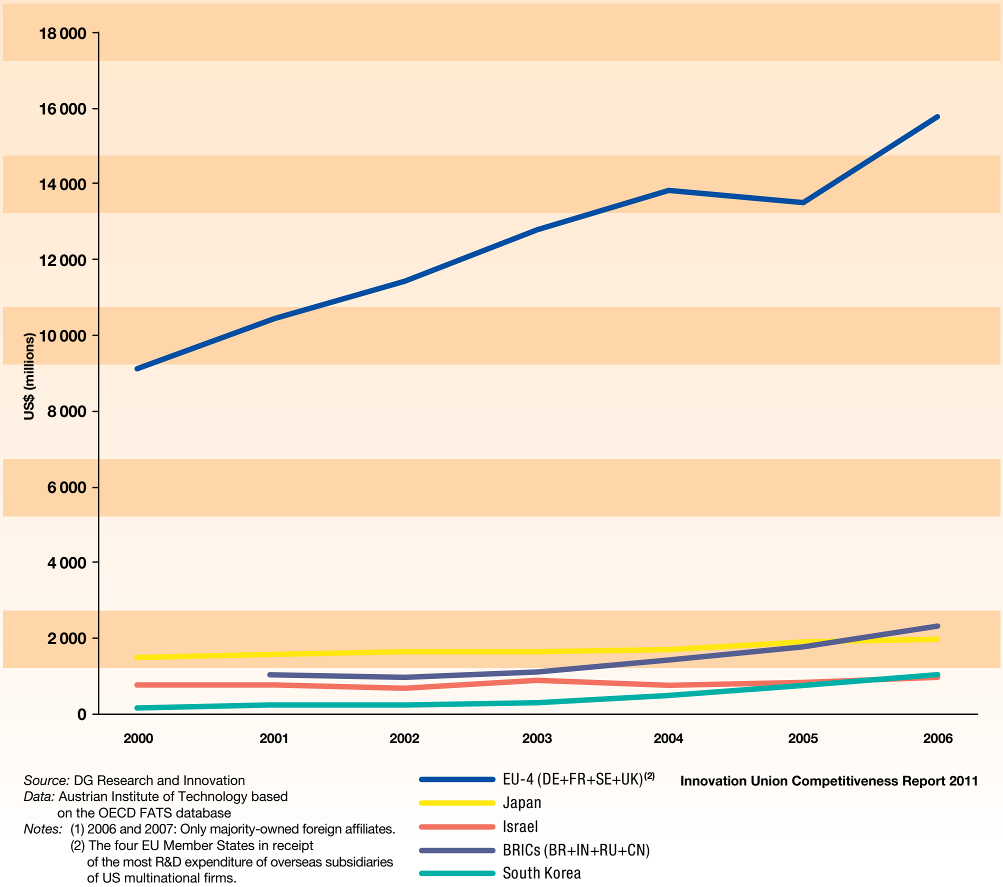
[129] OECD, *The internationalisation of business R&D: evidence, impacts and implications*, DSTI/STP(2007)28, October 2007.

FIGURE I.5.10 R&D expenditure of overseas subsidiaries of United States multinational firms, 2001-2007[(1)]



*Source:* DG Research and Innovation
*Data:* Austrian Institute of Technology based on the OECD FATS database
*Notes:* (1) 2006 and 2007: Only majority-owned foreign affiliates.
(2) The four EU Member States in receipt of the most R&D expenditure of overseas subsidiaries of US multinational firms.

When examining company-level data, the share of R&D conducted by companies headquartered in the EU outside has increased slowly but steadily during recent years and is expected to continue to do so, particularly in India and China[130]. Not only do larger companies engage much more internationally, but the tendency for faster growth of R&D investment outside the EU has also been found in smaller companies[131]. Those companies that have been increasing their R&D over the period 2005–2011 invested predominantly within the EU (but also in China, India and the US), while those which decreased their R&D investment between 2005 and 2008 have done so exclusively in the EU (with R&D in the other three macro regions remaining stable or slightly increasing).

Both patterns suggest that an increasing share of the global BERD is being taken by emerging countries. From a policy-makers' point of view, concerns may arise if the structure of R&D investment in the EU is seriously affected, e.g. when critical mass of R&D for a certain sector is gradually lost. Yet, the trend for EU firms to locate R&D activities abroad should not be seen as a trend to be reversed, as the study shows that the EU firms that exploit global technological expertise are also the companies that manage to maintain the strongest production activities in the EU. In fact, the absolute amount of R&D investment in the EU is expected to increase by around 40 % between 2005 and 2012. This reveals that R&D internationalisation is not a zero-sum game but also a way to enrich the R&D activity at home.

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[130] The 2009 EU Survey on R&D Investment Business Trends is part of the Industrial Research Investment Monitoring Activity of the Joint research Centre and DG RTD.

[131] Cincera, M., Cozza, C., Tübke, A. and Voigt, P.: 'Doing R&D or not, that is the question (in a crisis…), JRC-IPTS Working Papers on Corporate R&D and Innovation, 12/2010.

## 5.3. What is the link between the business R&D deficit and economic structure in Europe?

In the research-intensive economies, the business sector is the main funder of R&D (see Figure I.3.1) as well as the main performer of R&D. In the EU, the R&D intensity of the business sector was equal to 1.25 % of GDP in 2009, barely higher than in 2000 (1.21 % of GDP). In comparison, business R&D intensity amounted to 2.01 % of GDP in 2008 in the United States (as in 2000).

In each economy, the overall level of business R&D intensity results from the relative sizes of its economic sectors and their respective research intensities. About 85 % of business R&D is performed by the manufacturing industry in the EU. Combining the manufacturing industrial composition of the EU and the United States together with R&D intensity by type of manufacturing industry gives the industrial composition of manufacturing R&D expenditure and its overall level in the EU and the United States.

### *A larger and more research-intensive high-tech industry in the United States explains a large part of the R&D gap between the EU and the United States in manufacturing industry*

In manufacturing industry, R&D intensity — measured as R&D expenditure as a % of value added — varies greatly across sectors. The manufacturing sectors are usually grouped into four types of industry by decreasing order of R&D intensity[132]: high-tech, medium high-tech, medium low-tech and low-tech.

Figure I.5.11 (b) shows the average R&D intensity by type of industry for both the EU and the United States. The difference in R&D intensity across the four types of industry is clear-cut: in both economies, going from high-tech to low-tech, each industry type is several times less research-intensive than the one above and the research intensity is of a comparable order of magnitude (although not identical) on both sides of the Atlantic. Figure I.5.11 (b), therefore, highlights how strong an influence the research intensity in high-tech and medium high-tech industries has on the overall level of business R&D intensity in an economy.

The following observations can be made from Figure I.5.11:

- In both the EU and the United States, high-tech and medium high-tech sectors alone make up about 90 % of all manufacturing R&D (Panel c).
- Manufacturing R&D is largely dominated by high-tech sectors in the United States, while in the EU, the high-tech and medium high-tech sectors contribute to the same extent to total manufacturing R&D (Panel c).
- Relative to GDP, high-tech sectors perform R&D almost twice as much in the United States (0.87 % of GDP) as in the EU (0.46 % of GDP) (Panel c).
- This is because (i) the share of high-tech sectors in the US manufacturing industry is more than 40 % larger than the share of high-tech sectors in the EU manufacturing industry (17.7 % against 12.4 %, Panel a) and (ii) high-tech sectors are 60 % more research-intensive in the United States than in the EU (Panel b).
- The medium high-tech and low-tech sectors are also more research-intensive in the United States than in the EU (Panel b). Quantitatively, the higher research intensity of low-tech sectors in the United States has a limited impact on the overall level of business R&D expenditure. However, this may have important consequences on the innovative capacity and the productivity gains in low-tech sectors.

Among high-tech sectors, Information and Communication Technology (ICT) plays a central role in the EU business R&D deficit (see section I.5.5 below).

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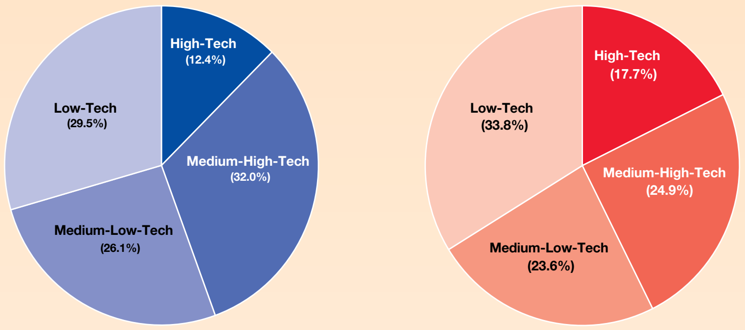
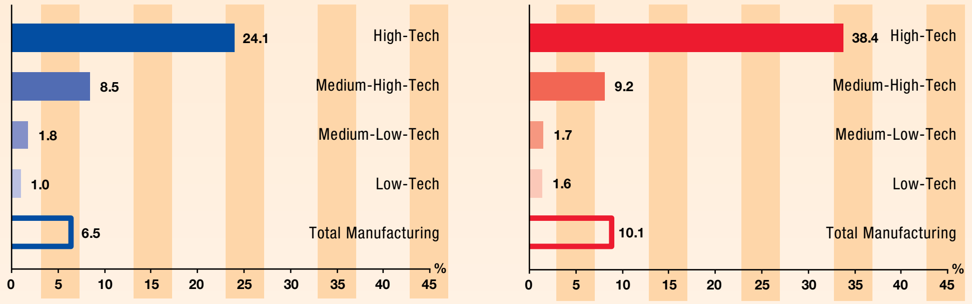
[132] Sectors included in each of these four types of industry are listed in the Methodological annex.

FIGURE I.5.11

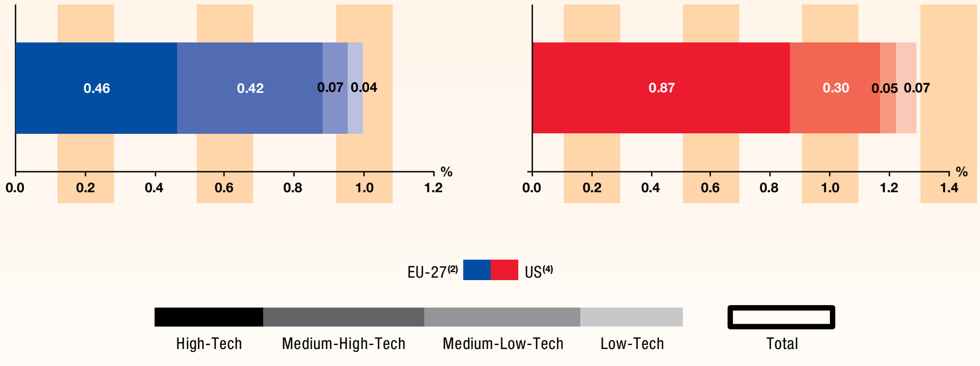
### (a) Manufacturing value added - % distribution by type of industry(1), 2006



### (b) Manufacturing BERD(3) as % of manufacturing value added by type of industry(1), 2006



### (c) Manufacturing BERD(3) by type of industry(1) as % of total GDP, 2006



*Source:* DG Research and Innovation

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*Data:* Eurostat, OECD

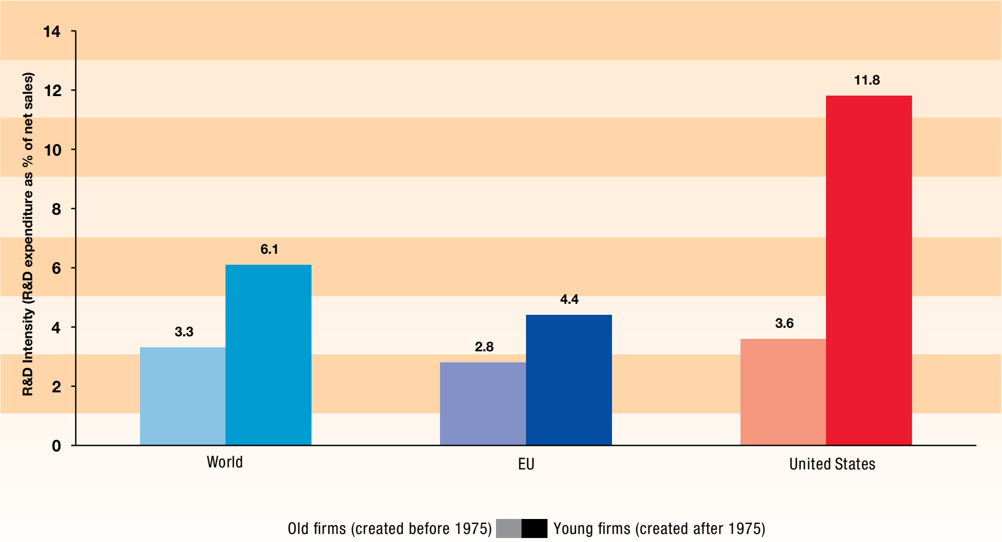
*Notes:* (1) See Methodological Annex for the list of sectors included in each type of industry.
(2) EU-27 does not include BG, EE, IE, EL, CY, LV, LT, LU, MT, PT, RO and SK. The 15 Member States included in the EU-27 aggregate account for more than 90% of Manufacturing Value Added and Manufacturing BERD in the EU.
(3) The Manufacturing BERD data for BE, FR, FI, SE, UK were classified by product field; the data for all other countries were classified by main activity.
(4) US: Building and repairing of ships and boats was included in medium high-tech rather than medium-low-tech.

## Box I.5.3 – The role of 'young' innovative firms in research-intensive sectors

The 2010 EU Industrial R&D Investment Scoreboard (referred to as the Scoreboard in this section) presents information on the world's top 1400 companies (1000 non-EU and 400 EU) ranked by their investment in R&D. The Scoreboard finds that the sectoral composition of EU and US companies explains the R&D intensity gap between EU and US companies[133]. In addition, it highlights the role played by 'young' companies (created after 1975) in the gap:

- Young companies on the Scoreboard are on average almost twice as research-intensive as old companies (3.3 % vs 6.1 % respectively, figure below). This suggests that young companies are more likely to be found in research-intensive sectors.
- Young companies on the Scoreboard represent 17.8 % of EU companies, while they represents 54.4 % of US companies (Figure I.5.13). This difference matters because young firms are more research-intensive than old firms.
- The EU-based young companies are much less research-intensive than their US counterparts (4.4 % vs 11.8 %, Figure I.5.12). This suggests that young companies are more concentrated in research-intensive sectors in the US.
- Altogether, a large part of the business R&D intensity gap between EU and US companies comes from a smaller number of young innovative companies in the most research-intensive sectors. The EU business R&D gap is a consequence of its industrial structure, in which new firms fail to play a significant role in the dynamics of the industry, in particular in high-tech sectors.

FIGURE I.5.12 **R&D Intensity of the EU and US *Scoreboard* companies by age of company**



*Source:* DG Research and Innovation, JRC-IPTS
*Data:* The 2010 EU Industrial R&D Investment Scoreboard

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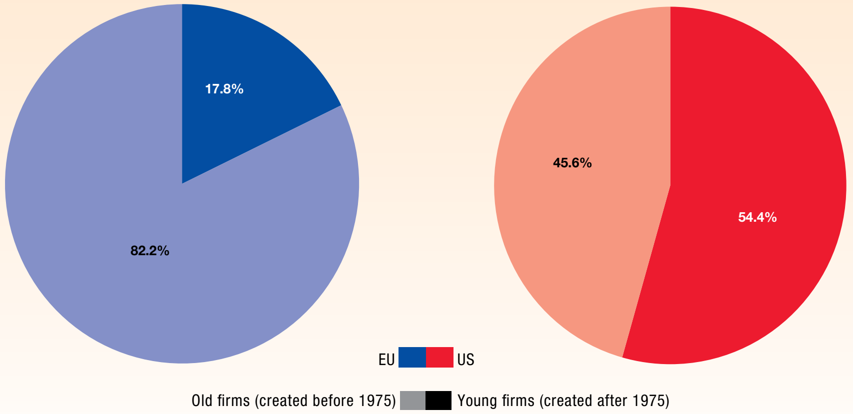
[133] The *Scoreboard* analyses R&D investments by top R&D-investing EU-based firms and US-based firms whatever the location of these investments. It therefore demonstrates the R&D intensity gap between top R&D- investing companies based on both sides of the Atlantic, which is not exactly the business R&D intensity gap between the EU and the US (which is about the R&D performed in the business sector on the territories of the EU and the US, whatever the nationality of the companies).

## FIGURE I.5.13 Shares of young and old *Scoreboard* companies



*Source:* DG Research and Innovation, JRC-IPTS
*Data:* The 2010 EU Industrial R&D Investment Scoreboard.

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***The evolution of overall business R&D intensity and structural change were very much tied together in the three largest Member States between 1995 and 2006***

The business R&D intensity is to a large extent determined by the structure of the economy. Statistically, an increase in value on this indicator can be caused by two possible phenomena: the weight of the research-intensive sectors grows in the economy (structural change) and/or the research intensity of individual economic sectors grows.

In Germany, France and the United Kingdom, 79 %, 73 % and 70 % of total BERD in 2001–2006 was performed in the high-tech and medium high-tech sectors respectively. Between the two periods 1995–2000 and 2001–2006, business R&D intensity increased in the only country where these sectors gained some weight in the economy, namely Germany (Table I.5.1). This increased weight of high-tech and medium high-tech sectors in Germany's economy even out-weighted a general decline in research intensity of these sectors (Table I.5.2).

In contrast, increased research-intensity in a number of individual high-tech and medium high-tech sectors did not allow France and the United Kingdom to compensate for the decrease in economic weight of these sectors. This observation highlights the close link between the evolution of overall business R&D intensity and structural change in the three large Member States since 1995[134].

## TABLE I.5.1 Evolution of structural change and business R&D Intensity in Germany, France and the United Kingdom, 1995-2006

| | High-Tech Value Added as % of total Value Added[(1)] | | High-Tech + Medium-High-Tech[(2)] Value Added as % of total Value Added[(1)] | | BERD as % of GDP | |
|---|---|---|---|---|---|---|
| | 1995-2000 | 2001-2006 | 1995-2000 | 2001-2006 | 1995-2000 | 2001-2006 |
| Germany | 2.2 | 2.5 | 11.7 | 12.4 | 1.6 | 1.7 |
| France | 2.2 | 2.0 | 6.5 | 5.7 | 1.4 | 1.4 |
| United Kingdom[(3)] | 2.6 | 2.2 | 7.5 | 5.6 | 1.2 | 1.1 |

*Source:* DG Research and Innovation
*Data:* Rindicate consortium, based on the OECD ANBERD and STAN databases
*Notes:* (1) The total value added of the economy.
(2) Medium-high-tech does not include 'Manufacture of other transport equipment'.
(3) UK: 'Office machinery and computers' is not included in high-tech (0.2% and 0.1% of total value added in DE and FR respectively).

🟩 increase
🟥 decrease between 1995-2000 and 2001-2006

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[134] The R&D intensity of an economy is mathematically related to the share of research-intensive sectors in the economy. Structural change can be driven by many factors, including R&D activities themselves.

## TABLE I.5.2 Evolution of the R&D Intensity of high-tech and medium-high-tech(1) industrial sectors in Germany, France and the United Kingdom, 1995-2006

| | Nace code | Industry | Germany | | France | | United Kingdom(2) | |
|---|---|---|---|---|---|---|---|---|
| | | | 1995-2000 | 2001-2006 | 1995-2000 | 2001-2006 | 1995-2000 | 2001-2006 |
| High-Tech | 24.4 | Pharmaceuticals, medicinal chemicals and botanical products | 24.2 | 🟥 22.2 | 32.9 | 🟥 32.2 | 45.5 | ⬛ 45.0 |
| | 30 | Office machinery and computers | 18.3 | 🟥 15.0 | 32.7 | 🟥 23.1 | :(2) | :(2) |
| | 32 | Radio, television and communication equipment and apparatus | 37.2 | 🟥 32.0 | 35.3 | 🟩 44.9 | 12.8 | 🟩 23.4 |
| | 33 | Medical, precision and optical instruments, watches and clocks | 11.7 | 🟩 14.1 | 21.1 | 🟥 17.6 | 8.2 | 🟩 9.3 |
| | 35.3 | Aircraft and spacecraft | 54.2 | 🟥 31.2 | 44.4 | 🟥 41.1 | 21.9 | 🟩 29.8 |
| Medium-High-Tech | 24 less 24.4 | Chemicals and chemical products, excluding pharmaceuticals | 11.4 | 🟥 10.0 | 9.4 | 🟩 12.0 | 6.7 | ⬛ 6.5 |
| | 29 | Machinery and equipment | 5.7 | ⬛ 5.8 | 5.0 | 🟩 5.9 | 4.9 | 🟩 6.0 |
| | 31 | Electrical machinery and apparatus | 4.1 | 🟥 3.6 | 7.5 | 🟩 9.9 | 8.2 | ⬛ 8.2 |
| | 34 | Motor vehicles, trailers and semi-trailers | 16.6 | 🟩 18.2 | 13.4 | 🟩 22.0 | 10.2 | ⬛ 9.9 |

🟩 increase
🟥 decrease between 1995-2000 and 2001-2006
⬛ no significant change between 1995-2000 and 2001-2006

*Source:* DG Research and Innovation **Innovation Union Competitiveness Report 2011**
*Data:* Rindicate consortium, based on the OECD ANBERD and STAN databases
*Notes:* (1) Medium-high-tech does not include 'Manufacture of other transport equipment'.
(2) UK: 'Office machinery and computers' is not among the top R&D performing sectors in the UK.

## 5.4. Which are the top ten performing economic sectors in R&D?[135]

This section gives an overview of the main features that characterise the evolution of business R&D intensity in the EU and its main competitors, in terms of the evolution of both the research intensity of the different economic sectors and their respective weights in the economy.

The two tables below show the research intensity and the weight in terms of value added (VA) of the 7 to 10 main R&D performing sectors in each economy (the EU, the United States, Japan, South Korea). These 7 to 10 sectors make 70% to 80% of total BERD in each economy. These sectors are almost exclusively manufacturing high-tech and medium high-tech sectors, but some are services sectors whose importance in an economy's BERD — despite their low R&D intensity — comes from their large size in the economy.

Comparability of BERD data at industry level across countries is not fully ensured, as methods and practices to allocate business R&D expenditures to the different sectors differ across countries. Therefore, it is preferable to compare the parallel evolutions (of the sectoral research intensities and of the sectoral composition) over time in each economy rather than the actual values of sectoral R&D intensities in the different economies.

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[135] This section is based on the study '*Sectoral analysis of the long-term dynamics of business R&D intensity*', commissioned by DG Research and conducted by the Rindicate consortium in 2009.

### *The research intensity of most of the main R&D performing sectors, in particular the manufacturing high-tech sectors, grew between 1995 and 2006 in the EU, the United States, Japan and South Korea*

Table I.5.3 shows that 8 out of the 10 sectors that make the bulk of EU BERD have become more research intensive (green) over the decade 1995–2006. In particular, the manufacturing high-tech and medium high-tech sectors, which are the most R&D-intensive in the economy, have become more research-intensive, apart from Aerospace and Chemicals (red).

In comparison, in the United States the high-tech sectors have seen a much more dramatic increase of their R&D intensity than in Europe, apart from Aerospace, whose R&D intensity declined even more sharply than in Europe. The R&D intensity of high-tech sectors is markedly higher in the United States than in the EU over the period 2001–2006[136]. Particularly astonishing is the difference in R&D intensity of the sector Medical, precision and optical instruments, which is almost three times more research intensive in the United States.

In South Korea, research intensity increased in all the main high-tech and medium high-tech sectors of that country, but the different high-tech sectors remain markedly less research-intensive than in the EU and the United States, while the medium high-tech sectors are of comparable research intensity. What makes the difference in the case of South Korea is that high-tech

TABLE I.5.3

## Evolution of the R&D intensity of the most important R&D performing industries in each country(1)

|  |  | Nace code | Industry |
|---|---|---|---|
|  |  |  | Total BERD intensity (expenditure / value added) |
| **Manufacturing** | High-Tech | 24.4 | Pharmaceuticals, medicinal chemicals and botanical products |
|  |  | 30 | Office machinery and computers |
|  |  | 32 | Radio, television and communication equipment and apparatus |
|  |  | 33 | Medical, precision and optical instruments, watches and clocks |
|  |  | 35.3 | Aircraft and spacecraft |
|  | Medium-High-Tech | 24 less 24.4 | Chemicals and chemical products excluding pharmaceuticals |
|  |  | 29 | Machinery and equipment |
|  |  | 31 | Electrical machinery and apparatus |
|  |  | 34 | Motor vehicles, trailers and semi-trailers |
| **Services** |  | 60-64 | Transport, storage and communications |
|  |  | 72 | Software services |
|  |  | 50-52 | Wholesale and retail trade |
|  |  | 45 | Construction |

*Source:* DG Research and Innovation
*Data:* Rindicate consortium, based on the OECD ANBERD and STAN databases and on the EU KLEMS database
*Note:* (1) Only the top R&D performing sectors that account for more than 70% of R&D are considered for each country.

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[136] It is to be noted that the fact that the intensity of the services sectors in the United States is markedly higher than the EU is partly due to the method used in the US to classify R&D expenditures into sectors.

and medium high-tech sectors have a significantly higher weight in the economy than in the case of the EU and the United States (see Table I.5.4), especially ‘radio, TV and communication equipment’ (one of the high-tech sectors) and ‘motor vehicles’ (one of the medium high-tech sectors). Due to their size in the economy, these two sectors together concentrate about 60% of total BERD in South Korea.

In Japan, the high-tech sector ‘office machinery and computers’ is exceptionally research-intensive, on the order of four to five times more research-intensive than the other high-tech sectors in Japan, the United States or the EU. The medium high-tech sectors in Japan are substantially more research-intensive than in the EU and the United States (up to four times more), in particular ‘chemicals’ and ‘electrical machinery’. Research intensity increased in all the main R&D performing high-tech and medium high-tech sectors in Japan, apart from ‘radio, TV and communication equipment', which very slightly decreased.

Research intensity of high-tech and medium high-tech sectors in China are clearly lower but they refer to the year 2000 and are therefore largely outdated. Therefore, China is not included in Table I.5.3 below.

| | EU | | United States | | South Korea | | Japan | | Highest value |
|---|---|---|---|---|---|---|---|---|---|
| | 1995-2000 | 2001-2006 | 1995-2000 | 2001-2006 | 1995-2000 | 2001-2006 | 1995-2000 | 2001-2006 | |
| | | | | | | | | | |
| | 1.36 | 1.41 | 1.93 | 1.86 | 1.92 | 2.44 | 1.99 | 2.34 | 2.44 (KR) |
| | 25.4 | 26.4 | 25.3 | 31.9 | 3.1 | 5.3 | 20.5 | 27.5 | 45.0 (UK) |
| | : | : | : | : | 10.6 | 11.4 | 36.0 | 115.6 | 115.6 (JP) |
| | 27.8 | 31.3 | 22.8 | 39.8 | 17.6 | 22.7 | 16.8 | 16.4 | 44.9 (FR) |
| | 12.2 | 13.0 | 39.9 | 48.9 | : | : | : | : | 48.9 (US) |
| | 37.3 | 33.4 | 32.8 | 22.4 | : | : | : | : | 41.1 (FR) |
| | 7.8 | 7.4 | : | : | 4.7 | 6.2 | 14.8 | 16.8 | 16.8 (JP) |
| | 5.0 | 5.4 | : | : | 3.6 | 5.1 | 7.8 | 8.8 | 8.8 (JP) |
| | 5.0 | 5.0 | : | : | : | : | 18.1 | 21.0 | 21.0 (JP) |
| | 13.7 | 16.0 | 15.2 | 14.9 | 16.0 | 14.5 | 13.1 | 15.5 | 22.0 (FR) |
| | 0.6 | 0.7 | : | : | 1.7 | 0.6 | : | : | : |
| | 2.8 | 3.8 | 12.5 | 14.7 | : | : | : | : | : |
| | : | : | 1.5 | 1.0 | : | : | : | : | : |
| | : | : | : | : | 0.8 | 0.9 | : | : | : |

*EU:* The top 10 R&D performing industries make up 80% of BERD.
*United States:* The top 7 R&D performing industries make up 70% of BERD.
*Japan:* The top 7 R&D performing industries make up more than 75% of BERD.
*South Korea:* The top 8 R&D performing industries make up 80% of BERD.

🟩 increase
🟥 decrease between 1995-2000 and 2001-2006

## TABLE I.5.4

## Evolution of the share in value added[1] of the most important R&D performing industries in each country[2]

| | | Nace code | Industry |
|---|---|---|---|
| Manufacturing | High-Tech | 24.4 | Pharmaceuticals, medicinal chemicals and botanical products |
| | | 30 | Office machinery and computers |
| | | 32 | Radio, television and communication equipment and apparatus |
| | | 33 | Medical, precision and optical instruments, watches and clocks |
| | | 35.3 | Aircraft and spacecraft |
| | | | **Total High-Tech manufacturing** |
| | Medium-High-Tech | 24 less 24.4 | Chemicals and chemical products, excluding pharmaceuticals |
| | | 29 | Machinery and equipment |
| | | 31 | Electrical machinery and apparatus |
| | | 34 | Motor vehicles, trailers and semi-trailers |
| | | | **Total Medium-High-Tech manufacturing** |
| Services | | 60-64 | Transport, storage and communications |
| | | 72 | Software services |
| | | 50-52 | Wholesale and retail trade |
| | | | **Total Services** |
| | | 45 | Construction |

*Source:* DG Research and Innovation
*Data:* Rindicate consortium, based on the OECD ANBERD and STAN databases and on the EU KLEMS database
*Notes:* (1) Share in the total value added of the economy.
(2) Only the top R&D performing sectors that account for more than 70% of R&D are considered for each country.

### *The economic weight of most of the main R&D-performing sectors declined between 1995 and 2006 in the EU, United States and Japan but increased in South Korea*

Table I.5.4 shows that, with the exception of Pharmaceuticals and the two services sectors, all the sectors that perform most of the BERD in the EU saw a decline or a stagnation of their weight in the EU economy in terms of VA. The same holds in the United States. The decrease of the weight of high-tech sectors is more marked in the United States than in the EU, although it remains higher[137].

What is remarkable is that the main R&D performing high-tech and medium high-tech sectors in South Korea account for 14 % of total VA in the economy, while the main R&D performing high-tech and medium high-tech sectors in the EU account for 7.8 % of total VA in the EU. Compared to the 1995–2000 period, this weight of high-tech and medium high-tech sectors in South Korea even increased (from 12.8 % of total VA). Although smaller than in South Korea, the share of the main R&D performing high-tech and medium high-tech sectors in Japan (9.6 % of total VA) is also higher than in the EU (7.8 % of total VA). However, this weight slightly declined between 1995 and 2006, as in the EU. In South Korea, and to a lesser extent in Japan, the very high weight of high-tech sectors in the economy plays a determinant role in the high overall level of business R&D.

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[137] See also the analysis of structural change in the EU in Part Part III, chapter 3.

| EU | | United States | | South Korea | | Japan | | Highest value |
|---|---|---|---|---|---|---|---|---|
| 1995-2000 | 2001-2006 | 1995-2000 | 2001-2006 | 1995-2000 | 2001-2006 | 1995-2000 | 2001-2006 | |
| 0.60 | 0.68 | 0.54 | 0.66 | 0.89 | 0.91 | 0.63 | 0.68 | 0.91 (KR) |
| : | : | : | : | 0.63 | 0.46 | 0.56 | 0.26 | 0.46 (KR) |
| 0.63 | 0.52 | 1.07 | 0.61 | 3.85 | 4.90 | 2.04 | 1.92 | 4.90 (KR) |
| 0.60 | 0.61 | 0.44 | 0.36 | : | : | 0.33 | 0.31 | 0.90 (DE) |
| 0.28 | 0.28 | 0.53 | 0.49 | : | : | : | : | 0.60 (UK) |
| 2.11 | 2.09 | 2.58 | 2.12 | 5.37 | 6.27 | 3.56 | 3.17 | 6.27 (KR) |
| 1.49 | 1.28 | 1.21 | 1.00 | 2.14 | 2.03 | 1.19 | 1.00 | 2.03 (KR) |
| 2.24 | 2.06 | 1.18 | 0.91 | 2.05 | 2.27 | 2.26 | 2.17 | 3.40 (DE) |
| 0.99 | 0.85 | : | : | 0.98 | 1.07 | 1.14 | 0.94 | 1.07 (KR) |
| 1.58 | 1.50 | 1.25 | 0.94 | 2.22 | 2.36 | 1.91 | 2.30 | 3.20 (DE) |
| 6.30 | 5.69 | 3.64 | 2.85 | 7.39 | 7.73 | 6.50 | 6.41 | 7.73 (KR) |
| 6.68 | 6.85 | : | : | 6.86 | 7.35 | : | : | : |
| 1.53 | 1.98 | 1.37 | 1.62 | : | : | : | : | : |
| : | : | 13.07 | 12.60 | : | : | : | : | : |
| : | : | : | : | : | : | : | : | : |
| : | : | : | : | 10.54 | 9.06 | : | : | : |

*EU:* The top 10 R&D performing industries make up slightly less than 17% of value added.
*United States:* The top 9 R&D performing industries make up slightly more than 19% of value added.
*Japan:* The top 8 R&D performing industries make up slightly less than 10% of value added.
*South Korea:* The top 9 R&D performing industries make up slightly more than 30% of value added.

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🟩 increase
🟥 decrease
⬜ no change between 1995-2000 and 2001-2006

### *Several of the sectors with the largest R&D intensity gains and losses are the same in the EU and the United States*

Figure I.5.13 presents the four sectors whose R&D intensity grew the fastest between the two periods 1995–2000 and 2001–2006 in the EU[138]. Two of them, 'Radio, TV and communication equipment and apparatus' and 'Pharmaceuticals', are high-tech sectors whose R&D intensity (R&D expenditures over value added) reached 31.2 % and 26.4 % respectively on average over the period 2001–2006 (from 27.8 % and 25.4 % respectively over 1995–2000). The medium high-tech sector 'Motor vehicles' progressed from 13.7 % to 16 %, while the service sector 'Computer and related services' progressed from 2.8 % to 3.8 %. The sector which experienced the largest fall in R&D intensity in the EU is the high-tech sector 'Aerospace' from 37.3 % to 33.4 %.

The trends in sectoral R&D intensity in the United States are similar to those of the EU, with 'Radio, TV and communication equipment and apparatus' and 'Pharmaceuticals' as top winners in R&D intensity, while 'Aerospace' and 'Chemicals (excluding "Pharmaceuticals")' saw their R&D intensity decline significantly between 1995 and 2006.

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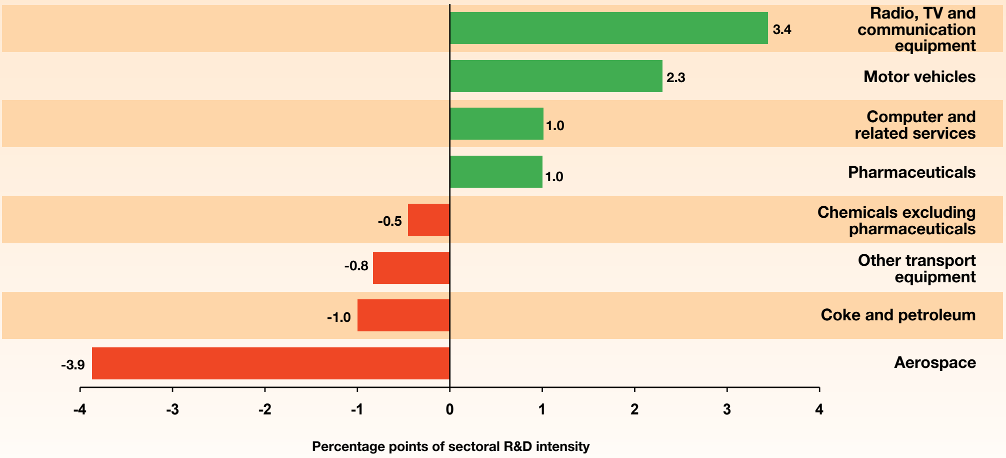
[138] The EU includes 11 Member States covering more than 90 % of EU BERD: Germany, France, the United Kingdom, Italy, Sweden, Spain, the Netherlands, Belgium, Finland, Denmark and Ireland.

FIGURE I.5.14

## R&D Intensity gains and losses in the EU[(1)] - sectors with the most significant gains and losses, 1995-2006[(2)]



*Source:* DG Research and Innovation

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*Data:* Rindicate consortium, based on OECD ANBERD and STAN databases and EU KLEMS database.

*Notes:* (1) EU includes 11 Member States covering more than 90% of EU BERD: BE, DK, DE, IE, ES, FR, IT, NL, FI, SE, UK.
(2) The difference in average R&D Intensity between the two periods 2001-2006 and 1995-2000, in percentage points.

In Japan, an extraordinary increase in R&D intensity occurred in the high-tech sector ‘Office machinery and computers’ between the two periods 1995–2000 and 2001–2006. The atypical evolution of this sector is responsible for a large part of the overall increase in business R&D intensity in Japan. The R&D intensity of ‘Pharmaceuticals’ is also among the top winners in R&D intensity in Japan. However, in contrast to the EU and the United States, no economic sector experienced a decline in R&D intensity in Japan between 1995 and 2006.

***Overall, the slight increase in business R&D intensity in the EU in 2001–2006 compared to 1995–2000 is linked to a research intensification of most of the sectors that perform the vast majority (80 %) of the EU BERD, in particular the high-tech sectors, while the weight of these sectors in the economy tended to decrease***

The above tables show that the slight increase in business R&D intensity overall in the EU in the period 2001–2006 compared to 1995–2000 is due to a research intensification of most of the sectors that perform the vast majority (80 %) of the EU BERD, in particular the high-tech sectors, while the weight of these sectors in the economy tended to decrease, with the notable exception of ‘Pharmaceuticals’.

In the United States, the same decline in the weight of high-tech and medium high-tech sectors is observed, while the increase in research intensity of the high-tech sectors is much larger than in the EU. However, in the United States in total, the decline in weight slightly over-compensates the gain in research intensity so that the overall business R&D intensity slightly declined in the United States.

The high business R&D intensity of South Korea comes from its economy’s composition, which is clearly less dominated by services than the EU or the United States, with the main South Korean high-tech and medium high-tech sectors being almost twice as important in the South Korean economy as in the EU or US economy. In contrast, high-tech sectors in South Korea are clearly less research-intensive than in the EU or the United States.

The high business R&D intensity of Japan (and its growth) comes from the exceptionally high and growing research intensity of the high-tech sector ‘Office machinery and computers’ and from very research-intensive medium high-tech sectors. In addition, the weight of high-tech sectors in Japan’s economy is one third larger than in the EU’s economy, although it suffered from a decline between 1995 and 2006 as in the EU and the United States. In total, the high growth in research intensity of the above-mentioned sectors in Japan largely overcompensates their decline in economic weight.

Altogether, in the four economies of the EU, the United States, South Korea, and Japan, the main R&D performing sectors are manufacturing high-tech and medium high-tech sectors that make more than 70 % of total BERD in each economy. The research intensity of these sectors generally grew in the four economies between 1995 and 2006, while their weight in the economy declined, except in Korea where their already high weight grew still greater. This increase in sectoral research intensity is more pronounced in the high-tech and medium high-tech of Japan and in the high-tech sectors of the United States than in the EU.

Among high-tech sectors, 'manufacture of office machinery and computers' (hereafter 'IT equipment'), 'manufacture of radio, television and communication equipment' (hereafter ' IT components, telecom and multimedia equipment') and 'manufacture of medical, precision and optical instruments, watches and clocks' (hereafter 'measurement instruments')[139] play a particularly important role in the EU business R&D deficit. Together with the two services sectors 'post and telecommunications' and 'computer and related activities'[140], they form what is called the 'Information and Communication Technologies' (ICT) industry. Section 5.5 offers a further insight in the R&D dynamics of that industry.

## 5.5. What is the role of the ICT industry in the European research landscape?[141]

The ICT industry, and the ICT-enabled innovation in non-ICT industries and services, makes an important contribution to the economic growth of advanced economies. The ICT sector was highlighted in the EU Lisbon Objectives, and has retained its prominence in the Europe 2020 Strategy. The ICT sector is a significant contributor to the ambition of achieving the target of investing 3 % of GDP in R&D in the EU. This section presents an analysis of ICT R&D over the period 2002-2007[142], i.e. the period of ICT sector growth that took place between two important financial events (the 'dot.com' crisis and the current financial and economic crisis).

### *The ICT sector is by far the largest R&D investing sector of the economy*

ICT technologies are highly pervasive technologies and the ICT sector underpins growth in all sectors of the economy. In the EU, the US and Japan, the ICT sector is by far the largest R&D-investing sector of the economy. In 2007, while the ICT sector represented 4.8 % of GDP and 3 % of total employment in the EU (6.1 million employees), it accounted for 25 % of overall business expenditure in R&D (BERD)[143] and employed 32.4 % of all business-sector researchers.

The EU ICT BERD remained stable during the period of analysis (see blue line in Figure I.5.15[144], left) with an ICT BERD intensity between 6 and 6.5 % of ICT sector value added, well below US ICT BERD intensity (see Table I.5.5). It does, however, demonstrate the importance of the sector when it comes to observing and understanding R&D expenditure, dynamics and performance in the EU. Not only does the ICT sector lead other economic sectors in terms of BERD, it also provides them with productivity-enhancing technology. Hence it contributes directly and indirectly to increasing labour productivity and overall EU competitiveness.[145]

### *Between two economic crises, the dynamics of the ICT sector was underpinned by structural change towards ICT services*

In 2007, total ICT sector employment exceeded for the first time its previous peak level in 2001, accompanied by an important redistribution of jobs from ICT manufacturing to ICT services sub-sectors. In 2007, the share of ICT services employment reached 68 % of the total ICT sector. ICT Services accounted for more than 75 % of total ICT value added (42 % in the 'computer services and software' sub-sector alone). The 'computer services and software' sub-sector is also the only EU ICT sub-sector with a strong and sustained increase in both BERD and the employment of researchers: from 2002–2007, BERD increased by 40 % (see dotted line in Figure I.5.15, left) and employment of researchers by 56 %. In 2007, the 'computer services and software' sub-sector became for the first time the leading ICT sub-sector in terms of employment of researchers (see dotted line in Figure I.5.15, right).

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[139] Codes 30, 32 and 33 in NACE Rev.1.1.

[140] Codes 64 and 72 in NACE Rev. 1.1.

[141] In this section, ICT industry includes economic activities with codes 30, 32, 33, 64 and 72 of NACE Rev. 1.1.

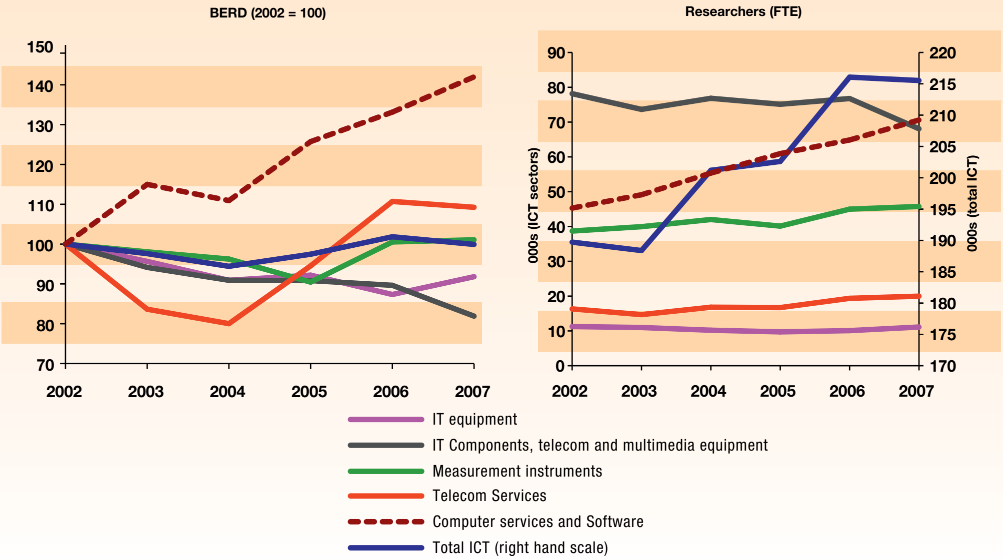
[142] This analysis was carried out by the JRC-IPTS in the context of PREDICT, a research project co-financed by JRC-IPTS and the Information Society & Media Directorate General of the European Commission. Further information, including details on the study methodology can be found at http://is.jrc.ec.europa.eu/pages/ISG/PREDICT.html.

[143] Followed by 'automotive' (16 %) and 'pharmaceutical/biotechnology' (13.3 %) in 2007.

[144] Source: JRC-IPTS estimates, based on data from Eurostat, OECD, EU KLEMS and national statistics..

[145] See the March 2009 European Commission Communication: 'A Strategy for ICT R&D and Innovation in Europe: Raising the Game', COM(2009)116, available at: http://ec.europa.eu/information_society/tl/research/documents/ict-rdi-strategy.pdf.

## FIGURE I.5.15 EU - Evolution of BERD$^{(1)}$ and researchers (FTE) by ICT sub-sector, 2002-2007



*Source:* DG Research and Innovation, JRC-IPTS
*Data:* The 2010 report on R&D
in ICT in the European Union
*Note:* (1) Real growth.

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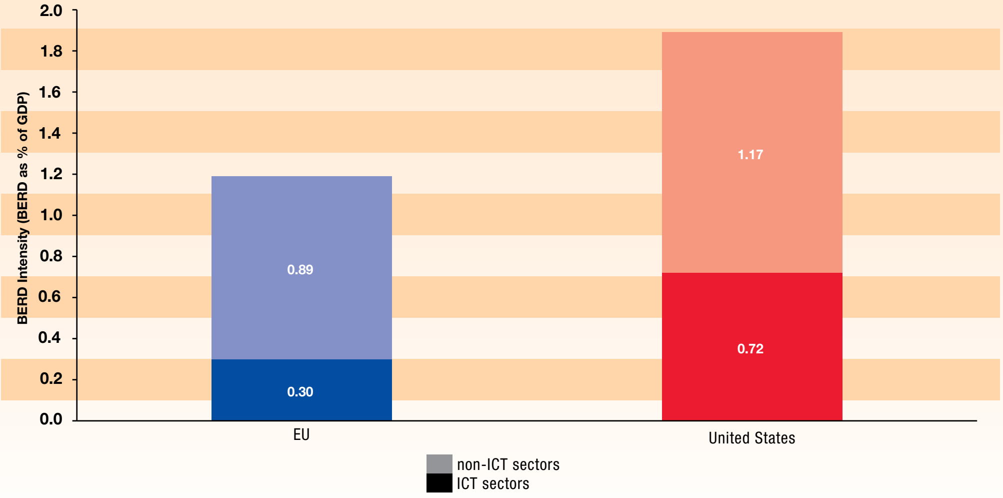
## FIGURE I.5.16 Contribution of ICT and non-ICT sectors to total BERD Intensity, 2007



*Source:* DG Research and Innovation, JRC-IPTS
*Data:* The 2010 report on R&D
in ICT in the European Union

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## TABLE I.5.5

## ICT BERD as % of GDP, size of the ICT sector in the economy and ICT R&D Intensity, 2007

| | ICT BERD as % of total GDP 2007 | ICT value added as % of total GDP 2007 | ICT R&D Intensity (ICT BERD as % of ICT value added) 2007 |
|---|---|---|---|
| EU | 0.30 | 4.8 | 6.2 |
| United States | 0.72 | 6.4 | 11.2 |
| Japan | 0.87 | 6.8 | 12.8 |
| South Korea | 1.30 | 7.9 | 16.5 |
| Chinese Taipei | 1.31 | 10.6 | 12.3 |

*Source:* DG Research and Innovation, JRC-IPTS
*Data:* The 2010 report on R&D in ICT in the European Union

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### *In 2007, ICT accounted for 63 % of the business R&D intensity gap between the United States and the EU*

Although impressive, the contribution of the European ICT industry to total BERD (24.9 %) is much lower than in Japan and the United States, where ICT drives 32.4 % and 39.2 % of total R&D, respectively. As shown in the figure below, ICT explains most (63 %) of the business R&D gap between the United States and the EU: in 2007, the ICT business R&D intensity gap explained 0.44 out of the 0.7 percentage points of GDP that constitute the total EU–US business R&D intensity gap (Figure I.5.16).

### *The weight and research intensity of ICT industry in the EU economy are smaller than in its main competitors*

The United States, Japan, Taiwan and South Korea are investing significantly more in ICT R&D than the EU (when comparing ICT R&D business expenditure over GDP ratios). Although the EU and the US have roughly equivalent GDPs, the US levels of both business ICT R&D expenditure (ICT BERD) and public ICT R&D funding are twice as large as those of the EU.

These points can be further elaborated from three perspectives:

- In 2007, ICT BERD intensity was 0.30 % of GDP for the EU, compared to 0.72 % for the United States. This difference can be attributed to both a smaller relative size of the ICT sector in the economy and to a lower R&D intensity of the ICT sector (Table I.5.5). This difference is even bigger when comparing the EU to Japan, South Korea and Taiwan. Company-level data analysis of global R&D investments of the 2008 ICT Scoreboard companies[146] produces similar results.
- Public funding figures also indicate that, compared to the United States, EU governments fund a smaller share of ICT R&D in relation to total public funding for R&D. In 2007, EU ICT GBOARD represented 6 % of total public funding for R&D in the EU, while it was close to 9 % in the United States. In addition, available (incomplete) data indicates a substantial ‘gap’ between the EU and the United States in terms of ICT R&D public procurement[147] and dual-use research[148].
- R&D output, proxied by patenting activity also appears to be notably more specialised in ICT in the United States than it is in the EU. In 2006, 50 % of all patents applied for by US-based inventors[149] were in ICT technologies, compared to only 20 % of all patents applied for by EU-based inventors.

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[146] The JRC-IPTS ICT Scoreboard includes the 453 ICT companies with the largest R&D budgets globally. It is extracted from the EU Industrial R&D Investment Scoreboard, (http://iri.jrc.ec.europa.eu/research/scoreboard_2008.htm). In the Scoreboard, the term ‘EU company’ concerns companies whose ultimate parent has its registered office in a Member State of the EU. For more methodological details, see: http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=3239.

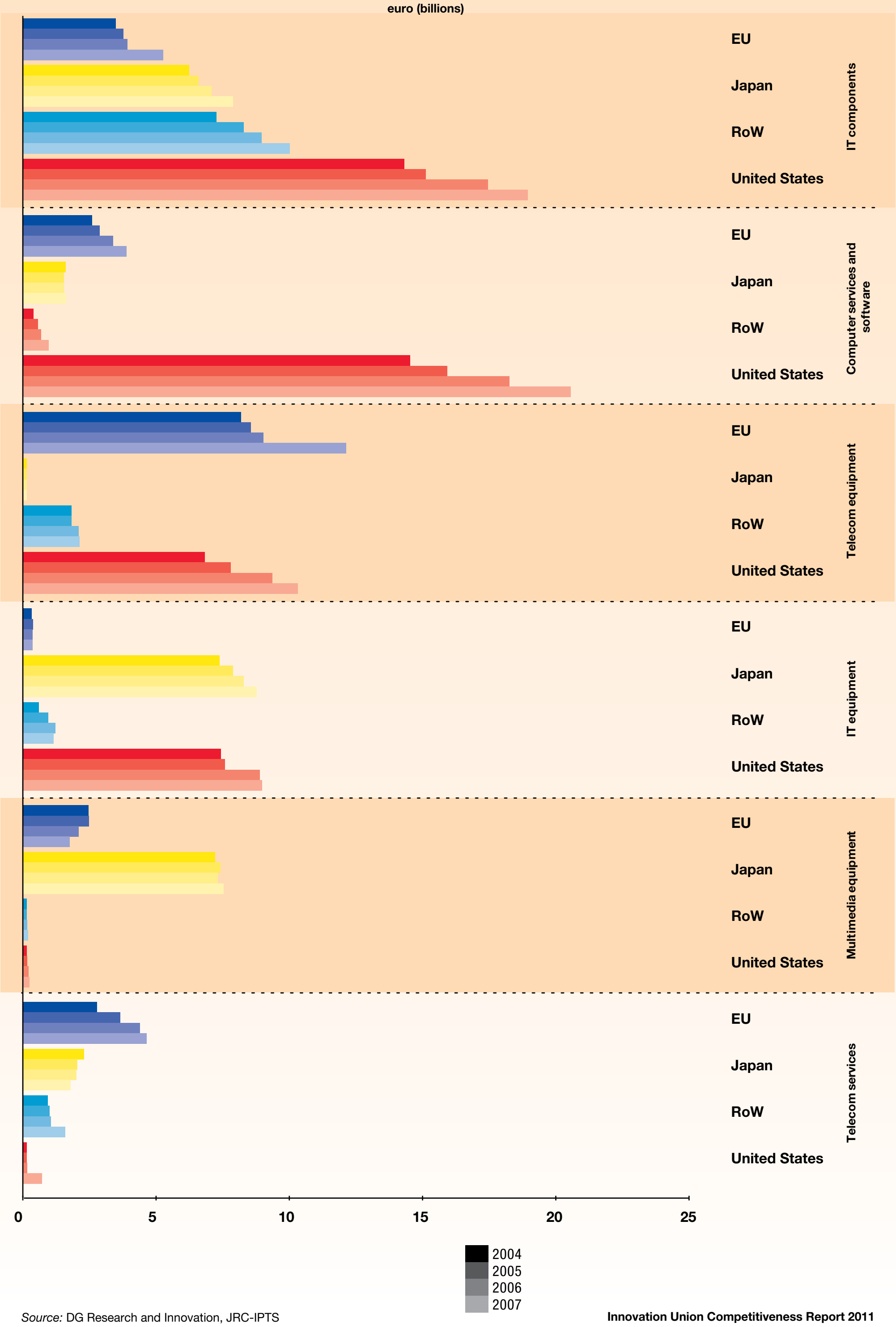
[147] See December 2007 EC Communication on pre-commercial procurement, COM(2007) 799, available at: http://ec.europa.eu/information_society/tl/research/priv_invest/pcp/documents/pcp_brochure_en.pdf.

[148] Dual-use research refers to tools or techniques, developed originally for military or related purposes, which are sufficiently commercially viable to support adaptation and production for industrial or consumer uses. The United States Department of Defense (DOD) has an important dual-use research program. Adapted from: http://www.answers.com/topic/dual-use-technology.

[149] Patent priority applications by inventors physically based (residing) in the US.

FIGURE I.5.17

## R&D investment in ICT sub-sectors by ICT Scoreboard companies, 2004-2007



*Source:* DG Research and Innovation, JRC-IPTS
*Data:* The 2010 report on R&D in ICT in the European Union

Further company-level data analysis of R&D, invested in ICT sub-sectors for the period 2004–2007 by ICT Scoreboard companies, shows that R&D investment by EU companies has been growing, in some cases strongly, in all ICT sub-sectors[150]. At the same time, the *ICT Scoreboard* shows that US companies clearly outperform the EU ones in several ICT sub-sectors that are key to the competitiveness of the EU industry, notably 'computer services and software' (Figure I.5.17).

Company data analysis also indicates that the EU does not generate as many large new and innovative ICT companies as the United States (and may additionally be threatened by emerging competitors from China and India). This appears particularly true in a key growth segment: 'computer services and software'. The lack of large innovation clusters in the EU may partly explain these difficulties, but market fragmentation, difficult access to financial capital, and other market rigidities are often cited[151] as other possible causes. The lack of large ICT companies in high-growth sectors and slower industrial growth clearly have a negative impact on the R&D investment indicators.

A cross-country comparison also needs to take into account the fact that ICT R&D is increasingly distributed globally. Analyses of a combination of indicators (global distribution of corporate R&D sites of major ICT companies[152], and international patents in ICT technologies[153]) indicate that the EU remains an important location for ICT R&D — for both EU and non-EU companies — but it is also observed that Asia is gaining importance in this respect. Such analysis further indicates that US companies have taken a 'first mover' advantage in developing ICT R&D collaborations with Asia. For example, the share of the ICT inventions developed in Asia and owned by US patent applicants grew from almost zero in the early 1990s to 1.5 % in 2006, while the share owned by EU patent applicants merely started growing in the late 1990s and reached only 0.5 % in 2006.

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[150] With the unique exception of Multimedia Equipment.

[151] See also: Information and Communication Technologies, Market Rigidities and Growth: Implications for EU Policies at http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1508.

[152] Based on the JRC-*IPTS ICT R&D Location Database*. This dataset includes location information for over 1 800 R&D sites that, in 2007 and 2008, belonged to 80 major multinational companies.

[153] Based on priority applications analysis from the PATSTAT database of EPO.

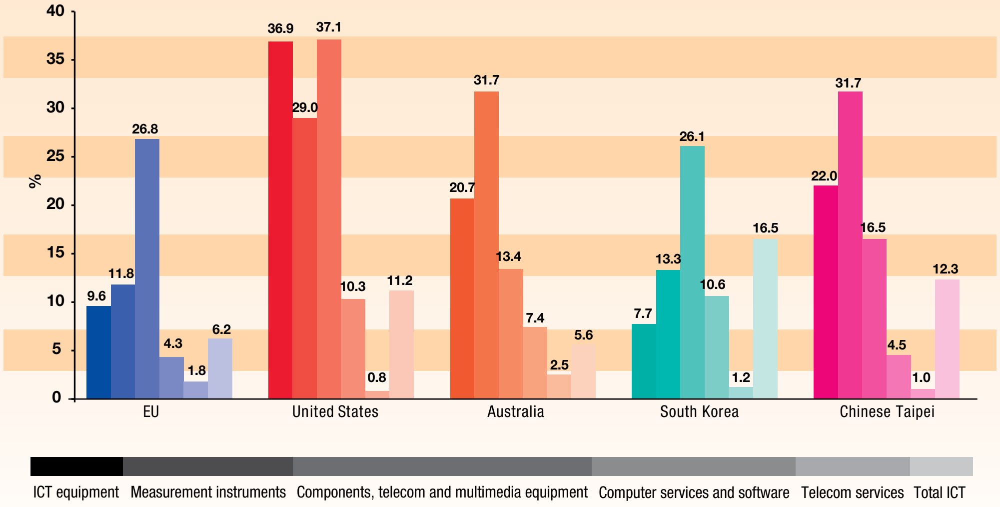

FIGURE I.5.18 **R&D Intensity (BERD as % of value added) by ICT sub-sector, 2007**

*Source:* DG Research and Innovation, JRC-IPTS
*Data:* The 2010 report on R&D in ICT in the European Union

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### *ICT sub-sectors are less research intensive in the EU than in its main competitors, with the exception of 'Post and telecommunications'*

Figure I.5.18 shows the R&D intensity (BERD/value added) of the ICT sub-sectors in an international perspective[154], and indicates that the overall lower R&D intensity of the ICT sector in the EU relative to the United States is reflected in all the sub-sectors, except the Telecom Services.

The comparative analysis of R&D intensities reveals different patterns of R&D specialisation. The EU's highest R&D intensity is in 'components, telecom and multimedia equipment', at the same value as South Korea. The US ICT manufacturing sector seems the least specialised in terms of R&D investments/value added. From the countries in our sample, the fast-growing 'computer services and software' sector is most R&D intensive in South Korea and the United States.

### *The best performing countries in ICT R&D in the EU are the Nordic countries*

In absolute terms, quite expectably, the EU's three largest economies (Germany, France and the United Kingdom), and to some extent the next two (Italy and Spain), dominate and set the average EU trend. When the size of the respective economies is taken into account, the best relative performers in ICT are the Nordic countries. In 2007, Germany, France, the United Kingdom, Italy and Spain accounted for more than 70 % of total ICT sector value added and two thirds of its employment. In ICT manufacturing, Germany alone contributed 27 % of EU employment and 30 % of value added. In ICT services, the United Kingdom remains the leading country for employment (19 % of EU employment) and a clear leader in value-added terms (25 % of EU value added). These five countries together contribute more than two thirds of EU ICT BERD, and they generate more than 75 % of all ICT patents (Germany generates almost 45 % of these).

Finland and Sweden invest the largest amount in ICT BERD in relation to their GDP (and above the US level). In 2007, Finland and Sweden were also (with Spain) the countries with highest levels of ICT R&D public funding in relation to their GDP (comparable to US level). Finland, Germany, the Netherlands and Sweden are the only four Member States with ratios of ICT patent applications in relation to GDP either above or close to the US ratio. The Member States that have experienced the largest increases in ICT BERD in recent years are the new EU Member States along with Portugal and Spain. In spite of strong ICT BERD increase, however, the new EU Member States still have very low ICT BERD in relation to their GDP. They also have very low ratios of ICT GBAORD to GDP. Although several new Member States, such as Hungary, the Czech Republic and Poland, recorded spectacular increases in ICT manufacturing employment, deeper analysis shows that these countries are still hosting rather low-value-added activities.

### *A lot of ICT R&D is also performed in non-ICT sectors of the economy*

Substantial ICT R&D is carried out in other sectors of the economy (for example, automotive or aeronautics). The size of this additional ICT R&D expenditure cannot be readily measured with current statistics. However, OECD has estimated that the magnitude of ICT R&D carried out outside of the ICT sector could be as large as an additional one third of the R&D carried out in the ICT sector itself[155]. After further statistical analysis and estimation, taking this additional R&D into account may eventually deepen our understanding of the nature of the EU–US gap in R&D investment. More importantly, it may also provide further evidence of the pervasive impact of ICT and ICT R&D investment on the overall economy.

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[154] The sectoral disaggregation presented in this chapter does not include data for Canada and Japan due to the unavailability of comparable data at this level of disaggregation.

[155] Estimated by OECD in a sample of countries: Czech Republic, Denmark, Norway, Finland and Japan (OECD, 2008 b).

# CHAPTER 6

# Outputs and efficiency of science and technology in Europe

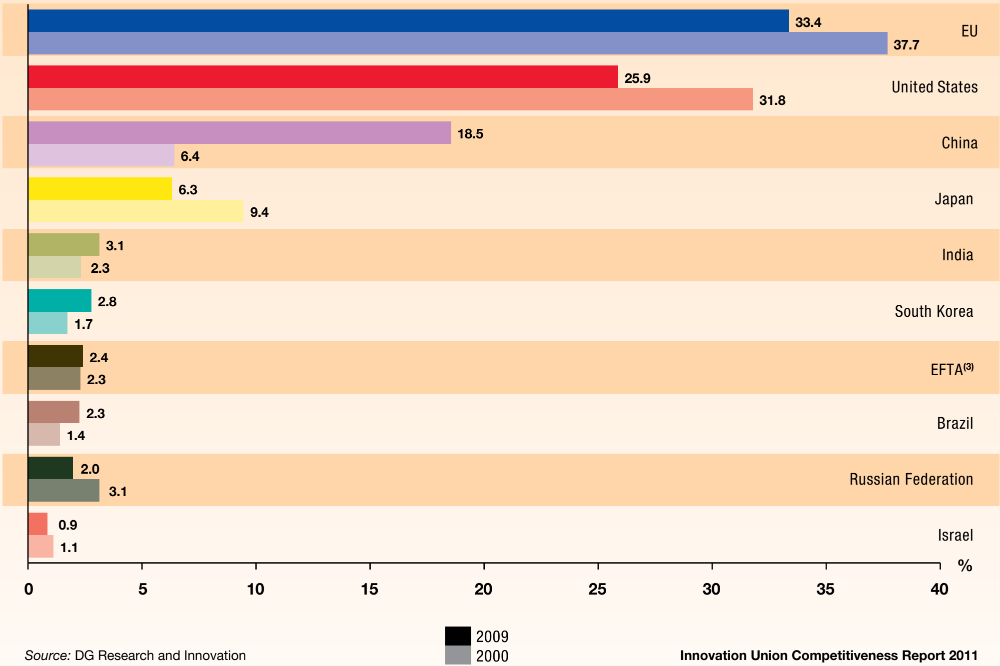
## HIGHLIGHTS

In 2009, the EU produced 33.4 % of world's total scientific publications, the largest scientific centre in the world. However, the capacity of the EU to produce high-impact scientific publications, a proxy for scientific quality, is lower than that of the United States. Among the scientific publications in 2007, the ratio of EU's contribution to the 10 % most cited scientific publications in 2007-2009 was 1.16, which is well above the ratio for Japan, South Korea and China, but behind the ratio of 1.53 for the United States. However, since 2001, the EU has improved its scientific quality from 1.04 to 1.16, while the United States has stagnated. In Europe, it is Denmark the Netherlands, Iceland, Belgium and Switzerland, which have achieved the highest quality in their scientific publications according to this indicator. In absolute and quantitative terms the United Kingdom, Germany, France and Italy are the countries with the highest number of scientific publications.

Concerning technological output, the latest available data is from 2007. Contrary to the strong European scientific production, the technological production in the EU is less competitive. In 2007, the EU Member States only accounted for 43 % of the EPO patent applications. In other words, more than 50 % of all EPO patent applications were generated outside the EU. Relative to GDP, the inventing activity of EPO patents in the EU has decreased since 2000, while it increased dramatically in South Korea and Japan. About half of the Member States do not produce high-tech EPO patents. Evidence at regional level shows a strong concentration of patents in a few of Europe’s regions.

The divergence between scientific publications and technological production in Europe is an indication of a weakness in the European research and innovation system. However, estimating efficiency of the European R&I system is more complex, relating input to output, while analysing the impact of scientific output on innovation. This report presents some experimental and preliminary evidence on the efficiency of public research systems. In the EU, the ratio of quantity and quality of scientific production to the number of researchers is clearly below that of the United States. On average, a researcher in the public sector in the United States produces 2.25 articles among the 10 % most cited articles worldwide, compared to 0.79 highly-cited articles per average researcher in the public sector in the EU. One of many explanations of this large difference is that public researchers in the United States benefit from total funding over 2 times higher per researcher than their colleagues in the EU. Further downstream, for almost all EU Member States and Associated countries, there is a positive relation between high-quality scientific output in the public sector and business sector investment in R&D. A growth of business sector R&D investment is in turn positively related to a growing patenting activity. Improving the efficiency producing high quality public research thus has potentially a positive impact on innovation. However, this relation is not linear or automatic, but depends on many dimensions of the public research system and its interaction with private actors, which will be further analysed in Part II of this report, capitalising on the emerging European Research Area.

FIGURE I.6.1 **World shares of scientific publications (%)(1), 2000 and 2009(2)**



*Source:* DG Research and Innovation
*Data:* Science Metrix / Scopus (Elsevier)
*Notes:* (1) Full counting method.
(2) Data for 2009 are provisional.
(3) EFTA: Liechtenstein is not included.

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## 6.1. Where does Europe stand in terms of scientific excellence?

Bibliometric indicators and patents are currently the most easily available and widely used proxies for measuring scientific and technological output. Bibliometric indicators give information on the codified knowledge produced by universities, research institutes and private firms. They also allow comparison of the scientific performance of different countries and regions. Patents, on the other hand, provide a valuable measure of the exploitation of research results and of inventiveness of countries, regions and firms. Both publications and patents play a role in the diffusion and exploitation of knowledge.

All the indicators and data on publications below refer to internationally peer-reviewed scientific publications which are indexed in Scopus (one of the largest abstract and citation databases of peer-reviewed literature)[156].

***The EU remains the largest producer of scientific publications in the world, followed by the United States. However both the shares of the EU and the United States worldwide are decreasing, whereas China is catching up rapidly***

In 2008, 33.4 % of the world's peer-reviewed publications were signed by EU authors, compared to 25.9 % in the United States (figure I.6.1). Both shares have considerably decreased between 2000 and 2009 as a result of the increasing scientific capacity of Asia. China is catching up fast, from 6.4 % of world publications in the Scopus database to 18.5 % in 2008. The average annual real growth of peer-reviewed scientific publications between 2000 and 2008 was 6.9 % in the EU, 5.6 % in the United States and 28.2 % in China.

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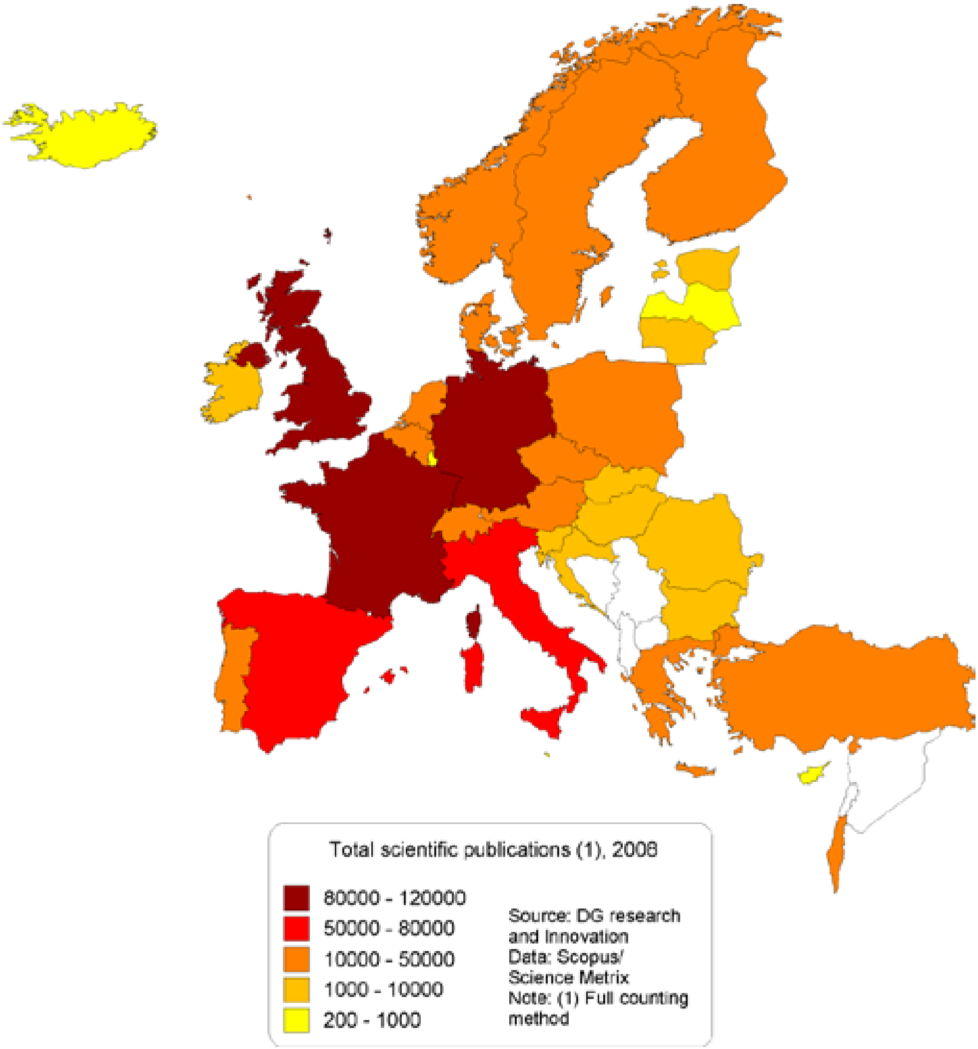
[156] http://www.scopus.com/home.url

FIGURE I.6.2

## Number of scientific publications of the EU Member States and Associated Countries, 2008



Source: DG research and Innovation
Data: Scopus/ Science Metrix
Note: (1) Full counting method

## TABLE I.6.1 Scientific publications

| | Total scientific publications[1] | | | Scientific publications within the 10% most cited scientific publications worldwide[1] | | |
|---|---|---|---|---|---|---|
| | 2000 | 2008 | Average annual growth (%) 2000-2008 | 2000 | 2007 | Average annual growth (%) 2000-2007 |
| Belgium | 11 820 | 20 285 | 7.0 | 1401 | 2787 | 10.3 |
| Bulgaria | 1925 | 2896 | 5.2 | 95 | 165 | 8.2 |
| Czech Republic | 5781 | 11 894 | 9.4 | 353 | 743 | 11.2 |
| Denmark | 8896 | 13 260 | 5.1 | 1327 | 2092 | 6.7 |
| Germany | 77 958 | 111 288 | 4.5 | 9085 | 13 576 | 5.9 |
| Estonia | 603 | 1392 | 11.0 | 41 | 132 | 18.2 |
| Ireland | 3178 | 7799 | 11.9 | 345 | 904 | 14.8 |
| Greece | 5924 | 13 855 | 11.2 | 459 | 1299 | 16.0 |
| Spain | 27 089 | 52 664 | 8.7 | 2347 | 5317 | 12.4 |
| France | 57 081 | 81 911 | 4.6 | 6049 | 9030 | 5.9 |
| Italy | 38 708 | 63 408 | 6.4 | 3816 | 6858 | 8.7 |
| Cyprus | 197 | 801 | 19.2 | 10 | 66 | 30.9 |
| Latvia | 359 | 613 | 6.9 | 18 | 16 | -1.8 |
| Lithuania | 612 | 2065 | 16.4 | 42 | 96 | 12.6 |
| Luxembourg | 90 | 503 | 24.0 | 5 | 38 | 33.7 |
| Hungary | 5164 | 7419 | 4.6 | 335 | 560 | 7.6 |
| Malta | 50 | 223 | 20.5 | 3 | 15 | 25.6 |
| Netherlands | 22 181 | 35 425 | 6.0 | 3207 | 5383 | 7.7 |
| Austria | 7967 | 14 225 | 7.5 | 946 | 1754 | 9.2 |
| Poland | 13 022 | 24 121 | 8.0 | 609 | 1210 | 10.3 |
| Portugal | 3804 | 10 781 | 13.9 | 317 | 949 | 16.9 |
| Romania | 2456 | 6967 | 13.9 | 120 | 278 | 12.7 |
| Slovenia | 1926 | 3701 | 8.5 | 102 | 284 | 15.8 |
| Slovakia | 2405 | 3968 | 6.5 | 90 | 204 | 12.4 |
| Finland | 8358 | 12 606 | 5.3 | 1028 | 1471 | 5.2 |
| Sweden | 17 409 | 22 976 | 3.5 | 2259 | 3117 | 4.7 |
| United Kingdom | 84 422 | 117 742 | 4.2 | 10 512 | 15 691 | 5.9 |
| EU | 367 207 | 546 837 | 5.1 | 37 150 | 55 557 | 5.9 |
| Iceland | 322 | 759 | 11.3 | 47 | 106 | 12.4 |
| Norway | 5978 | 10 963 | 7.9 | 674 | 1368 | 10.6 |
| Switzerland | 16 027 | 26 009 | 6.2 | 2563 | 4236 | 7.4 |
| Croatia | 1884 | 3882 | 9.5 | 52 | 170 | 18.5 |
| Turkey | 7246 | 23 092 | 15.6 | 326 | 1475 | 24.1 |
| Israel | 10 709 | 15 279 | 4.5 | 1207 | 1862 | 6.4 |

*Source:* DG Research and Innovation
*Data:* Science Metrix / Scopus (Elsevier)
*Note:* (1) Full counting method.

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### *The United Kingdom, Germany, France and Italy, followed by Spain and the Netherlands, remain the countries with most scientific publications in Europe in the last decade. Small countries register the highest growth rates in terms of number of publications between 2000 and 2008*

In 2008, the EU Member States with the highest number of scientific publications are the United Kingdom (21.9 % of the total EU-27 publications), Germany (20.8 %), France (15.1 %), Italy (11.3 %), and Spain (8.7 %). Figure I.6.2 and Table I.6 provides an overview of the absolute values.

The smallest countries (Luxembourg, Malta, and Cyprus) are leading in terms of growth rates between 2000 and 2008, both for the total number of publications and for the highly cited publications (see table I.6.1). Remarkable growth rates on publications are shown also by Lithuania (16.4 %), Turkey (15.6 %), Portugal and Romania (each with 13.9 %), whereas highly cited publications have increased spectacularly in Turkey (24.1 %), Croatia (18.5 %), Estonia (18.2 %), Portugal (16.9 %), and Greece (16 %).

### *The EU's capacity to produce high-impact scientific publications is well above other world regions and on increasing trend since 2000, but it remains substantially lower than that of the United States despite the stagnation of American high-impact scientific publication numbers*

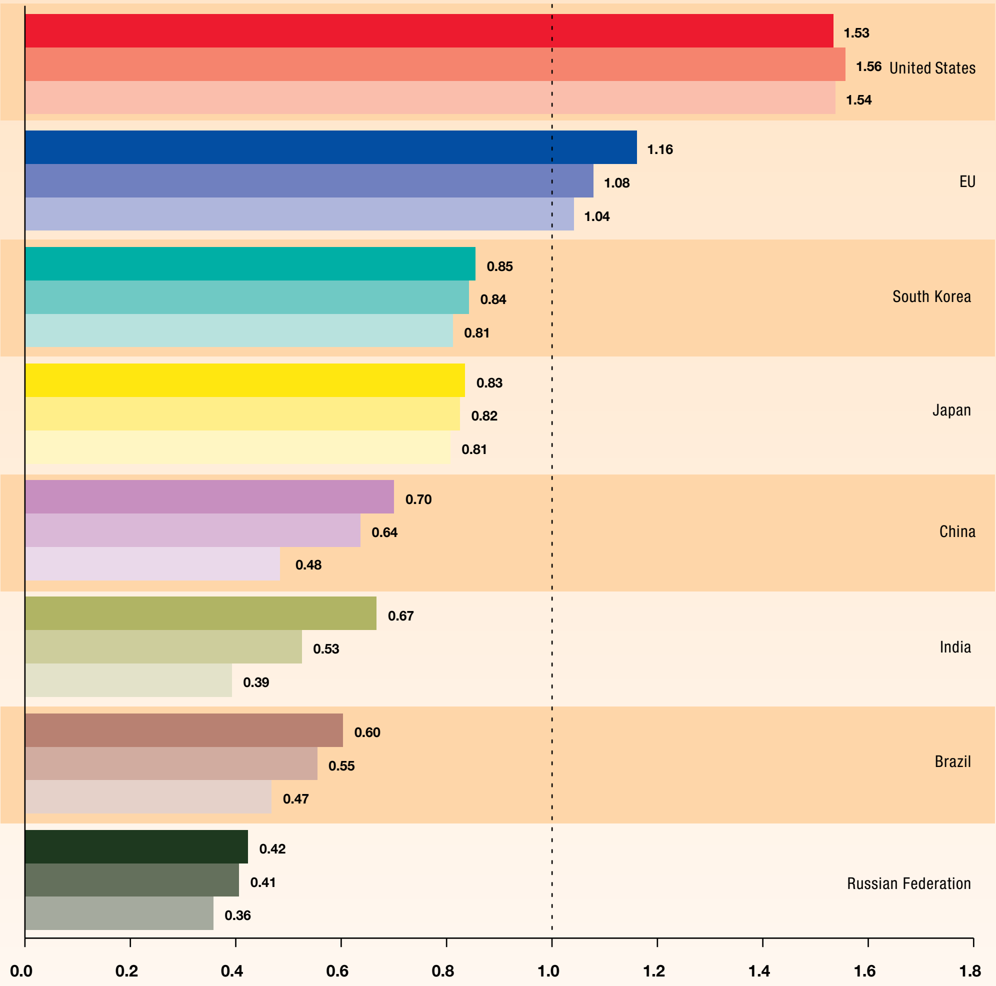
The number of citations that a scientific publication receives is an indication of the use of this publication in subsequent scientific works. It is, therefore, an indication of the impact of this publication on science. In each scientific field, one can assume that the top 10 % most-cited scientific publications are among the most influential publications in that field. The values reported in Figure I.6.3 concern publications of 2001 with a 2001–2004 citation window, publications of 2004 with a 2004–2007 citation window and publications of 2007 with a 2007–2009 citation window.

On average, a country is expected to have 10 % of its publications among the top 10 % most cited ones worldwide. A higher value means that this country produces highly cited publications more often than expected. This is the case of the United States and the EU as a whole and for a number of European countries, led by Switzerland, Iceland, Denmark, the Netherlands and Belgium. The EU has progressed since 2000 and so has the EU average, which reached 11.6 % in 2009 (from 10.4 % in 2001), while the United States has stagnated overall at 15.3 %. The EU–US gap in highly cited publications has, therefore, decreased since 2000, but it remains considerable. Japan, South Korea and China perform relatively lowly on this indicator, which is probably partly due to its English-language bias. However, China's performance increased significantly between 2000 and 2007, as well as that of India, Brazil and Russia. According to this indicator, a substantially smaller proportion of EU publications than US publications have a high impact. In absolute terms, the United States produces about 5 % more high-impact publications than the EU. This observation points to a difference in the efficiency of the research systems in both economies. The issue for the EU may not be only a deficit in translating excellent science into innovative products and processes - it may also be that the EU is actually producing excellent science less often than the United States.

The European countries with the highest ratio of highly cited publications out of the total number of publications are Denmark, the Netherlands, Belgium, Iceland, and Switzerland. EU-12 Member States have a low ratio of their publications among the 10 % most-cited publications worldwide (figure I.6.4). However in terms of growth rates between 2000 and 2008 the leading countries are Turkey, Croatia, Estonia, Portugal and Greece (table I.6.1).

## FIGURE I.6.3

## Contribution to the 10 % most cited scientific publications[1], 2001-2004, 2004-2007 and 2007-2009



■ Publications 2007: Citation window 2007-2009
■ Publications 2004: Citation window 2004-2007
■ Publications 2001: Citation window 2001-2004

*Source:* DG Research and Innovation

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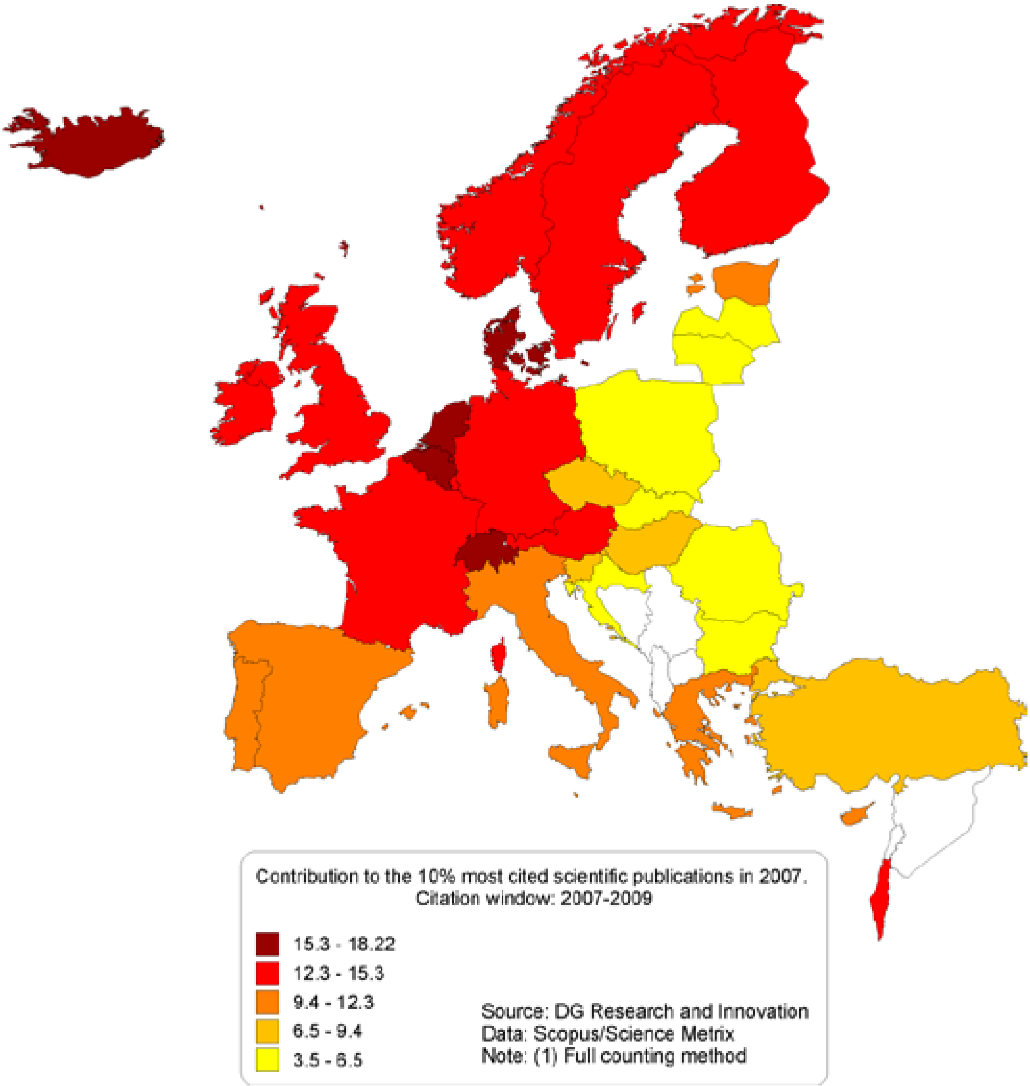
*Data:* Science Metrix / Scopus (Elsevier)

*Note:* (1) The 'contribution to the 10% most cited scientific publications' indicator is the ratio of the share in the total number of the 10% most frequently cited scientific publications worldwide to the share in the total number of scientific publications worldwide. The numerators are calculated from the total number of citations per publication for the publications published in 2001 and cited between 2001 and 2004, from the total number of citations per publication for the publications published in 2004 and cited between 2004 and 2007 and from the total number of citations per publication from the publications published in 2007 and cited between 2007 and 2009. A ratio above 1.0 means that the country contributes more to highly-cited high-impact publications than would be expected from it's share in total scientific publications worldwide.

## FIGURE I.6.4 Contribution to the 10 % most cited scientific publications as % of total national publications, 2007



Source: DG Research and Innovation
Data: Scopus/Science Metrix
Note: (1) Full counting method

## 6.2. How large is Europe's technological output?

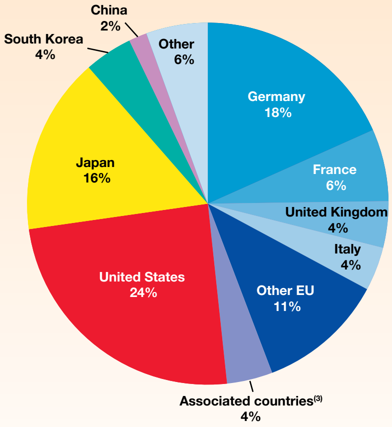
### *The EU Member States only accounted for 43 % of all EPO patent applications in 2007*

Figure I.6.5 below shows the countries of invention of EPO patent applications. 47 % of all EPO patent applications in 2007 were invented in Europe. In comparison, 24 % of them were invented in the United States and 16 % in Japan. The number of EPO patents invented in South Korea is about the same as the number of EPO patents invented in the United Kingdom or in Italy. Germany is by far the leading country in Europe in invention of EPO patent applications. Germany, France, the United Kingdom and Italy account for about one third of inventions of EPO patent applications.

### *Relative to GDP, the inventing activity of EPO patents in Europe and associated countries is highest in Israel, Switzerland and Germany. South Korea and Japan have dramatically increased their EPO patenting since 2000*

Normalising the number of EPO patent inventions by GDP allows correction for the size of the country, as does the normalisation by population. It also allows assessment of the role of inventing activity in the economy of the country. Switzerland, Germany, Sweden, Finland, Austria and the Netherlands are the European countries where the EPO patent invention activity is the most intensive. The trend, however, has been sharply negative in Finland and the Netherlands since 2000, while it was more stable in the four other countries. With sharp progress since 2000, Israel has now become the best performing country.

FIGURE I.6.5 **EPO patent applications(1) by inventor's country of residence, 2007(2)**



*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) Estimated values.
(2) Fractional counting; priority year.
(3) IS, LI, NO, CH, HR, TR, IL.

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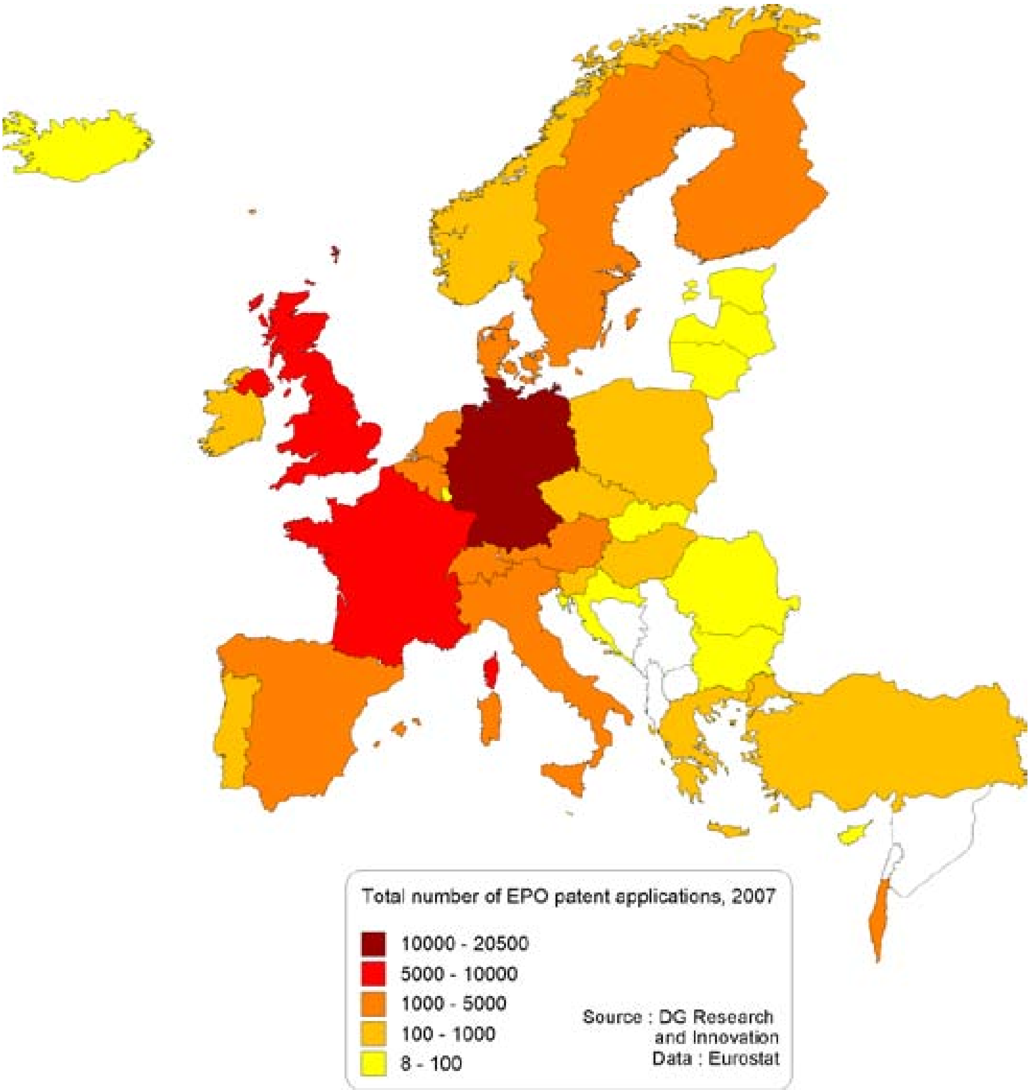
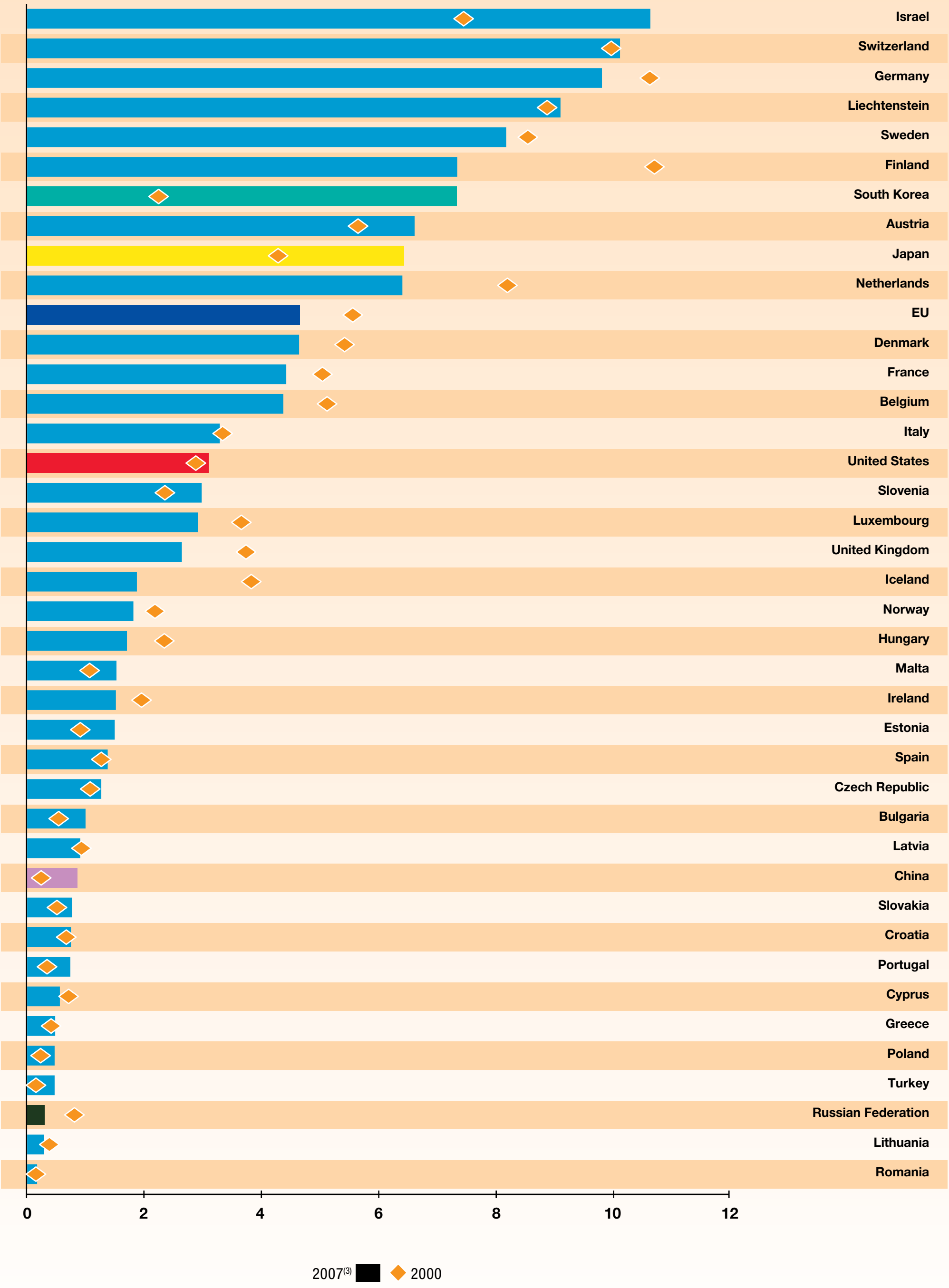
FIGURE I.6.6 **EPO patents applications, 2007**



Source : DG Research and Innovation
Data : Eurostat

## FIGURE I.6.7

## EPO patent applications(1) by inventor's country of residence(2) per billion GDP (current euro), 2000 and 2007(3)



*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) The values for 2007 are estimates.
(2) Fractional counting; priority year.
(3) LI: 2006.

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Among the medium and medium-low patenting European countries (Denmark, France, Belgium, Italy, Slovenia, Luxembourg and the United Kingdom), the trend has been negative since 2000, except in Slovenia. The number of EPO patents invented per GDP in these countries has been decreasing. In all other European countries, the situation did not change much between 2000 and 2007, with very few inventions of EPO patents. Altogether, relative to GDP, there were fewer inventions of EPO patents in EU in 2008 than in 2000.

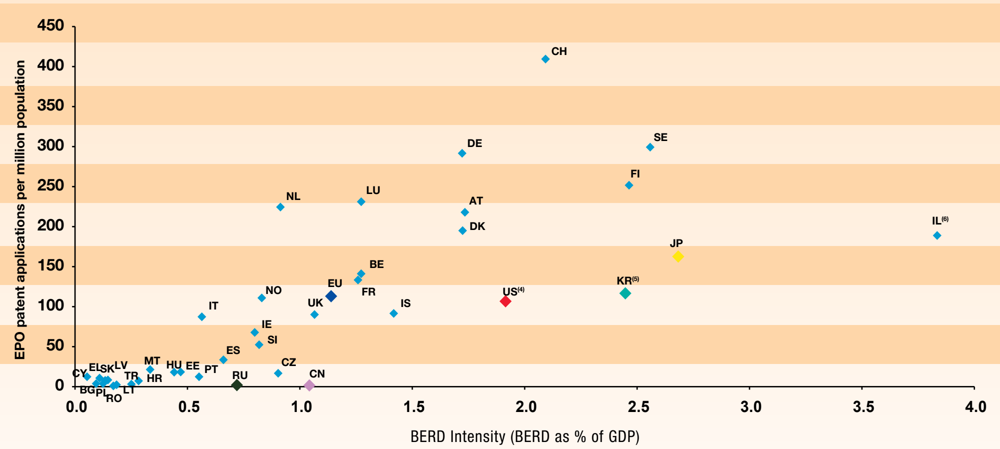
In the majority of cases, inventions are applied for in the country where they were invented, hence a home bias in favour of European countries when considering EPO patent applications. The latter are, therefore, less suited to comparing European countries to non-European countries. However, the most striking observation in the figure below is the outstanding progress observed in South Korea and to a lesser extent in Japan. These two countries have by far overtaken the United States in inventing EPO patents, relative to the size of their economy. Inventions of EPO patents per GDP in China have been multiplied by almost four since 2000 but remain at a relatively low level.

## *The level of patenting activity is positively correlated to the level of business investments in R&D*

Unsurprisingly, Figure I.6.8 below shows that countries that have high levels of patenting activity are countries with high levels of business R&D expenditure. However, the ratio between the two differs widely across countries. This ratio is an indication of the efficiency of business R&D in producing patents in a country[157]. Switzerland, Germany and the Netherlands are the European countries inventing the most EPO patents relative to their business R&D expenditure. In contrast, Central and Eastern European countries are those which invent the fewest EPO patents per euro of business R&D expenditure.

FIGURE I.6.8

**EPO patent applications(1) by inventor's country of residence(2) per million population and BERD as % of GDP, 2007(3)**



*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) The values for 2007 are estimates.
(2) Fractional counting; priority year.
(3) CH:2004
(4) US: BERD does not include most or all capital expenditure.
(5) KR: BERD does not include R&D in the social sciences and humanities.
(6) IL: BERD does not include defence.

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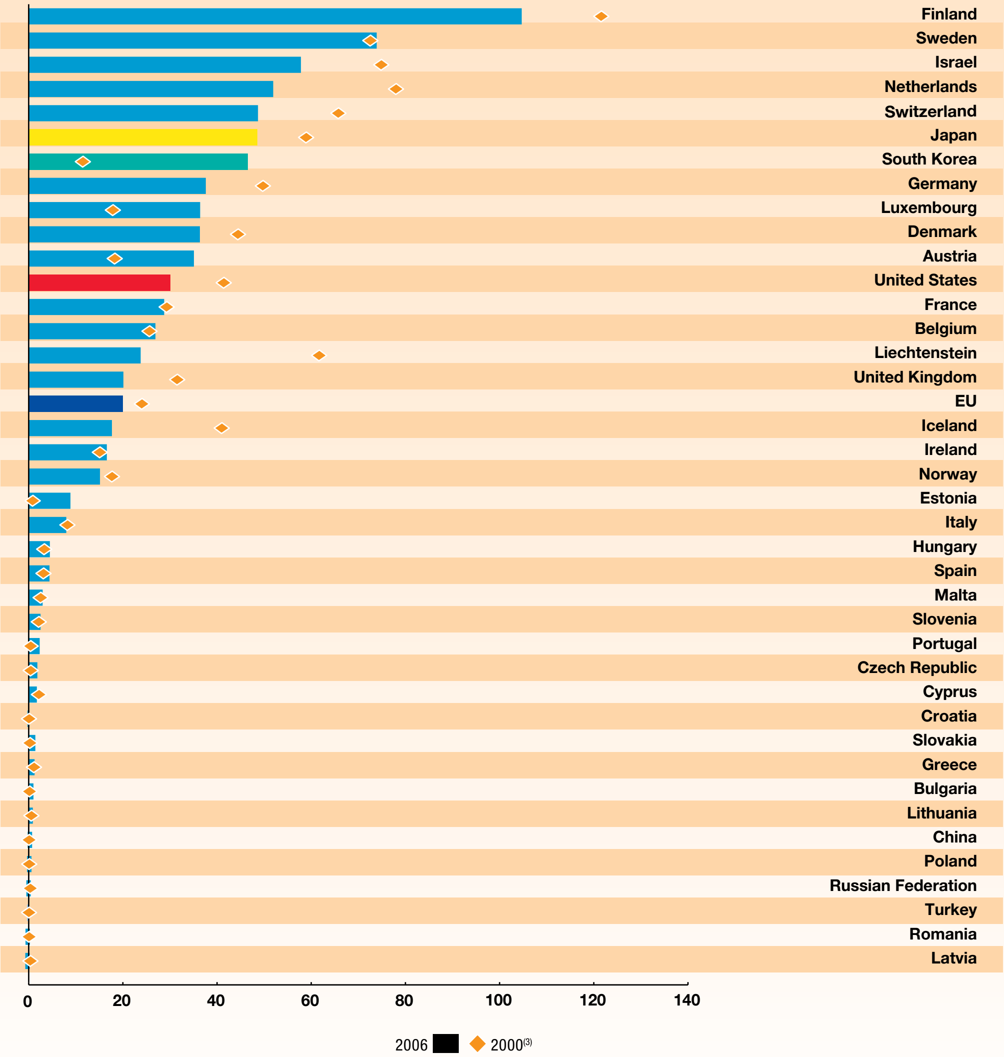
[157] Of course, this is only a first approximation. Many factors influence the level of patenting activity in a country. One prominent factor is the country's degree of specialisation in technology areas which are intensive in patents.

## FIGURE I.6.9

## High-Tech(1) EPO patent applications by inventor's country of residence(2) per million population, 2000 and 2006(3)



*Source:* DG Research and Innovation

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*Data:* Eurostat

*Notes:* (1) High-Tech: Computer and automated business equipment; Semi-conductors; Aviation; Communication technology; Laser; Micro-organism and genetic engineering.

(2) Fractional counting; priority year.

(3) MT: 2002.

## *About half of European countries do not invent high-tech EPO patents*

The best performing countries in terms of high-tech EPO patents[158] are the same as for all EPO patents (Figure I.6.9). However, Finland and Sweden are now ahead of Israel and Switzerland. The Netherlands, Japan and South Korea also go up the ranking, ahead of Germany. This indicates a higher concentration of patents in high-technology areas in these countries. Similarly, the United States is ahead of the EU in terms of inventions of high-tech patents per population, contrary to what happens when all EPO patents are considered (see Figure I.6.7 above). Germany invents fewer high-tech patents than its overall level of patenting activity would predict, indicating a concentration of patenting activity in medium technology areas. It is to be noted that half of the European countries produce virtually no high-tech EPO patents.

Surprisingly, in all countries, the number of high-tech EPO patent inventions decreased or remained unchanged relative to the population between 2000 and 2006, except in South Korea, Austria and Luxembourg. The progress observed in these three countries is larger than the one observed with all patents[159], suggesting an increasing concentration of patenting activity in high-technology areas in these countries.

## *Patent applications in the EU are concentrated in a few regions*

The figure below shows the intensity of patent applications at the EPO, by residence of inventor, in the EU Nuts 2 Regions, by million inhabitants. For most of the countries, patent activity is concentrated in a few regions and these regions tend to be geographically close, independently of whether they belong to the same country or not. This is the case for the north of Italy, the south of Germany and the south east of France - the darker parts of the map. The Nordic countries are also very active regions in terms of patent applications, with more than 100 patents per million inhabitants.

Patent activity varies strongly inside a single country from region to region, and strong disparities can be observed. Significant disparities were observed in Germany between the leading region of Stuttgart in the south, and the lowest-ranked region of Mecklenburg-Vorpommern in the east. Regional discrepancies are even larger in the Netherlands, between the regions of Noord-Brabant and Zealand. In contrast, discrepancies between regions are much lower in Finland and Sweden.

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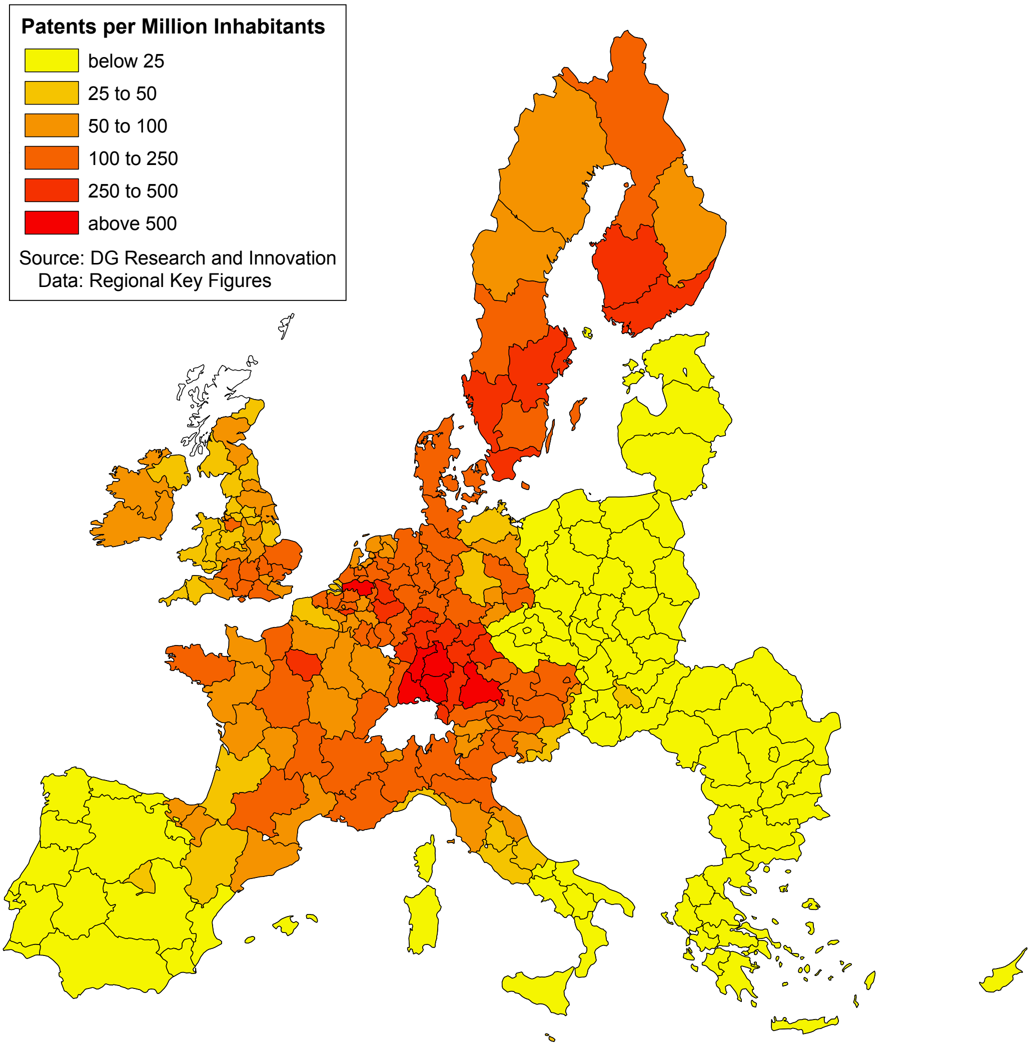
[158] High-tech patents are patents in the following technology areas: Computer, Aviation, Semi-conductors, Micro-organisms and genetic engineering, Communication technology, Laser.

[159] In the case of Luxembourg, one even observes a decrease in global patenting activity.

FIGURE I.6.10 **Patent intensity in the EU NUTS 2 regions 2007**



Source: DG Research and Innovation
Data: Regional Key Figures

## 6.3. Estimating efficiency: what is the return on investments?

### *The public sector in the EU has a lower scientific output per researcher than the United States*

In an innovation ecosystem, the public sector is in charge of delivering the cutting-edge knowledge and well-trained researchers which are needed to feed business inventiveness in the long run, but would be too costly for the private sector to train. Keeping in mind the importance of cutting-edge knowledge production by the public sector, one has to compare quantity and quality of public research in the EU and the United States.

The analysis can first measure the quantity of output of the public research sector. In this area, the publication output per researcher provides a rough measure of productivity of researchers in the public domain in both economies[160] (Figure I.6.11). Taking the data relating to the number of publications in 2007[161], one can see that the average number of publications per year per researcher in the public sector is 1.54 in the United States versus 0.70 in the EU[162]. Researchers in the EU public sector appear significantly less productive in terms of publication output compared to their US counterparts. However, it should be noted that research institutions in Europe have multiple "missions", which are not all oriented towards scientific publications[163].

Concerning the relative quality of publications produced in a country, the best proxy available is the share of a country's scientific publications which counts among the 10 % most-cited publications worldwide. As presented in chapter 6.1 in Part I, the contributions of the United States and the EU to the 10 % most-cited scientific publications in the citation window 2007-2009 are 1.53 for the United States and 1.16 for the EU.

To compare both quantity and quality of output per public researcher, one can calculate the Average Publication Quantity and Impact-10 that is publication per researcher x 10 % most-cited publication ratio (APQI-10)[164]. As a result, the APQI-10 /researcher is 2.35 in the United States versus 0.81 in the EU. Hence the APQI-10 per researcher in the United States is almost three times higher than in Europe (Figure I.6.11). This finding - with all its limitations - is very telling about the difference in output of public research in the United States and the EU. Taking the figures of 2007, we find that with just 38 % of the number of researchers (FTE) of the EU, researchers of the public sector in the United States produce a Total Publication Impact (TPI, equal to APQI-10 x number of researchers) higher than the total TPI of the EU (663 000 in the United States versus 619 000 in the EU).

A better understanding of this difference in both quality and quantity of output in the public domain requires a correlation with the financial resources available per researcher (Table I.6.3). If we look for the capital endowment per researcher, the tremendous difference between European researchers and US researchers in the public domain becomes obvious: on average a researcher in the public domain in the United States has financial resources more than two times higher than their colleagues in Europe have at their disposal. Put differently: the public research sector in the United States provides few, but excellently equipped research capacities. Funding per researcher (including remuneration schemes) in the public sector of the United States is higher than in the private sector - but limited to a number of researchers much smaller than in Europe.

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[160] Though there might be slight differences between the United States and the EU in the share of private-sector researchers publishing, it is fair to approach the activity of the public sector via the number of publications produced.

[161] For a more comprehensive review of scientific publication, see Part I, chapter 6.1.

[162] Eurostat data on number of researchers FTE; Data from the CWTS-Leiden University/Web of Science (Thomson Reuters Scientific).

[163] See Part II, Chapter 1.

[164] One could also construct a APQI-1 –Value- the Average Publication Quantity and Impact that is publication per researcher x **1 % most cited** paper. However, taking the analysis of Giovanni Dosi et al. in ‘European Science and Technology Policy: Towards Integration or Fragmentation?’ by Henri Delanghe, Ugur Muldur, Luc Soete, 2009, the results would turn much more to the disadvantage of Europe.

## TABLE I.6.2 R&D expenditure (euro) per researcher (FTE) in the public and private sectors

| | EU 2008 | US 2007 |
|---|---|---|
| Public sector expenditure on R&D per researcher | 107 614 | 231 424 |
| Private sector expenditure on R&D per researcher | 217 584 | 183 050 |
| Total expenditure on R&D per researcher | 159 328 | 192 711 |

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD

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This difference in the efficiency of public research to produce high quality output has impacts on the capacity of European business to build on the knowledge, ideas, and skills provided by the European public research sector. The following considerations apply:

1. The race for innovation is a winner-takes-all game. The first inventor usually takes the major profit from an innovation. Expected financial returns are higher, the greater the distance ahead of the nearest competitor (it takes longer for the competitors to come up with a similar innovation). The data presented above, and other specific analysis[165] suggest that public-sector research in Europe - even under assumption of perfect and frictionless knowledge transfer into the private sector - provides insufficient cutting-edge input to the private sector to be a winner in a completely new field of technology.

2. The outstanding achievements of top researchers attract young talents. The bigger the fame of a top researcher, the more she or he will attract young researchers with high potential from elsewhere. Moreover, many of these talents will not stay in public (academic) research, and will subsequently move - with all their talent and knowledge - to the business sector close to the location of the top researchers. As indicated by the recent MORE study, the issue of working with a leading expert in the field is a far lesser motivation for American researchers to come to Europe than vice versa. In contrast, an important motivation for European researchers to leave Europe for the US is to work with leading experts in their field[166].

3. The relatively high level of concentration of high quality research in the public sector in certain States in the US facilitates the networking between researchers in the public sector and the business sector, in particular when it concerns matching venture capital, researchers and inventors. Europe also has pockets of excellent public research with ideas and knowledge which could be highly relevant for the private sector, but to find these outstanding ideas would take much more effort for venture capitalist and R&D intensive firms. These large transaction costs in turn reduce the profitability of private investment into cutting-edge innovations in the EU.

The reasoning presented here is not entirely new. Earlier work provided evidence that excellent public research generates additional business R&D, which is critical for innovation and ultimate productivity and economic growth as well as other societal benefits. Several authors have argued that private investment in R&D and its localisation is likely to be stimulated by the quality and size of academic research. To give two examples: Dosi, Llerena and Sylos Labini (2009) presented cross-country comparisons showing that industry-financed R&D appears positively related with both the per capita number of highly cited researchers and expenditure on higher-education R&D[167]. Abramovsky, Harrison and Simpson (2007) investigated the relationship between the location of private sector R&D labs and university research departments in Great Britain and found that private R&D investment first of all co-locates with outstanding research departments of universities[168].

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[165] Please see, for instance: ‘Linking industrial competitiveness, R&D specialisation and the dynamics of knowledge in science: A look at remote influences’, Andrea Bonaccorsi, in ‘The Question of R&D Specialisation: Perspectives and policy implications’, IPTS, 2009.

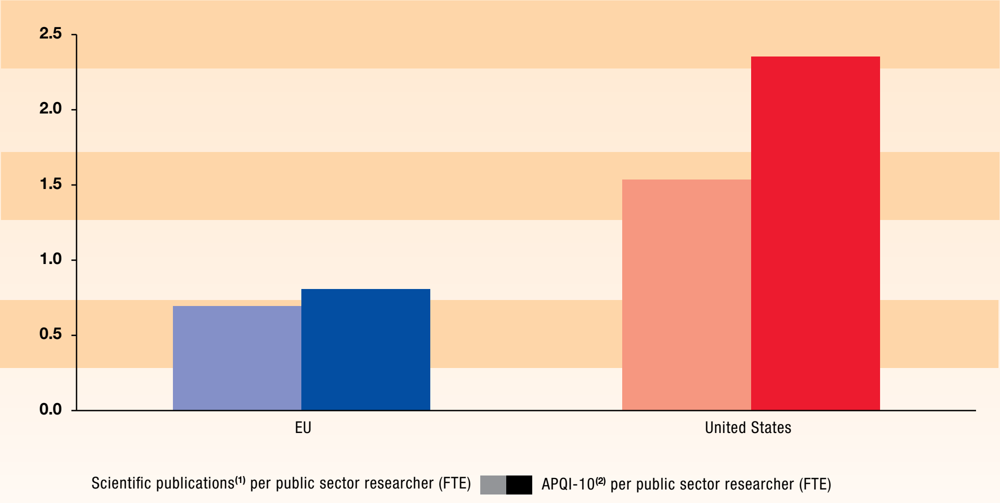
[166] See MORE Study 2010 - Report 3: Extra-EU mobility.

[167] Dosi, G., P. Llerena and M. Sylos Labini (2009), ‘Does the “European Paradox” still hold? Did it ever?’ in: H. Delanghe, U. Muldur and L. Soete (Eds) European Science and Technology Policy: Towards Integration or Fragmentation?, Cheltenham, UK, Northampton, USA: Edward Elgar, 214-236.

[168] Abramovsky, L., R. Harrison and H. Simpson (2007), ‘University Research and the Location of Business R&D’, Economic Journal, 117 (519), 114-41.

FIGURE I.6.11

## Scientific publications(1) and APQI-10(2) per public sector researcher (FTE), 2007



*Source:* DG Research and Innovation

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) Full counting method.
(2) APQI: Average Publication Quantity and Impact.

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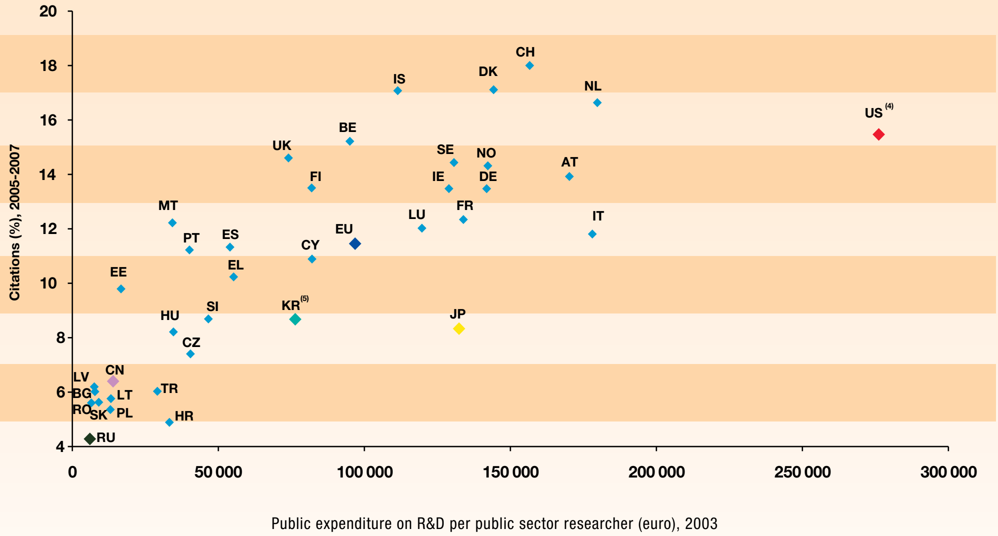
FIGURE I.6.12

## Public(1) expenditure on R&D per public sector researcher (euro), 2003(2) and scientific publications in the 10% most cited scientific publications worldwide as % of total scientific publications, 2005-2007(3)



*Source:* DG Research and Innovation

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) For this graph the public sector refers to the Government, Higher Education and Private non-Profit Sectors. Public expenditure on R&D excludes R&D financed by business enterprise.
(2) MT, AT, FI, CH: 2004; UK: 2005
(3) Full counting method.
(4) US: R&D expenditure does not include most or all capital expenditure.
(5) South Korea: R&D expenditure does not include R&D in the social sciences and humanities.

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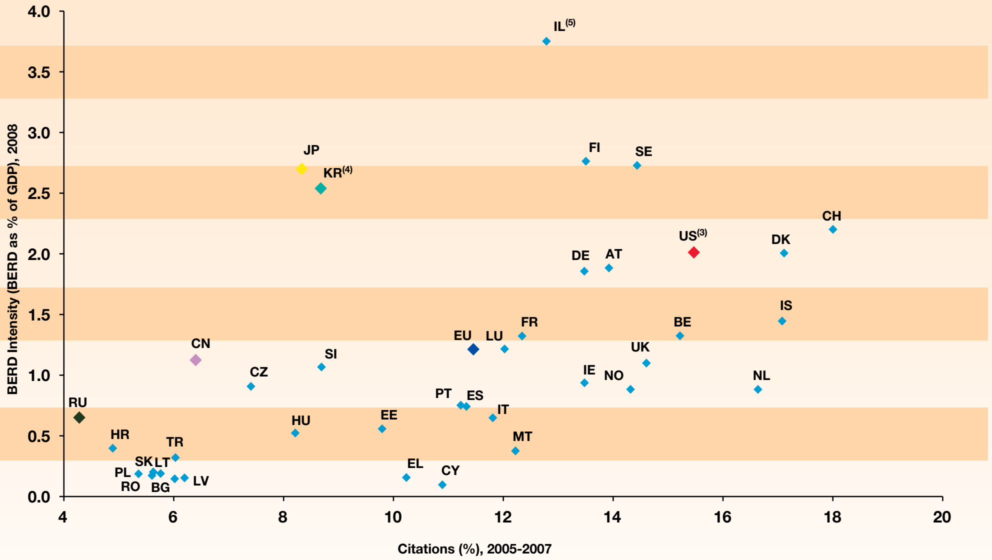
FIGURE I.6.13

**BERD Intensity, 2008(1) and scientific publications in the 10% most cited scientific publications worldwide as % of total scientific publications, 2005-2007(2)**



*Source:* DG Research and Innovation

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) EL: 2007
(2) Full counting method
(3) US: BERD does not include most or all capital expenditure
(4) KR: BERD does not include R&D in the social sciences and humanities
(5) IL: BERD does not include defence

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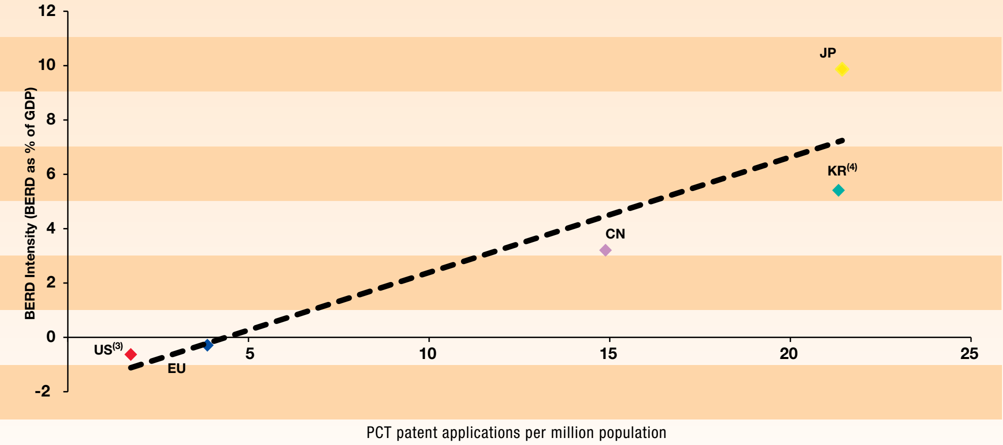
Given the importance of the production of cutting-edge knowledge in the public sector for seeding high-tech industries in the private sector, the next pages provide some reflections on European research funding. Figure I.6.12 presents the relationship between public investment per researcher in 2003 and the share of highly cited publications in the period from 2005–2007 (under the assumption that an investment into research in year X produce cited papers 2-4 years later). The relationship is quite straightforward - with the interesting exception of Italy: the more resources are available per researcher the more likely research results are produced that are regarded as seminal and cited accordingly. It is also interesting to note the large differences between European countries, where several countries (such as Switzerland, Denmark, the Netherlands and Iceland) present a higher number of highly-cited publications for less funding per researcher than the United States as a whole.

### *A higher scientific output in the public sector is positively related to a higher business sector R&D investment and innovation*

Figure I.6.13 follows this logic further downstream: The more cutting-edge knowledge has been produced, the more likely it is that such knowledge should spill over into new products and services and hence private R&D activities. Therefore, figure I.6.13 presents the relationship between the quality of public research in the period 2005-2007 (measured in the share of highly quoted papers) and the private R&D intensity in 2008. Quality of public research relates positively with private R&D activities.

FIGURE I.6.14

**PCT patent applications(1) per million population and BERD Intensity, average annual growth 2000-2007(2)**



*Source:* DG Research and Innovation

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*Data:* Eurostat, DG ECFIN, OECD

*Notes:* (1) Patent applications under the PCT (Patent Cooperation Treaty), at international phase, designating the EPO by country of residence of the inventor(s).
(2) KR: 2000-2006.
(3) US: BERD does not include most or all capital expenditure.
(4) KR: BERD does not include R&D in the social sciences and humanities.

Of course, quality of public research is not the only factor behind private R&D investments. A lack of adequate IPR protection and fragmented internal markets are also important determinants, and are detrimental to private R&D intensity[169]. But the capacities of the public-research sector of Europe to deliver cutting-edge knowledge, ideas and discoveries might be an issue in helping high-tech industries flourish still further in Europe.

Figure I.6.14 shows that those countries which have increased their private research efforts the most have also achieved higher technological outputs, measured by the increased rate in the number of patents. The same positive correlation is visible for EPO patent applications[170].

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[169] For a more comprehensive review of the framework conditions for business R&D, see Part III, Chapter 2 in this report.

[170] See Part I, Chapter 6.2, Figure I.6.8.

# Table of contents

# ANALYSIS

## Part II: A European Research Area open to the world - towards a more efficient research and innovation system

It is not sufficient to invest more to increase research activity in Europe. We also need to improve the overall efficiency of the European research system to ensure high quality science and technology and reinforce the attractiveness of European research internationally.

A majority of the strategic objectives towards a European Research Area policy, as well as key aspects of the Innovation Union initiative - such as a single market for knowledge - are focused on this overarching objective. The present part of the report includes many of these aspects of system efficiency for research and innovation with a specific focus on the transfer and circulation of knowledge, capitalising on science and technology produced.

Part II analyses reforms made at national level to strengthen research institutions and enhance their performance, knowledge transfer in public-private cooperation, progress towards gender equality, optimisation of research programmes in Europe, a framework for pan-European research infrastructures, mobility of researchers and free circulation of science and technology across Europe and beyond. Several of these areas benefit from a specific ERA initiative, accelerating the realisation of a true European Research Area.

# CHAPTER 1

# Strengthening public research institutions

## HIGHLIGHTS

The public dimension of the European research system builds on two categories of research institutions, which are almost equally important in terms of public funding: Higher Education Institutions (HEIs) and Public Research-performing Organisations (PROs). According to recent estimates, Europe hosts around 3 000 Higher education institutions: one third of all HEIs worldwide. However, Europe has only 1 000 research-performing HEIs and around 170 highly research-intensive universities in terms of academic output. There is no precise figure on the total number of public research-performing organisations, but Europe counts approximately 150 large PROs.

European countries are reforming their public research institutions, focusing on their autonomy, funding schemes, management and quality assurance. European universities have in recent years received more autonomy, and developed institutional strategies covering competitive funding, research priorities, international attraction of staff and other areas. University reforms are inspired by the process of the internationalisation of education and research and by European policies and Europe-wide competitive funding opportunities. Performance monitoring and evaluation has become a demonstrator for efficient and productive use of public funds in most of the Member States. Accountability and quality assurance processes in institutions have been fostered by ranking universities. Centres of excellence have emerged in a range of European countries to sustain global knowledge competition in research and innovation. The competences of public research organisations are also broadening, including a 'third mission', which is much linked to innovation and to interaction with the surrounding society. In the last year, Member States have enhanced cooperation with industry as a key dimension of the 'third mission' of universities in support of research-based innovations. However, the reforms concerning HEIs as well as for PROs are only half achieved.

Public research institutions, in particular research-based universities, are subject to an increasing number of international ranking systems measuring mainly the research missions of these institutions. These rankings all show a strong dominance of the US universities in the top 100 in the world. European universities are present among the top 100 in the world to various extents depending on the ranking method chosen. In general terms, only around 30 European universities are considered among the top 100 research universities in the world, and this number slightly decreased between 2005 and 2010. These highly ranked European universities are situated mainly in the United Kingdom, Switzerland and the Netherlands. European countries with a stronger emphasis given to public research-performing organisations are consequently less present in the world rankings, which are currently focused on higher education institutions.

An objective method to assess performance of all categories of European public research organisations – HEIs as well as PROs – is to consider success rates in European-wide competition for research funding. The EU is, via its Framework Programme (FP), a major funder of research. Proposals to both the Framework Programme (FP) and the European Research Council (ERC) are selected by rigorous, impartial assessment procedures by international experts. Therefore, FP7 and ERC grant winners can claim to perform excellent research. Success in EU competitive funding indicates that many of the non-university research-performing organisations are of excellent quality. In FP6, the PROs achieved both in terms of participation and budget, a larger share of the FP award than they would have comparative to their weight in the national research systems. When considering European-wide competition in basic research, as assessed by the grant allocation at the European Research Council, currently up to 41 European universities situated mainly in the United Kingdom, France, the Netherlands, Germany, Switzerland, Sweden and Israel, have shown outstanding research performance receiving 10 or more grants.

Finally, the chapter has compared the 170 or so top research intensive European universities in terms of academic output (i.e. publications) to their performance in the Europe-wide competition for research in the framework programme. In fact, only 60% of the funds granted to higher education institutions in FP6 was allocated to one of these 170 European universities. This finding indicates the complementary nature of the EU competitive funding, going beyond publications in technology development while being open to all public and private research-performing organisations.

## 1.1. What is a public research institution?

In recent years, the European Commission has made efforts to achieve higher transparency about research institutions in the European Research Area in order to focus and direct its research policy more efficiently. A research institution is an entity, such as a university or research institute – irrespective of its legal status (organised under public or private law) or way of financing – whose primary goal is to conduct fundamental research, industrial research or experimental development and to disseminate their results by way of teaching, publication or technology transfer. All profits are reinvested in these activities, the dissemination of their results or in teaching[171].

### *Two types of public research institutions dominate the European Research Area: Public Research-performing Organisations (PRO) and Higher Education Institutions (HEIs)*

Public research in Europe is mainly performed in two types of institutions: Higher Education Institutions (HEIs) and Public Research-performing Organisations (PROs), sometimes called non-university research organisations. 'Higher Education Institution' (HEI) means a university or any type of higher education institution which, in accordance with national legislation or practice, offers degrees and diplomas at masters or doctoral level, irrespective of its denomination in the national context. A research-performing HEI means an HEI which undertakes research or technological development as one of its main objectives i.e. which is also a 'research organisation' and which delivers Ph.D.s. (research doctorates). In the HEI category it is mainly universities which perform research. A specific category is the polytechnic universities, which perform a range of missions, with only a minor part dedicated purely to research. 'Public Research-performing Organisation' (PRO) means any mission-oriented public legal entity which undertakes research or technological development as one of its main objectives.

### 1.1.1. Public research-performing organisations

The landscape of public research-performing organisations in Europe is extensive and quite diverse. They account for almost 40% of public research expenditures in Europe on R&D[172]. However, comparable statistical data on PROs is currently relatively undeveloped. The variation starts with their different missions: basic research (e.g. Max-Planck-Institutes in Germany) or applied research, also known as 'technology developments' (e.g. TNO in the Netherlands). As well as organisations which include a hundred institutes, we find small stand-alone entities, some of which have associated themselves in networks (e.g. Helmholtz, CARNO). PROs may form parts of ministries, or agencies, or be independent. Some PROs are charities or foundations – others are Ltd companies[173], or affiliates of, for example, the Hungarian Academy of Science or the CNRS.

### *Public research-performing organisations in Europe show a large diversity of profiles and missions*

As described by an FP6 report[174], the first PRO was probably the Royal Botanic Garden in Edinburgh, founded in 1670. Other centres originating prior to the 20th century are usually observatories, geological investigators and meteorological laboratories, while health and agriculture PROs became more common towards the end of the 19th century. A sharp increase in the founding of new institutions could be observed after the First World War. In the second half of the 20th century 'big science' laboratories and institutions of larger scale came into existence, as well as intergovernmental or international labs such as CERN and EMBL.

In order to distinguish between different public-sector research institutes, three basic types of institute can be mentioned[175]:

- Scientific research institutes
- Government laboratories
- Research and Technology Organisations (RTOs)

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[171] FP7 defines a *research organisation* as a legal entity which a) is established as a non-profit organisation which b) carries out research or technological development as one of its main objectives. Public research organisations include a) Public research performing higher-education institutions and b) Public research-performing organisations.

[172] See the last section of this chapter as well as Arnold, E., K. Barker, and S. Slipersaeter: *Research Institutes in the ERA*, Brussels July 2010 and Arnold, E., J. Clark, Z. Járvorka: Impact of European RTOs, *A study of social and economic impacts of research and technology organisations*, Brussels October 2010.

[173] This might seem impossible. However, legal set-up as an Ltd company does not exclude being not-for-profit. A prominent example is the Forschungszentrum in Jülich, a GmbH.

[174] PREST: A Comparative Analysis of Public, Semi-Public and Recently Privatised Research Centres, project report CBSTII contract ERBHPV2-CT-200-01, Manchester, July 2002.

[175] Arnold et all, Research institutes in the ERA a.a.O.

Scientific research institutes are mainly associated with basic research. The German Max-Planck-Institutes or the French CNRS, as well as large parts of Science Academies in the Eastern European countries belong to this category.

Government laboratories serve the specific needs of their respective ministries or of regional and local authorities. They are engaged in technical norms, standardisation or metrology, testing, or charged with specific missions or with public duties.

Research and Technology Organisations are the most diversified types of institutes, as they carry out mainly applied research and technical development. They may be private but they are non-profit organisations.

The tables below illustrate the different tasks and missions of PROs in Germany and provide an overview on the main institutions and their tasks in this Member State. Unfortunately, data for other Member States are not available on a comprehensive scale.

## TABLE II.1.1 The structure of Public Research performing Organizations (PROs) in Germany, 2007

| Institution | R&D expenditure | | R&D personnel (FTE) | | | |
|---|---|---|---|---|---|---|
| | Total euro (millions) | % | Total | % | Of which: | |
| | | | | | Researchers | % |
| Max Planck (MPG) | 1 290 | | 11 785 | | 5 996 | |
| Fraunhofer (FhG) | 1 319 | | 10 519 | | 6 667 | |
| Helmholz (HFG) | 2 740 | | 23 283 | | 12 190 | |
| Science Leibnitz (WGL) | 966 | | 9 699 | | 5 480 | |
| Federal research establishments (BFE) | 681 | | 8 319 | | 3 675 | |
| Regional or local research establishments | 218 | | 2 990 | | 1 354 | |
| Other | 1 002 | | 10 930 | | 7 138 | |
| Science libraries and museums | 325 | | 3 119 | | 1 062 | |
| **Total PROs** | 8 540 | 46.1 | 80 644 | 43.7 | 43 561 | 37 |
| Higher education institutions | 10 000 | 53.9 | 103 953 | 56.3 | 72 985 | 63 |
| Total public research institutions | 18 540 | 100 | 184 597 | 100 | 116 546 | 100 |

*Source:* DG Research and Innovation
*Data:* Statistische Bundesamt. Statistische Jahrbuch 2009 from EFI report 2010

## TABLE II.1.2 Main activities and tasks(1) of Public Research performing Organizations (PROs) in Germany

| Institution | MPG | FhG | HGF | WGL | BFE |
|---|---|---|---|---|---|
| Basic research | 100 | 9 | 46 | 62 | 7 |
| Applied research | 3 | 91 | 57 | 48 | 74 |
| Technical development | 3 | 46 | 26 | 6 | 7 |
| Metrology / standardisation | 0 | 17 | 6 | 6 | 26 |
| Information | 3 | 3 | 3 | 23 | 22 |
| Further education | 22 | 3 | 34 | 19 | 7 |
| Infrastructure supply | 6 | 11 | 37 | 13 | 15 |
| Technology transfer to enterprises | 3 | 57 | 31 | 12 | 7 |
| Knowledge transfer to society | 19 | 0 | 14 | 23 | 15 |
| Consultancy to public authorities | 3 | 9 | 17 | 19 | 78 |
| Public duties | 3 | 3 | 9 | 10 | 56 |

*Source:* DG Research and Innovation
*Data:* Polt et al. from EFI report 2010
*Note:* (1) Tasks have been ranked in a five-scale Likert-skala in terms of highest importance (multiple choices of high priority feasible)

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According to a study made for EARTO[176], RTOs in the European Research Area may have quite a substantial economic impact[177]. This impact varies depending on the definition of economic impact – i.e. whether counting all the activities of the RTOs or only the activities involving state subsidies for research. The overall impact, including social returns, spans from EUR 25 billion to EUR 40 billion and the total return could be in the order of EUR 100 billion in a ten-year time horizon.

## TABLE II.1.3 Estimated economic impact of European Research and Technology Organizations (RTOs) - central estimates

| | Wide definition (€bn) | Narrow definition (€bn) |
|---|---|---|
| Direct | 12.2 | 9.8 |
| Indirect | 10.8 | 8.7 |
| Induced | + / - 4.6 | + / - 3.7 |
| Social returns | 12.9 | 10.4 |
| **Total** | 31.3 - 40.5 | 25.2 - 32.6 |

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*Source:* DG Research and Innovation
*Data:* EARTO, 2009

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176 The study refers to the RTO subgroup of PROs
177 Arnold et al: Impact of European RTOs, a.a.O.

### *Europe has around 150 large public research-performing organisations*

A study financed by the European Commission[178] identified the 150 biggest and most nationally recognised public research-performing organisations in 36 countries in Europe, in which each organisation counted more than 50 researchers or over 100 affiliated staff[179].

The inventory also showed the panoply of ways in which the PROs are organised, and the role they play in their countries. They differ widely as each one is embedded in its national system and culture. Also, the organisation may vary insofar it is a public research unit, a research agency, a foundation, or a non-profit enterprise.

When comparing the EU-15 Member States with the EU-12, the former account for the vast majority of the funding made available to PROs. In terms of the number of researchers at the PROs, the difference between EU-15 and EU-12 is less significant. Due to the tradition of the Academy in the new Member States, quite large public research-performing organisations exist. However, in the last decade, the public research-performing organisations in EU-12 have undergone profound changes.

## 1.1.2. Higher Education Institutions (HEIs)

HEIs, like PROs, perform different missions. In addition to teaching and research, HEIs play an essential role in innovation. Building on the so-called 'third mission', higher education institutions have increasingly taken on societal and economic roles. They are important employers in their region, and universities are providers of services, playing a crucial role in the service society. HEIs' 'third mission' is in fact a bundle of missions, touching on innovation, regional, societal and economic involvement as well as international engagement.

### *The HEI sector performs various missions of which the 'third mission' is least recognised*

The so-called 'third mission'[180] of HEIs encompasses the relations between universities and non-academic partners. The mission goes beyond the mere transfer of knowledge to economic actors (through patents, licences, spin-offs, etc.) and it reflects the richness of the relationships between the university and society at large. The third mission thus includes:

- Transfer of 'competences trained through research' to industry;
- Further education to postgraduates and adults;
- Ownership of knowledge (patents, copyright, etc.), the use of that knowledge (university spin-offs) and contracts with industry and public bodies;
- Participation of academics in governance structures, including advisory boards;
- Development of activities serving the community (museums, law shops, etc.).

The universities' third mission is highly dependent on the mix of activities they deploy. For the growing number of institutions providing specialised professional higher education, the third mission aims mainly to develop an 'industry-relevant' research portfolio and masters degrees which fit industry's needs. The industry-relevant mission has been enhanced strongly in the EU Member States (see also Part II, chapter 2).

### *The European Commission funds the elaboration of a mapping system of higher education institutions that considers all their major missions and tasks*

The EU has started to analyse and classify the different roles and missions of higher education institutions in order to help HEIs to develop their profile and for users to orient themselves in the increasingly diversified European HEI landscape. The rationale for developing a European classification of higher education institutions lies in the desire to better understand and use diversity

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[178] EUROLABS report (2009) carried out by ECORYS (NL), COWI (DK) and IDEA (BE) taking stock of the Public Research-performing Organisations (PROs) and Intergovernmental Research Organisations (IROs) in Europe. The inventory was established at the level of organisations and not of institutes. Based on 2006 figures, the PROs covered by the study received basic institutional funding amounting to at least 50.3% of total government R&D spending (GOVERD). Overall, the organisations had a total budget of EUR 31 000 million and a staff count of 292 500.

[179] Performance related criteria like publications or patents do not yet exist in a comparable format.

[180] Based on: Laredo, P (2007), "Revisiting the third mission of Universities: towards a renewed categorisation of university activities", *Higher Education Policy*, 20.4, 441-456. Universities are important players in the local economy and in their social context.

as an important basis for the further development of European higher education and research systems.

The aim of the European higher education classification is to draw benefits of increasing diversity of missions of HEIs in Europe. The U-Map project[181], therefore, developed a classification model to map the diversity of European higher education institutions according to their various missions, such as education, research, innovation, regional involvement and internationalisation.

The 'European Classification of Higher Education Institutions: the 'U-Map' project was established to map the strength of all types of higher education and research institutions and to display comparable institutional profiles. Rankings or benchmarks may be applied when an institutional profile like this exists. Six dimensions of HEIs have been identified and these profiles have been made operational by specific indicators as follows:

- Educational profile on teaching and learning:
    - degree-level focus
    - range of subjects
    - orientation of degrees
    - expenditures on teaching
- Student profile:
    - mature students
    - part-time students
    - distance-learning students
    - size of student body
- Research involvement:
    - peer-reviewed publication
    - doctorate production
    - expenditures on research
    - Involvement in knowledge exchange:
    - start-up firms
    - patent applications filed
    - cultural activities
    - income from knowledge-exchange activities
- International orientation:
    - foreign degree-seeking students
    - incoming students in international exchange programs
    - students sent out on international exchange programs
    - international academic staff
    - importance of international sources of income in the overall budget of the institution
- Regional engagement:
    - graduates working in the region
    - first-year bachelor students from the region
    - importance of local/regional income sources

The six dimensions may be transformed into a profile viewer of a specific HEI, representing a strong international research university:

---

[181] The first project was finalised in 2010: see http://www.u-map.org/U-MAP_report.pdf. The aim is to design and select appropriate instruments and construct the multi-dimensional ranking of 150 pilot institutions in over 40 countries. Final results are expected in June 2011. The feasibility study is being funded by the European Commission and carried out by the CHERPA Network in association with the European Federation of National Engineering Associations (FEANI) and the European Foundation for Management Development (EFMD).

The U-Multi-rank approach is based on a number of important principles:

*User-driven*: the nature of a university ranking should be determined by its purpose and by the needs of its potential users.

*Multi-dimensional*: the importance of different dimensions and indicators vary among different user groups; a university ranking should not produce a consolidated score but should treat different dimensions separately.

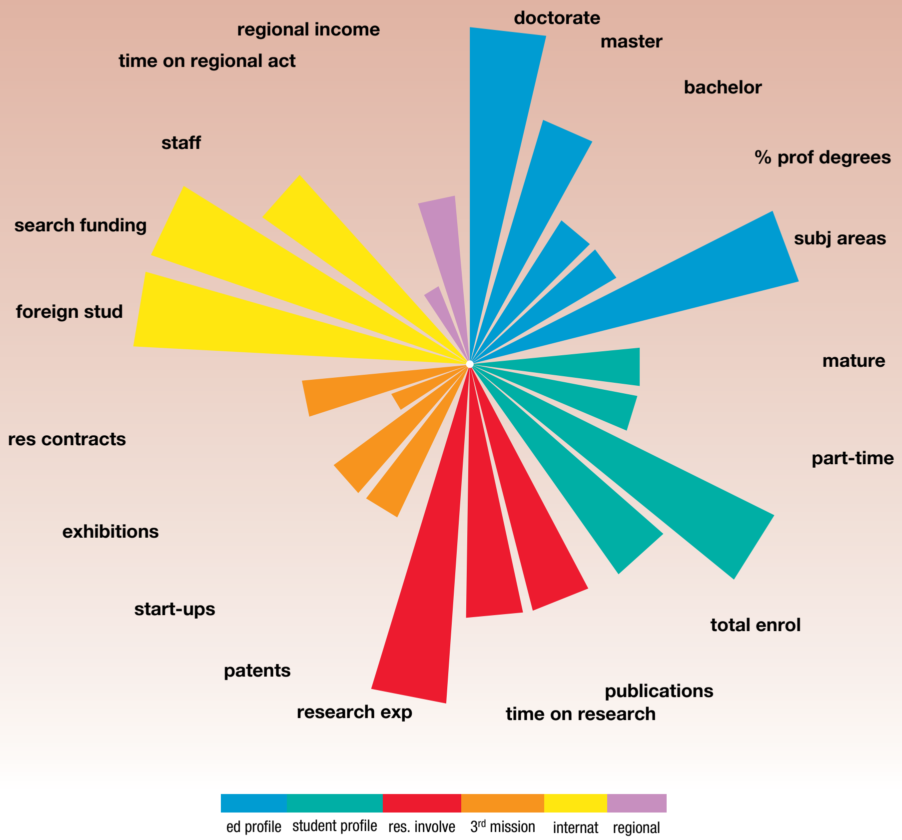
*Field-specific and institutional rankings*: performance may vary considerably across disciplines within one university; an effective ranking should also offer field-specific information.

*Diversity*: ranking should respect the diversity of higher education institutions and compare only institutions with a similar profile.

*Performance-orientation*: ranking should focus primarily on achieved performance and not on inputs, reputation or descriptive characteristics.

*Context*: an international ranking must take into account the linguistic, cultural, economic and historical contexts of different higher education systems.

FIGURE II.1.1 **Representation of future profile of a higher education institution**



A mapping exercise will allow at a later stage specific rankings beyond research performance. It may contribute to the creation of a stronger profile for European higher education on a global stage and to the realisation of the goals of the Europe 2020 strategy and the Bologna Process.

***Around 47% of all higher education institutions in Europe are clearly research-active and only 6% are highly research-intensive***

In parallel, the European Commission has started to build foundations to better monitor the European research and education area. A feasibility study[182] carried out preparatory work for regular data collection by national statistical institutes on individual higher education institutions (HEI) in the EU Member States, Norway and Switzerland. The so-called EUMIDA study focussed on HEI data in national databases, insofar as these databases are maintained by national statistical institutes, ministries, or other organisations with a public mission. It reviewed a number of issues including data availability, data confidentiality and the resources needed to create and maintain a pan-European university register.

---

[182] Also known as the EUMIDA project http://www.eumida.org/

### *Europe has 2906 recognisable HEIs of which are 1364 research-active ones*

The EUMEDIA study estimated the total number of HEI in the EU[183] at 2906. These HEIs cover 90% of all students registered in higher education.

Institutions fulfilling at least three of the following six criteria were regarded as research-active:

- existence of an official research mandate;
- existence of institutionally recognised research units (e.g. on an institution's website);
- inclusion in the R&D statistics (availability of R&D expenditure data), as a sign of institutionalised research activity;
- awarding doctorates or other ISCED 6 degrees; consideration of research in an -institution's strategic objectives and plans;
- regular funding for research projects either from public agencies or private companies.

Applying this definition, the study concluded that 1364 of the 2906 HEIs were 'research active' (the total numbers will grow when France and Denmark provide their full data). Of the 1364 institutions, only 850 award doctorates, meaning that a significant number of research active institutions are found outside the traditional perimeter of HEIs, i.e. in the domain of non-university research (particularly in countries with dual higher-education systems).

### *Europe has 171 universities which are highly research-intensive in terms of scientific production*

Articles published in referenced journals[184] are the performance measure for academia to which research universities would affiliate them. The referenced articles are the basis for scientometric analysis applied by the Leiden Ranking as a performance of a university. The total of article production by universities in a country may serve as a proxy for national scientific production. However, this ranking provides an overview of the main centres of academic production in Europe. The scientometric analysis displays the volume and visibility of scientific production over a nine year period (1997–2006). If a certain threshold of production is applied at 5000 articles with an average impact in the fields above 0.50, the analysis results in a list of 171 universities from 21 countries. Most of these universities are located in EU-15 Member States and some EU-12 Member States (see table below). Beyond this threshold, the production of scientific articles decreases rapidly. Therefore, we can assume that Europe has around 171 top research universities or research-intense universities[185].

---

[183] In defining the perimeter of HEI, the study excluded a number of small entities, mostly schools associated with industry or professional associations, which deliver ISCED 5B (vocational training) degrees but are not considered as 'institutions' as they do not have significant autonomy in managing staff and financial resources. The study comprised two pilot data collections: a core set of data covering all HEI in a country and an extended set of data covering a subset of institutions defined as 'research active'. It collected data on 2457 institutions as France and Denmark (in part) did not provide data. Norway and Switzerland were also included as case studies in the project.

[184] For details on the methodology used to assign articles to universities, including a discussion of measurement issues relating to capturing the research activity of specialised universities, see: http://www.cwts.nl/hm/bibl_rnk_wrld_univ_full.pdf. The top research universities in Europe were selected from a list compiled by CWTS in the ASSIST project. The level of scientific production was measured by the number of articles published in journals referenced in the Web of Knowledge. The visibility of publications at world level was measured by applying the CPP/FCSm indicator, the so-called 'crown' indicator of the CWTS ranking.

The selection has two limitations. Firstly, universities have been defined in a narrow sense. As a consequence a few large HEI have been excluded due to their non-university label: e.g. Politecnico di Milano or French 'Grandes Écoles'. Therefore, the total sample of HEI that have produced more than 5000 papers within the 1997–2006 period should be slightly larger. The other limitation is related to the non-consideration of specialised universities which are in general smaller or active in scientific domains that have a lower publication pace, as is the case of social sciences and humanities, mathematics or engineering sciences, e.g. London School of Economics.

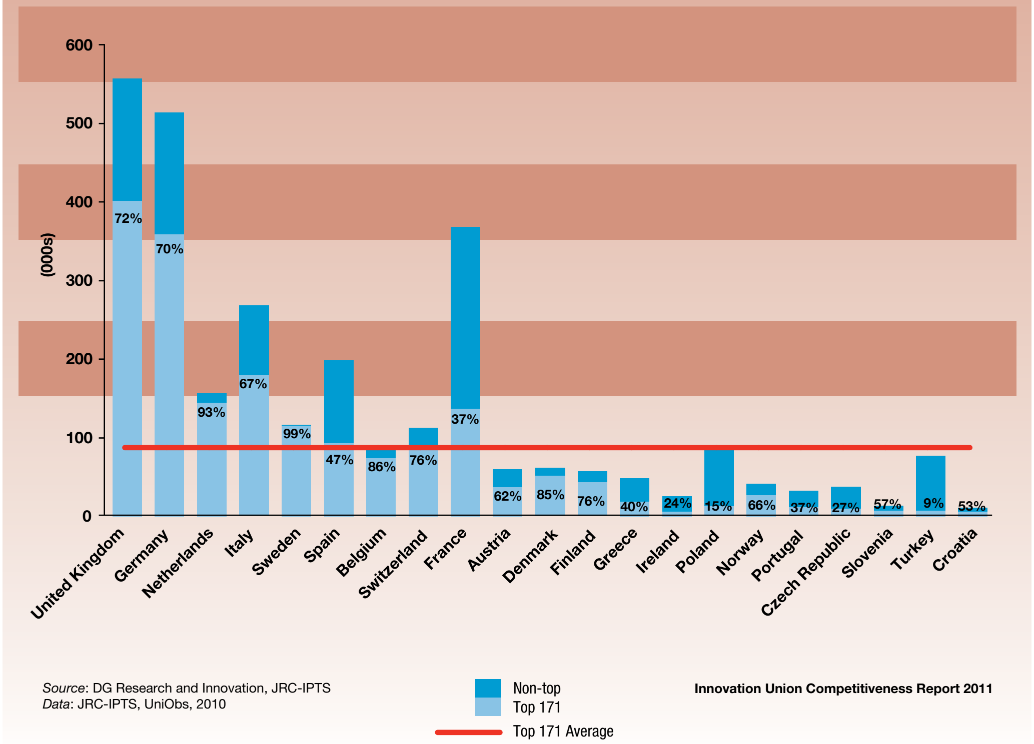
[185] For more comprehensive data and analysis of higher education institutions in Europe, see also JRC-IPTS University Observatory.

## TABLE II.1.4 Scienific publications produced by the top European research universities, 2000-2006

| | Top European research universities | | Scientific publications 2000-2006 | |
|---|---|---|---|---|
| | Total | % distribution | Total | Share in total national scientific publications % |
| Germany | 35 | 20 | 348 469 | 54 |
| United Kingdom | 32 | 19 | 401 967 | 58 |
| Italy | 18 | 11 | 180 032 | 53 |
| France | 14 | 8 | 136 921 | 30 |
| Netherlands | 11 | 6 | 144 759 | 73 |
| Spain | 10 | 6 | 93 493 | 37 |
| Sweden | 10 | 6 | 115 579 | 78 |
| Belgium | 7 | 4 | 73 883 | 67 |
| Switzerland | 7 | 4 | 85 071 | 60 |
| Finland | 5 | 3 | 43 804 | 60 |
| Austria | 4 | 2 | 37 025 | 49 |
| Denmark | 4 | 2 | 52 149 | 67 |
| Norway | 3 | 2 | 27 023 | 50 |
| Greece | 2 | 1 | 19 364 | 31 |
| Poland | 2 | 1 | 12 877 | 11 |
| Portugal | 2 | 1 | 12 100 | 27 |
| Croatia | 1 | 1 | 5 806 | 43 |
| Czech Republic | 1 | 1 | 10 148 | 21 |
| Ireland | 1 | 1 | 5 914 | 19 |
| Slovenia | 1 | 1 | 9 306 | 56 |
| Turkey | 1 | 1 | 7 145 | 7 |
| Bulgaria | 0 | 0 | 0 | 0 |
| Estonia | 0 | 0 | 0 | 0 |
| Cyprus | 0 | 0 | 0 | 0 |
| Latvia | 0 | 0 | 0 | 0 |
| Lithuania | 0 | 0 | 0 | 0 |
| Luxembourg | 0 | 0 | 0 | 0 |
| Hungary | 0 | 0 | 0 | 0 |
| Malta | 0 | 0 | 0 | 0 |
| Romania | 0 | 0 | 0 | 0 |
| Slovakia | 0 | 0 | 0 | 0 |
| **Total** | 171 | 100 | 0 | 0 |

*Source:* DG Research and Innovation, JRC-IPTS
*Data:* JRC-IPTS, UniObs, 2010

FIGURE II.1.2 Number of scientific publications (thousands) and top universities' national shares of scientific publications (%), 2000-2006



*Source*: DG Research and Innovation, JRC-IPTS
*Data*: JRC-IPTS, UniObs, 2010

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These 171 most-productive universities in science account for 60% of the total number of international scientific articles in Europe. This holds true also for most of the Member States. Universities from smaller research systems included in the top 171 represent 60–70% of the scientific publications from their respective country. The same pattern applies for large research systems such as those of the United Kingdom, Germany and Italy. However, the situation is different in Spain and particularly in France. Universities in France and Spain which belong to the top 171 account for a share of only 37% and 47% respectively of the total national scientific production (see figure II.1.2.)[186].

## *European public research-performing organisations are more evenly distributed across Europe than the top research-intensive universities, but the academic linkages are centred in Western Europe*

After having identified the most important public research-performing organisations and the most academic-research-intensive universities in Europe, it is valuable to see where they are located in Europe, as they constitute an important section of the public part of the European research system. Their location is indicated in the map below. The picture shows a distribution that has a concentration in the middle axis of Europe reaching from the United Kingdom to the north of Italy. For centuries, the 'Blue Banana' - a banana-shaped metropolitan axis running from London to Milan - has been Europe's breeding place

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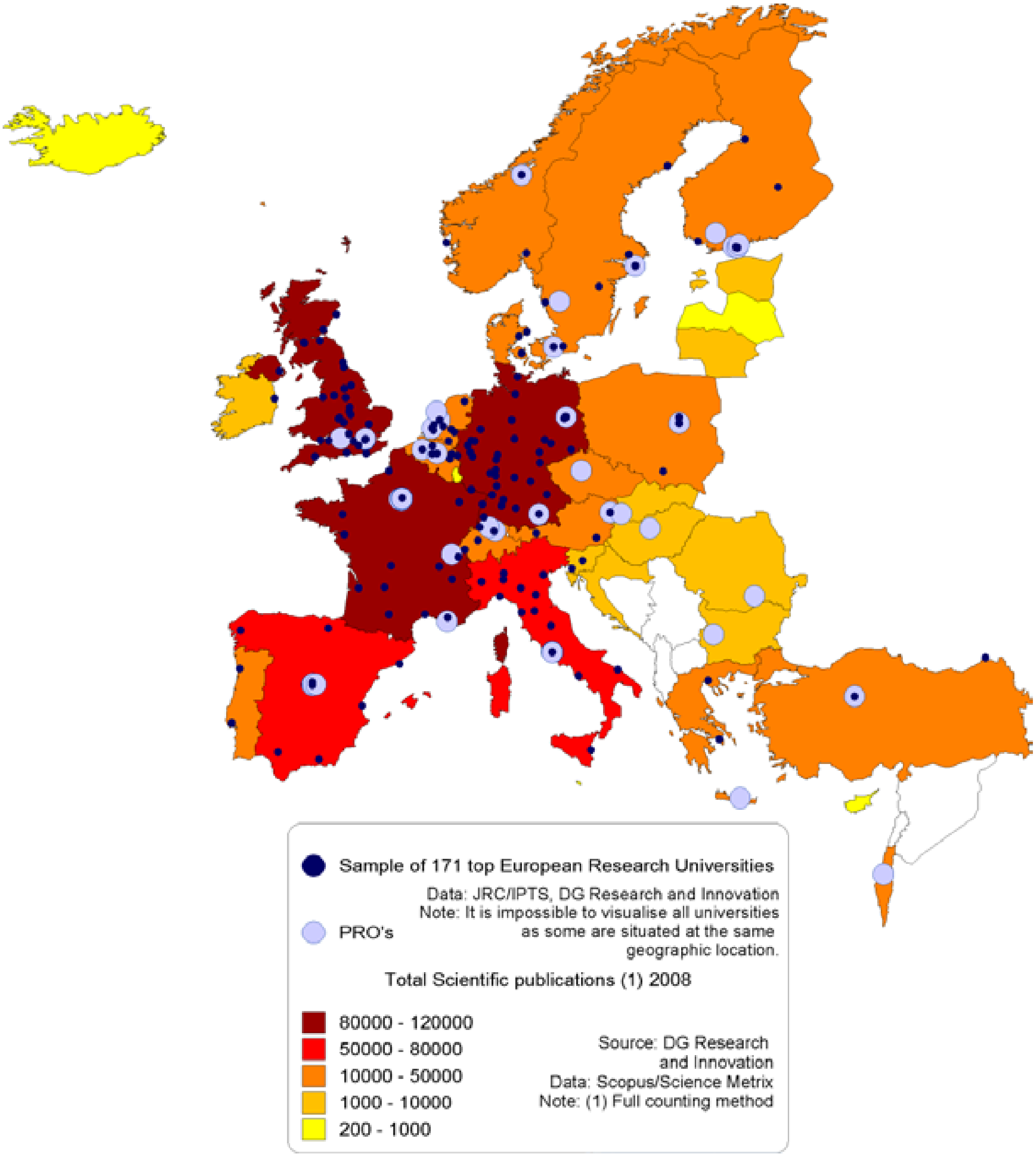
[186] Table II.1.4. and Figure II.1.2. are from Henriques, L., Schoen, A., Pontikakis, D, 2009, "Europe's top research universities in FP6: scope and drivers of participation", *JRC Technical Notes 24006* http://ftp.jrc.es/EURdoc/JRC53681_TN.pdf

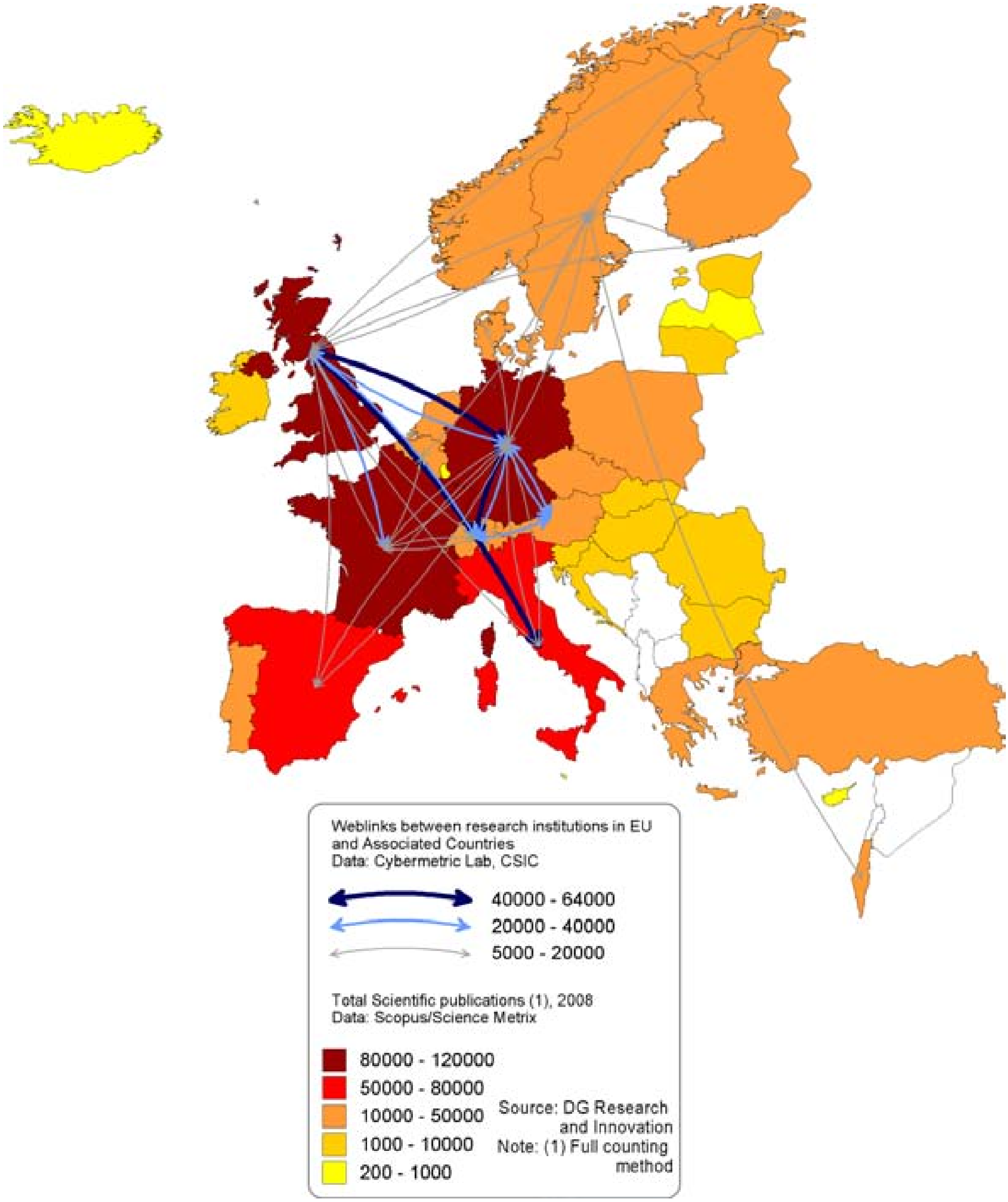
**FIGURE II.1.3** Distribution of top public research institutions in Europe, 2009



Data: JRC/IPTS, DG Research and Innovation
Note: It is impossible to visualise all universities as some are situated at the same geographic location.

Source: DG Research and Innovation
Data: Scopus/Science Metrix
Note: (1) Full counting method

FIGURE II.1.4 **Web-based links between the top public research institutions in Europe, 2010**



Source: DG Research and Innovation

Note: (1) Full counting method

for innovation and growth[187]. It seems that the major public research institutions are part of this configuration, both with respect to their location and to their linkages. Even though EU-12 count on important PROs, these are less connected to informational flows counting web-links to the major research centres in Western Europe.

## 1.2. What reforms are taking place in public research institutions?

European higher education systems have undergone important changes over the last few decades (Geuna, 2001 ; OECD, 2005, Kyvik, 2004). The changes have fostered public discussion on the Bologna reforms, which has brought higher education and universities into the reform limelight. However, PROs have also undergone restructuring, like the science academies in the new Member States or efforts in the United Kingdom to privatise government laboratories in the defence area. However, we lack sufficient statistical evidence on these reforms. Therefore, this sub-chapter will concentrate mainly on HEIs and complement the text with reforms of PROs insofar as they are available.

### 1.2.1. Institutional strategies in higher education institutions

Current reforms of European higher education institutions[188] are aimed at various institutional structures and they are guided by several motivations. The latest 'Trends 2010'[189] report of the European University Association (EUA) detected intensive reform of universities in Europe. Reforms of universities have several dimensions, such as implementing the Bologna Process (78% of respondents), quality assurance reforms (63%) – enhanced by reforms in funding allocation schemes and legal reforms for increased autonomy of the universities – and reforms adapting to the internationalisation of research and education (61%). These are reforms which have altered institutional higher education policies and strategies. More institutions are developing an integrated internationalisation approach to teaching and research and putting focus on strategic partnerships. The report concludes that the European Higher Education Area and the European Research Area have given new opportunities to universities, and charged HEIs with new responsibilities in a close interface between education, research and innovation.

***The framework for the European universities is changing: more autonomy, performance-based funding, higher share of project funding, engagement in competitive research, and international competition for staff.***

The most frequent reforms introduced in the universities in European countries mentioned by the report of EUA were:

- 18 countries have introduced a reform of quality assurance for degrees and education ;
- 15 countries have changed their research policies, taking into account the international competitive environment ;
- 12 countries have expanded the institutional autonomy of their HEIs ;
- 12 countries have fostered reforms in their funding system in order to diminish institutional funding in favour of competitive funding.

Other changes identified in the survey were: governance reforms of universities to cope with knowledge transfer, new career structures, new entry requirements to the different cycles of study, and innovation policies.

While eight countries (Austria, the Czech Republic, Spain, Greece, Italy, Poland, Slovakia and Slovenia) increased their number of universities, eleven countries (Belgium, France, Germany, Denmark, Estonia, Finland, Hungary, Iceland, Norway, Sweden and Slovenia) pushed their institutions for mergers. Mergers may support better economy of scale, but in many of these countries the aim is to raise quality and strive for excellence by critical mass. The current reforms of universities often aim at autonomy, particular in view of strengthening the excellence at universities.

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[187] Gert-Jan Hospers: Beyond the Blue Banana? Structural Change in Europe's Geo-Economy, Intereconomics, March/April 2003.

[188] The last STC Key Figures Report 2008/2009 gave an overview on reforms based on a Commission expert group grounded in findings from CHE. See Part II chapter 1, p. 92 ff. This volume takes into account more recent reports.

[189] The report is based on a longitudinal analysis of higher education institutions. The data comes from 821 responses from universities and 27 responses from the National Rectors' Conferences. The recent survey compares with similar ones reported in 2005 and 2007.

## TABLE II.1.5 The most important reforms in European universities (beside the Bologna Process)

| Institution | Funding | Autonomy | QA | Research policies |
|---|---|---|---|---|
| Belgium | • |  | • | • |
| Czech Republic | • |  |  | • |
| Denmark | • |  | • |  |
| Germany |  | • | • | • |
| Estonia |  |  | • |  |
| Ireland |  |  | • | • |
| Greece |  |  | • | • |
| Spain |  | • | • |  |
| France |  | • | • | • |
| Italy |  | • |  |  |
| Latvia |  | • | • | • |
| Lithuania | • | • |  |  |
| Luxembourg | • | • |  | • |
| Hungary |  |  |  | • |
| Netherlands | • |  | • |  |
| Austria |  | • | • |  |
| Poland |  | • | • | • |
| Slovakia |  |  | • | • |
| Slovenia | • | • | • | • |
| Finland | • | • |  |  |
| United Kingdom | • |  | • | • |
| Iceland | • |  | • | • |
| Norway | • | • | • | • |
| Serbia |  |  | • |  |

*Source:* DG Research and Innovation
*Data:* EUA: Trends 2010: A decade of change in European Higher Education

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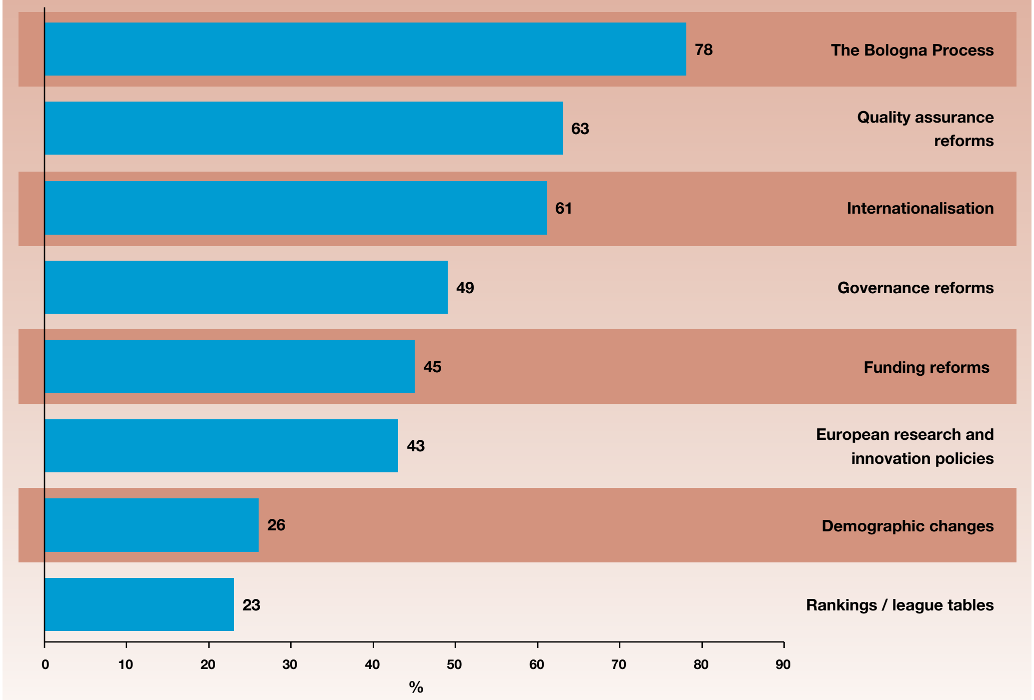
* In the original UEA survey, data on Belgium was split in the two major regions. The Commission has merged the table for reasons of comparability as countries with cultural regional diversity, such as Germany and Spain for example, have as well different reforms in their respective regions.

## *Internationalisation and European policies are among the main drivers of new university strategies and reforms*

The comparison of excellence at worldwide level is a high impact exercise. In this sense, ranking activities influence strongly institutional strategies of international active universities. Moreover, efforts to achieve competitive funding at a European level have fostered the trend of profile building, international mobility and openness to non-national staff[190].

European policy issues have had a crucial impact on university reform. The Bologna Process was and is of high importance to the reform of higher education degrees. The internationalisation of science and the Bologna Process have stipulated quality assurance reforms, along with the process of accreditation of the degrees. As the figure below shows, European research and innovation policies had a high impact on the institutional strategies of universities. Another important factor is the expanding European dimension in research, which attributes higher importance of

FIGURE II.1.5 **Importance of developments for institutional strategy**



*Source*: DG Research and Innovation
*Data*: EUA: Trends 2010: A decade of change in European Higher Education

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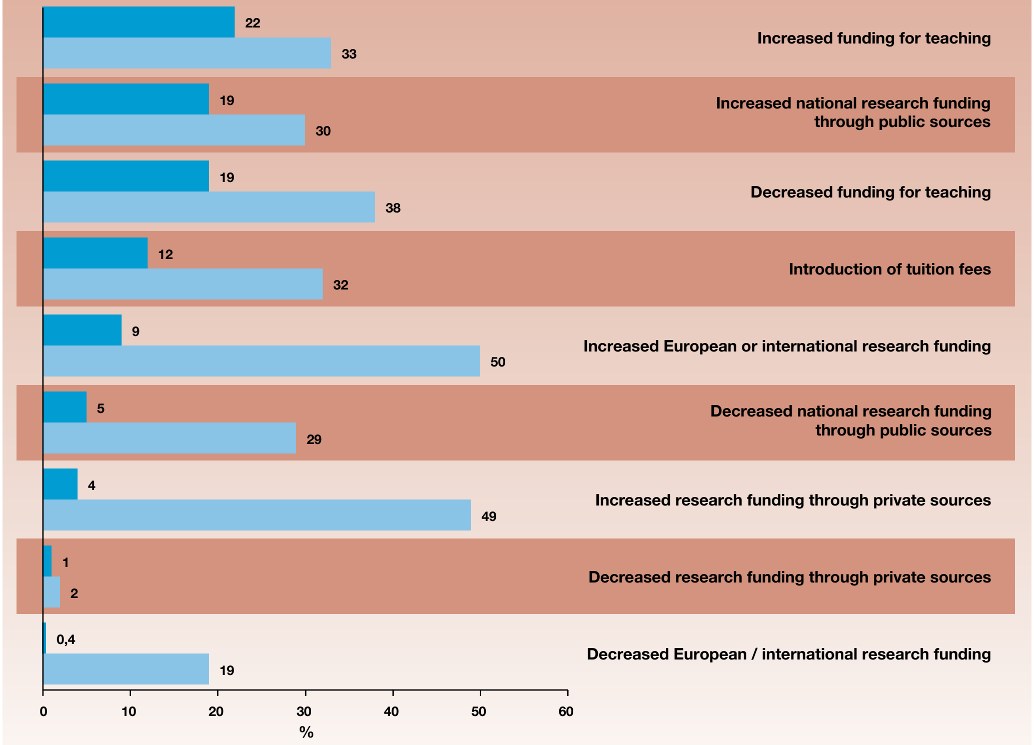
[190] See also the chapter on researcher mobility, Part II, chapter 5.

FIGURE II.1.6 The three most important developments in the funding of universities in the past five years



*Source*: DG Research and Innovation
*Data*: EUA: Trends 2010: A decade of change in European Higher Education

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competitive funding in comparison to institutional funding. Although ranking and lead tables play a certain role in the institutional strategies of universities, competitive European funding provides additional funds to national resources and may be considered as one proof of international competitiveness and a benchmark for scientific excellence. In this view, the Danish Ministry for Science, Technology and Innovation has applied an interesting benchmarking and ranking analysis of OECD, EU and BRIC countries based on 20 indicators. The purpose of monitoring Danish research institutions is to raise the research quality and respective features in the Danish research system[191].

The current pressure to implement the Bologna Process and to assure quality of degrees catches most of the attention of university managers. However, funding remains a critical issue. As the HEIs are mostly public national or even regional institutions, increased European or international research funding figures under the top three issues, and even decreased European or international funding is a source of concern. The reflection on increased research funding through private sources indicates the new strategic thinking of universities and the international influence that has invaded the former national public institutions, which no longer can rely on static public institutional funding.

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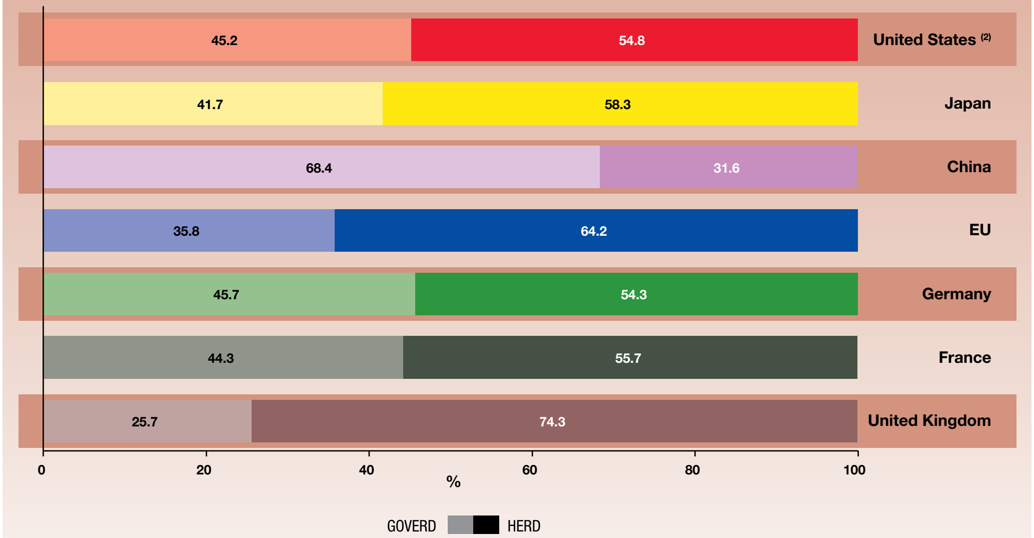
[191] Ministry of Science, Technology and Innovation: Research Barometer 2009, Danish Research in an International Perspective, Copenhagen, December 2009.

### 1.2.2 Public expenditures and funding of PROs and HEIs

***Over 60% of public research funding in the EU is provided to HEIs and 40% to PROs, with a trend of a slightly increasing share for HEIs***

In the EU, 35.8% of public R&D funds are distributed to public research-performing organisations (PROs) and 64.2% to higher education institutes (HEIs), which shows an increase of the relative funding to higher education institutions over the last five years (in 2004, HEIs received 62% of public expenditures on R&D). In the United States, the HEIs receive 54.8% of the public R&D funding and in China 31.6%. China and the United States have had the same trend of increase in the share of public expenditures to higher education institutions relative to the funding to PROs (in 2004, the share of HEIs in the United States was 53% and China 28%, according to OECD). Comparable distributions to that of the United States are found in France and Germany, while the United Kingdom spends much less of its R&D funding on PROs. In most of the EU Member States, it is predominantly the universities which perform public research.

FIGURE II.1.7 **GOVERD and HERD as % of total public expenditure on R&D, 2009(1)**



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*Source*: DG Research and Innovation
*Data*: Eurostat, OECD
*Notes*: (1) US, JP, CN: 2008.
(2) US: (i) Most or all capital expenditure is not included (ii) GOVERD refers to federal or central government only.

## TABLE II.1.6

## Government Intramural Expenditure on R&D (GOVERD) and Higher Education Expenditure on R&D (HERD), 2009(1)

| | GOVERD | | HERD | |
|---|---|---|---|---|
| | Total euro (millions) | as% of GDP | Total euro (millions) | as% of GDP |
| Belgium | *575* | *0.17* | *1 511* | *0.45* |
| Bulgaria | *102* | *0.29* | *26* | *0.07* |
| Czech Republic | 448 | 0.33 | 379 | 0.28 |
| Denmark | *193* | *0.09* | *2 012* | *0.90* |
| Germany | *9 840* | *0.41* | *11 700* | *0.49* |
| Estonia | 22 | 0.16 | 83 | 0.60 |
| Ireland | *122* | *0.08* | *829* | *0.52* |
| Greece | *281* | *0.12* | *661* | *0.29* |
| Spain | 2 927 | 0.28 | 4 058 | 0.39 |
| France | *6 879* | *0.36* | *8 648* | *0.45* |
| Italy | *2 680* | *0.18* | 6 049 | 0.40 |
| Cyprus | *17* | *0.10* | *33* | *0.20* |
| Latvia | 21 | 0.11 | 33 | 0.18 |
| Lithuania | 52 | 0.20 | 117 | 0.44 |
| Luxembourg | *111* | *0.29* | *58* | *0.15* |
| Hungary | 214 | 0.23 | 223 | 0.24 |
| Malta | *2* | *0.03* | *10* | *0.18* |
| Netherlands | *1 326* | *0.23* | *4 169* | *0.73* |
| Austria | *403* | *0.15* | *1 799* | *0.66* |
| Poland | 719 | 0,23 | 777 | 0,25 |
| Portugal | *206* | *0.12* | *987* | *0.59* |
| Romania | 194 | 0.17 | 138 | 0.12 |
| Slovenia | 136 | 0.39 | 96 | 0.27 |
| Slovakia | 103 | 0.16 | 76 | 0.12 |
| Finland | *645* | *0.37* | *1 362* | *0.77* |
| Sweden | 467 | 0.16 | *2 627* | *0.90* |
| United Kingdom | *2 679* | *0.17* | *7 756* | *0.50* |
| EU | *31 251* | *0.27* | *56 024* | *0.48* |
| Iceland | 49 | 0.47 | 68 | 0.67 |
| Norway | *778* | *0.29* | *1 548* | *0.57* |
| Switzerland(2) | 76 | 0.02 | 2 482 | 0.72 |
| Croatia | 103 | 0.23 | 123 | 0.27 |
| Turkey | 470 | 0.11 | 1 773 | 0.40 |
| Israel(3) | *292* | *0.21* | *763* | *0.54* |
| Russian Federation | 3 331 | 0.36 | 785 | 0.08 |
| United States(4) | *28 709* | *0.29* | *34 786* | *0.36* |
| Japan | 9 494 | 0.29 | 13 264 | 0.40 |
| China | 8 257 | 0.28 | 3 816 | 0.13 |
| South Korea | 2 590 | 0.41 | 2 394 | 0.38 |

*Source:* DG Research and Innovation

*Data:* Eurostat, OECD

*Notes:* (1) EL: 2007; IS, CH, US, JP, CN, KR: 2008; FI: 2010
(2) CH: GOVERD refers to federal or central government only
(3) IL: (i) GOVERD does not include defence (ii) HERD does not include R&D in the social sciences and humanities
(4) US: (i) Most or all capital expenditure is not included (ii) GOVERD refers to federal or central government only
(5) Values in italics are estimated or provisional or forecasts

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When government intramural expenditure on R&D (GOVERD) and higher education expenditure on R&D (HERD) are compared in Table II.1.6., marked differences between Member States are observed. In relation to GDP, on average Member States spend half as much on PROs as they spend on HEIs. Only Bulgaria, Romania and Slovakia spend more on PROs due to the strong role of their Academy of Sciences. High relative expenditures on HEIs are done in Sweden, Denmark, Finland, Austria, and the Netherlands. In absolute terms, Germany, the United Kingdom, France and Italy hold the bulk of the total HEI spending. In absolute numbers (total euros), GOVERD spending in Germany and France alone holds at 51.4% and Germany spends up to three times as much as the United Kingdom.

### *In several European countries a shift has emerged towards performing research in universities*

Historically, a structural change between the two types of research institutions can be observed. The share of PROs fell slightly by 2.2% over nearly a decade[192] as the table on development of relative expenditure of PROs in relation to HEIs shows. In several countries, a shift towards performing publicly financed research in HEIs can be witnessed - (for example, the Czech Republic, Cyprus and Slovakia have decreased their high share of PROs following privatisation and the reduction of spending for non-civil R&D and nuclear energy). Other countries have integrated PROs into universities (like it was the case in Estonia). The most striking cases in the EU-15 may be the shift of Denmark (a decrease of almost 20%), Portugal and the United Kingdom. The share for PROs in the United Kingdom fell from 38% in 2000 to 25.7% in 2009, partly linked to the privatisation of the PROs in this Member State. In Portugal the share fell from 38.9% to 17.2% (Table II.1.7).

Countries like Bulgaria, Romania and Slovenia have kept a strong PRO sector over a decade as the research is largely performed in their Academies of Sciences. Germany and France - the countries in the EU-15 where PROs represent a large part of public research - have kept their structure at around 46% for PROs, with a slight decrease of 2% for France. In countries like Belgium and Sweden, the relative expenditures on HEIs have increased a few percentage points over the last decade, while Spain has had the opposite trend with an increasing GOVERD.

## 1.2.3 Funding of higher education institutions

One of the levers of the HEI reforms is the changes made in overall funding. The reforms brought increasing importance to project funding and other sources of funds (such as private contracts or non-profit donations) and the change of funding allocation criteria. Despite differences in the national funding systems and in the instruments used, one of the most important changes lies in the way governments allocate funds. In this context, the reforms imply a move from funding allocation criteria based on size and past input, towards more output-oriented criteria. In addition, there is a perceptible trend toward reducing core funding (institutional funding) while increasing competitive funding (contractual funding) from national and – increasingly – European funds.

### *The share of public funds received on a competitive basis increases with the level of financial autonomy of the institutions*

A study made by the European Commission services has collected new data with comprehensive coverage throughout Europe on a large sample of universities[193] in order to investigate the structure of the university budgets. The analysis reviewed the level of financial autonomy and the share of competitive funding.

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[192] In many European countries, there has been a slow shift from a public research system where PROs and teaching universities are the main knowledge institutions to a system characterised by the research centrality of HEIs. This trend is visible from the early 1990s, not only in Europe but also in Japan, South Korea and the United States.(see Foray and Lissoni, 'University research and public-private interactions', in Hall and Rosenberg (eds), Handbook of Economics of Innovation, North-Holland, 2010).

[193] The study covers 200 research-active universities from 33 European countries (the 27 Member States as well as Croatia, Iceland, Israel, Norway, Switzerland and Turkey) within the framework of the 'European Observatory of Research-Active Universities and National Public Research Funding Agencies' (UniObs). The criteria followed in selecting the universities were based on research performance and country representativeness. The UniObs monitoring is managed by the JRC-IPTS. (See de Dominicis, L., Elena Pèrez, S., Fernandez-Zubieta, A.: "European university funding and financial autonomy"). A study on the degree of diversification of university budget and the share of competitive funding", JRC scientific and Technical report nr 24761, EN, European Commission, Luxemburg.

## TABLE II.1.7

## GOVERD as % of total public expenditure on R&D(1), 2000-2009

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 23.7 | 23.8 | 25.3 | 23.6 | 26.3 | 27.3 | 27.4 | 27.6 | *26.7* | *27.6* | : |
| Bulgaria | 87.4 | 84.5 | 87.7 | 87.9 | 87.8 | 86.4 | 87.0 | 85.8 | 85.9 | *79.7* | : |
| Czech Republic | 64.1 | 60.2 | 59.5 | 60.5 | 60.3 | 55.0 | 54.0 | 55.2 | 55.5 | 54.1 | : |
| Denmark(2) | 39.0 | 38.4 | 24.2 | 23.2 | 21.9 | 20.8 | 20.2 | 10.9 | 8.7 | *8.7* | : |
| Germany | 45.8 | 45.6 | 44.7 | 44.3 | 45.3 | 46.0 | 46.3 | 46.3 | 45.7 | *45.7* | : |
| Estonia | 30.6 | 21.8 | 26.2 | 25.0 | 22.6 | 21.4 | 24.4 | 17.2 | 21.5 | 20.7 | : |
| Ireland | 28.6 | 27.1 | 28.0 | 24.0 | 22.0 | 21.4 | 20.0 | 20.6 | 19.4 | *12.8* | : |
| Greece | : | 32.9 | : | 30.3 | *29.2* | 29.9 | *30.3* | *29.8* | : | : | : |
| Spain | 34.8 | 33.9 | 34.1 | 33.6 | 35.1 | 37.0 | 37.6 | 40.0 | 40.5 | 41.9 | : |
| France | 48.0 | 46.6 | 46.7 | 46.3 | 47.7 | 48.6 | 46.2 | 45.6 | 44.3 | *44.3* | : |
| Italy | 37.9 | 36.1 | 34.9 | 34.1 | 35.2 | 36.4 | 36.3 | 32.5 | 28.4 | *30.7* | : |
| Cyprus | 65.2 | 63.5 | 58.0 | 53.7 | 50.6 | 45.0 | 41.0 | 34.8 | 34.4 | *33.5* | : |
| Latvia | 37.0 | 33.8 | 32.1 | 35.6 | 35.0 | 31.5 | 30.4 | 36.0 | 36.7 | 38.8 | : |
| Lithuania | 53.4 | 55.8 | 40.2 | 33.5 | 31.4 | 31.4 | 31.7 | 29.2 | 30.3 | 31.0 | : |
| Luxembourg | 96.7 | 95.6 | : | 96.8 | 89.9 | 88.9 | 84.7 | 81.8 | 72.4 | *65.8* | : |
| Hungary(3) | 52.1 | 50.1 | 56.6 | 54.0 | 54.6 | 52.7 | 51.0 | 50.8 | 51.5 | 48.9 | : |
| Malta | : | : | 21.9 | 10.1 | 7.5 | 14.1 | 12.9 | *7.8* | 13.1 | *15.2* | : |
| Netherlands | 31.5 | 33.8 | 32.4 | 28.0 | 28.5 | 26.4 | 26.8 | 26.0 | 24.0 | *24.1* | : |
| Austria | : | : | 17.4 | : | 16.1 | *17.3* | 17.8 | 18.3 | *18.3* | *18.3* | : |
| Poland | 50.6 | 48.9 | 57.3 | 56.2 | 55.0 | 53.5 | 54.4 | 51.1 | 51.2 | 48.1 | : |
| Portugal | *38.9* | 36.2 | *33.4* | 30.5 | *29.8* | 29.2 | *26.2* | 23.9 | 17.4 | *17.2* | : |
| Romania | 61.5 | 70.5 | 60.8 | 77.3 | 77.2 | 71.4 | 64.6 | 58.5 | 58.7 | 58.5 | : |
| Slovenia | 60.9 | 59.9 | 59.7 | 61.7 | 60.6 | 59.1 | 61.9 | 61.1 | 62.0 | 58.8 | : |
| Slovakia | 72.2 | 72.5 | 74.5 | 70.6 | 60.3 | 59.2 | 57.6 | 58.6 | 57.5 | 57.5 | : |
| Finland | 37.2 | 36.1 | 35.1 | 33.5 | 32.4 | 33.4 | 33.3 | 31.2 | 31.9 | 32.5 | 32.1 |
| Sweden(4) | : | 12.6 | : | 13.8 | 11.9 | 18.4 | *17.8* | 18.4 | *17.2* | 15.1 | : |
| United Kingdom | 38.0 | 30.7 | 27.7 | 30.2 | 30.2 | 29.1 | 27.7 | 26.0 | 25.7 | *25.7* | : |
| EU | *40.0* | *38.4* | *37.3* | *36.8* | *37.3* | *37.8* | *37.1* | *36.2* | *35.5* | *35.8* | : |
| Iceland | *61.1* | 51.7 | *60.4* | 53.8 | : | 51.7 | 46.2 | 41.5 | 41.5 | : | : |
| Norway(5) | : | 36.3 | 37.1 | 35.5 | 34.3 | 33.7 | 34.2 | 32.8 | 31.6 | *33.4* | : |
| Switzerland(6) | 5.4 | : | 4.8 | : | 4.5 | : | 3.6 | : | 3.0 | : | : |
| Croatia | : | : | 38.8 | 36.1 | 35.9 | 41.0 | 42.0 | 43.0 | 45.4 | 45.7 | : |
| Turkey | 9.3 | 11.1 | 9.8 | 13.6 | 10.5 | 17.5 | 18.5 | 18.0 | 21.4 | 20.9 | : |
| Israel(7) | 26.8 | 26.7 | 26.3 | 25.9 | 26.4 | *25.1* | *25.8* | *27.0* | *27.2* | *27.7* | : |
| Russian Federation | 84.3 | 82.3 | 81.8 | 80.7 | 82.2 | 81.9 | 81.5 | 82.1 | 81.8 | 80.9 | : |
| United States(8) | 47.4 | 48.2 | 47.5 | 46.9 | 45.9 | 46.0 | 45.7 | 45.2 | *45.2* | : | : |
| Japan(9) | 40.5 | 39.7 | 40.7 | 40.5 | 41.4 | 38.2 | 39.5 | 38.2 | 41.7 | : | : |
| China | 78.6 | 75.2 | 73.9 | 72.0 | 69.2 | 68.8 | 68.1 | 69.4 | 68.4 | : | : |
| South Korea(5) | 54.1 | 54.3 | 56.4 | 55.4 | 54.5 | 54.4 | 53.7 | 52.3 | 52.0 | : | : |

*Source:* DG Research and Innovation

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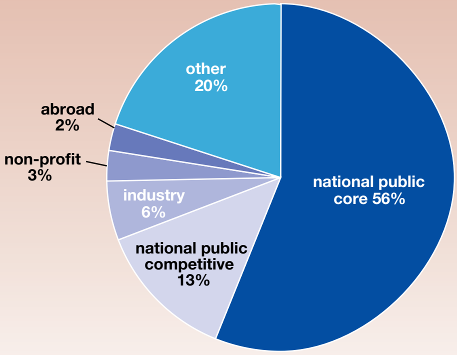
*Data:* Eurostat, OECD

*Notes:* (1) Public expenditure on R&D: GOVERD (Government Intramural Expenditure on R&D) plus Higher Education Expenditure on R&D (HERD)
(2) DK: Breaks in series occur between 2002 and the previous years and 2007 and the previous years
(3) HU: A break in series occurs between 2004 and the previous years
(4) SE: A break in series occurs between 2005 and the previous years
(5) NO, KR: A break in series occurs between 2007 and the previous years
(6) CH: GOVERD refers to federal or central government only
(7) IL: (i) GOVERD does not include defence (ii) HERD does not include R&D in the social sciences and humanities
(8) US: (i) Most or all capital expenditure is not included (ii) GOVERD refers to federal or central government only
(9) JP: A break in series occurs between 2008 and the previous years
(10) Values in italics are estimated or provisional or forecasts

The figures below show the results on funding sources of the 200 most research-intense universities in Europe:

- 70% of the total university income comes from government allocations. Sources from private companies represent about 6%, around 3% comes from the non-profit sectors and approximately 2% is from abroad.
- On average about 20% of public funding from government (national and regional) is assigned on a competitive basis, with institutions in the United Kingdom and technological universities having the highest shares of competitive funds.
- Large intra-country variability exists in the shares of government competitive funds, which could be attributed to the strategic behaviour of single institutions in acquiring funds or to their ability to compete successfully against other institutions (examples of successful institutions are the University of Cambridge in the United Kingdom, the University of Karlsruhe in Germany, the University of Florence in Italy, and the universities of Leiden and Wageningen in the Netherlands.)
- Universities with a high degree of autonomy are the ones that have the most diversified budget. Most of the institutions with a highly diversified budget are located in the United Kingdom.

FIGURE II.1.8 **The 200 most research intensive universities in Europe: income by source of funds[(1)] (%)**



*Source*: DG Research and Innovation, JRC-IPTS
*Data*: European university funding and financial autonomy
*Note*: (1) Average of all institutions.

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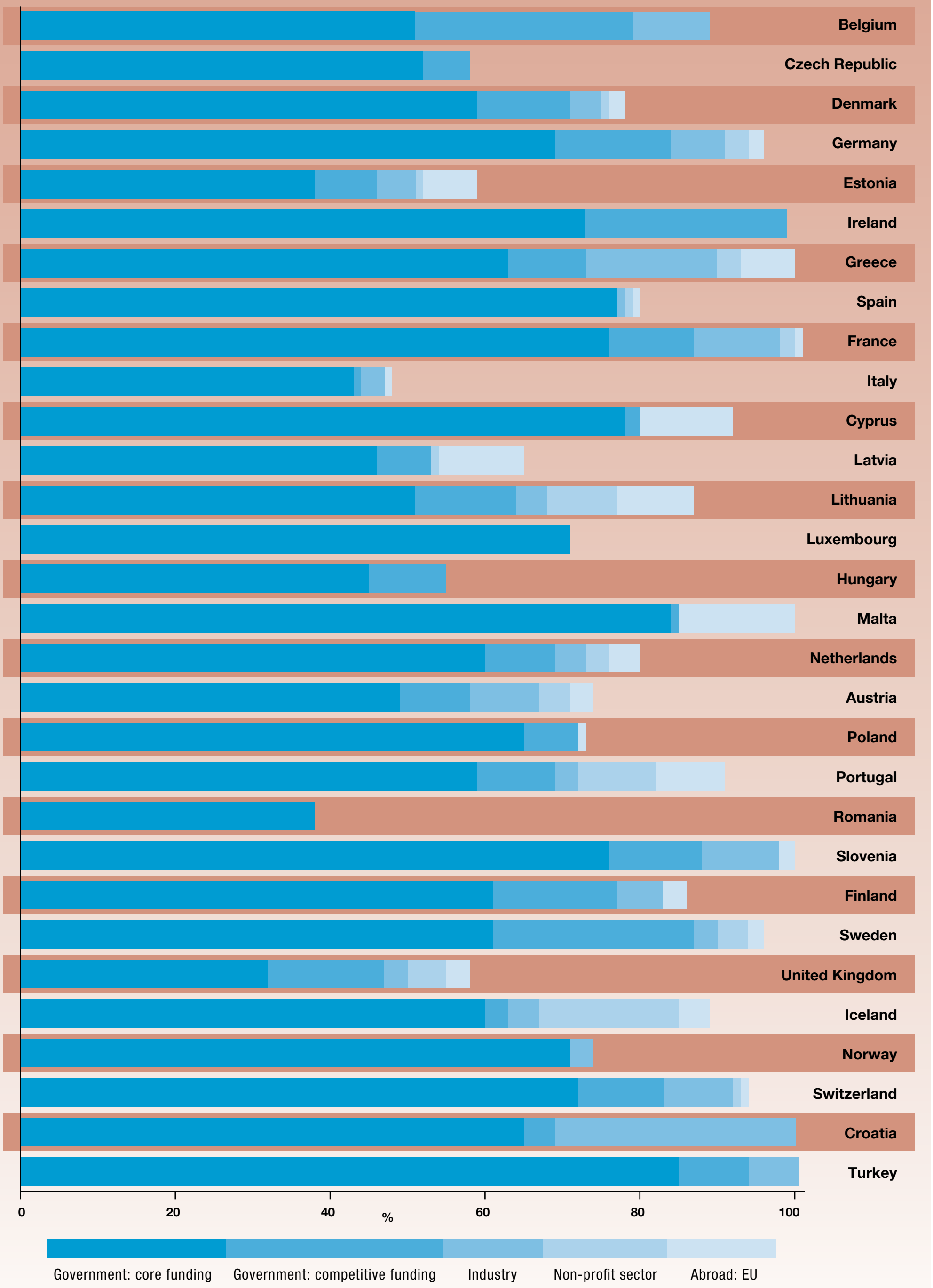
FIGURE II.1.9

## The 200 most research intensive universities in Europe: income by source of funds, averages by country



*Source*: DG Research and Innovation, JRC-IPTS
*Data*: JRC-IPTS: European university funding and financial autonomy.

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The UniObs analysis of different sources of university income reveals the following:

- Government is still the main source of funding of European universities. For the majority of universities in the European countries, government core funds account for around 70% or more of the total university income. The share of competitive funds allocated by government varies considerably, ranging from 1% on average for universities in Italy to 28% on average for institutions in Belgium.
- Funding data show that, in general, research-active universities in Europe have a proportion lower than 10% of their budget coming from industry. In France, Greece, Bulgaria and Croatia, universities receive, on average, above 10% of their total budget from industry. Universities studied in Croatia show the highest share of income from industry (30%), mainly due to overall lower funding from government.
- Income from 'abroad' represents less than 10% of the total budget for the great majority of universities in the sample, and in 83% of them, that income falls below 5%. Data on public funds were mostly available at institutional level and confirm that core funding is the major source of income for the selected European universities.
- Data indicates that in approximately three quarters of the countries, the universities have a share of funds coming from the non-profit sector which represents less than 5% of their total income. The non-profit sector could be an important source of income, as proved by universities in Iceland and in Portugal, where, on average, it represents 18% and 10% of the total university budget.
- Philanthropic sources could potentially be an important source of income for universities, particularly for research activity. However, large-scale philanthropy is not as well developed in Europe as in the United States[194].

## 1.2.4 Philanthropic funding for research

The most recent Ross–CASE Survey indicates that in the United Kingdom philanthropy could become a significant funding source for some universities, providing funds at the level of about 2.3% of total institutional expenditure. However, funds remains highly unevenly distributed. 51% of the cash income is received by Oxford and Cambridge, and a further 24% by the leading 20 research-teaching universities in a total of 116 universities. Previous studies from the United States and the United Kingdom have noted that the vast majority of funds from philanthropic sources tend to be raised by 'elite' universities. The 'Council for Aid to Education' notes that 20 leading universities in the United States account for 26% of all gifts in 2009 to higher education institutions.

### *Philanthropic funding for research has become a significant source for leading universities*

According to a survey on philanthropic funding carried out by the University of Kent and the VU University of Amsterdam[195], funds are most likely to be raised from corporations, charitable trusts and foundations. Alumni associations are generally a less productive source of funding, although European universities are accelerating their efforts in this area. The average amount varies from EUR 100000 to EUR 10 million with a few exceptions of over EUR 10 million.

TABLE II.1.8 **Success of fundraising efforts for research purposes**

**Answers to a question with a number from 1 - 10, where 1 = 'not at all' and 10 = 'very'**

| | Median | N |
|---|---|---|
| Charitable trusts and foundations | 6 | 89 |
| Corporations | 5 | 91 |
| Wealthy individuals | 4 | 77 |
| Alumni | 2.5 | 72 |
| Other | 2 | 59 |

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*Source:* DG Research and Innovation
*Data:* University of Kent, VU University of Amsterdam

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[194] Actually, the exercise of data collection within the UniObs has shown that only half of the sample of universities was able to provide reliable data on this stream of income, which gives an indication of the low importance of this particular stream of income and the subsequent poor accountability.

[195] Breeze, B., I. Wilkinson, B. Gouwenberg, T. Schuyt: Giving in evidence: Fundraising from philanthropy for research funding in European universities, Brussels, September 2010.

**TABLE II.1.9** **Average amount of philanthropic funds (euro) annually raised for research**

| | % (N = 112) |
|---|---|
| Less than 100,000 | 17 |
| Between 100,000 and 1,000,000 | 27 |
| Between 1,000,000 and 10,000,000 | 17 |
| More than 10,000,000 | 5 |
| Don't know | 34 |

**Innovation Union Competitiveness Report 2011**
*Source:* DG Research and Innovation
*Data:* University of Kent, VU University of Amsterdam

## 1.2.5 International competition and strategies for excellence

As indicated in the last edition of this report[196], Member States have put in practice different measures to foster excellence in universities and PROs: a higher share of competitive funding, more managerial governance structures ('New Public Management Approach'), higher emphasis on the selection of human resources, and strengthening of the 'third mission' of universities to bring public research institutions closer to the non-academic world (including science–industry links), and to establish centres of excellence[197].

### *Many Member States have put in place policies to foster excellence*

Over the last decade, most EU Member States have launched activities to foster the excellence of their public research base. Member States acknowledge excellence in research in two main dimensions: the scientific quality and the relevance of research with regard to its potential economic use or societal benefit.

In 2006, 'National Institutes of Technology' were launched in Italy and Austria to develop a national R&D-excellence flagship. Other Member States like Belgium, Estonia, Sweden and Malta also launched new initiatives to create centres of excellence, such as the Platforms of Strategic Importance (PSI) in Malta or the Linnaeus grant system in Sweden. In Germany, the 'excellence initiative' for universities provided funds for nine selected universities.

A handful of countries have followed the 'New Public Management approach' on performance contracts with universities. Austria, France and Denmark have introduced performance contracts since 2003. In the Austrian case, 20% of the income from the Education Ministry is dependent upon the performance indicators specified in the contract. In Germany the first performance contracts were signed between the governments of Baden- Wurttemberg, Berlin and Lower Saxony and their universities. Since then, this kind of instrument has been introduced in all German States. In Spain, regional governments, such as Catalonia, have developed multi-annual programme contracts with public universities since 1997. Public funding is then provided according to progress in the chosen area. Specific objectives are established regarding university management, technology transfer, and relationships with society.

### *Performance monitoring and evaluation has become a demonstrator for efficient and productive use of public funds in Member States*

Member States report a growing interest in performance monitoring and evaluation - a corollary which demonstrates efficient and productive use of public funds. Several countries have created new institutions with a quality control mission external to universities, including the Evaluation Agency for Higher Education and Research (AERES) created by France in 2007, the National Research and University Assessment Agency (ANVUR) in Italy, and Lithuania's Centre for Quality Assessment in Higher Education (has a remit covering not only education but also research). In the Netherlands, university quality control is mostly handled internally by universities themselves, supported by Quality Assurance Netherlands Universities (QANU). Spain has a whole range of institutions, including the Centre for the Development of Industrial Technology (CDTI), the National Agency for Evaluation and Prospective Studies (ANEP) and the National Commission for the Evaluation of Research Activity (CNEI).

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[196] STC report 2008/2009, p. 92ff.

[197] See also G. Veltri, A.Grablowitz, F. Mulatero: Trends in R&D policies for a European knowledge-based economy, European Commission JRC_IPTS, Luxembourg 2009.

A quality control system has been applied by the UK's Research Assessment Exercise (RAE) since 1986. The RAE ratings are used to allocate around 30% of the national science budget. The funding credits are heavily skewed in favour of the best performing departments and as a result the stronger research universities have seen substantial growth in their research income in the period, while those universities with a weaker research base have seen their income shrink. This has led to a situation where some 50% of block funding is awarded to the top 10 research universities, which account for around 30% of total university research capacity. Denmark has followed the United Kingdom in this type of quality control with a strong feedback loop from evaluation results to resource allocation.

### *Common features emerge in Europe for centres of excellence*

A centre of excellence[198] performs research and technology development (RTD) at world standard, in terms of measurable scientific production (including training) and/or technological innovation. Even if this concept is understood in different ways in Europe, it has common features[199]:

- 'critical mass' of high level scientists and/or technology developers;
- well-identified structure (mostly based on existing institutions) having its own research agenda;
- integration of connected fields and associated complementary skills;
- high rate of mobility of qualified human resources;
- surrounding innovation system (adding value to knowledge);
- high levels of international visibility and scientific and/or industrial connectivity;
- reasonable stability of funding and operating conditions over time (the basis for investing in people and building partnerships);
- sources of finance which are not dependent on public funding over time.

Proximity to excellent research centres is becoming a major element in decisions made over the location of production sites by multinational companies[200]. Although a physical concentration of excellent researchers is still a key factor in RTD strategies, advanced ICT tools progressively allow effective interaction in networks. Several European countries have recently implemented measures to give reinforced support to such centres of excellence.

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[198] Broader evidence on technology clusters and knowledge transfer in Europe is presented in the following chapter, Part II, chapter 2.

[199] Veltrini et al., p. 46.

[200] In this context, it is also relevant to compare with the analysis of foreign R&D expenditures, see Part I, Chapter 5.2.

## Box II.1.1 – Examples of policies on centres of excellence

**Estonia**

The Excellence Centres programme is aimed at higher education institutions' research units and is intended to restructure the Estonian research landscape by developing a small number of centres of excellence in the areas considered a priority for economic growth. The budget for the programme for 2007–2013 is significantly large, and the number of new centres selected is small (seven against the ten in the previous programme period). The programme is now concentrated on fewer scientific fields – biotechnology, ITC, medical research.

**Finland**

In 2006 a national strategy was adopted to create Strategic Centres of Excellence in Science Technology and Innovation (CSTI) – international high-level centres in fields that are crucial to the future of the Finnish business sector and society. The operation of the clusters draws on strong commitment from businesses, universities, research institutes and funding organisations. Priority is to be given to thematic areas: energy and environment; metal products and mechanical engineering; forestry cluster; health and wellbeing; information and communication industry and services.

**France**

In France, the 2006 Law on Research established the possibility for higher education institutions and research centres to combine their activities and resources in two formats:

- research and Higher Education Clusters, which have the aim of gathering top class partners on a common physical location to enable them to cooperate in a more integrated way. Their legal form can be flexible and their status and activities are not limited in time.
- thematic Advanced Research Networks (TARN), a scheme for supporting research and higher education actors who decide to engage in a specific scientific project, in one or more scientific areas, and whose quality and international visibility give them global scope. These networks will have the dedicated status of Foundations for Scientific Cooperation, in order to give them the necessary flexibility and ability to respond in the context of international competition.

**Germany**

The Initiative for Excellence was launched in 2005 to improve the quality of academic research with a substantial budget. It has three dimensions:

- the creation of Research Schools for young scientists providing structured PhD programmes within an excellent research environment and a broad area of science;
- the creation of Excellence Clusters in cooperation with non-university research institutions, universities of applied science and industry;
- the funding of up to ten selected universities under the heading of 'Future concepts for top class research at universities'; each selected institution should have at least one excellence cluster, one research school and an overall strategy for becoming an internationally recognised 'beacon of science'.

This programme will run until 2011 and is 75% government funded. Universities submit their applications, which are then evaluated by an independent international jury. In 2008, the German Research Foundation and the Science Council presented a joint position paper on further development beyond 2011, assessing the interim results positively and arguing for continuation along the existing lines with increased funding.

## 1.3. How well do European public research institutions perform?

To answer the question of how far European research institutions achieve worldwide excellence, some groundwork is required on the quantity and quality of public research institutions. As demonstrated in chapter 1.1., a range of public research-performing organisations have a mission to perform basic or applied research. Also, higher education institutions like universities are charged with a mission to perform research and teaching. However, PROs and HEIs are charged with a 'third mission', which includes innovation. In order to assess the performance of European research institutions advancing to excellence in research, a proper assessment has to do justice to these different types of mission. However, the statistical base, and even research on these issues is lacking and current indicators do not allow a systematic comparison across countries. In particular, data or indicators on innovation are poorly developed, as are those on technical performance, patenting, and other economic performance indicators[201].

The present section provides an overview of the current international ranking systems of research institutions. It also analyses excellence of European research institutions based on success rates in Europe-wide funding competitions, in particular the EU research Framework Programme (FP) and grants from the European Research Council (ERC).

### 1.3.1. Performance in major international research ranking systems

Scientific excellence is an undisputed factor of attraction of a university. Rankings and league tables of higher education institutions (HEIs), therefore, mainly relate to scientific excellence. Furthermore, these systems do not measure performance of PROs. According to the International Ranking Expert Group (IREG) of the UNESCO European Centre for Higher Education (UNESCO–CEPES) in Bucharest and the Institute for Higher Education Policy in Washington, DC[202], rankings and league tables should contribute to the definition of 'quality' in higher education institutions within a particular country, complementing the rigorous work conducted in the context of quality assessment and review performed by public and independent accrediting agencies.

Rankings of HEIs have the potential to form the framework of national accountability and quality assurance processes. Therefore, the European Commission has carried out feasibility studies to assess the European HEI landscape in view of the European Research Area (ERA) and the European Higher Education Area (EHA).

***Different types of ranking systems compete worldwide. They are either output oriented or include reputation surveys***

Ranking approaches with the highest attention are:

- Academic Ranking of World Class Universities (ARWU) Shanghai Jiaotong University, since 2003;
- Times Higher Education World University Rankings (THE), since 2004;
- The Leiden Ranking, Centre for Science and Technology Studies (CWTS), Leiden University, since 2008;
- Webometrics, since 2008, Consejo Superior de Investigación Científica (CSIC) in Spain.

The most cited ranking systems in Europe are the ARWU Shanghai Jiao Tong Academic Ranking of World Universities (Shanghai) and the Times World University Ranking (THE). Both rely on a combination of objective science output and subjective assessments (opinions on reputation) of universities .

***Scientific output elements are gaining increasing importance in ranking systems***

The purely output oriented ranking system is based exclusively on peer reviewed international journals (the Leiden Ranking). This ranking focuses on universities worldwide with more than 700 Web of Science indexed publications per year[203]. The fourth ranking system

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[201] An interesting analysis at national level is made in the Norwegian Science and Technology indicators report 2009, www.forskningsradet.no/indikatorrapporten.

[202] IREG established a set of principles of quality and good practice in HEI rankings – the Berlin Principles on Ranking of Higher Education Institutions (Berlin, 18 to 20 May, 2006) http://www.che.de/downloads/Berlin_Principles_IREG_534.pdf.

[203] About 1 000 of the largest (in terms of number of publications) universities in the world are covered. The bibliometric analysis is based on the scientific output of many hundreds of active researchers in each of these universities.

counts web-publications and web-links measuring attractiveness (the Webometric ranking made by CSIC in Spain)[204]. It covers the most recent tool of academic communication and indicates the forefront of timely distribution of information.

### Fewer European universities are ranked among world top 100 in 2010 than in 2005

The table below shows that all four ranking systems confirm the dominance of the US universities in the top 10 class. Europe accounts for 20–30% of the top 10 universities, while the rest are mainly in the United States.

When considering a broader sample of universities – the top 100 in the world – a more differentiated picture emerges, although the lead of US universities remains. While THE and ARWU present roughly similar results in respect of the 2010 US advantage over Europe[205] and Asia, the Leiden CWTS ranking provides a slightly more positive assessment of European and Asian universities. However, Webometrics shows a clear lead by US universities in the use of electronic publication and visibility-attractiveness on the web, indicating that, according to these criteria, the EU gap is much larger. When comparing the rankings of 2005 with those of 2010, the most striking finding is that there are fewer European universities among the top 100 in 2010. This is a clear trend in all ranking systems. The presence of top European universities has fallen 6–20% (depending on the ranking system), while more Asian universities are represented in the top 100, according to some ranking systems.

### TABLE II.1.10 Distribution of the top 10 universities in the world according to four academic ranking systems, 2005 and 2010

| Ranking | Europe | | United States | | Asia | | Others | |
|---|---|---|---|---|---|---|---|---|
| | 2005 | 2010 | 2005 | 2010 | 2005 | 2010 | 2005 | 2010 |
| Shanghai | 2 | 2 | 8 | 8 | 0 | 0 | 0 | 0 |
| Times | 3 | 3 | 7 | 7 | 0 | 0 | 0 | 0 |
| CWTS Leiden | 1(1) | 2 | 6(1) | 6 | 2(1) | 1 | 1(1) | 1 |
| WEBOMETRICS | 0 | 0 | 10 | 10 | 0 | 0 | 0 | 0 |

*Source:* DG Research and Innovation
*Note:* (1) 2003-2007

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[204] Web indicators are useful for ranking purposes insofar as they show the global performance and visibility of the universities. The Web research links covers formal (e-journals, repositories) as well as informal scholarly communication. Web indicator-based ranking reflects a broad picture of activities, as many professors and researchers support their intellectual activities with a web presence. The ranking exercises of universities reflect research intensity, the publication of research results and the value of esteem of the publication based on visibility on the Web.

[205] In the THE ranking, the United States increased from 31 to 54 over 5 years, mainly due to a change in the calculation base – a reduction of reputational factors in the 2010 survey.

## TABLE II.1.11 Distribution of the top 100 universities in the world according to four academic ranking systems, 2005 and 2010

| Ranking | Europe | | United States | | Asia | | Others | |
|---|---|---|---|---|---|---|---|---|
| | 2005 | 2010 | 2005 | 2010 | 2005 | 2010 | 2005 | 2010 |
| Shanghai | 35 | 33 | 57 | 55 | 8 | 5 | 0 | 7 |
| Times | 33 | 29 | 31 | 54 | 15 | 10 | 21 | 7 |
| CWTS Leiden | 33 (1) | 33 | 42 (1) | 42 | 14 (1) | 15 | 11 (1) | 10 |
| WEBOMETRICS | 21 | 16 | 72 | 70 | 2 | 3 | 5 | 11 |

*Source:* DG Research and Innovation
*Note:* (1) 2003-2007

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* The values for CWTS Leiden the 100 and the 250 largest universities worldwide for the period 2003-2007
*Source:* http://www.universityrankings.ch/fr/methodology/leiden
http://www.cwts.nl/ranking/world_100_yellow.html

### 1.3.2. Performance in Europe-wide competitive funding as a measurement of excellence

The ranking systems presented above provide worldwide ranking at institutional level. However, their main weaknesses consist in their exclusive focus on higher education institutions, and the predominance of science over technology performance. The concept of excellence in research and innovation is complex, and data availability to fully assess the 'excellence' of an institution or an individual researcher is poor. However, from a ERA point of view, an interesting hypothesis suggests that the success of research institutions in Europe-wide competition for funding would present a proxy for excellence. Such an approach could not assess worldwide performance of research institutions, but it would have the advantage of including not only Higher Education Institutions, but also public research-performing organisations as well as private research institutions. Another advantage is that both scientific and technological performance would be considered when assessing excellence.

Research institutions and research teams can compete for an increasing amount of research funding available in an open and transparent way at European level. The research Framework Programme (FP) of the European Union is, by volume, the biggest research funder in Europe. The EU research Framework Programme applies competitive procedures with independent and impartial evaluation performed by international experts. Given this profile and scope, the success rates for participation in the Framework Programme are an interesting indicator measuring the ability to participate, and the quality or even excellence of research institutions in Europe. As part of the FP funding, the grant allocation by the European Research Council may be conceived of as an assessment mechanism for scientific research excellence in Europe. The success rates in the FP vary between the various specific fields, but in general the higher the competition, the lower the success rate. On average, the success rate in FP7 is around 25%, meaning that the FP is highly selective[206].

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[206] The commonly accepted success rate of funding programmes is on average 30-33%.

However, there are arguments against the approach of measuring excellence by success rates in the FP programmes. Some arguments focus on the population and the incentives. These arguments state that despite the economic incentives offered by the EU Framework Programme, the administrative burden for the application and execution phase may discourage many good research teams. Another argument is that research institutions active in a country with large amount of public research grant funding available (often larger countries) have a lower incentive to invest in the higher risk of an application at the EU level. Other arguments would point at the conditions for success. These arguments see high probability of success in the EU Framework Programme as less based on scientific or technological excellence, than on size and capital (as the risk of failure has to be overcome), or in the capacity to accumulate knowledge in application procedures and its networking ability. These arguments do not discard the interest in a ranking based on success in open Europe-wide competition, but they do call for a certain analytical precaution and warn against overly comprehensive interpretations. In order to assess the FP ranking approach, this section starts with an analysis comparing the success rates of research institutions in the Framework Programme with the existing world ranking of research performance of European universities.

### *There is a certain - but not absolutely clear - correlation between research universities with high scientific output rankings and top participants in FP7*

The analysis of top research universities in Europe according to participation rate in the Framework Programme, reveals that the 171 universities identified by the methodology of peer-reviewed journals[207] have also participated intensively in the FP7. The data also shows that these universities have taken part in the lion's share of the FP7 funding (60% of all the funds to HEIs). The 171 research universities provide most of the participants in collaborative projects (58% of the HEI participants), and they are also central actors in the resulting networks. Their high success rate in FP6 instruments, such as Networks of Excellence (NOE) and Integrated Projects (IP) indicate that they are key players in structuring and coordinating the European Research Area. Moreover, research output and research visibility are the key determinants for the top research universities, and this was an important motivating factor in participation in FP6[208]. A comparison between high output of academic production and the success of universities in projects in FP7, also shows a clear positive relation. The figure below compares the output-based Leiden ranking and the success in grants for FP7 research projects. Strong deviations in the list of the twenty first ranked universities are only given by four universities (Rotterdam, Lausanne, Basel and Munich).

The figure below, relating the top 100 European universities in the Leiden ranking to the number of participation in the FP7, show a positive correlation, although many universities have a different pattern. However, focusing on the FP7 funding, the correlation is even clearer. The amount of EC contributions from FP7 shows a high correlation (correlation coefficient of 0.67) between the two rankings, in particular for the top 30 universities. Among the 100 top universities in the Leiden ranking, the first ranked universities are also those that have received the largest EC contributions from FP7. However, it must be noted that the FP success rate in terms of participation or received EC financial contributions is size-dependent, unlike the Leiden ranking. If a Leiden high-ranked university is relatively modest in size, it is less likely to rank as high in terms of participation or received FP funding. Vice-versa, a very large lower-ranked university in the Leiden ranking might have a higher FP rank due to advantages associated with size.

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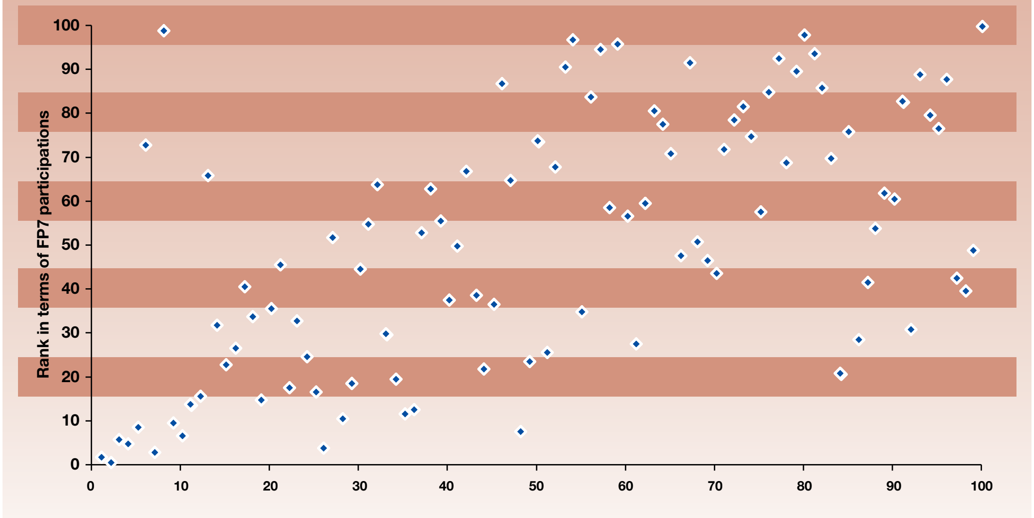
[207] See section 1.1.2. of this chapter.

[208] Henriques, L., Schoen, A., Pontikakis, D, 2009, "Europe's top research universities in FP6: scope and drivers of participation", JRC Technical Notes 24006 http://ftp.jrc.es/EURdoc/JRC53681_TN.pdf Additional evidence on FP6 are found in Henriques, L. and Veltri, G.: "University participation in EU Framework Programme: centrality and excellence", December 2010, Seville, Draft.

## FIGURE II.1.10 The top 100 universities in terms of FP7 participations (ranked) versus their 2008 Leiden rankings[1]



Leiden rank, 2008 [1]

*Source*: DG Research and Innovation
*Data*: DG Research and Innovation
*Note*: (1) The 2008 Leiden ranking by size-independent, field-normalized average impact.

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A comparison of the four different ranking approaches[209] gives the following picture for European universities:

- The rank deviations stay in reasonable variations for the majority of universities, with exceptions that could be explained by structural factors.
- Subjective assessments based on surveys for reputation of universities have a stronger bias on rankings in relation to the FP ranking than those ranking systems based on output indicators.

### *International competitive performance in FP7 displays the top 100 European research universities*

The table below on FP7 '*participation and university ranking*' displays the hundred best performing universities in Europe in FP7. The table also compares results of FP7 rankings with three other ranking systems: the Leiden Ranking (CWRS), the Webometrics ranking and the Times Higher Education ranking (THE). The highest number of universities among the top 100 universities in the FP is situated in Germany (26), the United Kingdom (17) and the Netherlands (10). These three countries cover more than half of the ranks; 13 Member States are not represented at all under the first 100. The first 50 ranks are also taken by the same three countries. However, in the first fifty ranks, the United Kingdom leads clearly (14), followed by the Netherlands (7) with Germany in third place (5). Compared to the size of the country, Belgium (4), Switzerland (4), Sweden (4) and Denmark (3) are doing extremely well.

---

[209] The 'Shanghai (ARWU) ranking' allows comparisons only for the first 50 ranks as the following ones are grouped to ranking classes.

## TABLE II.1.12 FP7 participation and university ranking

| FP7 participation rank | University | Country | Leiden rank 2008 | Deviation | Webometrics rank[1] 2010 | Deviation | THE rank 2008 | Deviation |
|---|---|---|---|---|---|---|---|---|
| 1 | Univ Cambridge | UK | 2 | -1 | 1 | 0 | 1 | 0 |
| 2 | Univ Oxford | UK | 1 | 1 | 3 | -1 | 4 | -2 |
| 3 | Imperial Coll London | UK | 7 | -4 | 83 | -80 | 3 | 0 |
| 4 | Katholieke Univ Leuven | BE | 26 | -22 | 44 | -40 | 21 | -17 |
| 5 | Eth Zurich | CH | 4 | 1 | 2 | 3 | 6 | -1 |
| 6 | Ecole Polytecn Federale Lausanne | CH | 3 | 3 | 10 | -4 | 12 | -6 |
| 7 | Univ Coll London | UK | 10 | -3 | 8 | -1 | 2 | 5 |
| 8 | Univ Manchester | UK | 48 | -40 | 100 (273) | -92 | 8 | 0 |
| 9 | Tech Univ Denmark | DK | 5 | 4 | (280) |  | 64 | -55 |
| 10 | Univ Edinburgh | UK | 9 | 1 | 4 | 6 | 5 | 5 |
| 11 | Karolinska Inst Stockholm | SE | 28 | -17 | (495) |  | Not listed | - |
| 12 | Kobenhavns Univ | DK | 35 | -23 | 49 | -37 | 15 | -3 |
| 13 | Lunds Univ | SE | 36 | -23 | 57 | -44 | 23 | -10 |
| 14 | Delft Univ Technol | NL | 11 | 3 | 48 | -34 | 31 | -17 |
| 15 | Univ Utrecht | NL | 19 | -4 | 15 | 0 | 25 | -10 |
| 16 | Univ Helsinki | FI | 12 | 4 | 6 | 10 | 42 | -26 |
| 17 | Univ Southampton | UK | 25 | -8 | 12 | 5 | 37 | -20 |
| 18 | Univ Sheffield | UK | 22 | -4 | 80 | -62 | 30 | -12 |
| 19 | Wageningen Univ | NL | 29 | -10 | (284) |  | 61 | -42 |
| 20 | Univ Nottingham | UK | 34 | -14 | (304) |  | 34 | -14 |
| 21 | Univ Bologna | IT | 84 | -63 | 13 | 8 | 72 | -51 |
| 22 | Uppsala Univ | SE | 44 | -22 | 28 | -6 | 28 | -6 |
| 23 | Vrije Univ Amsterdam | NL | 15 | 8 | (287) |  | 67 | -44 |
| 24 | Univ Gent | BE | 49 | -25 | (291) |  | 54 | -30 |
| 25 | Univ Catholique Louvain | BE | 24 | 1 | 17 | 8 | 49 | -24 |
| 26 | Univ Newcastle Upon Tyne | UK | 51 | -25 | 43 | -17 | 63 | -37 |

| FP7 participation rank | University | Country | Leiden rank 2008 | Deviation | Webometrics rank(1) 2010 | Deviation | THE rank 2008 | Deviation |
|---|---|---|---|---|---|---|---|---|
| 27 | Univ Zurich | CH | 16 | 11 | (408) |  | 35 | -8 |
| 28 | Univ Aachen (Rwth) | DE | 61 | -33 | 64 | -36 | 76 | -48 |
| 29 | Tech Univ Dresden | DE | 86 | -57 | 69 | -40 | 124 | -95 |
| 30 | Aarhus Univ | DK | 33 | -3 | 84 | -54 | 20 | 10 |
| 31 | Univ Roma Sapienza | IT | 92 | -61 | 62 | -31 | 88 | -57 |
| 32 | Univ Geneve | CH | 14 | 18 | 11 | 21 | 27 | 5 |
| 33 | Kings Coll Univ London | UK | 23 | 10 | (334) |  | 7 | 26 |
| 34 | Univ Amsterdam | NL | 18 | 16 | 23 | 11 | 14 | 20 |
| 35 | Univ Libre Bruxelles | BE | 55 | -20 | 47 | -12 | 80 | -45 |
| 36 | Univ Bristol | UK | 20 | 16 | 65 | -29 | 10 | 26 |
| 37 | Lmu Univ Munchen | DE | 45 | -8 | 18 | 19 | 38 | -1 |
| 38 | Radboud Univ Nijmegen | NL | 40 | -2 | (478) |  | 98 | -60 |
| 39 | Univ Leeds | UK | 43 | -4 | 40 | -1 | 39 | 0 |
| 40 | Natl & Kapodistrian Univ Athens | EL | 98 | -58 | (481) |  | 178 | -138 |
| 41 | Tech Univ Munchen | DE | 17 | 24 | 59 | -18 | 16 | 25 |
| 42 | Univ Padova | IT | 87 | -45 | 89 | -47 | 137 | -95 |
| 43 | Aristotle Univ Thessaloniki | EL | 97 | -54 | (371) |  | 200 | -157 |
| 44 | Univ Barcelona | ES | 70 | -26 | 67 | -23 | 71 | -27 |
| 45 | Univ Groningen | NL | 30 | 15 | 27 | 18 | 56 | -11 |
| 46 | Univ Glasgow | UK | 21 | 25 | 30 | 16 | 29 | 17 |
| 47 | Ek Univ Tubingen | DE | 69 | -22 | 66 | -19 | 60 | -13 |
| 48 | Polytechnic Univ Milano | IT | 66 | -18 | (284) |  | 126 | -78 |
| 49 | Charles Univ Prague | CZ | 99 | -50 | 26 | 23 | 101 | -52 |
| 50 | Goteborg Univ | SE | 41 | 9 | 88 | -38 | 78 | -28 |
| 51 | Univ Autonoma Barcelona | ES | 68 | -17 | 95 | -44 | 92 | -41 |
| 52 | Leiden Univ | NL | 27 | 25 | (313) |  | 19 | 33 |
| 53 | Univ Birmingham | UK | 37 | 16 | 91 | -38 | 22 | 31 |

| FP7 participation rank | University | Country | Leiden rank 2008 | Deviation | Webometrics rank(1) 2010 | Deviation | THE rank 2008 | Deviation |
|---|---|---|---|---|---|---|---|---|
| 54 | Univ Firenze | IT | 88 | -34 | 90 | -36 | 169 | -115 |
| 55 | Univ Maastricht | NL | 31 | 24 | (688) | | 45 | 10 |
| 56 | Univ Oslo | NO | 39 | 17 | 5 | 51 | 40 | 16 |
| 57 | Univ Liverpool | UK | 60 | -3 | (415) | | 55 | 2 |
| 58 | Univ Wien | AT | 75 | -17 | 9 | 49 | 52 | 6 |
| 59 | Univ Paris VI P&M Curie | FR | 58 | 1 | 14 | 45 | 46 | 13 |
| 60 | Univ Wales Cardiff | UK | 62 | -2 | (424) | | 53 | 7 |
| 61 | Univ Napoli Federico II | IT | 90 | -29 | (374) | | Not listed | - |
| 62 | Univ Pisa | IT | 89 | -27 | 39 | 23 | 143 | -81 |
| 63 | Univ Heidelberg | DE | 38 | 25 | 19 | 44 | 17 | 46 |
| 64 | Joh Wolfg Goethe Univ Frankfort | DE | 32 | 32 | 78 | -14 | 103 | -39 |
| 65 | Univ Bern | CH | 47 | 18 | 97 | -32 | 82 | -17 |
| 66 | Univ Basel | CH | 13 | 53 | (362) | | 42 | 24 |
| 67 | Univ Freiburg | DE | 42 | 25 | 42 | 25 | 48 | 19 |
| 68 | Friedrich Alexander Univ Erlangen | DE | 52 | 16 | 74 | -6 | 140 | -72 |
| 69 | Univ Munster | DE | 78 | -9 | 38 | 31 | 178 | -109 |
| 70 | Univ Genova | IT | 83 | -13 | (391) | | Not listed | - |
| 71 | Univ Ulm | DE | 65 | 6 | (367) | | 122 | -51 |
| 72 | Rfw Univ Bonn | DE | 71 | 1 | 51 | 21 | 105 | -33 |
| 73 | Univ Lausanne | CH | 6 | 67 | (321) | | 69 | 4 |
| 74 | Univ Hamburg | DE | 50 | 24 | 29 | 45 | 118 | -44 |
| 75 | Univ Autonoma Madrid | ES | 74 | 1 | (351) | | 94 | -19 |
| 76 | Univ Koln | DE | 85 | -9 | 46 | 30 | 132 | -56 |
| 77 | Friedrich Schiller Univ Jena | DE | 95 | -18 | (353) | | 185 | -108 |
| 78 | Univ Grenoble I Joseph Fourier | FR | 64 | 14 | (373) | | 124 | -46 |
| 79 | Univ Valencia | ES | 72 | 7 | 63 | 16 | 192 | -113 |
| 80 | Univ Complutense Madrid | ES | 94 | -14 | 32 | 48 | 108 | -28 |
| 81 | Bjm Univ Wurzburg | DE | 63 | 18 | (410) | | 136 | -55 |

| FP7 participation rank | University | Country | Leiden rank 2008 | Deviation | Webometrics rank$^{(1)}$ 2010 | Deviation | THE rank 2008 | Deviation |
|---|---|---|---|---|---|---|---|---|
| 82 | Polytechnic Univ Torino | IT | 73 | 9 | (275) | | 198 | -116 |
| 83 | Ruhr Univ Bochum | DE | 91 | -8 | (314) | | 185 | -102 |
| 84 | Univ Paris XI Sud | FR | 56 | 28 | (421) | | 97 | -13 |
| 85 | Freie Univ Berlin | DE | 76 | 9 | 16 | 69 | 36 | 49 |
| 86 | Ga Univ Gottingen | DE | 82 | 4 | (316) | | 79 | 7 |
| 87 | Jg Univ Mainz | DE | 46 | 41 | (284) | | 149 | -62 |
| 88 | Univ Leipzig | DE | 96 | -8 | 25 | 63 | 147 | -59 |
| 89 | Univ Aix Marseille II Mediterranee | FR | 93 | -4 | - | | Not listed | - |
| 90 | Univ Duisburg Essen | DE | 79 | 11 | - | | Not listed | - |
| 91 | Heinrich Heine Univ Dusseldorf | DE | 53 | 38 | (331) | | 144 | -53 |
| 92 | Christian Albrechts Univ Kiel | DE | 67 | 25 | (344) | | 196 | -104 |
| 93 | Univ Lyon I Claude Bernard | FR | 77 | 16 | (281) | | 187 | -94 |
| 94 | Univ Toulouse III | FR | 81 | 13 | (561) | | 167 | -73 |
| 95 | Univ Paris VII Denis Diderot | FR | 57 | 38 | - | | 152 | -57 |
| 96 | Humboldt Univ Berlin | DE | 59 | 37 | 21 | 75 | 59 | 37 |
| 97 | Univ Paris V Rene Descartes | FR | 54 | 43 | (282) | | 165 | -68 |
| 98 | Univ Marburg | DE | 80 | 18 | 99 | -1 | 159 | -61 |
| 99 | Erasmus Univ Rotterdam | NL | 8 | 91 | (678) | | 42 | 57 |
| 100 | Moscow Mv Lomonosov State Univ | RU | 100 | 0 | 71 | 29 | 61 | 39 |

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*Source:* DG Research and Innovation
*Data:* DG Research and Innovation, CWTS Leiden, CSIC, Times Higher-Education ranking
*Note :* (1) The values in brackets for Webometrics refer to the world rank. Webometrics ranks 12000 higher education institutions. The Webometrics European rankings cover the first hundred European universities in the world rankings (up to world rank 273).

### *Non-university public research organisations are performing slightly better than the HEIs in FP6*

Success rates in Europe-wide competitive funding (as measured by participation in the European research FP programme) constitute a comparative measuring stick of research performance assessment of the two types of public research institution in Europe (HEI and PRO). The shares of the two types of institution reveal a stronger role for PROs in FP6 in comparison to their national weight – such as share of national budgets received.

The reasons for the higher success rate of PROs may be that the FP is more strongly oriented towards applied research and technology development than to basic research, which may favour higher participation rates of PROs than universities. Another possible reason may be that PROs have better administrative capabilities to participate in competition, because they rely to a higher extent on competitive funding than HEIs. PROs are also comparatively well organised in international associations like EARTO, EuroHORCs, ESF, ALLEA or EASAC[210], although European network organisations also exist among universities. However, the higher success rates of PROs in Europe-wide competitive funding could simply be an indication of the very high performance quality of many PROs in Europe.

TABLE II.1.13 **Participation and funding of Public Research performing Organizations (PROs) and Higher Education Institutions (HEIs) in FP6**

| | Participations | | | Budget | | |
|---|---|---|---|---|---|---|
| | Total | % of FP6 | % of PROs+HEIs | Total | % of FP6 | % of PROs+HEIs |
| PROs (all countries) | 22 510 | 30.4 | 45.6 | 5 093 455 968 | 30.6 | 44.8 |
| HEIs (all countries) | 26 826 | 36.2 | 54.4 | 6 264 618 165 | 37.6 | 55.2 |
| Total PROs + HEIs | 49 336 | 66.5 | 100 | 11 358 074 133 | 68.2 | 100 |
| Total FP6 | 74 137 | - | - | 16 665 265 137 | - | - |

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*Source:* DG Research and Innovation
*Data:* DG Research and Innovation

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[210] Associations include RTOs – the Research and Technology Organisations as a subcategory of PROs. The membership of these associations is quite diverse. There are several organisations bringing RTOs together: EARTO (350 RTOs), EuroHORCs (19 RTOs from 6 countries), ALLEA (3 RTOS) and TAFTIE; from this it can be concluded that over 50% of the RTOs are not participating in any association . There are 2 organisations bringing funders together: EuroHORCs (23 funders) and TAFTIE (20 funders). There are also organisations bringing universities together: e.g. UEA (800 higher education institutes) and LERU (20 research-intensive universities); There are a large number of academic societies bringing scientists together, often by thematic area; there are also associations of academies like ALLEA and EASAC – including a small number of academies that are also RTOs – which are not discipline oriented.

### 1.3.4 ERC and academic excellence

The European Research Council (ERC) is striving for scientific excellence in Europe and worldwide. It is an inclusive institution that seeks excellence irrespective of nationality, gender, or location. It monitors the demographics of its applicants and grantees to optimise procedures for equitable treatment. ERC grant winners and the institutions that host them can be considered excellent scientific performers in Europe.

***The success rate at the European Research Council is becoming a prime assessment mechanism for scientific research excellence in Europe for both universities and PROs***

ERC grants are addressed to individual researchers. Over time, accumulated data on grant winners shows the performance of individual countries, regions, and institutions. After six competitions and more than a thousand grant winners, a pattern of excellence of institutions emerges as a picture of the geographical distribution of institutions hosting ERC grantees across Europe. However, just as with the data on Framework Programme participation, the success rates in ERC are not size-independent, an important consideration in assessing the excellence of both the individual institutions and the country presence.

If we consider the 1762 grants allocated in the six calls and the research institutions that receive ten or more grants, the numbers show a concentration in 41 institutions. These institutions host 796 grantees or 45.2%% of the total. The concentration is even higher in the first 10 institutions, which host 389 grantees or 22.1% of the total.

***In absolute terms, Research institutions in the United Kingdom, France, and Germany have received most ERC grants. However, individual grant winners at these institutions may come from other countries.***

Dominantly, host institutions of grantees are universities. Out of the 41 institutions which have ten or more grantees, 28 are universities and 13 are PROs. However, the higher the rank or the more grantees received per institution, the larger the share of PROs. The CNRS (F) is the clear leader with 96 grantees. Among the first 20 institutions, universities are slightly more present than PROs (by a ratio 11:9). This picture is reversed if the grantees are counted.

Overall, the United Kingdom is the country accounting for the most excellent research organisations concentrated in universities. France is the second country in terms of overall grants. Contrary to a tradition of concentrating research in universities in the United Kingdom, no university ranks high in France. Strong concentrations of ERC grants in France have gone to CNRS or PROs like INSERM, CEA, INRIA, and the Pasteur Institute. Other European countries showing high excellence in several of their non-university research organisations are Germany, Switzerland, the Netherlands, Italy, Spain, Israel, and Sweden.

When assessing the excellence based on individual researchers, i.e. grant winners, some countries like Germany, Italy, Greece, Austria, and Poland are better situated than when their research institutions are assessed in terms of ERC grants. A higher proportion of top researchers of these countries have chosen a host institution in another European country[211]. This may indicate a slight mismatch between the excellence of the individual researcher and the excellence of the research organisations in these countries and the importance of mobility in the European Research Area.

***Scientific excellence of research institutions is not equal to scientific excellence of researchers***

One aspect in this context is the level of research funding. The grant distribution reflects the reality of unevenly distributed national R&D investments across Europe. Regions that systematically invest strongly in their own R&D systems benefit by creating research environments that breed and attract excellent investigators. There is a strong correspondence between national investments in R&D and success in the ERC grants. The EU-12 collectively invests 2.4% of EU-27 funds in R&D and receives 4% of the ERC grants hosted by EU-27 countries. Conversely, the EU-15 collectively invests 97.6% of EU-27 funds in

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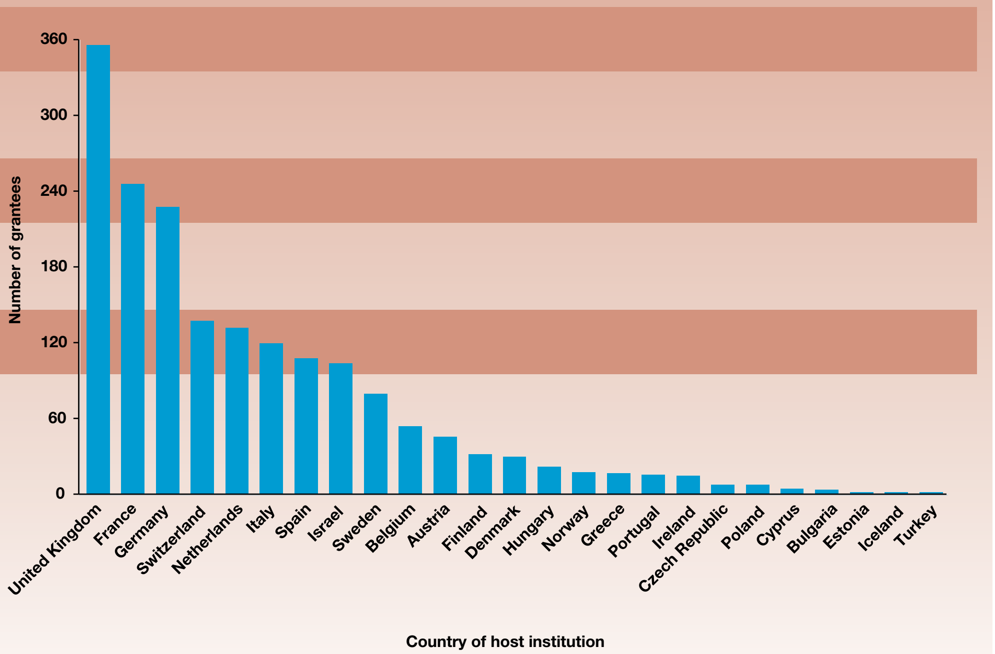
[211] Since this is also an aspect of transnational mobility patterns of researchers, see also Part II, chapter 5 for a more comprehensive analysis of researchers' mobility.

## TABLE II.1.14 Research institutions with 10 or more European Research Council (ERC) grantees

| Rank | Host institution | Starting grants | Advanced grants | Total |
|---|---|---|---|---|
| 1 | National Centre for Scientific Research (CNRS) | 62 | 34 | 96 |
| 2 | University of Cambridge | 25 | 22 | 47 |
| 3 | Max Planck Society | 22 | 22 | 44 |
| 4 | University of Oxford | 22 | 21 | 43 |
| 5 | Swiss Federal Institute of Technology of Lausanne (EPFL) | 19 | 20 | 39 |
| 6 | Hebrew University of Jerusalem | 20 | 13 | 33 |
| 7 | Swiss Federal Institute of Technology (ETH Zurich) | 9 | 23 | 32 |
| 8 | Weizmann Institute | 15 | 17 | 32 |
| 9 | Imperial College | 14 | 14 | 28 |
| 10 | University College London | 14 | 13 | 27 |
| 11 | National Institute for health and medical research (INSERM) | 14 | 10 | 24 |
| 12 | Commission for Atomic Energy (CEA) | 15 | 5 | 20 |
| 13 | University of Edinburgh | 10 | 8 | 18 |
| 14 | University of Zurich | 8 | 10 | 18 |
| 15 | Catholic University of Leuven | 15 | 2 | 17 |
| 16 | Technion - Israel Institute of Technology | 14 | 3 | 17 |
| 17 | Karolinska Institute | 8 | 8 | 16 |
| 18 | Ludwig Maximillian University Munich | 6 | 10 | 16 |
| 19 | University of Helsinki | 7 | 9 | 16 |
| 20 | Leiden University | 7 | 7 | 14 |
| 21 | National Institute for Research in Computer Science and Control (INRIA) | 8 | 6 | 14 |
| 22 | University Amsterdam | 8 | 6 | 14 |
| 23 | University of Bristol | 5 | 9 | 14 |
| 24 | University of Vienna | 6 | 8 | 14 |
| 25 | Free University of Amsterdam | 10 | 3 | 13 |
| 26 | Radboud University Nijmegen | 9 | 4 | 13 |
| 27 | Utrecht University | 8 | 5 | 13 |
| 28 | Medical Research Council | 6 | 6 | 12 |
| 29 | University of Amsterdam | 5 | 7 | 12 |
| 30 | University of Geneva | 4 | 8 | 12 |
| 31 | Aarhus University | 6 | 5 | 11 |
| 32 | Ghent University | 10 | 1 | 11 |
| 33 | Lund University | 5 | 6 | 11 |
| 34 | Pasteur Institute | 7 | 4 | 11 |
| 35 | University of Heidelberg | 8 | 3 | 11 |
| 36 | Stockholm University | 6 | 5 | 11 |
| 37 | Cancer Research UK | 3 | 7 | 10 |
| 38 | National Research Council (CNR) | 10 | 0 | 10 |
| 39 | Technical University Munich | 5 | 5 | 10 |
| 40 | University of Copenhagen | 6 | 4 | 10 |
| 41 | University of Groningen | 9 | 1 | 10 |

*Source:* DG Research and Innovation
*Data:* European Research Council (ERC)

FIGURE II.1.11 **European Research Council (ERC) grants by host country, 2007-2010**(1)



*Source*: DG Research and Innovation
*Data*: European Research Council (ERC)
*Note*: (1) Starting grants: 2007, 2009, 2010; Advanced grants: 2008, 2009, 2010.

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R&D and reaps 96% of ERC grants in EU-27 host institutions. Countries investing less in their R&D capacity are less attractive to foreign recruitment and may suffer repatriation of their nationals (e.g., Greece, Poland and Turkey all invest around 0.6% of their GDP in R&D and have large fractions of their nationals hosted in other European countries)[212].

Figure II.1.13 shows the balance of non-national to national-grantees in research institutions in terms of absolute number of ERC grant holders. The balance shows that the United Kingdom harvests the largest number of grantees that do not have UK citizenship, followed by Switzerland and France. On the contrary, Germany, Italy and Greece have a strong negative balance by sending out more excellent researchers than they receive in their own institutions.

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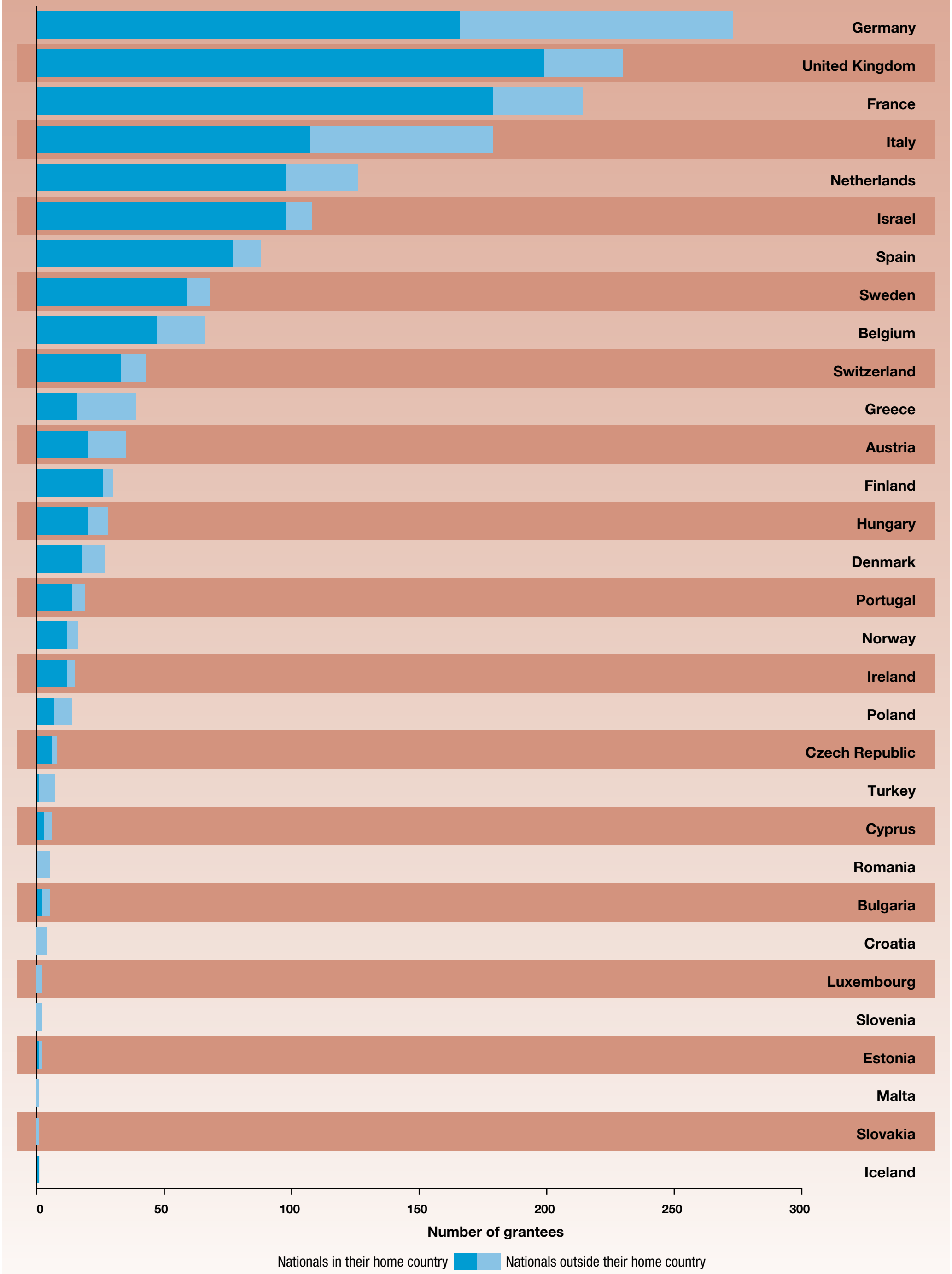
[212] M. Antonoyiannakis, J. Hemmelskamp, and F. C. Kafatos: The European Research Council Takes Flight, in: Cell 136, Elsevier Inc. 2009.

## FIGURE II.1.12 Nationality of European Research Council (ERC) grantees, 2007-2010[(1)]



*Source*: DG Research and Innovation
*Data*: European Research Council (ERC)
*Note*: (1) Starting grants: 2007, 2009, 2010; Advanced grants: 2008, 2009, 2010.

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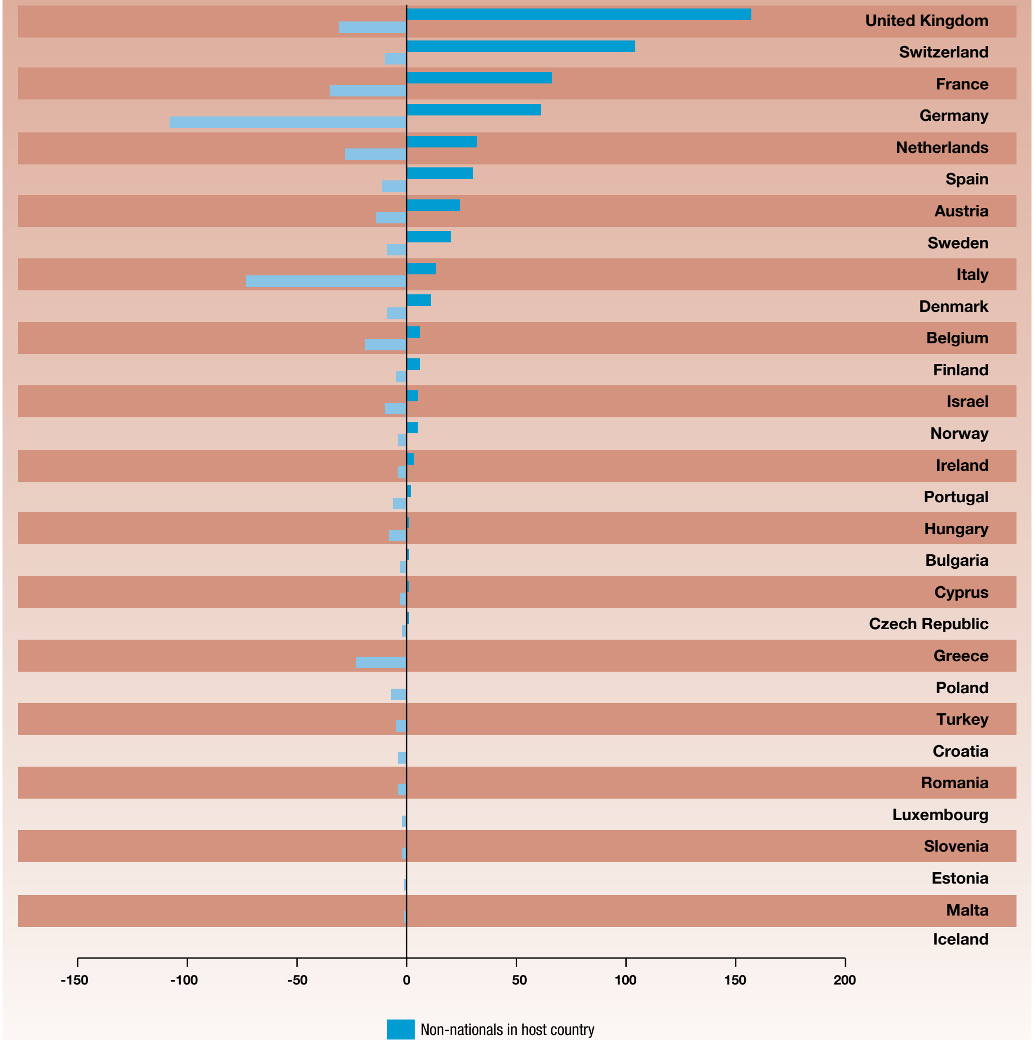
FIGURE II.1.13 International mobility of European Research Council (ERC) grant holders, 2007-2010(1)



*Source*: DG Research and Innovation
*Data*: European Research Council (ERC)
*Note*: (1) Starting grants: 2007, 2009, 2010; Advanced grants: 2008, 2009, 2010.

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# CHAPTER 2

# Knowledge transfer and public–private cooperation

## HIGHLIGHTS

Over the period 1995-2006, public research institutions increased their patent applications from 834 to 2228 a year filed in the EPO. However, these academic patent applications still represent only 4.1% of the total number of patent applications. Knowledge transfer policies, therefore, focus on enhancing public-private cooperation, cluster creation and knowledge transfer offices or platforms. In this context, knowledge transfer can take different forms: contractual arrangements, collaboration and co-development of R&D, as well as informal flows of information and movement of people between public and private institutions.

Contractual arrangements can be measured by public sector expenditure on R&D financed by business enterprises, normalised by GDP. Over the period 2000-2008, in the EU a slightly growing share of public research has been financed by business enterprises, up from 0.4% of GDP in 2000 to 0.05% in 2008. This funding level is above both the United States (0.02%) and Japan (0.015%). However, considering public-private scientific cooperation, as measured by co-publications, the EU is lagging behind the United States despite good progress in several Member States. In 2008, public-private co-authored scientific articles per million researchers was 70.2 in the United States, compared to only 36.2 in the EU. However, Sweden, Denmark and Finland had public-private co-publication rates of above 100 and Austria achieved the highest growth from a ratio of 36 in 2002 to almost 66 in 2007.

One factor behind the lower public-private scientific cooperation in the EU could be that in general universities and PROs are not the main cooperation partners for innovative firms, except in Finland, Austria and Belgium. Another reason may be the lower size and intensity of researchers in the private sector in Europe, given that public-private cooperation to a large extent is made by people. A recent EU-wide study found that in 2009 only 5-6% of the researchers in the EU had moved back-and forth between public and private sector.

## 2.1. Is knowledge transferred in public–private cooperation?

As described in the previous chapter on public research institutions, the 'third mission' of higher education institutions and public research-performing organisations includes, among other aspects, an IPR management and the commercialisation of scientific and technological outputs. Given the specific structure of the European research system - with a relatively large part of R&D performed by public research institutions – the 'third mission' is even more relevant.

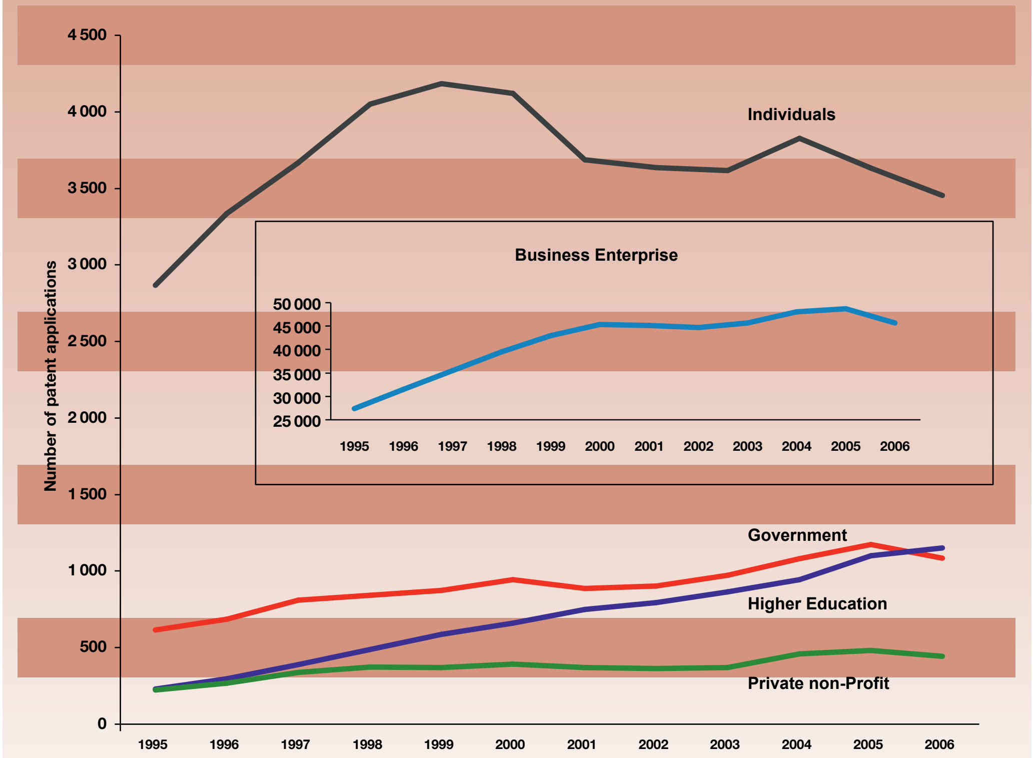
### *The higher education institutions, the public research-performing organisations and the private non-profit organisations have increased their number of patent applications by 9% per year in the last decade, but its overall share of patenting remains very low*

Patenting is one of the most common indicators used to measure the technological output of R&D. Therefore, patent data provides one relevant way to measure if public funds are turned into technologies with potential to be commercialised. Patent statistics now offer the opportunity to collect data on the level of institutions, thereby providing more information on the 'third mission' of public research institutions.

The figure II.2.1. shows that since 1995 the higher education institutions (HEIs) have increased their number of patent applications by five times, from 224 to 1150. Although patents of HEIs still represent a very small share of the total number of EPO patents, this share is growing. In 1995, HEIs patents represented less than 1% of the total EPO patent applications, compared with 2.0% for 2006. Patents applied for by PROs in the EU increased as well, passing from 610 in 1995 to 1078 in 2006, which implies that the share of patents of EU PROs in total EPO patents increased from 1.9% in 1995 to 2.1% in 2006. The graph also illustrates the role of private non-profit organisations, which, even though on a smaller scale (0.9% of total EPO patent applications in 2006), also increased their patent applications, having doubled the value they had for 1995 (passing from 216 to 437).

Individual patents represented 6.8% of EPO patent applications in 2006, government 2.1%, higher education 2.0%, and private non-profit 0.9%. However, 89.9% of patent applications to the EPO were filed by the business sector in 2006. Thus total academic patent applications (or patent application by public sector institutions) still have a very low share (4.1%) in the total number of patent applications. However, patent applications invented in the higher-education and government sectors are more numerous, as a number of inventions by researchers working in universities or public research institutions may then be filed by the individual himself/herself or by a company created for this occasion. Nevertheless, the share of EPO patents filed by public research organisations remains low overall.

FIGURE II.2.1 **EU – EPO patent applications by institutional sector, 1995-2006[(1)]**



*Source*: DG Research and Innovation
*Data*: Eurostat
*Note*: (1) All values for 2006 are provisional.

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## Box II.2.1 – Public support to technology transfer of Higher Education Institutions and of Public Research-performing Organisations*

**Estonia**

The SPINNO programme supports universities and research centres to create a favourable environment for the transfer of knowledge and the commercialisation of the results of R&D activities. This may include the creation and development of a set of administrative rules necessary to regulate business activities and intellectual property, and the development of competences, structures and networks relating to knowledge and technology transfer. Funding is also available for the commercial exploitation of ideas deriving from R&D activities and the opportunities for cooperation with business.

**France**

Technology Platforms (TPs) support and institutionalise the promotion of innovation and technology transfer. This measure is geared both to higher education institutions and SMEs and aims at making the two parties mutually aware and open to cooperation. TPs have three main objectives, organised around SMEs' needs:

- provide resources and competences of higher education institutions, training institutions, but also secondary technical education institutions (vocational high schools) and lifelong-learning professional training organisms, for the benefit of SMEs;
- create a common space for training and technological services;
- develop a network gathering various technology transfer structures.

Only the TPs that have received a certification label in 2007 from the ministry in charge of research can benefit from its financial support. The legal status of a TP is defined on a case-by-case basis; it often takes the form of a Public Interest Group.

**Latvia**

The Ministry of Economy launched a programme providing support for the establishment of technology transfer contact points at research institutions, and since then six technology transfer offices have been set up. The aim of these establishments is to promote cooperation between scientists and entrepreneurs from the private sector, and to encourage the establishment of new high technology companies.

**Portugal**

Since 2001 the GAPI network (Support Offices for Industrial Property Promotion) has located several small offices on university premises, R&D facilities and business associations that provide information and carry out activities relating to the promotion of industrial property. Within universities they have operated as 'technology licensing offices' and they have encouraged patenting.

**Spain**

The 2008–2011 sub-programme in support of the technology transfer function in research organisations offers backing (for up to four years) to Transfer Offices of Research Results (TORRs). Its aim is to encourage the valorisation of knowledge produced by universities and other research organisations, by reinforcing and consolidating TORRs and other similar units.

**The United Kingdom**

The Knowledge Transfer Partnership (KTP) programme involves public research-performing organisations, higher education institutions, companies, graduates, and Further Education Colleges. The aim is to promote collaboration in view of building up successful businesses though technology transfer (among the partners of the projects). Staff from research organisations gain ideas and business support for further research and consultancies, deepening collaboration for developing businesses; higher education institutions are able to apply their wealth of knowledge and expertise to important business problems; recently qualified graduates (known as KTP Associates) are given the opportunity to work in companies managing challenging projects central to the development needs of participating companies.

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*See: ERAWATCH: national profiles – research policies http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.home

The low level of direct commercialisation of scientific output by public research institutions raises the important challenge of knowledge transfer in public–private cooperation. Knowledge transfer can take different forms: e.g. contractual arrangements where public research institutions perform R&D financed by private enterprises, collaboration between public and private R&D performers, informal flows and the circulation of researchers between public and private institutions, teaching and training in IPR management and entrepreneurial skills.

The chapter will present the existing indicators on different aspects of knowledge transfer in public–private cooperation, recognising that each indicator only describes one specific aspect of the more complex reality of public–private cooperation in R&D. However, when placing the indicators side by side, a larger understanding emerges of the Knowledge Transfer performance of different EU Member States and Associated countries.

### *A sign of increasing knowledge transfer in public–private cooperation is the growing share of public research financed by private sector*

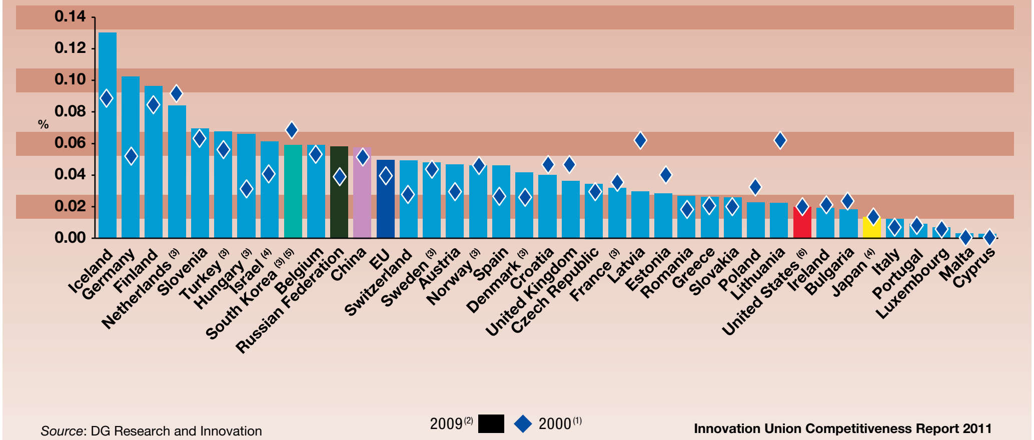
Cooperation between public and private knowledge producers can be partly measured by the share of public sector research financed by business enterprise. Several reasons explain the motivation for the private sector to finance public research: the lack of in-house research capabilities, the interest in diversifying the scope of the firm's activities, the acquisition of external knowledge, the need to use a public research organisation (or a public university) according to rules of national funding programmes, etc. It is important to note that the use of GDP as the common denominator implies a need to refer to the size of the country as well as its economic growth. However, it is difficult to interpret this indicator, since the values also reflect the size and funding structure of public research in each country.

Business enterprise is an increasingly important source of funding for public R&D in the EU, almost 0.05% of GDP in 2008, increasing from 2000 (0.041% of GDP). This is higher than the same funding share in the United States (0.02% of GDP in 2008) or Japan (0.015% of GDP in 2007), as shown in figure II.2.2. The indicator measures contractual cooperation between public and private knowledge producers. Very different situations among the individual Member States and Associated Countries can be observed, with shares of 0.096% for Germany and 0.089% for Finland, the highest among the EU Member States. The intensity of contractual R&D collaboration ranges from 0.13% of GDP in Iceland, to less than 0.005% in Malta and Cyprus. Other countries with a very low share are Luxembourg, Portugal, Ireland and Italy, all below 0.002% of GDP. Among the larger European countries, the intensity of Germany is around three times that of France (with 0.029%) and the United Kingdom (with 0.036%). While Germany clearly increased its public–private cooperation over the period 2000–2008, France and the United Kingdom both registered a significant decrease in values for this indicator over the same period. Other countries showing a significant decrease for the period 2000–2008 are the Netherlands, Latvia, Poland, Estonia, Lithuania and Denmark.

The figure shows that China and South Korea have values slightly above the EU average, but with different trends: the former has been increasing this share, showing in 2007 a value of 0.057% of GDP, and the latter decreased the share after 2000, reaching 0.064% of GDP in 2007. In contrast, the United States and Japan are substantially below the EU value.

FIGURE II.2.2

**Public sector expenditure on R&D (GOVERD + HERD) financed by business enterprise as% of GDP 2000(1) and 2009(2)**



*Source*: DG Research and Innovation

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*Data*: Eurostat, OECD

*Notes*: (1) EL, CY, SE, IS, NO: 2001; AT, HR: 2002; IT, MT: 2005.
(2) EL: 2005; BE, LU, NL, AT, NO, IL: 2007; EU, BG, DE, ES, FR, IT, CY, PT, IS, CH, US, CN, JP, KR, IL: 2008.
(3) DK, FR, HU, NL, SE, NO, TR, JP, KR: Breaks in series occur between 2000 and 2009.
(4) IL: (i) GOVERD financed by business enterprise does not include defence; (ii) HERD financed by business enterprise does not include R&D in the social sciences and humanities.
(5) KR: R&D expenditure for 2000 does not include R&D in the social sciences and humanities.
(6) US: (i) GOVERD financed by business enterprise refers to federal or central government only; (ii) HERD financed by business enterprise does not include most or all capital expenditure.

## *Public–private collaboration is also reflected through co-publications, where the EU is lagging behind despite good progress in several Member States*

The number of public–private co-authored research publications in the Web of Science database[213] is another way of showing collaboration established between the public and the private sectors. As in Figure II.2.3. this type of partnership is more frequent in the United States than in Japan and much more so than in the EU; in this last case, the figures for the United States are more than double of those for the EU (70.2 publications versus 36.2 in 2008), even if the average annual growth registered between 2003 and 2008 is higher in Europe. Japan has remained stable over the same period, with figures between 55 and 57 publications[214].

In the EU, the northern countries publish more strongly in public–private partnerships, with figures much higher than the EU average (see Figure II.2.4.). The Netherlands, Denmark, Finland and Sweden have reached levels of co-publications well above those for the United States and Japan. These expressive results of collaboration are also made evident through other indicators discussed in this chapter. It is, for example, the case of the choice for collaborative partners by innovative firms in Finland, and in a lesser scale, by Austria and the Netherlands. Austria has been growing strongly, putting in evidence a good performance on the link between the two sectors, and almost doubled the number of co-publications between 2002 and 2007 (from 36.1 to 65.7 co-publications).

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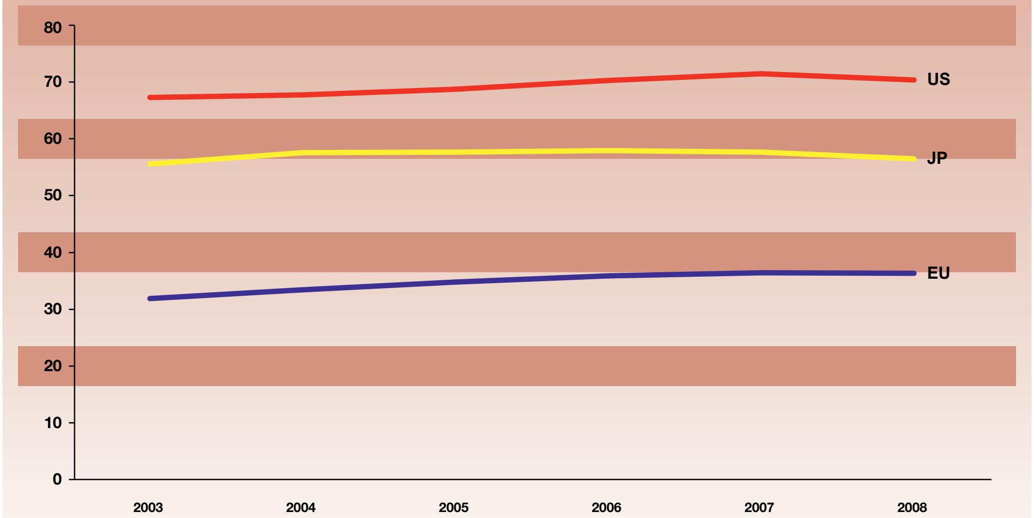
[213] The definition of the 'private sector' excludes the private medical and health sector. Publications are assigned to the country/countries in which the business companies or other private sector organisations are located.

[214] See also Section 'Overall picture', Chapter 3.2.

FIGURE II.2.3

## Public-private co-publications per million population, EU, United States and Japan, 2003-2008



*Source*: DG Research and Innovation
*Data*: Innovation Union Scoreboard 2010

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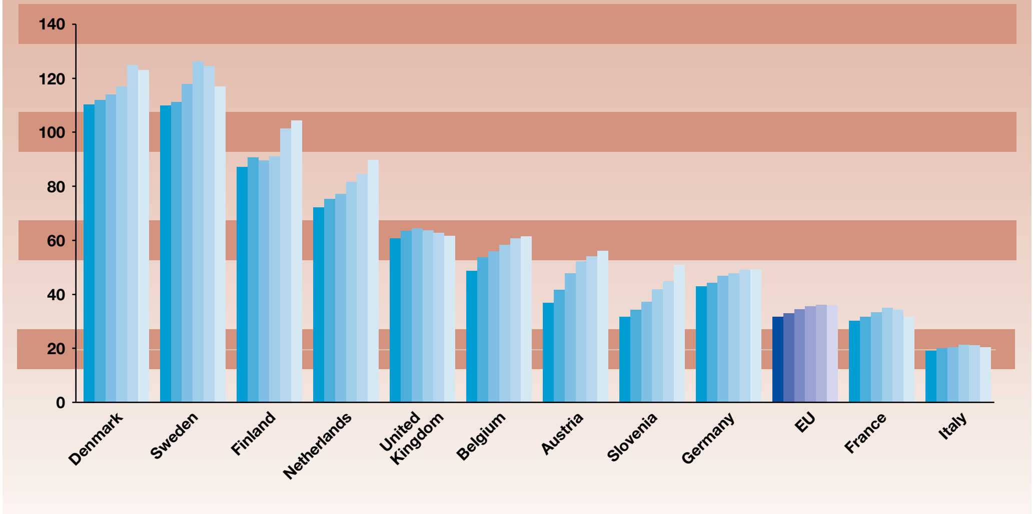
FIGURE II.2.4

## Public-private co-publications per million population, selected Member States, 2000-2008



*Source*: DG Research and Innovation
*Data*: Innovation Union Scoreboard 2010

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Why do firms engage themselves in domestic or international collaboration? Usually the main reasons are related to the aims of 1) reducing transaction costs relative to pure market-based transactions, 2) exploring and assimilating new knowledge embedded in other firms' core competencies and 3) accessing other potential international markets. But collaboration is not without risks and failures. Innovative firms have different potential partners for collaboration within the EU, and different situations can be found when comparing countries.

## Box II.2.2 – Searching for the bottlenecks of public-private cooperation

The CONCORD 2010 conference, held in Seville, 3–4 March 2010, provided a forum for technical and academic discussions on the role of corporate R&D, which factors affect the relationships between corporate R&D and downstream impacts, including the collaboration of individual R&D actors with other private- and public-sector actors. Building on the papers presented at the conference, some conclusions on the Collaboration aspects were drawn:

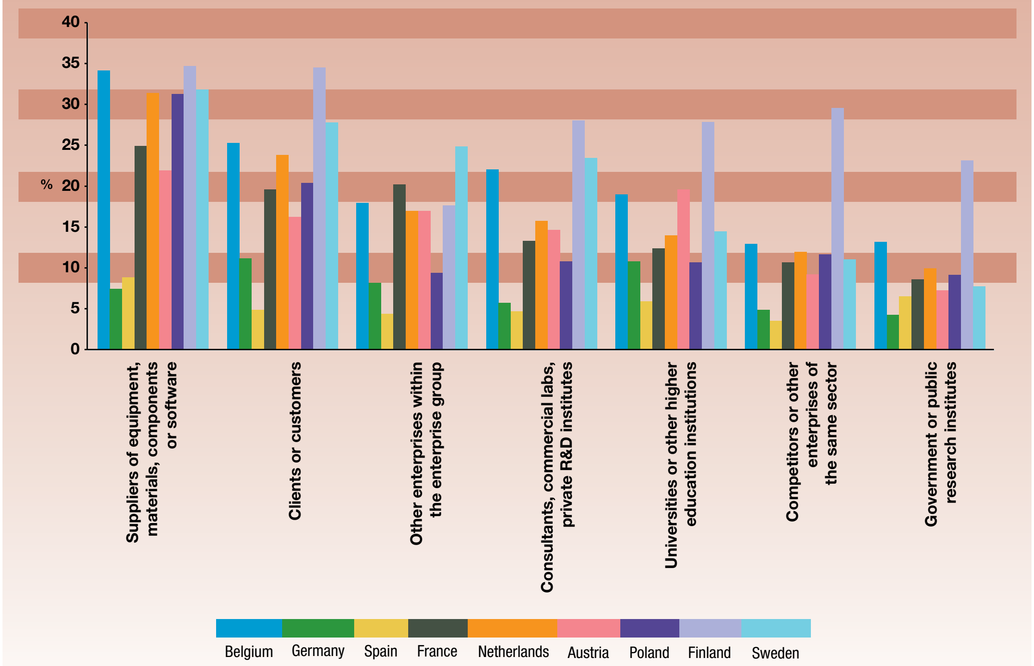
- collaboration requires persistency over time;
- positive impact of collaboration depends on choice of partners;
- local cluster-formations to optimise collaboration evolve over time;
- support for collaboration (as FPs) has positive effect on productivity, but in a long-term perspective (5 years).

Case studies presented on strategic technology alliances and research partnerships show that when a firm envisages collaboration, it has to measure the risks and advantages of taking such initiative, one of the critical issues being the fear of knowledge leakage, even when the company needs the complementary knowledge assets. Also, when comparing domestic with international collaboration, the latter involves added degrees of uncertainty.

A good and well-established partnership for collaboration constitutes a learning experience that turns into a **repository of knowledge** (on the specific aspects of that collaboration). This can have a lock-in effect in the sense that the same actors will most probably be involved in subsequent partnerships, instead of looking for new partners and different institutional contexts. Another aspect not to be forgotten is the different motivations and perspectives of the actors involved: firms want to make profits, improve their capacity, increase their competitiveness, while universities or public research institutions give preference to the increased sharing and networking aspects (this also emerges from the analysis of the collaboration networks formed in the context of FP6, showing how industry prefers to have minor networking tasks).

From a case study on **new technology based start-ups deriving from R&D collaborations funded by EU**, over a ten year period (1994–2003), some relevant aspects on collaboration emerged: 1) FPs' (specially since FP6) played a bridging role between world knowledge sources through the collaborations created; 2) to overcome their lack of internal competencies, high-tech start-ups need to carefully select their partners through a network of alliances, bearing in mind the specialised competencies their alliance partners possess; 3) R&D alliances seem to be more fruitful if they involve industrial partners located in a variety of countries and if partners' countries are close to worldwide dispersed sources of knowledge.

FIGURE II.2.5 **Main cooperation partners of innovative enterprises as % of innovative enterprises, 2006-2008**



*Source*: DG Research and Innovation
*Data*: Eurostat

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***Universities and PROs are not the main cooperation partners for innovative firms. Finland, Austria and Belgium show the highest share of cooperation between public research institutions and innovative firms***

The CIS (Community Innovation Survey) is a relevant tool to improve the evidence on the dynamics of knowledge transfer and to perceive the strategies enhancing the innovation performance. Some flaws related to the concept of innovation used in the survey - which reflects a wide range of activities under the same umbrella - require caution in reading and analysing the data. Another less positive aspect is that, not being a mandatory survey, for some countries the data is not available, thus reducing the scope of the analysis and benchmarking.

In general, for the period 2006–2008, suppliers of equipment, clients and customers, other enterprises within the company group, consultants and private R&D laboratories were more frequently partners of innovative companies than Higher Education Institutions or Public Research-performing Organisations (PROs), as shown in figure II.2.5.

In Finland, 28% of the innovative firms collaborate with universities and other higher education institutions, while one in four innovative firms cooperate with PROs. Finnish innovative firms also show a high degree of external collaboration with suppliers of equipment, materials, components or software and clients or customers as is the case of Belgium, Sweden, Poland and the Netherlands; but innovative firms in Belgium use the suppliers of equipment and clients or customers as partners twice as often as higher education institutions or PROs. The Austrian innovative firms also show a relatively high level of collaboration with higher education institutions and, to a lesser degree, PROs. Polish firms use suppliers of equipment and software more frequently than the Austrian firms (31.3% against 21.9%). In Germany and Spain, innovative firms show a low degree of collaboration (only 20.7% and 18.7% respectively), including low levels of cooperation with HEIs and PROs.

### *Public–private cooperation is taking place between people*

The existence of skilled personnel and human resources are key conditions for knowledge transfer. The gap in knowledge transfer is partly related to lower numbers of researchers and R&D personnel in the private sector in the EU compared to its main competitors[215]. Even though there has been an increase in the number of researchers in the private sector in the EU (from 536 785 in 2000 to 707 534 in 2008, the average annual growth rate being 3.8%), the EU still has a lower share of business researchers (47%) than the United States (79.6%) and Japan (69.3%). In general, there is a correspondence in the Member States between the shares of researchers (FTE) employed in the business sector and the shares of R&D performed by business enterprise[216].

### *Researchers move mainly from public to private sector. There are low levels of circulation and mutual flows of researchers.*

Alongside direct cooperation between public- and private-research performers, mutual flows of staff and researchers are at the heart of knowledge transfer. A recent study on mobility patterns and career paths of EU researchers[217] - including a survey conducted in industry - showed that there is a substantial flow of researchers from the public to the private sector, with 42% of the respondents indicating that their career path started in the public sector and ended in the private sector. In contrast, 37% of the industry researchers state that they have always worked in the private sector. This suggests that in many instances mobility flows are mainly oriented from the public to the private sector, with low levels of circulation and mutual flows. In fact, round-tripping between the private and the public sectors, seems to be of a lower importance. Only between 5% and 6% of the industry researchers have career paths that involve such round-tripping (in either direction) and less than 5% of those interviewed have moved from the private to the public sector. The findings are equally valid for the EU-15 as for the EU-12. It is also relevant to note the substantial difference in the way individual sectors recruit industry researchers.

## TABLE II.2.1 Career paths of industry researchers by region of residence

| Path | Respondents by region of residence | | | % distribution | | |
|---|---|---|---|---|---|---|
| | EU-15 | EU-12(2) | EU-27 | EU-15 | EU-12(2) | EU-27 |
| Always private sector | 723 | 238 | 961 | 38.2 | 35.1 | 37.4 |
| Public to private | 802 | 285 | 1 087 | 42.4 | 42 | 42.3 |
| Public to private and back | 27 | 12 | 39 | 1.4 | 1.8 | 1.5 |
| Private to public | 28 | 8 | 36 | 1.5 | 1.2 | 1.4 |
| Private to public and back | 80 | 30 | 110 | 4.2 | 4.4 | 4.3 |
| Other | 189 | 79 | 268 | 10 | 11.7 | 10.4 |
| Total | 1 891 | 678 | 2 569 | 100 | 100 | 100 |

*Source:* DG Research and Innovation

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*Data:* IDEA Consult: MORE questionnaire on industry researchers

*Notes:* (1) Based on question: As a summary of your career path, which one of the following career paths describes your situation best (please consider only changes of employer not research visits)

(2) EU-12: The 12 Member States that have joined the EU since 2004

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[215] For a graphic presentation of the number (and growth) of FTE researchers in the EU, the United States, China, Japan and South Korea, see Part I, Chapter 4 as well as the initial section ‘Overview picture’, Chapter 2.2.

[216] See also Part I, Chapter 6.3.

[217] See the study ‘More’, ‘Mobility Patterns and Career Paths of EU Researchers’, financed by the European Commission, presented in Part I, chapter 4 and in Part II, Chapter 5. http://ec.europa.eu/euraxess/pdf/research_policies/MORE_Industry_report_final_version.pdf

For example, the flow of researchers in manufacturing is mainly an intra-sector flow (74%).

The evidence also stresses that the career paths of internationally mobile industry researchers (i.e. researchers that have at least once lived in a country other than their country of graduation) are substantially different from those of nationally located industry researchers (i.e. researchers that have always lived in the same country as their country of graduation). The former group of mobile researchers have more often moved from the public to the private sector than the latter group. International mobility thus seems to be closely associated with career paths from the public to the private sector[218].

When asked about the motives for their mobility, the responses of the industry researchers express a strong parallel with the factors that motivate enterprises to locate R&D facilities in a particular region: e.g. to stay close to high quality of R&D personnel and intellectual property rights, and to benefit from quality and accessibility of research environment – like universities.

## 2.2. What is the current landscape of technology clusters in Europe?

Within the clusters, technology cooperation creates higher levels of efficiency, higher levels of business formation and higher levels of innovation

Knowledge transfer does not take place independently of space and geographical factors. This dimension is the basis of the development of 'clusters'. The cluster concept was first developed by M. Porter, who gave the definition of clusters (1998) in terms of spatial proximity[219]. Several other definitions can be found in literature, all involving the concentration of one or more sectors in a region, and the evidence of collaboration and networking between firms and institutions.

Clusters foster excellence through competition and cooperation between different actors, mainly when the actors share a common vision and work in partnership. Studies seem to indicate that regions with a strong, sufficiently diversified cluster have better growth conditions, are less vulnerable and more sustainable[220]. Thus Clusters have the potential to better position regions in the global competition, by valorising strengths, increasing synergies and creating new business dynamics.

- Companies can operate **with a higher level of efficiency**, drawing on more specialised assets and suppliers with **shorter reaction times**.
- Companies and research institutions can achieve **higher levels of innovation**, knowledge spill-over and close interaction with customers and other companies to create more new ideas and provide intense pressure to innovate (the cluster environment also lowers the cost of experimenting).
- The **level of new business formations** tends to be **higher** in clusters. Start-ups are more reliant on external suppliers and partners, all of which they find in a cluster (clusters also reduce the costs of failure).
- From a survey made of all EU Member States, **around half of the countries** started applying cluster policy **after 1999**.
- Almost all of the European cluster programmes have **private businesses as their target group**. The other major target group is R&D performing institutions.

Quantitative evidence on clusters in Europe has been collected since 2007 by the European Cluster Observatory[221], an online platform that aims to improve cluster mapping in Europe. The European Cluster Observatory has identified and mapped more than 2000 clusters, in 259 regions, and classified them in 38 categories on the basis of employment data – i.e. as clusters of economic activity in a certain sector. One limitation of this data is that it does not directly show the innovative potential of each cluster. Therefore, a complementary approach has been developed to

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[218] Idem.

[219] 'Geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions (for example, universities, standards agencies, and trade associations) in particular fields that complete but also cooperate'.

[220] This data analysis has been made by the Fraunhofer Institute, financed by the European Commission, DG RTD, in the project 'Regional Key Figures', Knowledge Driven Clusters in the EU, final Report, August 2010.

[221] European Cluster Observatory, funded by the European Commission, is managed by the Centre for Strategy and Competitiveness (Stockholm School of Economics) http://www.clusterobservatory.eu

identify clusters based on patent data, i.e. as clusters of inventive activity in a certain technological field, independent of the underlying scope of economic activity. The combination of these two approaches will allow the analysis of the existing clusters in the EU, and avenues for reflection on the production versus use of technologies at regional level. However, the data on patents is based on the technological performance of regions (the number of patent applications) and does not yet distinguish patenting in individual clusters.

Identifying and measuring clusters is not a task that can be easily carried out. When measuring agglomerations delimited by industries, it is not clear ex ante what constitutes a cluster. We are dealing with 'value chains' of related industries. Clusters are by definition cross-sectoral and cross-technological in nature. However, there is no data available on value chains on a regional basis (or data that can be converted in a regional dimension). Nevertheless, there is comprehensive evidence-based knowledge about sectoral fields (classifiable as 3- to 4-digit NACE classes) or technological areas (classifiable by IPC classes) that can be considered related to, and thus delimiting, a certain type of cluster. It is based on such a definition that the following analysis is conducted for sectoral and technological clusters[222].

Given the strong sector specificity of clusters, the following maps illustrate clusters in three of the key sectors for the European economy. Data on other sectors is available at the European Cluster Observatory and in the "Regional Key Figures" study. The selection made for this analysis focuses on clusters linked to European competitiveness and relevant for tackling some societal challenges, as further analysed in Part III, chapter 5 of this report. Given the terms of reference for these studies, data was only collected for EU Member States, not for the Associated countries.

### *Major technology clusters in the IT industry are formed around large IT companies, and there is a relatively clear difference between regions that produce and regions that use these technologies*

The United Kingdom, Germany and France are the three Member States with the highest concentration of large firms on IT technologies, according to the European Industrial R&D Scoreboard. Sectors such as computer software and hardware, computer services, internet and other IT services - all highly R&D research intensive - are mostly present in these three countries, gathering around a variety of small firms (the United Kingdom with more than 30 large firms, Germany and France with more than 20)[223]. Sweden, Italy, Finland and the Netherlands also count on a positive and enabler presence of large firms in these sectors.

Precisely, clusters in the field of information technologies are dominated by large companies from both software and hardware industries. Examples visible in figure II.2.6 are the cluster around Nokia in Finland, the cluster in Karlsruhe region, the videogames sector in the region of Paris, or the semiconductor industry of 'Silicon Saxony', around Dresden. Both types of cluster – employment and technology – are distributed and relatively differentiated across Europe. The technology clusters are more concentrated in space. In general, clusters are more present in Central Europe, northern Italy, south-east France, the Nordic countries, the United Kingdom and Ireland. This concentration of cluster contrasts somewhat with the specialisation index in ICT (a larger category, including the Communication technologies), which is more widely spread in Europe, indicating possible growth of future clusters[224].

A good example of a technology cluster in the field of IT is the region Provence-Alpes-Côte-d'Azur (PACA) in the south east of France. The region is widely known for its technological competences and is responsible for 40% of the manufacturing of microelectronics in France. The region hosts 41 000 employees in ICT, whereby the cluster organises 25 international groups with 13 000 employees of which 6 500 work in R&D. The region has 14 higher education institutes and is training 1 500 engineers and doctors per year. Additionally, 1 200 researchers work in public research.

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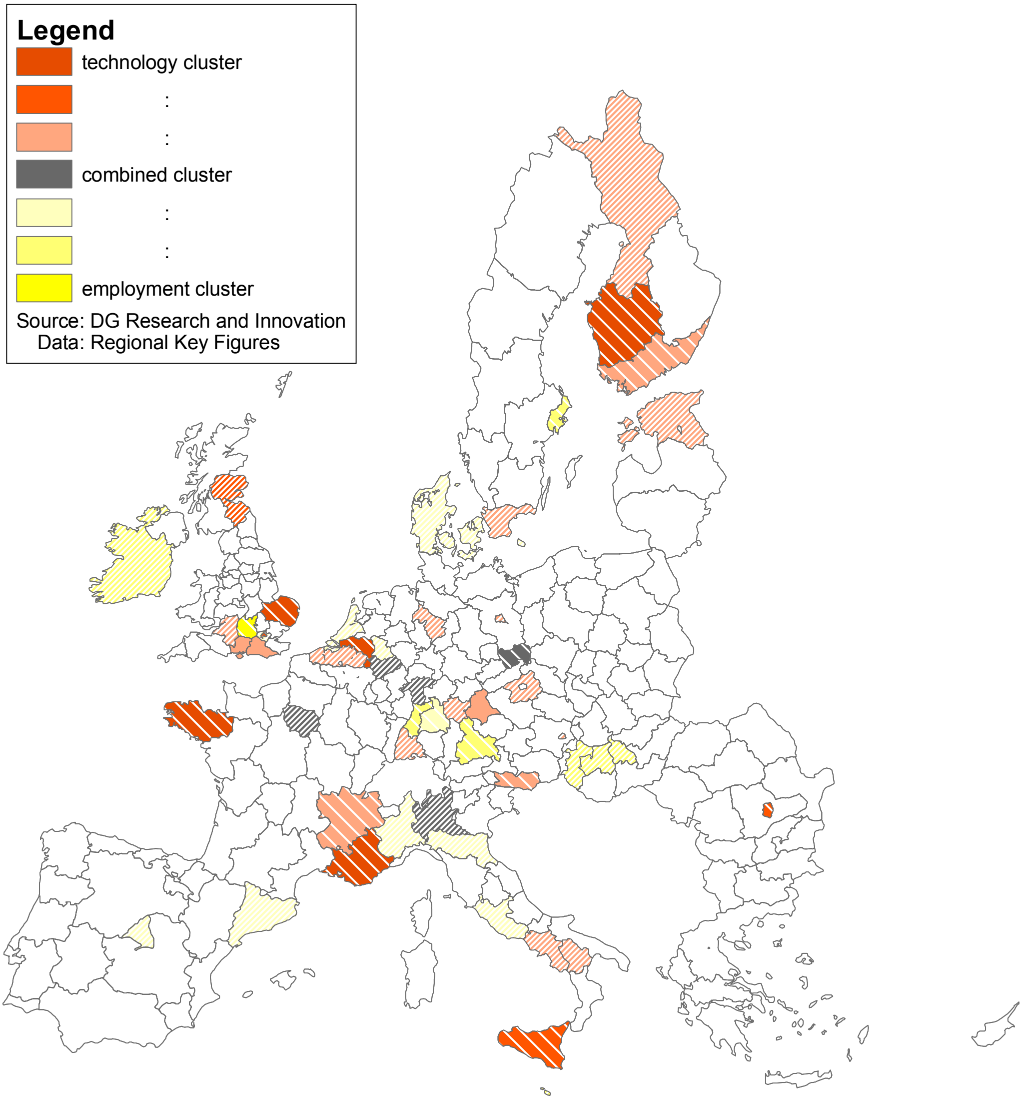
[222] See the 'Regional Key Figures', Knowledge Driven Clusters in the EU, final Report, August 2010, previously mentioned.

[223] See the 2010 EU Industrial R&D Investment Scoreboard, DG RTD /JRC IPTS http://iri.jrc.ec.europa.eu/research/docs/2010/SB2010_final_report.pdf

[224] See section 'New Perspectives', Chapter 2.4. For more data on the R&D capacity in ICT, see also Part I, Chapter 5.4 and 5.5 (R&D investment and economic structure) and Part I, Chapter 6.2 (on patenting).

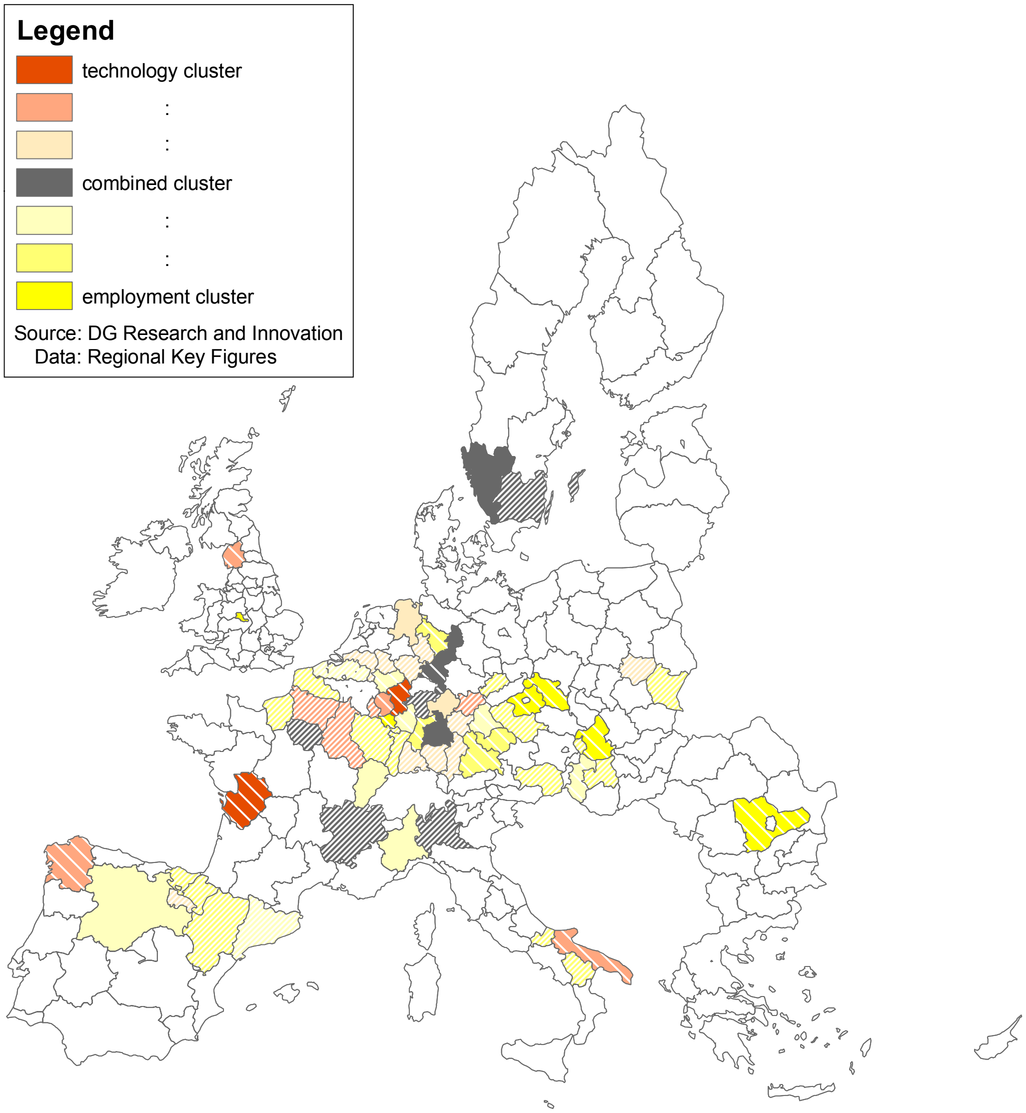
FIGURE II.2.6 **Technology clusters in the Information Technology (IT) Field**



Source: DG Research and Innovation
Data: Regional Key Figures

*Note:* Based on Cluster Observatory Data; the majority of data points being from 2005;(figures may differ from claims of cluster management organisations); Categories calculated by the difference of the number of patent and the number of employment 'stars'; scaffolding indicates overall cluster strength with no scaffolding as the strongest category

FIGURE II.2.7 **Technology clusters in the Automotive Field**



Source: DG Research and Innovation
Data: Regional Key Figures

*Note:* Based on Cluster Observatory Data; the majority of data points being from 2005; (figures may differ from claims of cluster management organisations); Categories calculated by the difference of the number of patent and the number of employment 'stars'; scaffolding indicates overall cluster strength with no scaffolding as the strongest category

### *Clusters in the automotive industry are widely spread across the European Union, linking large manufacturing firms with highly specialised SMEs*

Figure II.2.7 illustrates the automobile sector wich is important in the European economy. It is characterised by large manufacturing corporations, complemented in the value chain by a set of medium-sized companies acting as suppliers, and smaller firms usually with a high degree of specialisation. The 2010 EU R&D Investment Industrial Scoreboard (the top EU 1 000 R&D investors) identified 42 major companies active in this sector (Automobiles and Parts, according the ICB classification of sectors), with a total R&D investment of EUR 27.5 million, and a total employment of 2.1 million persons. 19 of these companies were located in Germany, 7 in France, 6 in Italy, 4 in the United Kingdom, 2 in Austria, besides companies in Sweden, Spain and the Netherlands.

The location of clusters based on employment data shows the presence of EU's largest car manufacturing firms, like Daimler, BMW and Volkswagen (Germany), Seat (Spain), Fiat (Italy), Renault (France) and Volvo (Sweden). A few clusters in other regions are also visible where suppliers are concentrated[225].

It is interesting to compare the distribution of technology and employment cluster types in the automobile sector. A first finding is that overall clusters in the automotive industry are widely spread across the European Union, with the main sources of technology located in Western Europe and a dominance of employment clusters in the EU-12 Member States and in Spain. The comparison also highlights the fact that a country can have an employment cluster in the automotive sector without being located close to a corresponding technology cluster, as is the case for Poland and the North of Spain. In France, clusters of employment and clusters of patent application are both present but placed in different regions. However, compared to the IT and medical technology sectors, the automobile sector has a close proximity of clusters producing and using technologies (including more combined clusters).

### *Employment clusters in the field of medical technologies are mostly concentrated in Central Europe, while technology clusters are more distributed across Europe. SMEs play an important role.*

Medical technology is a research-intensive sector. The United Kingdom, Germany, Italy, Ireland, France, Belgium, the Netherlands, Denmark and Sweden are the most important medical technology producers, with a special medical technology concentration for the regions of Wales, Freiburg, Upper Franconia or West Sweden (FigureII.2.8). These regions display either a technology or an employment clustering effect. In France and Germany combined clusters are more frequent. This specialisation is also reflected in leadership in patents in the fields of medical technologies and related topics, in particular for Denmark, Sweden, the Netherlands and Germany[226].

When compared with clusters in other sectors, in the case of the medical technologies the distribution is more spread out. It is also the case for the pharmaceutical companies, although they have a very marked presence in the United Kingdom, with 18 companies out of the 67 present in the 2010 R&D Industrial Scoreboard. Smaller countries, like Portugal, Luxembourg, Slovenia and Malta also account for at least one larger pharmaceutical firm in the Scoreboard. The Health Care Equipment sector (a services sector) shows a higher degree of concentration in Germany, Sweden and the United Kingdom, which constitute half of the companies present in the 2010 R&D Industrial Scoreboard.

It is worth mentioning the presence of combined clusters, technology and employment, around Switzerland, visible in the map below. Swiss Pharmaceutical and Health Care and equipment companies present in the 2010 R&D Industrial Scoreboard invested more than EUR 12 million in R&D in 2009 and employed more than 200000 persons

The use of medical technologies by firms is a key driver in the European market. For this aspect, it is mainly Germany and some Italian regions which show a concentration of employment clusters. The predominant firm structure in these regions is composed of SMEs, which are less R&D-intensive than larger companies, but which constitute an important source of employment. Technology clusters

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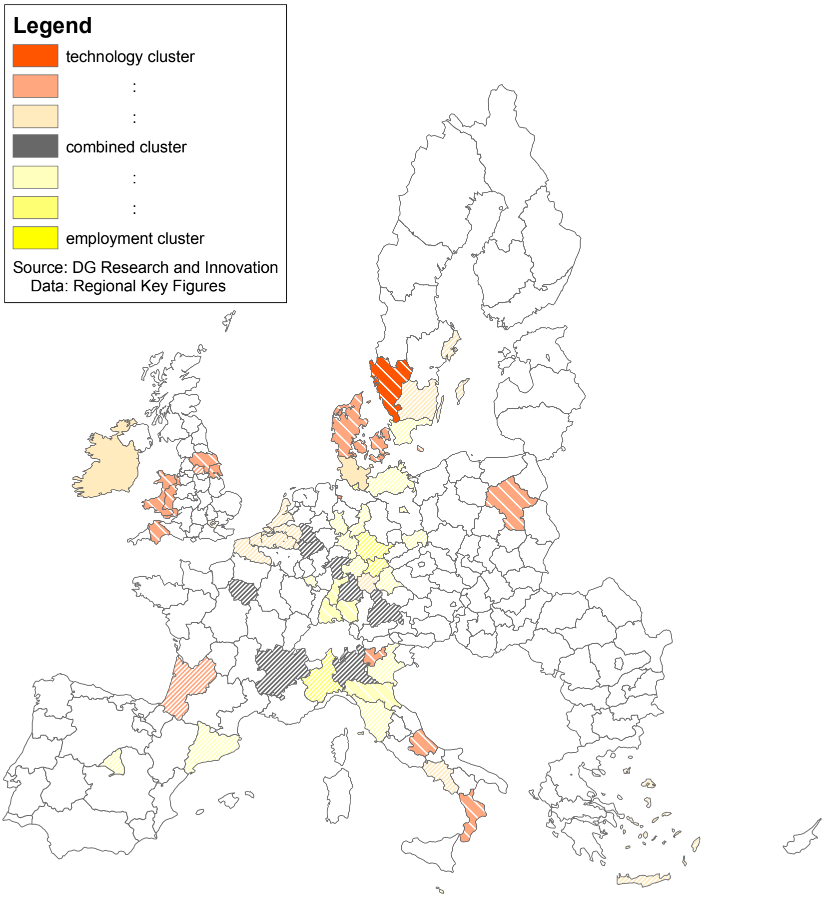
[225] European Commission-financed project, Regional Key Figures Cluster booklet, August 2010.

[226] For data on health technology patents, see also Part III, chapter 5.2 and for specialisation index in biotechnology see the section 'New Perspectives', chapter 2.4.

FIGURE II.2.8 **Clusters in the Field of Medical Technologies**



Source: DG Research and Innovation
Data: Regional Key Figures

*Note:* Based on Cluster Observatory Data; the majority of data points are from 2005; (figures may differ from claims of cluster management organisations); as well as on own calculations drawing on the EPO Worldwide Patent Statistical Database categories calculated by the difference of the number of patent and the number of employment 'stars'; scaffolding indicates overall cluster strength, with no scaffolding as the strongest category.

are more dispersed across Europe than employment clusters. In the heart of the EU the predominance is for mixed clusters.

A good example of a cluster in this field is Bioscience Wales, one of the United Kingdom's most successful bioscience clusters with a well-established reputation for scientific and academic excellence. It gathers 276 companies involved in the research, development and manufacture of medical, biotechnology and pharmaceutical products plus another 46 companies providing consultancy services to the sector. The sector registered a 19% growth in the last three years and employs around 15000 people.

In the last decade there has been a strong support from the Welsh Government to the sectors of bioscience, with specific programmes aimed at driving forward collaboration and research to improve the transfer of knowledge and expertise from the Welsh research base into the economy.

# CHAPTER 3

# Addressing the gender gap in science and technology

## HIGHLIGHTS

Today 45% of all PhD graduates are women. Women, however, are not represented in this proportion in the labour market of science and innovation research. National science and innovation labour markets show vertical and horizontal segregations in terms of participation of women and men.

The highest proportions of women are found in the countries with the lowest R&D expenditure per researcher and the lowest proportions of women are in the sectors with the highest R&D expenditure per researcher.

In order to address the relatively low representation of women in science, the highest innovative European countries have developed very active policy agendas.

The proportion of female grade-A staff has increased from 5.8% to 7.2% in the field of engineering and technology, from 15.6% to 17% for medical sciences (the lowest growth) and an increase from 23.9% to 27% in humanities. However, the most important institutions and areas of decision making in the scientific landscape remain dominantly led and managed by men. There is a strikingly low presence of women in academic decision-making positions in all European countries.

The business and enterprise sector lags behind the public higher-education sector, with only 19% of female researchers compared to 39% of women in the higher education institutions.

The level of gender equity is a result of the combined effect of the R&D innovation systems, the relevance of science for the national economy, the features of the labour market, and the equity policies in place. A wide variety of historical developments and national policy settings that shape and influence the roll-out of policy towards gender equity in science and research can be observed across the EU. Despite many EU initiatives and policy directives, national frameworks of R&D and social policy crucially determine the overall conditions for women in science and research.

The figure II.3.1. illustrates the gross domestic expenditure on R&D (GERD) per R&D personnel by country. R&D personnel include researchers, technicians/equivalent staff and other supporting staff as defined in the Frascati Manual[227], in all fields. A pattern emerges in the figure, spelling out the fact that the highest proportions of women are found in the countries with the lowest R&D expenditure per R&D personnel and the lowest proportions of women are in the sectors with the highest R&D expenditure per R&D personnel.

The line of best fit shows a strong negative linkage between a country's expenditure on R&D and their proportion of women in science. The distance of a country from the line of best fit indicates the loss/gain of access and/or control over R&D expenditure, in the same way that the 'honey pot' indicator did in the ENWISE report[228]. If a country is below the line, it shows that there are fewer women in R&D than the R&D expenditure per R&D personnel would predict in that country.

There are six hypotheses that might be used to explain the negative link between the proportion of women in R&D and the level of development of the country's national system of innovation: lower salaries of women researchers, lower-paid sectors of R&D, 'feminine' sectors of R&D, higher overall levels of employment for women, a male 'brain drain', and combinations of these. Most of the given hypotheses have been proven to cause these imbalances in various contexts. They are also subject to Member States' equity policies[229].

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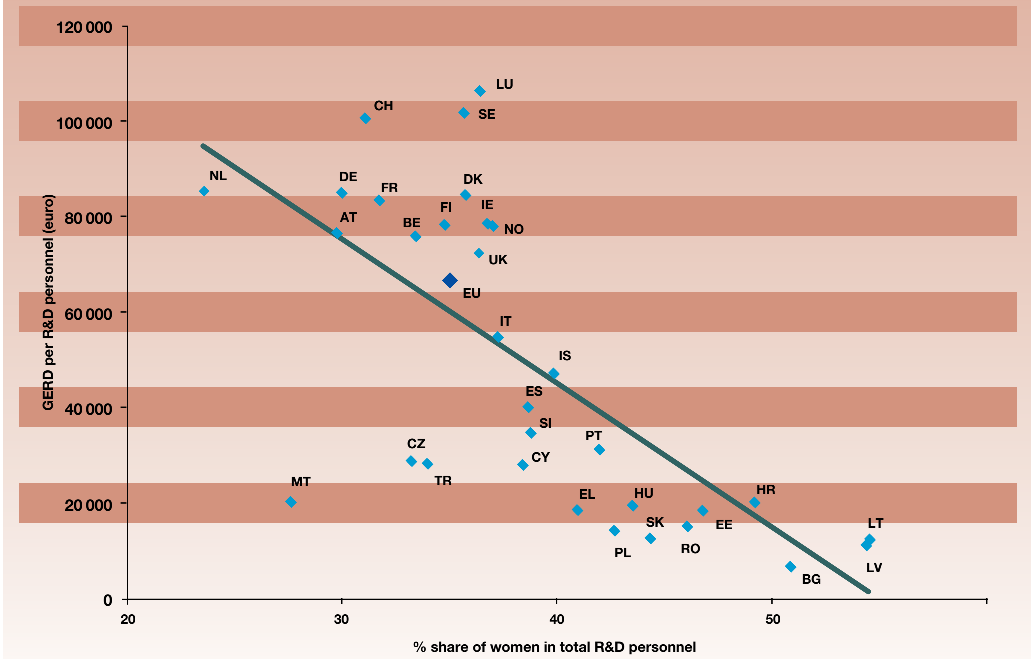
[227] OECD (2002) Frascati Manual 2002 *The Measurement of Scientific and Technological Activities, Proposed Standard Practice for Surveys on Research and Experimental Development*, OECD Publishing.

[228] European Commission (2003) *Waste of talents: turning private struggles into a public issue*; Women and Science in the ENWISE countries, A report to the European Commission from the ENWISE Expert Group on women scientists in Central and Eastern European countries and in the Baltic States, Luxembourg.

[229] Cf. Benchmarking policy measures for gender equality in science, EC 2008.

FIGURE II.3.1 Share (%) of women in total R&D personnel(1) and R&D expenditure (GERD) per R&D personnel, 2007(2)



*Source*: DG Research and Innovation
*Data*: Eurostat
*Notes*: (1) Head Count
(2) NL: 2003; CH: 2004; EL: 2005; FR, IT: 2006; CZ, SK, IS: 2008

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The most common form of policy towards equity in science and research both in the US and in Europe involves the human resources approach. The key indicator of success here relates to the proportional participation of women in all areas of the science and research system.

***Several high-innovative European countries have developed a very active policy agenda in order to address the below-average (EU) representation of women in science.***

*The Gender Challenge in Research Funding* report[230] proposes an instructive classification based on the general gender equality context in each country (see Table II.3.1). Thus, countries are roughly divided into proactive ones – which promote and monitor gender equality in research with active policies and measures – versus comparatively inactive countries that display few such measures and initiatives. Within the proactive countries, four important sub-groups are established: the five Nordic countries belong to the 'global gender equality leaders'. These northern welfare states are characterised by early (from the late 1970s to the early 1980s onwards) committed efforts to embed gender equality into science policy and society at large. A second proactive group comprises 'newly active countries with traditionally fewer women in research' such as Germany, the Netherlands, Austria, Belgium, and Switzerland. In recent years, these countries have developed a very active policy agenda in order to address the below-average (EU) representation of women in science. Thirdly, the proactive countries also include 'newly active member states with more women in research' such as Spain, the United Kingdom and Ireland. The last group, quite large and heterogeneous, includes the remaining countries; they can be characterized as relatively inactive when it comes to gender equality in research funding. These countries show little initiative in monitoring gender balance or promoting gender equality in research in general. Some have among the highest proportions of women in HE research in a European comparison, some average and some less than average proportions.

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[230] http://ec.europa.eu/research/science-society/document_library/pdf_06/the-gender-challenge-in-research-funding-report_en.pdf

**TABLE II.3.1** **The gender challenge in research funding (classification based on EC 2009)**

| Gender Equality Leaders, small gender gap, more women in HE research (Group 1) | Newly active countries, few women in HE research (Group 2) | Newly active countries, with more women in HE research (Group 3) | Relatively inactive countries, some with more women in HE (Group 4) |
|---|---|---|---|
| Finland | Austria | United Kingdom | Bulgaria |
| Norway | Belgium | Spain | Croatia |
| Sweden | Germany | Ireland | Czech Republic |
| Ireland | Netherlands | | Cyprus |
| Denmark | Switzerland | | Greece |
| | | | Estonia, Italy, Luxembourg |
| | | | Hungary, Malta, Poland |
| | | | Portugal, Romania |
| | | | Turkey, Israel |

*Source:* DG Research and Innovation

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## 3.1. Is the gender gap in science and technology closing?

Labour markets in all European countries are characterised by horizontal and vertical segregation. Evolution over the last 20 years points towards stagnating if not rising levels of segregation. There is no evidence of a spontaneous movement towards less segregation in the European labour markets.

- Horizontal segregation is understood as under-(over-) representation of a certain group in occupations or sectors not ordered by any criterion.
- Vertical segregation refers to the under-(over-) representation of a clearly identifiable group of workers in occupations or sectors at the top of an ordering based on 'desirable' attributes – income, prestige, job stability etc., independently of the sector of activity. Under-representation at the top of occupation-specific ladders was subsumed under the heading of 'vertical segregation', whereas it is now more commonly termed 'hierarchical segregation'

### *The gender gap is slowly closing in the public sector, but major inequalities persist in top academic positions and in the business sector*

A revolution has occurred over the last 30 years. The remarkable rise in women's level of education is related to the growth of women's employment in the field of science and research. The share of women in total research employment has been growing at a faster rate than men's in most European countries. However, there are large differences between countries. In higher education, women constitute the majority of bachelor and master students and they even represent 45% of Ph.D. graduates. If the growth rate in the number of male and female Ph.D. graduates as it was observed in 2000 is sustained, women will catch up with men at this highest level of education as well.

Differences between educational fields still persist even though the percentage of women in all fields has risen. At PhD level, most fields are dominated by women: education, humanities and arts, agricultural and veterinary sciences, health and welfare. Female PhDs represent 47% in social sciences and law and 41% in mathematical sciences and computing, but only 20% in engineering, manufacturing and construction.

On average throughout the EU, only 13% of institutions in the higher education sector are headed by women in 2007.

We can see that this proportion varies from 27% to 0%. The countries that show the highest proportion of women are Norway, Sweden, Finland, Italy and Estonia (more than 19%).

Based on the compound annual growth rate across sectors, a difference can be observed between the higher education sector and the private and business sector. In the first one, the compound annual growth rate in the number of female researchers has been stronger than that of men over the period 2002–2006 in most countries. There seems to be some move towards a more gender-balanced research population in higher education. The government sector presents a very similar pattern. However, for the business enterprise sector, the compound annual growth rate of the number of female researchers was stronger than that of men in only the half of the countries over the period 2002–2006. This shows that women are catching up with men at a slower pace in the business and enterprise sector than in the higher education and government sectors.

There are also differences in the evolution of the research population according to the field of science. On average throughout the EU, the most positive growth figures have characterised the fields of the medical sciences, the humanities, engineering and technology, and the social sciences. Only in natural sciences has the number of female researchers actually shrunk at a yearly rate of -0.4% over recent years. The situation varies widely according to the different European countries.

The evolution of vertical segregation is harder to investigate since data only concerns the higher education sector. There is an improvement in women's relative position at the PhD level, but also at the different stages of the academic career in grades A, B and C. This improvement is very slow. A positive factor is that there is a more marked closing of the gender gap among scientists than on the labour market in general. The dissimilarity index also decreased between 2004 and 2007 (in some countries it remained stable). These results let us suppose that the career situation is more favourable for the youngest generations of female academics. However, the gender gap is still disproportionately high compared with the increase in the proportion of women amongst students. For the period 2004–2007, the proportion of female grade-A staff increased in the EU-25 from 5.8% to 7.2% in the field of engineering and technology, from 15.6% to 17% for medical sciences (the lowest evolution) and from 23.9% to 27% in humanities. However, the most important institutions and areas of decision-making in the scientific landscape remain dominantly led and managed by men.

## 3.2. Do women scientists choose the same careers as men?

### 3.2.1. Women employed in research

***Women are under-represented in science and engineering employment, although the gap is closing***

Figure II.3.2 compares the proportion of women in total employment with their share amongst the highly educated employed as professionals or technicians[231] and amongst those working as scientists and engineers[232] for the year 2009. 'The fact that the proportion of women is higher amongst highly educated professionals or technicians (52%) than in total employment (45%) illustrates the fact that tertiary-educated women are more successful than the others in finding a job.

However, their proportion lowers to 32% in the group of employed scientists and engineers which in turn exemplifies the problem of gender segregation in education. Between 2002 and 2009, women were catching up with men as women's compound annual growth rate exceeded that of men both in total employment and in the two more precise subgroups. The difference is largest amongst scientists and engineers, where the share of women annually grew grown by 5.5% on average between 2002 and 2009, compared with a male growth rate of just 2.9%. These growth rates are respectively 4.9% and 3.4% for highly educated women and men working as professionals or technicians'[233]. This growth rate is thus higher for these

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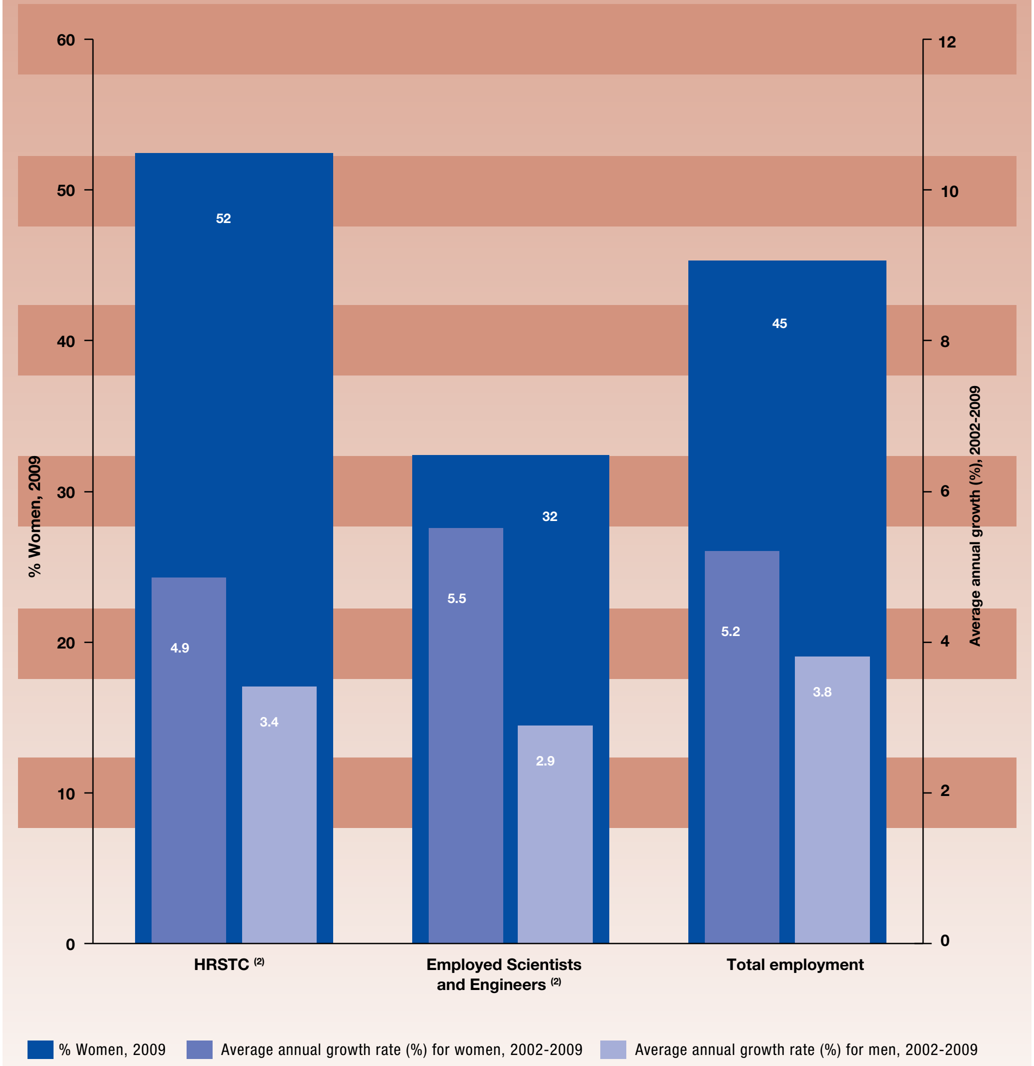
[231] 'Technicians and associate professionals' (ISCO-3) are defined as follows: 'occupations whose main tasks require technical knowledge and experience in one or more fields of physical and life sciences, or social sciences and humanities. The main tasks consist of carrying out technical work connected with the application of concepts and operational methods in the above-mentioned fields, and in teaching at certain educational levels' (p. 127, She Figures, 2009).

[232] The group 'Scientists and Engineers' includes the Physical, mathematical and engineering occupations (ISCO '88 COM code 21) and the Life science and health occupations (ISCO '88 COM code 22).

[233] See *Figures 2009*, p. 20.

FIGURE II.3.2

## EU - Human Resources in Science and Technology - Core (HRSTC), Scientists and Engineers and total employment (1) - women as % of total, 2009 and average annual growth rate (%), 2002-2009



*Source*: DG Research and Innovation
*Data*: Eurostat
*Notes*: (1) All values refer to age group 25-64.
(2) 2009: EU does not include LU; 2002-2009: EU does not include LU and RO.

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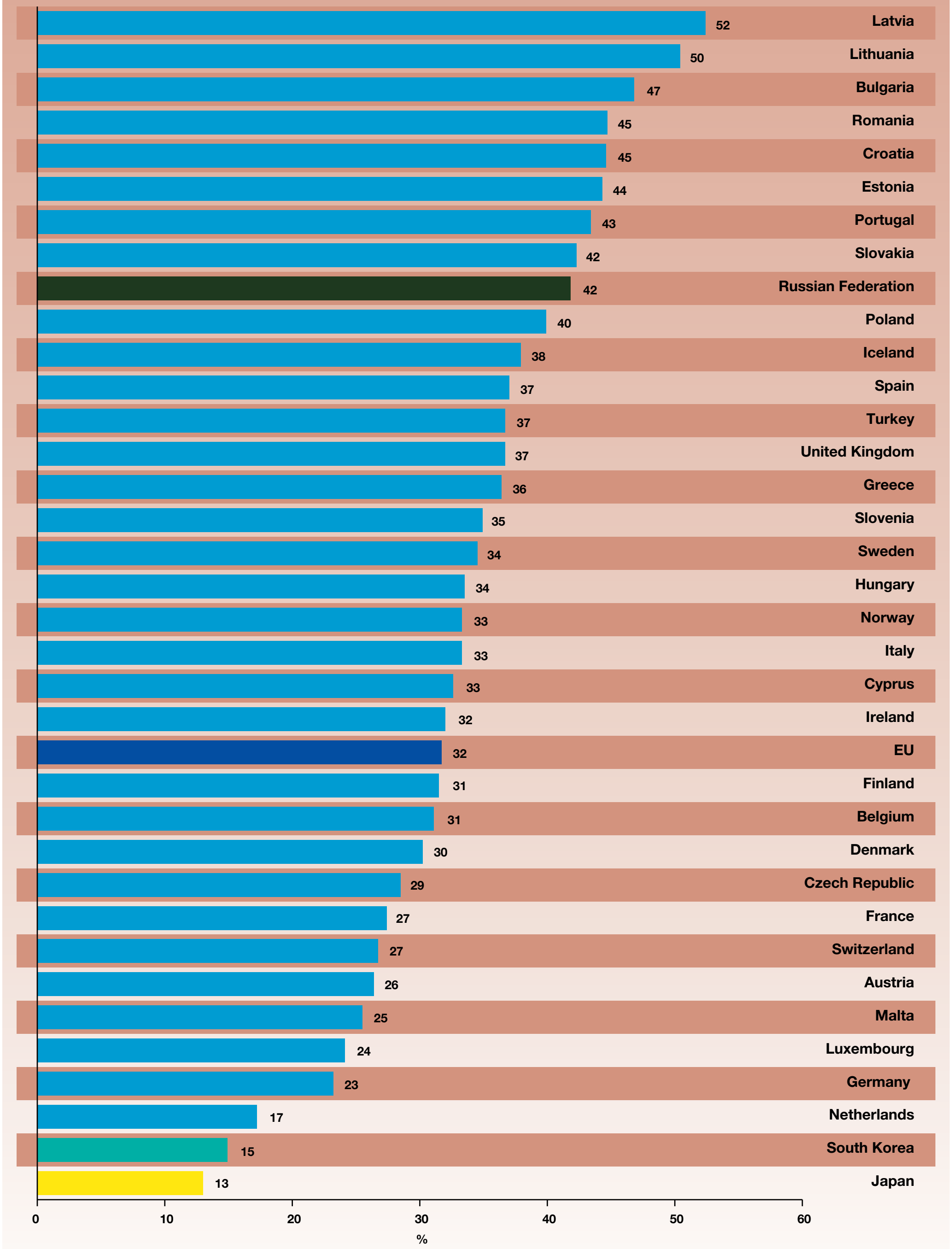
FIGURE II.3.3

## Female researchers (Head Count) as % of total researchers (Head Count), 2007(1)



*Source*: DG Research and Innovation
*Data*: Eurostat
*Note*: (1) NL: 2003; CH: 2004; EL: 2005; FR, IT: 2006; CZ, SK, IS, RU: 2008.

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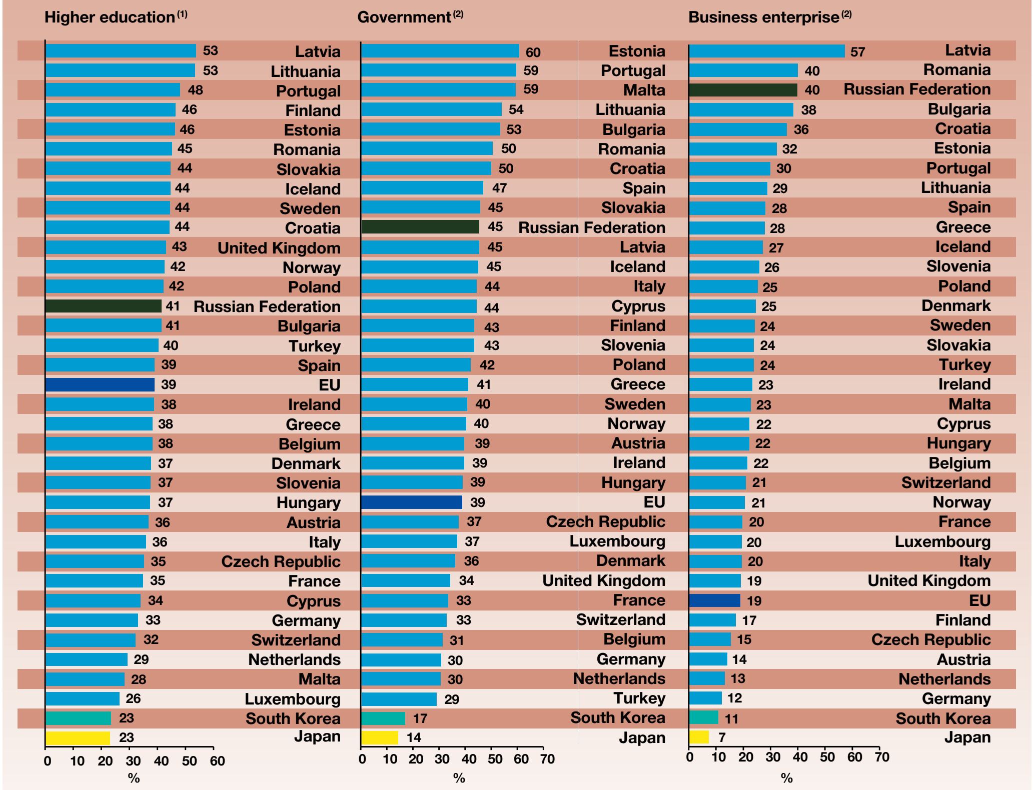
FIGURE II.3.4 **Researchers (FTE) by sector – Female as% of total, 2007**



*Source*: DG Research and Innovation
*Data*: Eurostat
*Notes*: (1) NL: 2003; EL: 2005; FR, IT: 2006; CZ, EE, MT, SK, IS, RU: 2008.
(2) EL: 2005; FR, IT: 2006; CZ, EE, MT, SK, IS, CH, RU: 2008.
(3) CH: 2004; EL: 2005; FR, IT: 2006; CZ, SK, IS, RU: 2008.

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categories than for the total employment – where it is limited to 1.8% for women and to 1.1% for men. The same is observed for the compound annual growth rate of the numbers of female and male scientists over the period 2002–2009. Women tend to catch up with men over time. The number of female researchers increased at a faster rate than the number of male researchers during the period (with the exception of the Czech Republic, Romania, Bulgaria, Hungary, Latvia and France). In the EU on average, the number of female researchers increased at a rate of 6.2% per year compared with 3.7% for male researchers.

Figure II.3.3 presents the proportion of female researchers by country. The average proportion of female researchers in the EU in 2006 is 32%. At the top of the ranking of the proportion of women in research, there is Latvia (52%), followed by Lithuania (50%), Bulgaria (47%), Rumania and Croatia (5%), Estonia (44%) and Portugal (43%). In general, Baltic States and Eastern countries show a very high level of representation of women in research. At the end of the scale, there is the Netherlands with only 18% women researchers.

### *Women represent 39% of researchers in the higher education sector and in the government sector but only 19% in the business and enterprise sector*

An analysis by sector (higher education, government, and business enterprise sectors) shows a very similar presence of women in the public and in the higher education sectors and a considerably lower presence in the private and business sector (Figure II.3.4). On average in the EU, women represent 39% of researchers in the higher education sector and in the government sector but only 19% in the business and enterprise sector. The degree of cross-country disparity is very similar in higher education and public enterprise, but much larger in private enterprise. In all sectors, two countries systematically show low proportions of female researchers – the Netherlands and Japan[234] – whereas Lithuania and Romania always have the highest proportions of women in research. The data presented in She Figures 2003 allows comparison of this evolution of the percentage of women researchers by sector with the EU-15. For the higher education sector, this proportion was 33% in 2000 (Figure II.3.5). The evolution was also strong in the government sector where the percentage was 34% in 2000. Finally, the percentage of women researchers in the private sector stood at 18% in 2000.

### *While the gender imbalance within the public sector has levelled out over recent years, the imbalance between public and private sectors persists*

In the higher education sector, the compound annual growth rate in the number of female researchers was stronger than that of men over the period 2002– 2006 in most countries (26 out of 31). The inverse holds true in only five countries. These countries are the Czech Republic, Greece, the Netherlands, Latvia, and Sweden. However, the differences in growth rates are extremely modest in the latter three countries. Exceptions aside, in most countries, there seems to be some move towards a more gender-balanced research population in higher education. Throughout the EU on average, the annual growth rate for women has been 4.8% compared with 2.0% for men. The level of the growth rates of both female and male researchers is extremely variable over the different countries. The government sector puts forth a very similar pattern. It has a larger share of female than of male researchers, and women's presence has been strengthening over recent years in the majority of countries. On average in the EU, the number of female researchers has been growing at a pace of 5.4% per year compared with 2.3% for men. There are just four exceptions to this overall pattern. Finally, in the business enterprise sector, where the proportion of female researchers is generally lower than that of men, the compound annual growth rate of the number of female researchers was stronger than that of men over the period 2002–2006 in roughly half of the countries (17 out of 33). In these countries, there thus seems to be some move towards greater equality in this sector. There is, nevertheless, a high level of cross-country disparity in the level at which this balancing out is taking place.

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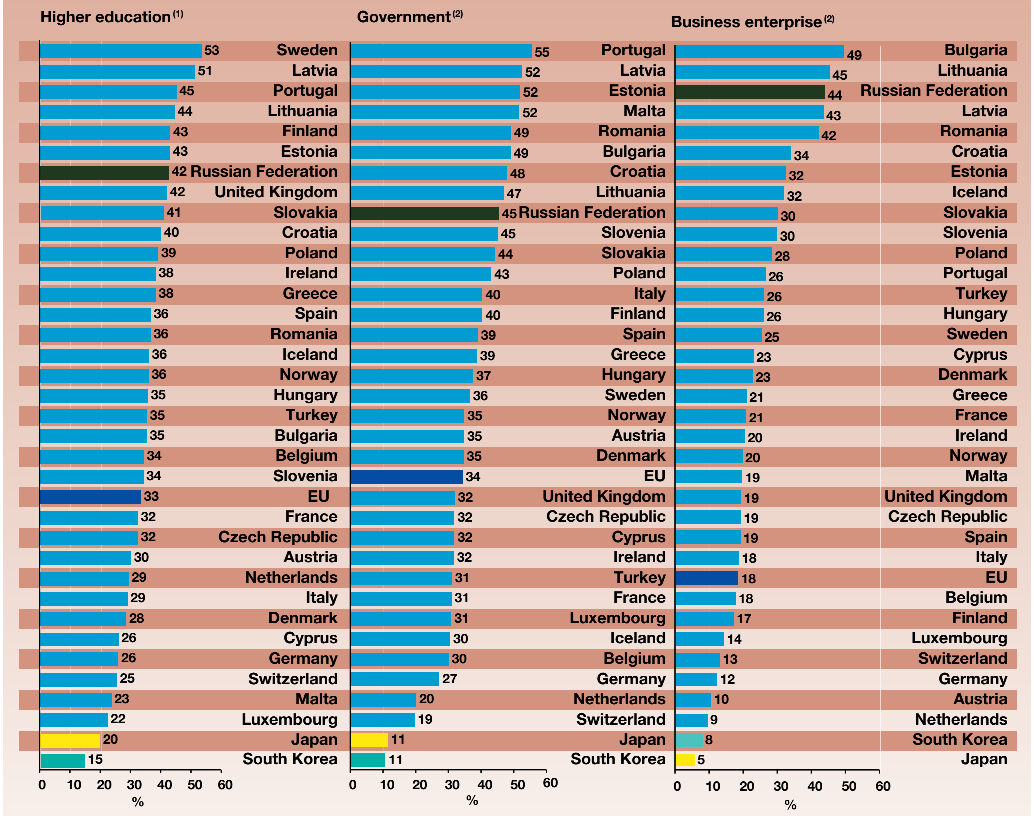
[234] However, there are other countries in this situation as regards the higher education sector (Malta, Luxembourg and Switzerland) and the government sector (Switzerland, Turkey and Germany).

FIGURE II.3.5 **Researchers (FTE) by sector – Female as% of total, 2000**



*Source*: DG Research and Innovation

*Data*: Eurostat

*Notes*: (1) EL, SE, IS, NO: 2001; BE, IE, MT, NL, AT, SK, HR: 2002; DE: 2003; FI: 2004, UK: 2005.
(2) EL, NL, UK, IS, NO, JP: 2001; BE, IE, MT, AT, SK, HR: 2002; DE, SE: 2003; FI: 2004.
(3) DK, DE, IE, EL, ES, NL, IS, NO, JP: 2001; AT, SK, HR: 2002; LU, SE: 2003; MT, FI: 2004; UK: 2005.

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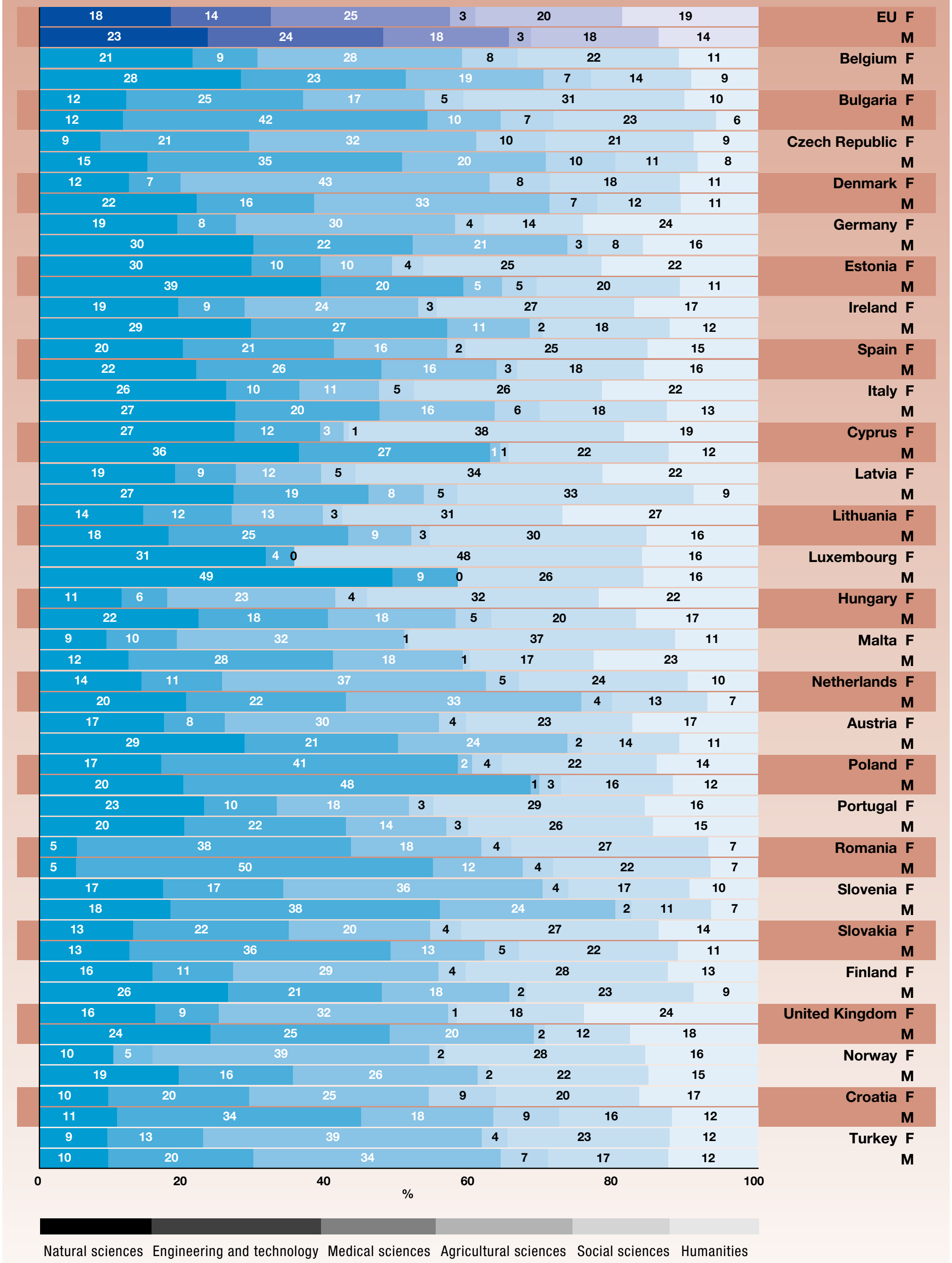
### 3.2.2. Women employed in research across fields of science

***Female researchers are more concentrated in medical sciences and less in engineering***

The distribution of male and female researchers in the higher education sector across different fields of science in 2008 (Figure II.3.6) indicates that female researchers are concentrated in medical sciences (25% on average in the EU). It is the contrary for agriculture, where they constitute 3% on average in the EU. The widest gender gap is, not surprisingly, observed in engineering. Again there are many cross-country differences in the relative importance of each of the fields of science. 'Whereas just 9% of female researchers are in the natural sciences in Malta, 27% are in Cyprus. In engineering and technology, the low proportions of female researchers observed in Norway (5%). Austria (8%), Denmark (7%) and Hungary (6%) contrast sharply with the much higher shares of women in Romania (38%), Poland (41%) and Bulgaria (25%). Such contrasting national patterns also characterise the medical sciences, which have particularly high shares of female researchers in Sweden (51%), Malta (32%), and Denmark (43%) and particularly low shares

FIGURE II.3.6

## Researchers (Head Count, female and male) in the higher education sector – % distribution by field of science, 2008[(1)]



*Source*: DG Research and Innovation
*Data*: Eurostat
*Notes*: (1) EU, BE, DK, NL, AT, FI, UK: 2007; EE, IT, MT, SK, TR: 2009.
(2) EU does not include EL, FR, LU, SE.

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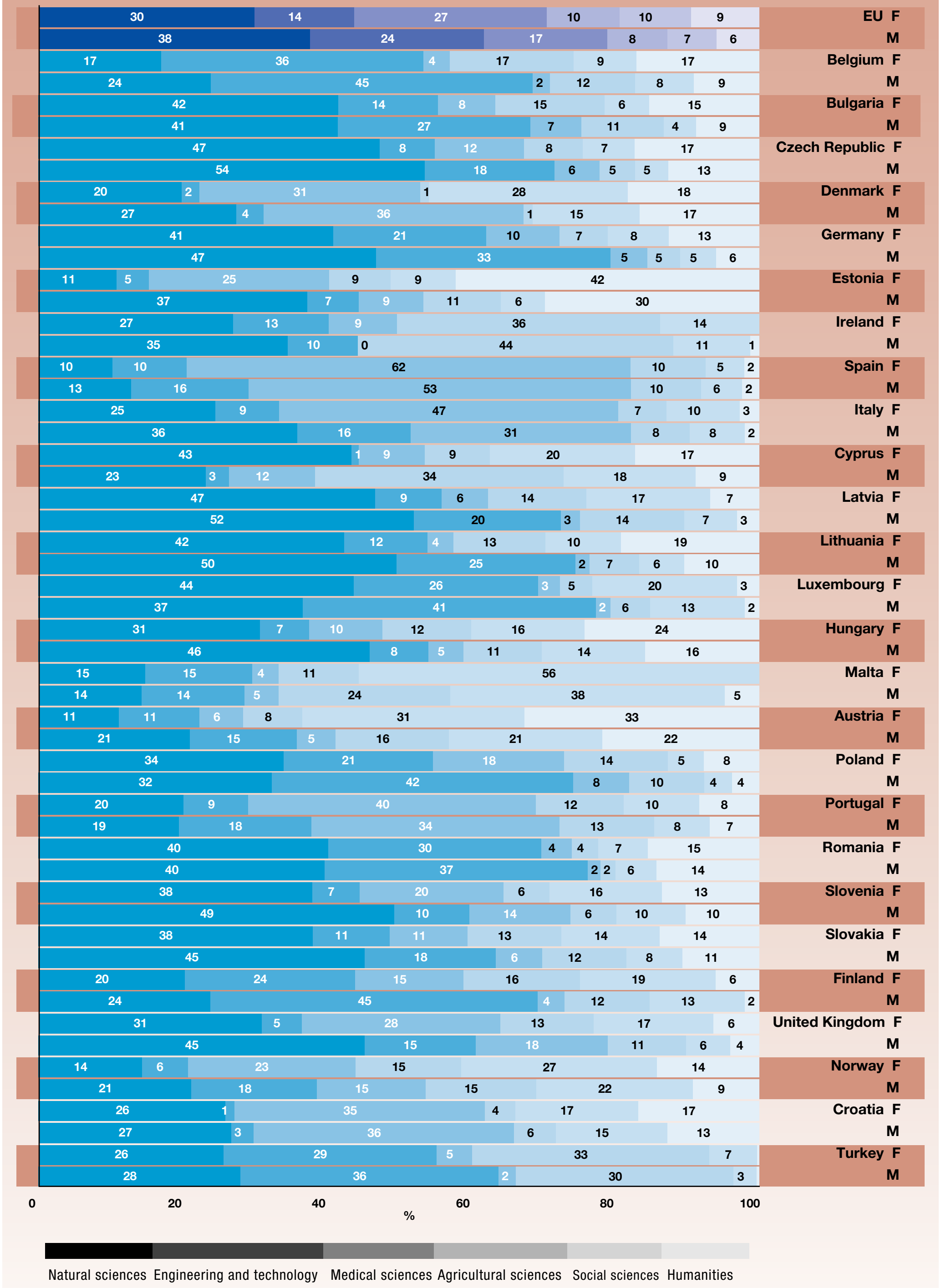
## FIGURE II.3.7

## Researchers (Head Count, female and male) in the government sector – % distribution by field of science, 2008⁽¹⁾



*Source*: DG Research and Innovation
*Data*: Eurostat
*Notes*: (1) EU, BE, DK, IE, LU, AT, FI: 2007; EE, MT, SK, TR: 2009.
(2) EU does not include EL, FR, NL, SE.

in Estonia (10%), Latvia (12%) and Lithuania (13%). The share of female researchers in the humanities is lowest at 7% in Romania, whereas it peaks at 27% in Lithuania, followed by Germany and UK with 24%. In social sciences there are few cross-country variations in the proportions of researchers.

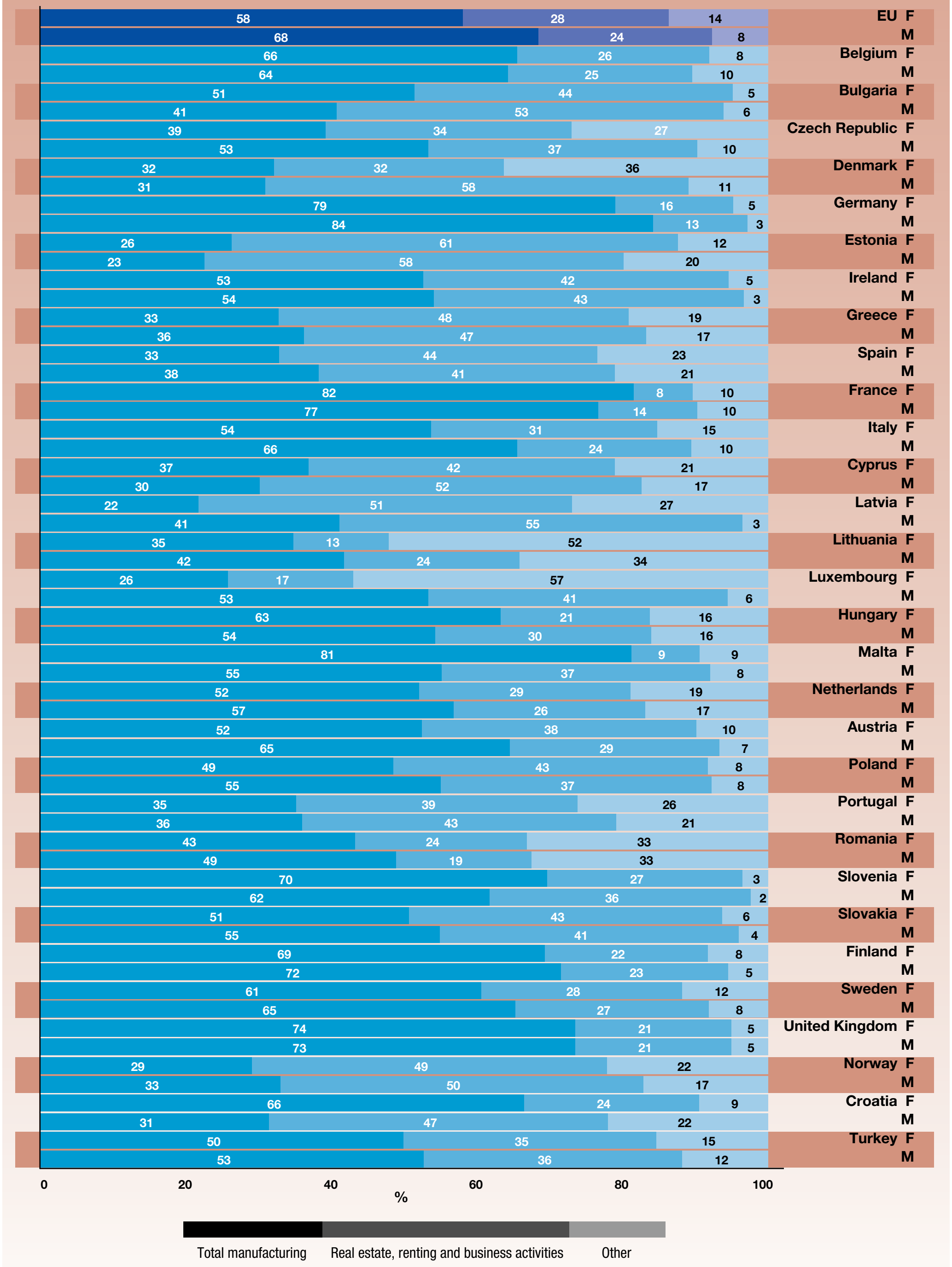
Concerning the government sector (Figure II.3.7), female researchers are best represented in the medical sciences (as in the higher education sector) and also in the natural sciences (27% and 30% on average in the EU-27). In medicine the share of female researchers is 10 percentage points higher than that of male researchers. In natural sciences, there are a slightly larger proportion of male researchers. Again, a very wide gender gap is observable among the research population in the field of engineering. Engineering hosts only 14% of women researchers (the gap stood at 14% in 2008 throughout the EU). As in higher education, female researchers are least present in agriculture and in the social sciences (10% on average in the EU). Again, cross-country differences are observable: whereas just 10% of researchers in natural sciences in Spain are female, in Latvia the share is 47%. In engineering and technology, the low proportions of female researchers observed in Cyprus (1%), Denmark (2%), UK (54%), and Croatia (1%) contrast sharply with the much higher shares of women in Belgium (36%), Turkey (39%), Luxembourg (26%), and Romania (30%). Such contrasting national patterns also characterise the medical sciences, with particularly high shares of female researchers in medicine in Spain (62%), Italy (47%) and Portugal (40%) and particularly low shares in Lithuania (4%), Belgium (4%), Malta (4%) and Turkey (5%). The share of female researchers in the humanities is lowest at 0% in Ireland and Spain with 2% whereas it peaks at 42% in Estonia and 33% in Austria. Whereas there was the least cross-country variation in the proportions of researchers in the social sciences in the higher education sector, in the government sector, this fails to hold true. Indeed, the proportion of female researchers ranges from 2% in Turkey to 50% in Malta.

### *Among the researchers in the business sector, around two thirds of all women do research in the manufacturing sector*

Finally, regarding the business enterprise sector, researchers are distributed across different economic activities (Figure II.3.8). Two sectors of activity are studied: manufacturing; and real estate, renting and business activities. Research activities are mainly conducted within the manufacture and real-estate sectors. These two economic sectors can be compared with all other economic activities taken together. In most countries, the highest shares of both male and female researchers are in manufacturing. The share of women in this sector stood at 58% and that of men at 68% in 2008 (for the EU). However, for Estonia, Greece, Spain, Poland, Slovakia, and Norway, the share of female researchers is highest in real estate, renting and business activities rather than in manufacturing. The share of male researchers is also highest in this sector of economic activity in Denmark, Estonia, Greece, Cyprus, Latvia, Slovakia and Norway. Moreover, if one focuses on pharmaceuticals as a subgroup of the overall manufacturing sector, the share of female researchers at the level of the EU increases to 38.5% from 17.3% in the broad sector of manufacturing. This illustrates that women are relatively better represented in the manufacture of pharmaceuticals than in that of other products. Besides manufacturing, the share of female researchers in real estate, renting and business activities stood at 28% at the level of the EU in 2008. Finally, the other sectors of economic activity host only 14% of female researchers and 8% of male researchers (in the EU on average).

FIGURE II.3.8

## Researchers (Head Count, female and male) in the business enterprise sector – % distribution by economic activity, 2008(1)



*Source*: DG Research and Innovation
*Data*: Eurostat
*Notes*: (1) FR: 2004; IE, EL, NL: 2005; EU, BE, DK, DE, IT, LU, AT, SE, UK: 2007; SK: 2009.
(2) EU does not include IE, EL, FR, NL.

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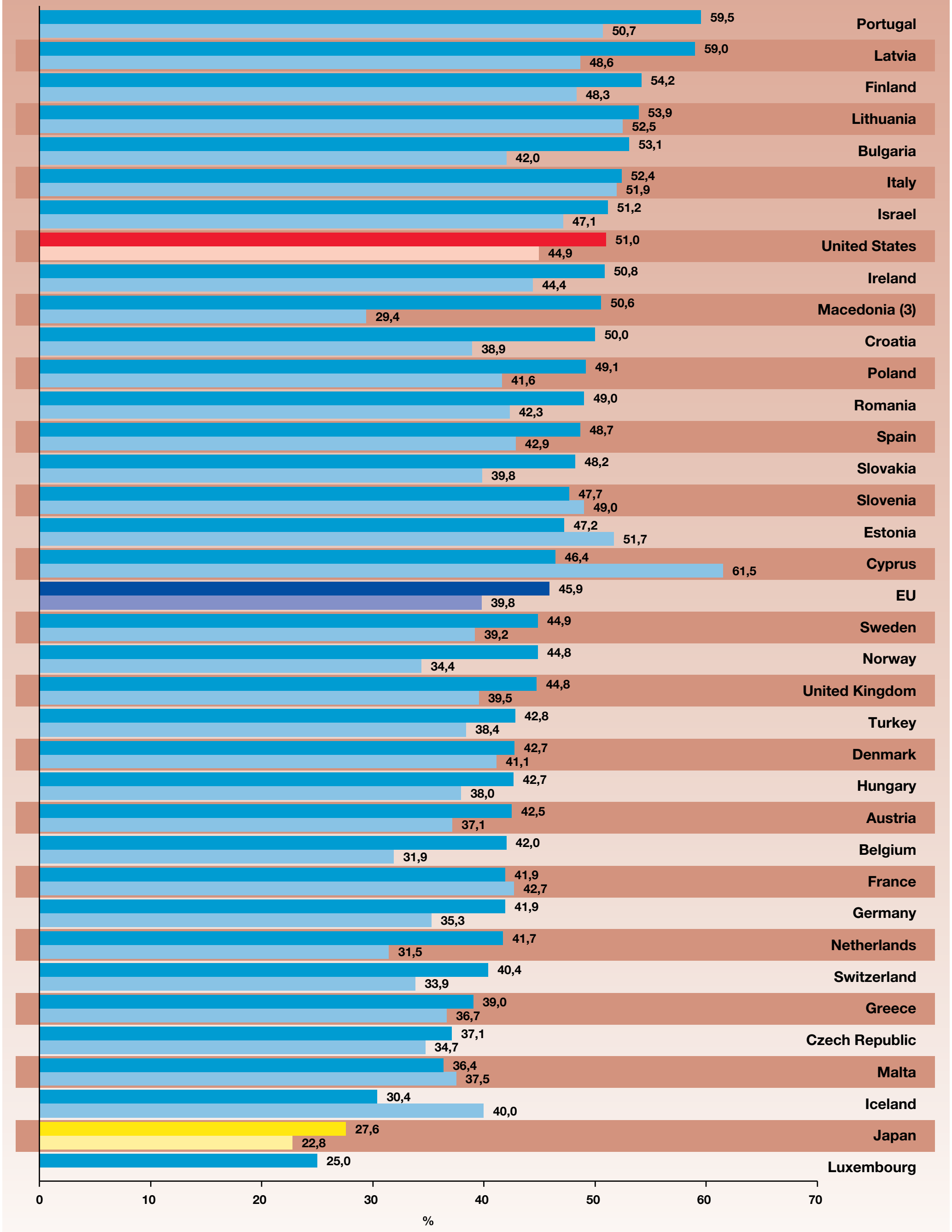
## FIGURE II.3.9 Female PhD (ISCED 6) graduates as % of total PhD (ISCED 6) graduates, 2001(1) and 2008



■ 2008
■ 2001

*Source*: DG Research and Innovation
*Data*: Eurostat
*Notes*:(1) MT, IS, CH: 2002; RO, HR: 2003, CY: 2004.
(2) EU: LU and RO are not included in the EU aggregate for 2001.
(3) The Former Yugoslav Republic of Macedonia.

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## 3.2.3 Segregation in higher education

Decisions with respect to the field of study could lead to horizontal segregation between women and men on the labour market.

### *Forty-five per cent of all PhD graduates are women*

Figure II.3.9 shows the proportion of female PhD graduates for 2008; on average in the EU, nearly 46% of all PhD graduates are women. The top-ranked countries are Portugal (60%), Latvia (59%), Finland and Lithuania (54%) and Bulgaria (53%). Ten countries have 50% or more female PhD graduates. At the bottom of the rank, the countries with the lower scores are Luxembourg and Malta, with respectively 25% and 36%. A notable evolution has occurred in the proportion of female PhDs between 2001 and 2008. In general, with the exception of France, Cyprus, Estonia, Slovenia and Malta the percentage of female PhDs has grown in all countries for which data is available between 2001 and 2008. Marked changes are observed in Portugal (from 50% to 59.53%) over the period as well as Bulgaria (from 42% to 53%) and Latvia (from 48.6% to 59%). The proportion rose from 42.9% to 48.7% in Spain; from 34,4% to 44.8% in Norway; from 31.9% to 42% in Belgium; from 31.5% to 41.7% in the Netherlands; from 39.8% to 48.2% in Slovakia, and from 35.3% to 41.9% in Germany.

### *Women's share amongst PhD graduates has been growing in recent years*

Figure II.3.10 yields the compound annual growth rate of PhD graduates by sex, and one can observe that with the exception of Italy, France, Norway, Finland, Hungary, Bulgaria and Estonia, the share of women amongst PhD graduates has been growing in recent years. In the majority of countries, the compound annual growth rate of female PhD graduates exceeds that of men over the period. On average in the EU, the number of female PhD graduates increased at a rate of 6.8% per year compared with 3.2% for male PhD graduates. The difference between the female and male rates is greater in Croatia, Portugal, Slovakia, Romania, Denmark and Switzerland. These figures clearly prove that women are catching up with men. This increase of women's educational level will probably result in women being at least equally or even more present than men at the PhD level in the near future.

On the basis of She Figures 2003, we can compare the compound annual growth rate of PhD graduates for the period 1998–2001 to the period 2002–2006. During the first period, the compound annual growth rate was 4.8% for women and 2.4% for men. During the second period these numbers were 6.5% and 2.9% respectively. The compound annual growth rate has significantly risen over time.

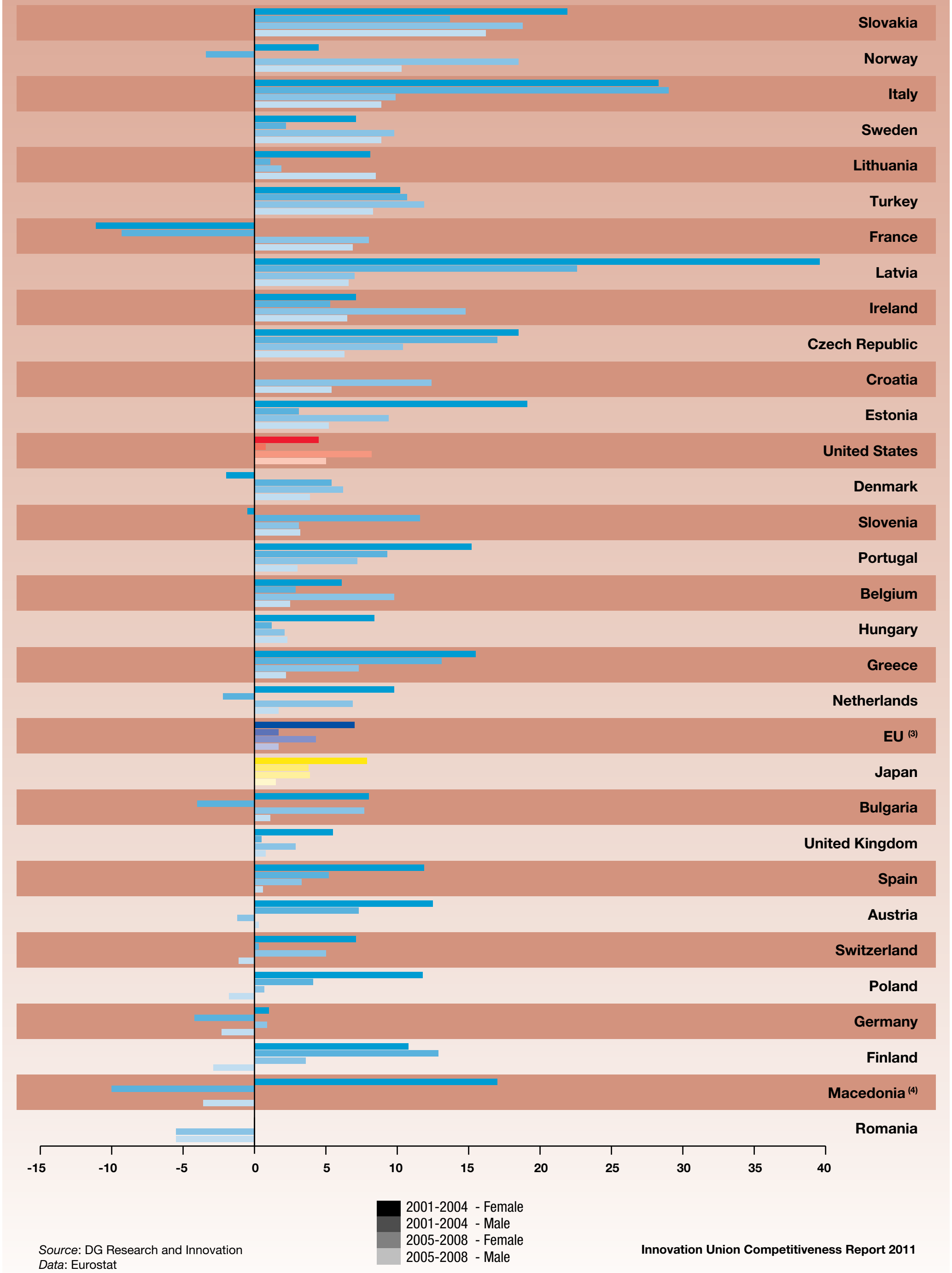
## 3.2.4 Segregation in education: fields of science

When studying segregation it is necessary to look at the gender distribution of PhD graduates across fields of study. Despite the rise in women's level of education and in their proportion among Ph.D. graduates, there remains a significant degree of segregation in specific fields of study.

### *On average throughout the EU in 2006, women PhD holders were over-represented in education, health, humanities, agriculture, veterinary while women are under-represented among PhDs in engineering*

Women constitute a majority in the fields of health and welfare (54%), of humanities and art (52%), and of agriculture and veterinary (51%). In social sciences, business and law, their proportion is 47%. This proportion falls to 41% for science, mathematics and computing and drops even lower to 25% for engineering, manufacturing and construction. However, this situation strongly varies between countries: the feminisation of the field of education is most pronounced in Portugal, Slovenia and Finland, where only one in four PhD education graduates was a man, and in Estonia, Cyprus and Iceland where 100% of the PhD graduates in education were women. This is probably due to very small sample sizes of PhD graduates in this field in these countries. When comparing the degree of masculinisation of engineering, manufacturing and construction cross-nationally, it appears that less than one in five PhD holders in this field is a woman in Germany (14%), Switzerland (19%) and Japan (11%). On the contrary, in Estonia, engineering appears to be a women's field, and 59% of PhD graduates are female. Estonia is clearly an exceptional case. Nevertheless, the smallest relative degrees of masculinisation of this field (>35% of PhDs being female) are observed in Italy, Portugal, Latvia, Lithuania, Croatia, and Turkey.

FIGURE II.3.10 Female and male PhD (ISCED 6) graduates - average annual growth (%), 2001-2004(1) and 2005-2008(2)



*Source*: DG Research and Innovation
*Data*: Eurostat
*Notes*: (1) FR: 2001-2003; CH: 2002-2004.
(2) FR: 2006-2008.
(3) EU: (i) LU and RO are not included in the EU aggregate for 2001-2004; (ii) LU is not included in the EU aggregate for 2001-2004.
(4) The Former Yugoslav Republic of Macedonia.

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The proportion of female PhD graduates in engineering, manufacturing, and construction is much lower than the EU-27 average (7.9%) in many countries; the lowest is observed in Germany (2.9%). At the other end of the scale, in Sweden this field boasts up to 20% female PhDs. In contrast with these relatively low shares of female PhDs in engineering, more than 30% of male PhDs are in this field in Sweden, Finland, Denmark, Bulgaria, the Czech Republic, and Slovenia. There is even more cross-country disparity in the proportion of female PhDs in health and welfare. There is usually more gender balance in science, mathematics, and computing and in the social sciences, business and law.

Table II.3.2 compares the proportion of female Ph.D. graduates between 2001 and 2008 in a number of countries. Between these two dates, there are differences in the evolution of the number of female PhD graduates by broad field of study. The most important finding is that women's share among Ph.D. graduates has increased in all fields of study. The disciplines where the rise of women has been most marked are education (increase by 12 percentage points between 2001 and 2008), followed by social science, business and law (increase by 9 percentage points). In engineering, manufacturing and construction, their proportion has increased by 6 percentage points as in science, mathematics, and computing.

## TABLE II.3.2

## Female PhD (ISCED 6) graduates as % of total PhD (ISCED 6) graduates by field of study, 2001(1) and 2008(2)

| | Education | | Humanities and Arts | | Social sciences, business and law | | Science, mathematics and computing | | Engineering, manufacturing and construction | | Agriculture and veterinary | | Health and Welfare | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2001 | 2008 | 2001 | 2008 | 2001 | 2008 | 2001 | 2008 | 2001 | 2008 | 2001 | 2008 | 2001 | 2008 |
| Belgium | 55 | 39 | 31 | 41 | 35 | 43 | 34 | 38 | 15 | 30 | 31 | 50 | 40 | 55 |
| Bulgaria | 44 | 53 | 44 | 70 | 40 | 60 | 46 | 53 | 28 | 35 | 52 | 62 | 52 | 49 |
| Czech Republic | 63 | 63 | 50 | 44 | 42 | 43 | 24 | 40 | 27 | 22 | 31 | 48 | 51 | 37 |
| Denmark | 50 | - | 52 | 52 | 38 | 49 | 31 | 32 | 24 | 22 | 43 | 56 | 51 | 55 |
| Germany | 42 | 56 | 45 | 51 | 32 | 38 | 27 | 36 | 12 | 15 | 53 | 60 | 45 | 54 |
| Estonia | - | 80 | 36 | 50 | 50 | 33 | 32 | 45 | 0 | 35 | 50 | 33 | 65 | 67 |
| Ireland | 50 | 73 | 54 | 57 | 49 | 69 | 43 | 47 | 22 | 19 | 37 | 63 | 60 | 59 |
| Greece | 52 | 55 | 51 | 56 | 52 | 37 | 32 | 33 | 21 | 25 | 44 | 37 | 65 | 44 |
| Spain | 54 | 57 | 45 | 50 | 44 | 51 | 45 | 50 | 23 | 31 | 33 | 48 | 49 | 58 |
| France | 50 | 52 | 57 | 57 | 42 | 47 | 39 | 38 | 27 | 27 | 57 | 28 | 57 | 50 |
| Italy | - | 71 | 62 | 59 | 48 | 52 | 49 | 51 | 36 | 35 | 56 | 58 | 63 | 62 |
| Cyprus | - | 50 | 0 | 20 | - | - | - | - | - | - | - | - | - | - |
| Latvia | 67 | 86 | 50 | 65 | 67 | 62 | 44 | 58 | 29 | 29 | 100 | 100 | - | 63 |
| Lithuania | : | : | 60 | 55 | 71 | 54 | 45 | 53 | 30 | 37 | 100 | 72 | 44 | 67 |
| Luxembourg | - | : | - | : | - | : | - | : | - | : | - | : | - | : |
| Hungary | 61 | 66 | 42 | 51 | 43 | 42 | 26 | 31 | 24 | 33 | 31 | 47 | 38 | 44 |
| Malta | - | - | 0 | 50 | - | 0 | - | 50 | 0 | 0 | 0 | - | 0 | 33 |
| Netherlands | - | : | 32 | 41 | 37 | 47 | 25 | 31 | 14 | 24 | 33 | 47 | 42 | 52 |
| Austria | 62 | 73 | 51 | 49 | 39 | 49 | 36 | 38 | 13 | 21 | 51 | 57 | 72 | 56 |
| Poland | - | : | 48 | 55 | 44 | 48 | 45 | 54 | 20 | 28 | 44 | 58 | 47 | 55 |
| Portugal | 66 | 77 | 65 | 67 | 46 | 61 | 50 | 55 | 39 | 39 | 56 | 58 | 67 | 74 |
| Romania | : | : | 49 | 61 | 54 | 50 | 50 | 51 | 30 | 26 | 33 | 44 | 48 | 54 |
| Slovenia | 81 | 80 | 51 | 66 | 63 | 55 | 43 | 49 | 23 | 24 | 69 | 52 | 58 | 52 |
| Slovakia | 45 | 61 | 37 | 53 | 47 | 50 | 45 | 49 | 29 | 36 | 38 | 49 | 54 | 54 |
| Finland | 66 | 84 | 53 | 56 | 48 | 59 | 37 | 47 | 21 | 28 | 39 | 62 | 65 | 72 |
| Sweden | 66 | 73 | 44 | 52 | 41 | 48 | 33 | 37 | 24 | 29 | 48 | 56 | 53 | 60 |
| United Kingdom | 55 | 63 | 46 | 49 | 40 | 55 | 39 | 38 | 19 | 22 | 40 | 57 | 52 | 55 |
| EU | 55 | 67 | 49 | 54 | 40 | 49 | 36 | 42 | 21 | 26 | 46 | 54 | 49 | 55 |
| Iceland | - | 50 | - | - | 100 | 0 | - | 0 | - | 0 | - | - | 100 | 71 |
| Norway | 55 | 56 | 47 | 51 | 40 | 52 | 9 | 34 | 14 | 29 | 37 | 43 | 41 | 57 |
| Switzerland | 25 | 67 | 43 | 49 | 29 | 37 | 26 | 38 | 13 | 22 | 56 | 67 | 47 | 47 |
| Croatia | 0 | 73 | 42 | 71 | 49 | 49 | 40 | 54 | 18 | 24 | 44 | 37 | 49 | 53 |
| Macedonia(3) | 67 | 45 | 25 | 43 | 10 | 33 | 58 | 64 | 11 | 29 | - | 33 | 75 | 68 |
| Turkey | 35 | 42 | 26 | 38 | 34 | 39 | 44 | 43 | 32 | 31 | 39 | 47 | 55 | 61 |
| United States | 65 | 67 | 45 | 48 | 53 | 58 | 34 | 39 | 17 | 22 | 36 | 39 | 62 | 73 |
| Japan | 46 | 49 | 47 | 48 | 33 | 37 | 17 | 21 | 8 | 12 | 23 | 28 | 23 | 31 |

*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) CH: 2002; RO, HR: 2003, EL: 2004
(2) EU, IT: 2008
(3) The Former Yugoslav Republic of Macedonia

## 3.3. Is Europe utilising the full potential of female researchers?

### *Europe counts more women than men in its student population, but there are fewer women relative to men as they progress higher up the academic career ladder*

Available data on vertical segregation concerns mostly the academic sector. The academic career path of women remains strongly marked by the vertical segregation. In general, the proportion of women is clearly declining as they reach higher up the academic ladder. This phenomenon is commonly illustrated by the scissors diagram (Figure II.3.11) that is built on cross-sectional data: the diagram shows the proportion of men and women at each stage of the academic career in a given year and compares them to the proportion that one would expect to find given the numbers of men and women undergraduates in prior years, based on the assumption that men and women were equally likely to stay in the system and to progress through at equal rates.

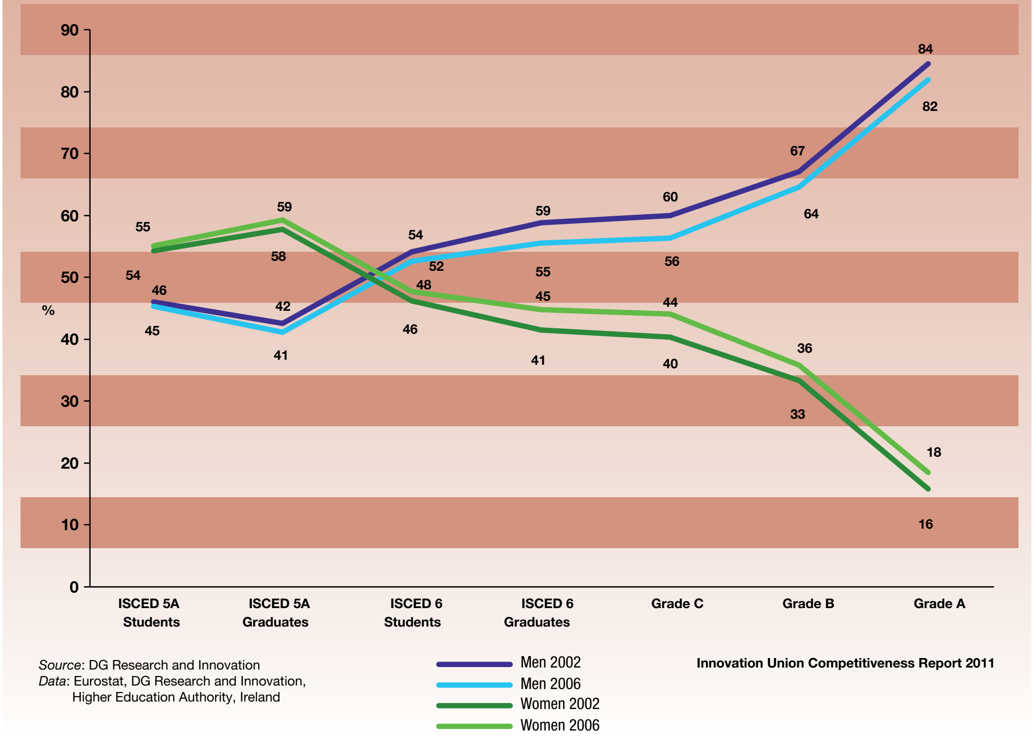
In the first two levels of university education (ISCED 5A students and graduates), the proportion of women outnumbers those of men. Indeed this high proportion of women in the student population is one of the most striking elements of the evolution of the last 30 years in most European countries. The situation changes when reaching the ISCED 6 student level (students in programmes leading to the award of an advanced research qualification – such as the PhD – that are devoted to advanced study and original research) where the proportion of women is 48%. Then the proportion of women drops back to 45% for the PhD graduates and the gender gap widens. The PhD degree often constitutes a necessary level to enter the academic career, so that the attrition of women's numbers at this level will have a knock-on effect on their relative representation at the first stage of the academic career. Furthermore, women represent only 44% of grade-C academic staff, 36% of grade-B academic staff and 18% of grade A academic staff. The grade-C academic staff are the first grade/post to which a newly qualified PhD graduate would normally be recruited. The grade-B academic staff represents researchers working in positions more senior than newly qualified PhD holders, but less senior than those of grade-A staff. Finally, the grade-A academic staff constitutes the single highest grade/post at which research is normally conducted. The figures illustrate the workings of a 'sticky floor', a metaphor to point towards the difficulties graduate women face when trying to slip into the first levels of the academic career. This figure clearly bears witness to the existence of a glass ceiling composed of hard-to-identify obstacles that hold women back from accessing the highest positions in the hierarchy.

### *Over the period 1999–2006, the population of women in higher academic positions has slightly improved*

Figure II.3.11 allows the evaluation of the evolution of vertical segregation from 1999 to 2006. It shows an improvement in women's relative position. At the level of ISCED 5A graduates, the increase in the proportion of women between 1999 and 2006 was of three percentage points (at these low levels, the proportion of women is higher than that of men). At the level of ISCED 6 students, women's proportion also rose by three percentage points, while for ISCED 6 graduates there was an increase by seven percentage points between 1999 and 2006. The proportion of women at Grade C increased by six points over the period, while there was an increase by only four points at Grade B and five points at Grade A. The increase in the proportion of women was higher among ISCED 6 graduates and Grade C, and it diminishes among higher hierarchical levels. The increase in the proportion of women is lower at higher hierarchical levels. This illustrates a higher resistance to the integration of women in higher levels (especially Grade A) or it could be due to a time lag on the impact on academia of the positive evolution at PhD level. However, it is also worth noting that these improvements appear to be very slow.

Figure II.3.12 presents the evolution of the proportion of women in Grade-A academic position by country for the years 2002–2007. Several countries such as Slovakia and Switzerland show very important evolutions of their proportion of women at Grade A. In Portugal, Estonia and Greece, the percentage remains almost stagnant over the period.

FIGURE II.3.11 **EU – proportions of women and men in a typical academic career – students and academic staff, 2002 and 2006**



*Source*: DG Research and Innovation
*Data*: Eurostat, DG Research and Innovation, Higher Education Authority, Ireland

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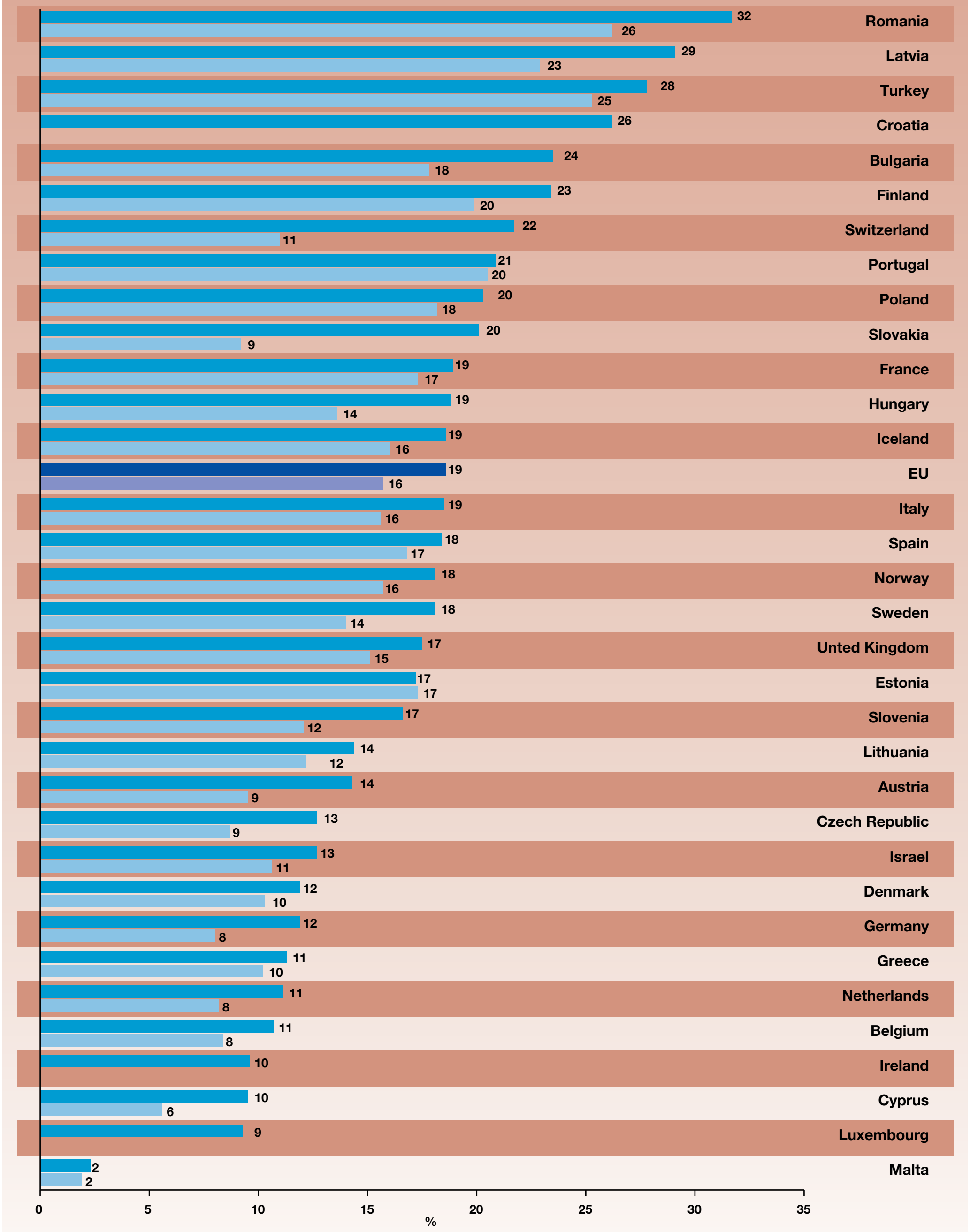
### *The under-representation of women throughout the academic career is particularly visible in science and engineering*

The previous figures documented vertical segregation in the academic world (in the EU). The scissors diagram (Figure II.3.13) concentrates only on the fields of science and engineering. The picture differs considerably and shows a considerably higher degree of women's under-representation. This field lacks attractiveness for women, since only 31% chose this field of science in 2006. However, this is particularly problematic only at the earlier stages of the academic career since the proportion of women increases throughout the first hierarchical echelons to reach 36% at the levels of PhD students and graduates. For the rest, an academic career in science and engineering shows the same pattern as in general over all fields of study. The most notable evolution between 1999 and 2006 concerns the proportion of women at Grade C (increase by seven percentage points over the period). However, for ISCED 5A and at Grade A, women's proportion has increased by just two to three percentage points over the period. The evolution for ISCED 6 (students), ISCED 6 (graduates) and Grade B are respectively four, six and five percentage points.

## FIGURE II.3.12 Proportion of women in Grade A academic positions, 2002[(1)] and 2007[(2)]



■ 2007
■ 2002$^{(1)}$

*Source*: DG Research and Innovation
*Data*: DG Research and Innovation, Higher Education Authority, Ireland
*Notes*: (1) EL: 1999; IL: 2001; AT: 2002; NL, UK, NO: 2003.
(2) EL: 2000; PT: 2003; EE, MT: 2004; DK, FR, CY, LU, AT, IL: 2006; UK: 2006/2007; HR: 2008
(3) The EU average was estimated by DG Research and Innovation.

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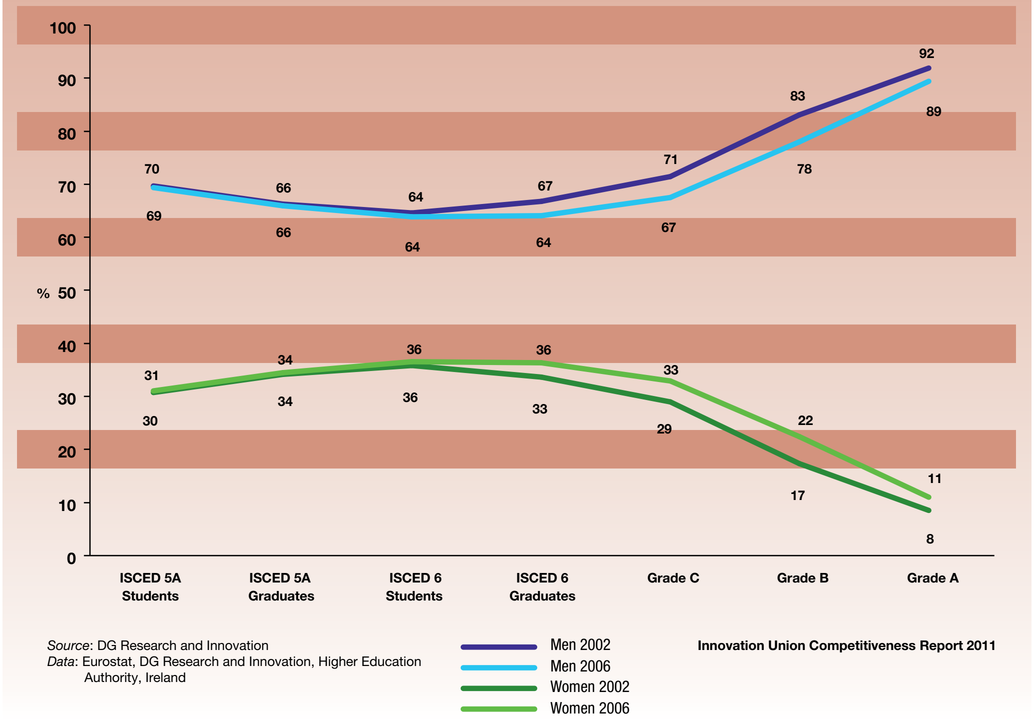
FIGURE II.3.13 EU - proportions of women and men in a typical academic career in science and engineering – students and academic staff, 2002 and 2006



*Source*: DG Research and Innovation
*Data*: Eurostat, DG Research and Innovation, Higher Education Authority, Ireland

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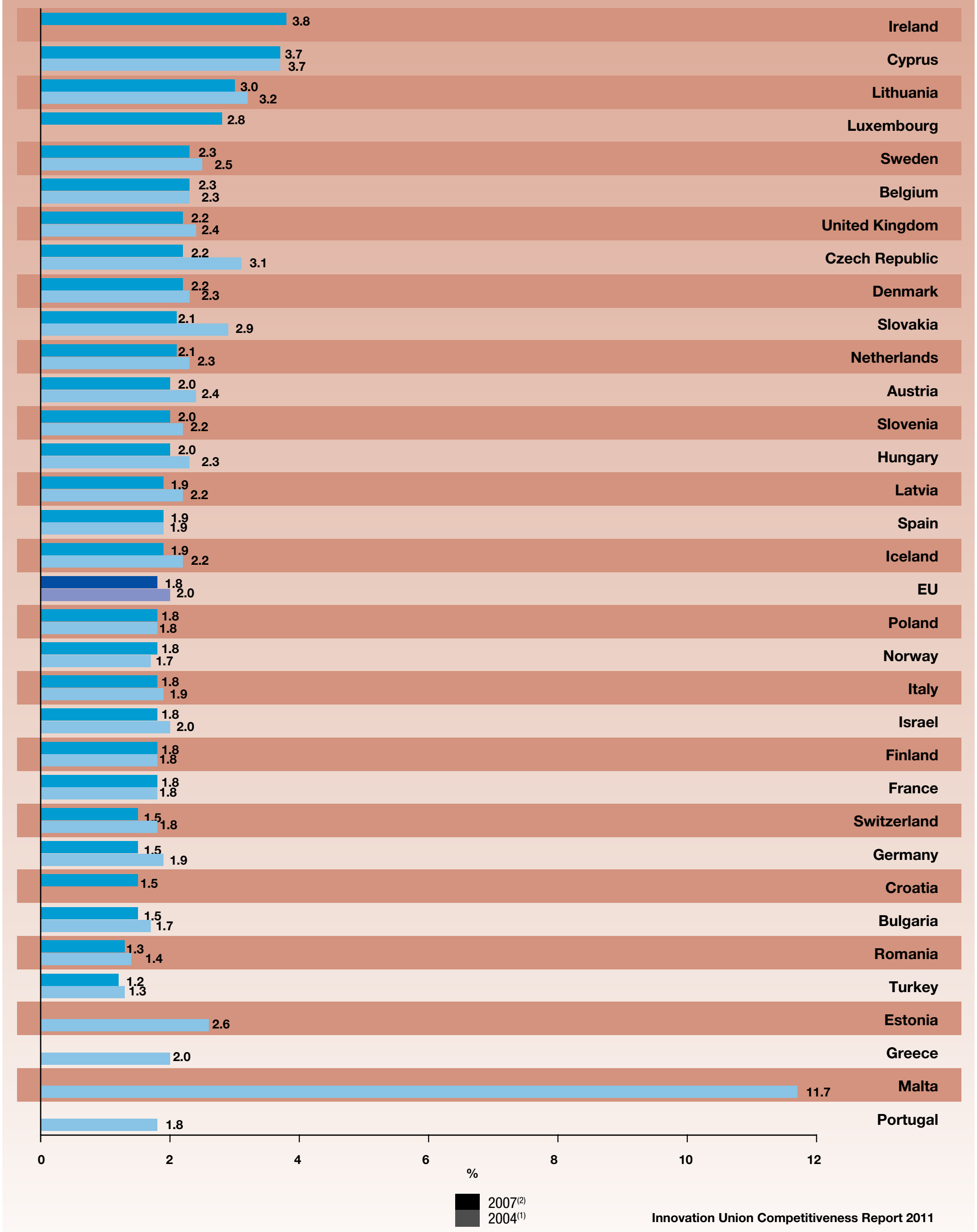
### *The probability of female researchers reaching a top academic position is lowest in Ireland, Cyprus, Lithuania, Luxemburg, Sweden and Belgium*

The glass ceiling index (GCI) illustrates the difficulties women have in getting access to the highest levels of the hierarchy and measures their relative probability, as compared with that of men, of reaching a top position. The GCI compares the proportion of women in grade A positions (equivalent to Full Professors in most countries) to the proportion of women in academia (grade A, B, and C), indicates the opportunity, or lack thereof, for women to move up the hierarchical ladder in their profession. The value runs from zero to infinity. A GCI of 1 indicates that there is no difference between the promotion of women and men. A score of less than 1 means that women are over-represented at grade A level. A GCI score of more than 1 means women are under-represented in grade A positions (glass ceiling effect). In other words, the interpretation of the GCI is that the higher the value, the thicker the glass ceiling and the more difficult it is for women to move into a higher position. On average for the EU-27, the GCI stands at 1.8 (Figure II.3.14). No country presents a GCI equal to or below 1. Its value ranges from 11.7 in Malta to 1.3 in Romania. The index is the highest in Ireland, Cyprus, Lithuania, Luxembourg, Sweden and Belgium. The case of Malta is extreme: it is the only country where so few female academics get into grade A positions. This can at least partly be explained by the fact that there is only one university in Malta. Between 2004 and 2007, the index decreased or remained stable in all countries.

### *There is a strikingly low presence of women in very high positions such as at the head of universities or other higher education institutions*

Women's under-representation in the higher levels of the academic hierarchy is reflected in the composition of the decision-making committees and leadership positions that are mainly composed of men. Consequently, one observes a strikingly low presence of women in very high positions such as at the head of

FIGURE II.3.14 **Glass Ceiling Index, 2004(1) and 2007(2)**



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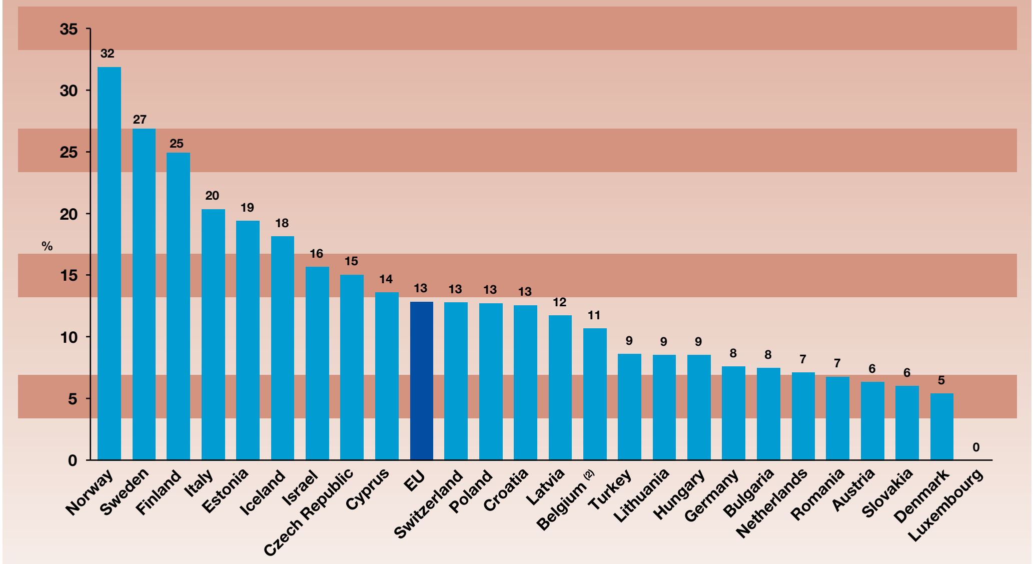
*Source*: DG Research and Innovation
*Data*: Eurostat, DG Research and Innovation, Higher Education Authority, Ireland
*Notes*: (1) EL: 2000; IL: 2001; PT, NO: 2003.
(2) DK, IE (in part), FR, CY, LU, AT, IL: 2006; UK: 2006/2007; HR: 2008
(3) The EU average was estimated by DG Research and Innovation.

FIGURE II.3.15 **Proportion of female heads of institutions in the Higher Education Sector (HES), 2007(1)**



*Source*: DG Research and Innovation

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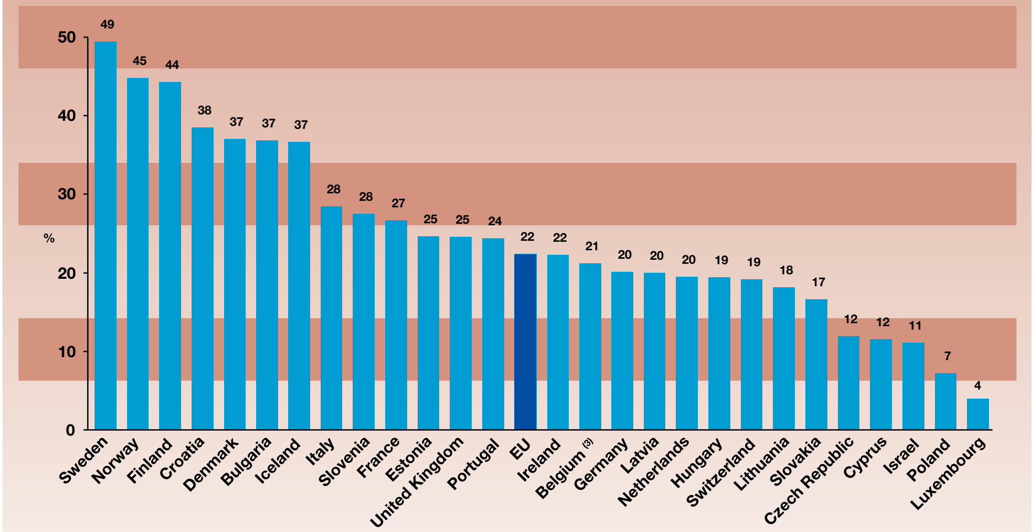
*Data*: DG Research and Innovation

*Notes*: (1) RO: 2006/2007; DK, CY: 2007/2008; BE (2), DE, EE, HU, AT, PL, SK, FI, SE, HR, CH, IL: 2008; IT: 2009.
(2) Belgium refers to the Dutch-speaking community only.
(3) The EU average was estimated by DG Research and Innovation.

universities or other higher education institutions. Figure II.3.15 illustrates this phenomenon well. On average throughout the EU, only 13% of institutions in the higher education sector were headed by women in 2007. We can see that this proportion varies from 27% to 0%. The countries that show the highest proportion of women are Norway, Sweden, Finland, Italy and Estonia (more than 19%). On the other hand, the countries that show a very low proportion of women in such leading positions are Luxembourg, Denmark and Slovakia (under 7%). When considering only universities and assimilated institutions (institutions that are able to award PhD titles), the proportion is even lower. The EU average shows only 9% of universities with a female head. The highest shares of women rectors are observed in Sweden, Iceland, Norway, Finland, but also in Israel. On the contrary, in Denmark, Cyprus, Lithuania, Luxembourg and Hungary, no single university is headed by a woman. Romania, Austria, Slovakia, Italy, the Netherlands, the Czech Republic, Belgium and Germany also have very low proportions of women rectors (7% at most). When comparing these results with the proportion of women in grade A, it is obvious that the proportion of women continues to fall as they advance on the academic ladder.

The proportion of women on boards adds interesting information to this overall pattern. Even if the coverage of boards differs across countries, one can state that in general, boards' data covers scientific commissions, R&D commissions, boards, councils, committees and foundations, academy assemblies and councils, and also different field-specific boards, councils and authorities. These all have a crucial power of influence on the orientation of the research. Figure II.3.16 presents data on the proportion of women on boards for the year 2007 – an EU average of 22%. The Nordic countries show particularly high proportions of women on boards. In Sweden, Norway and Finland, the share of female board members exceeds 44%. It is not surprising, as in these countries, there is an obligation to have at least 40% of members of each sex on all national research committees and equivalent bodies. The countries that show the lowest levels of women on boards (less than 20%) are Hungary, Lithuania, Switzerland, Slovakia, the Czech Republic, Cyprus, Israel, Italy, Poland and Luxembourg.

## FIGURE II.3.16 Proportion of women on boards(1), 2007(2)



*Source*: DG Research and Innovation

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*Data*: DG Research and Innovation

*Notes*: (1) There is no common definition of boards. The total number of boards varies considerably between countries. "She Figures 2009", p.99.
(2) FR, PL: 2002; PT: 2003; IE: 2004; CZ, SK, IL: 2008; IT: 2009.
(3) Belgium refers to the French-speaking community only.
(4) The EU average was estimated by DG Research and Innovation.

### *For all countries and all sectors, the proportion of male researchers is higher than the proportion of female researchers*

Data related to vertical segregation in sectors other than the higher education sector does not exist. Data for 2006 is available concerning the gender distribution of R&D staff within different occupations (researchers, technicians and others) for the higher education sector, the government sector, the business and enterprise sector and for all sectors put together. According to the Frascati manual, researchers are 'professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned', while technicians are 'persons whose main tasks require technical knowledge and experience in one or more fields of engineering, physical and life sciences or social sciences and humanities. They participate in R&D by performing scientific and technical tasks involving the application of concepts and operational methods, normally under the supervision of researchers.' Finally, other supporting staff include 'skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D projects or directly associated with such projects.' These definitions allow us to distinguish a certain hierarchy among R&D occupations: researchers are placed at the highest level, followed by technicians and other supporting R&D staff. According to this data, one observes that for all countries and all sectors, the proportion of male researchers is higher than the proportion of female researchers. Among the two other levels (technicians and other), the proportion of women exceeds that of men. Table II.3.3 presents the values of the ID index measuring vertical segregation (across professional categories – ISCO88, 3-digits) for three populations: the total workforce, the population of researchers and the population of the most highly qualified researchers (with a Ph.D. degree) for all Member States of the EU in 2007.

Vertical segregation among researchers should be understood as a different distribution of male and female researchers over the hierarchy of professions. The table shows that vertical segregation in the population of researchers is lowest in Spain, Cyprus, Belgium, Greece, Luxembourg and the Netherlands, and highest in Italy, Romania and Bulgaria. In 19 countries, the ID

## TABLE II.3.3

### Vertical segregation (ID-index): researchers compared to total labour force, 2007

| | Total labour force | Researchers (ISCED 5A, 5B, 6) | Researchers with a PhD (ISCED 6) |
|---|---|---|---|
| Spain | 0.47 | 0.24 | 0.12 |
| Cyprus | 0.46 | 0.25 | 0.34 |
| Belgium | 0.45 | 0.26 | 0.14 |
| Greece | 0.40 | 0.26 | 0.29 |
| Luxembourg | 0.45 | 0.27 | 0.10 |
| Netherlands | 0.46 | 0.27 | 0.19 |
| Lithuania | 0.53 | 0.29 | 0.12 |
| Portugal | 0.47 | 0.29 | 0.14 |
| Austria | 0.49 | 0.30 | 0.27 |
| Latvia | 0.52 | 0.31 | 0.25 |
| Czech Republic | 0.52 | 0.32 | 0.20 |
| Denmark | 0.46 | 0.33 | 0.19 |
| France | 0.33 | 0.34 | 0.16 |
| Poland | 0.42 | 0.34 | 0.26 |
| Germany | 0.47 | 0.35 | 0.32 |
| Norway | 0.47 | 0.35 | 0.09 |
| United Kingdom | 0.49 | 0.35 | 0.11 |
| Hungary | 0.52 | 0.36 | 0.27 |
| Estonia | 0.57 | 0.37 | 0.57 |
| Ireland | 0.51 | 0.37 | 0.12 |
| Finland | 0.55 | 0.40 | 0.15 |
| Slovakia | 0.54 | 0.40 | 0.44 |
| Slovenia | 0.42 | 0.41 | 0.19 |
| Sweden | 0.47 | 0.45 | 0.11 |
| Italy | 0.39 | 0.48 | 0.13 |
| Romania | 0.39 | 0.52 | 0.24 |
| Bulgaria | 0.47 | 0.55 | 0.33 |

*Source:* DG Research and Innovation

*Data:* LFS 2007, own calculations

*Note:* (1)The data concerning researchers with a PhD should be interpreted with caution due to small sample size

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index is lower among researchers than on the labour market as a whole, and it drops even further when one compares total researchers with the subsample of the most highly qualified researchers. In a second group including France, Italy, Romania and Bulgaria, the level of dissimilarity in the distribution over professional categories is higher when only researchers are concerned than when the total labour force is analysed. In all of these countries, the ID index, although higher for researchers than for the total workforce, is lower amongst the most highly qualified researchers (ISCED 6) than amongst researchers of all levels of education (ISCED 5A and 5B) and than for the total workforce. In Cyprus, Slovakia, Greece, and to a smaller extent Estonia, professional dissimilarity is highest in the total workforce, lowest in the population of researchers, and falls between these two extremes for the most highly qualified male and female researchers.

# CHAPTER 4

# Optimising research programmes and infrastructures

## HIGHLIGHTS

The European research system is going through reforms in order to enhance excellence and efficiency. These reforms are made at national level but efficiency gains from using the European research system are increasingly exploited.

At the European level, reforms in the funding allocation for research and in research organisations capitalise on the expanding EU funds for research. In 2007–2008, the EU research Framework Programme (FP) represented about 7.5% of civil R&D expenditures financed by governments in Europe. Total EU funding of R&D (FP and Structural Funds[235]) reached almost 16% of total national civil R&D budgets in EU-27. National public funding of intergovernmental research infrastructures and intergovernmental Europe-wide research programmes and agencies represents about 3.5% of civil R&D expenditures financed by governments in Europe. When examining national R&D budgets and adding national public funding to bi- and multi-lateral R&D programmes, about 4.5% of EU Member States' R&D budget was directed to 'trans-nationally coordinated research'[236] in 2008.

The trans-national coordination of research funding is expected to rise in Europe. In particular, European countries are jointly deciding and funding the construction and major upgrade of 44 pan-European research infrastructures in all the main scientific fields for an estimated total construction cost of EUR 21–22 billion, and Joint Programming Initiatives are being launched to address major societal challenges through jointly programmed public research. FP instruments of coordination of R&D programmes (ERA-NET, ERA-NET+, JTIs, Art. 185) and other Europe-wide R&D programmes (EUREKA, COST, ESA, EFDA, EUROCORES) are equally major driving forces for trans-nationally coordinated research activities.

In absolute numbers, scientific cooperation through the EU FP mainly takes place between the four larger Member States. However, when corrected by the size of the country, researchers in smaller countries, including new Member States, have a higher integration propensity in the scientific cooperation funded by the FP. Also, relative to their R&D expenditure level, convergence objective regions benefit more from FP7 funding than regions with higher R&D intensity.

The modalities and conditions for participation of non-resident research performers in national R&D programmes vary across countries and across different types of programme within a country. However, there is as yet no robust estimation of the degree of openness of national R&D programmes in Europe. Reforms should lead to the opening up of most national programmes to non-resident participation – which does not necessarily imply funding – and to an increase in the number of national programmes that are fully open. Opening up national programmes also necessitates a greater alignment of participation and funding rules in Europe in order to facilitate the participation of non-residents, reduce red tape, abolish the tax on innovation due to unnecessary administrative costs and ease trans-border cooperation

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[235] 2007–2008 FP spending (annual average), Structural Funds earmarked for Research, Technology, Development and Innovation (RTDI) activities over the period 2007–2013 (annual average).

[236] *Trans-nationally coordinated* research funding, also coined *intergovernmental* research funding, implies the coordination of national funding for research activities *bi- or multi-laterally*, through *Europe-wide research* programmes and agencies, or through *intergovernmental research infrastructures*. It is distinct from EU Framework Programme funding which comes directly from the EU budget, is managed by the European Commission, and does not imply the coordination of national funding.

## 4.1. Are national and European research programmes becoming more closely integrated?

Public funding needs to be optimally distributed to research performers, and there are several ways to do this. National public funding can be allocated as recurrent funding to national research institutions, or competitively to selected research projects; it can be used domestically only, but it can also be opened to non-resident researchers, or used in coordination with public funding from other countries. Finally, in Europe, part of public funding of R&D comes from the EU budget. This chapter analyses the relative importance of the different allocation modes of public funding in Europe. The efficiency of research in Europe partly depends upon the balance between them.

### 4.1.1 The two main allocation modes of direct public research funding[237]

#### *Institutional funding is dominant in most countries, but project-based funding represents more than half of total direct government funding in certain countries*

Governments can use two main modes of direct R&D funding: institutional and project-based. Institutional funding can help ensure stable research funding in the long run, while project-based funding can be used to promote competition within the research system as well as targeting strategic areas. Project-based funding includes R&D national contracts from line ministries and contributions from the government to national funding agencies (e.g. research councils).

The balance between these two modes of funding varies across countries. In several countries since the 1970s, the volume of project-based funding has strongly increased both in real terms and as % of GDP. In Switzerland, Austria, Norway, France, Italy and the Netherlands, project-based funding has been multiplied by two to five in real terms between 1970 and 2002[238]. The long-term trend of public R&D funding mode favours project funding over institutional funding. Since 2000 however, there is a relative stability between the two modes of funding in Europe, except in Austria where the share of project funding has increased sharply[239].

Despite this long-term trend, in most countries more than half of direct government funding is still institution-based (Figure II.4.1). Among European countries, Belgium, Finland and Ireland are three exceptions, with more than 50% of project-based direct government funding. There is no strong relationship between the level of direct government funding (GBAORD as % of GDP) and the share of the latter that is project-based.

#### *The public sector (higher education and government sectors) is the quasi-exclusive destination of institutional funding, while the business sector is the destination of a good share (20-40%) of the project-based funding*

The public sector (higher education and government sectors) is the quasi-exclusive destination of institutional funding, although in some countries (the Czech Republic, Austria, Poland, Belgium and Germany) the business sector also receives some (very small share) of it (Figure II.4.2)[240]. In contrast, in all countries the business sector is the destination of a good share (20–40%) of the project-based funding – up to 60% in Austria and 90% in Israel. In some countries, the project-based funding is primarily managed by independent agencies (Belgium, Netherlands, Austria), while in others the research ministry and other ministries are the main, sometimes exclusive, managers of this type of funding (Czech Republic, Poland and Germany)[241].

#### *The development of trans-nationally coordinated (intergovernmental) public R&D activities and open public R&D programmes is growing*

Public R&D funding in Europe is channelled through different funding modes at EU, inter-governmental, national and regional level. Although substantial

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[237] The data presented in this section is based on preliminary data from the OECD Microdata project on public R&D funding of the Working Party of National Experts in Science and Technology (NESTI), 2009. This is new, experimental data to be treated with care.

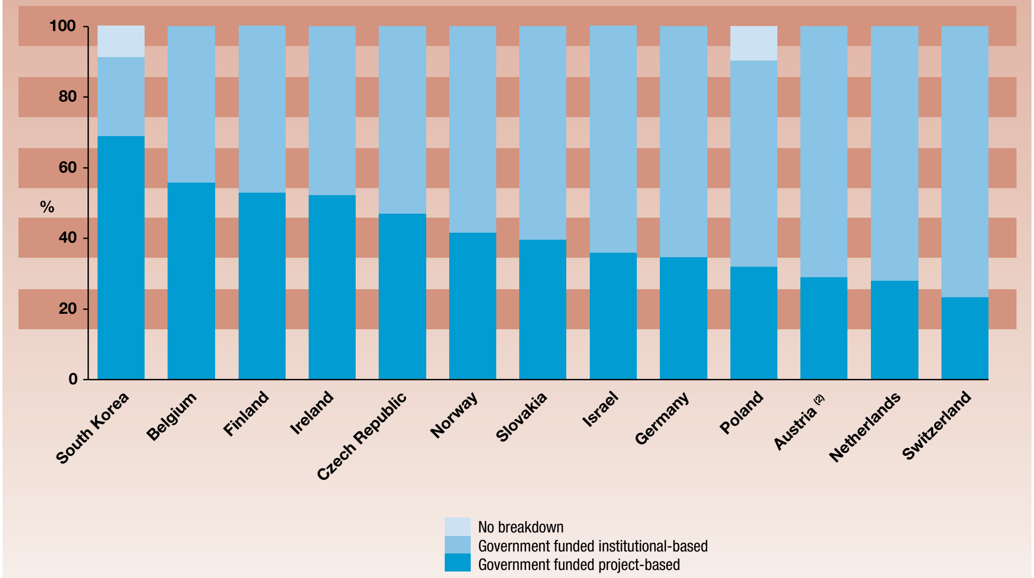
[238] Lepori et al. 'Comparing the evolution of national research policies: what patterns of change?' *Science and Public Policy*, 34(6), July 2007, pages 372–388. This study covers six European countries: Switzerland, Austria, Norway, France, Italy and the Netherlands.

[239] OECD, based on preliminary data from the Microdata project on public R&D funding of the Working Party of National Experts in Science and Technology (NESTI), 2009. This observation is done on a limited number of countries which could provide the data back to 2000.

[240] Ibid. Data to be treated with care as the destination of funds is not always clear in GBAORD data.

[241] Ibid.

FIGURE II.4.1 **Government funded R&D by type of funding(1), 2008(2)**



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*Source*: DG Research and Innovation
*Data*: OECD, based on preliminary data from the microdata project on public R&D funding of the Working Party of National Experts in Science and Technology (NESTI), 2009-2010.
*Notes*: (1) This is an experimental indicator. International comparability is currently limited.
(2) AT: 2009.

between FP6 and FP7, the increase in the EU R&D budget is necessarily limited in comparison to what can be achieved with the coordination and opening-up of the national research programmes which remain the bulk of public research in EU-27. The development of trans-nationally coordinated (intergovernmental) public R&D activities and open public R&D programmes are, therefore, meant to be a key and growing element of the ERA in the future.

### 4.1.2. Trans-nationally coordinated (intergovernmental) research in Europe[242]

***Together, the EU research Framework Programme (FP) and intergovernmental public funding represent about 11% of civil R&D expenditures financed by governments in Europe.***

In 2009, governments of EU Member States and EFTA countries contributed EUR 2.6 billion to intergovernmental research, a slight increase compared to 2008 (EUR 2.3 billion) and 2007 (EUR 2.4 billion) (Figure II.4.3)[243].

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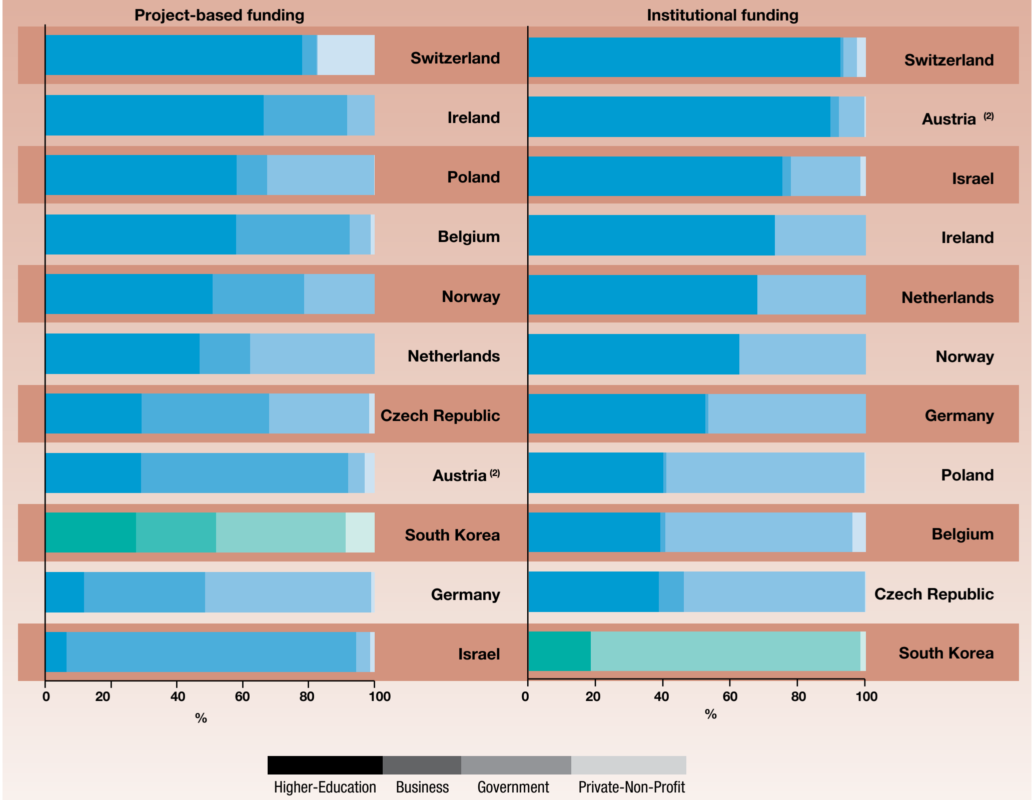
[242] In this chapter, ‘intergovernmental’ and ‘trans-national’ are used interchangeably and refer to coordination between countries.

[243] For this 2010 report, figures provided by all intergovernmental programmes were checked with respect to 2008/2009 report, when they were used for the first time. Consistency was ensured by checking that:
- year of allocation was year of national budgetary commitment: this moved allocation of ERA-NET joint calls from scheduled to actual year, not altering the total;

FIGURE II.4.2

## National public funding by funding modes(1) and sector of performance, 2008(2)



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*Source*: DG Research and Innovation
*Data*: OECD, based on preliminary data from the microdata project on public R&D funding of the Working Party of National Experts in Science and Technology (NESTI), 2009-2010.
*Notes*: (1) This is an experimental indicator. International comparability is currently limited.
(2) AT: 2009.

In 2009, national public contributions to intergovernmental research were equal to 43% of the amount of FP available that year (EUR 6.1 billion). In 2007 and 2008, they represented respectively 3.5% and 3.2% of all civil R&D expenditures financed by governments of EU Member States and EFTA countries.

Although they underestimate the amount of national public funds for trans-nationally coordinated research (bi-lateral and multi-lateral research programmes are not included), these figures show that there is considerable room for increased cross-border programme collaboration and coordination.

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- budget allocated was checked by independent sources for ERA-NET joint calls. (ftp://ftp.cordis.europa.eu/pub/fp7/docs/fp6-era-net-study-summary-web-version_en.pdf)
- Only budgets for R&D activities were included. This reduced by 75% allocation of ESA funds from 2007 onwards. Most of what was mentioned in the 2008/2009 report (covering years until 2006) appearing to be industrialisation activities, not R&D.
- Only public research funding was counted. This reduced by 70% allocation of Eureka funds from 2007 onwards. Most of what was mentioned in the 2008/2009 report (covering years until 2006) appeared to be private funding or industrialisation activities, not R&D.

## Box II.4.1 – Intergovernmental research

Intergovernmental research includes:

(i) research performed in *intergovernmental research infrastructures* (CERN, EMBL, ESO, ESRF, ILL, see below); future research infrastructures of the ESFRI Roadmap (see below) will belong to this category;

(ii) European-level *intergovernmental research programmes and agencies* (ESA, EMBO, ESF, EUREKA), as well as a number of FP *instruments of coordination* (ERA-NET, ERA-NET+, JTIs, Art. 185); the latter were introduced in FP6 and FP7 and they already represented 20% of national funding directed to intergovernmental research in 2008–2009 (see zoom-in in Figure II.4.3); the Joint Programming Initiatives (see below) belong to this category;

(iii) *bi- or multi-lateral programmes* between European countries. In Figure II.4.3, however, these programmes are not included[244].

Intergovernmental research funding is also coined *trans-nationally coordinated research* funding. It implies the *coordination of national funding* for research activities. It is distinct from EU Framework Programme funding which comes directly from the EU budget, is managed by the European Commission, and does not imply the coordination of national funding. This does not prevent part of the EU FP funding from being used to trigger the coordination of national funding (FP instruments of coordination: ERA-NET, ERA-NET+, JTIs, Art. 185).

In 2007 and 2008, EU FP funds represented respectively 7.4% and 7.7% of all civil R&D expenditures financed by governments of EU Member States and EFTA countries (Figure II.4.3 below). FP funds are not the sole EU funds allocated to R&D. A significant share of Structural Funds is used for RTDI[245] projects in Member State: about 14.4%, i.e. EUR 50 billion over 2007–2013, an amount comparable with that of the FP (see Chapter 3 in Part I for an analysis of total EU funds for R&D). However, the use of Structural Funds for trans-national coordination appears to be extremely limited, and, therefore, is not included in Figure II.4.3. There is considerable room for more coordination of regional R&D funding as expressed by regions participating in the ERA-NET scheme[246] and Joint Programming Initiatives.

### *Project-based funding is easier to coordinate trans-nationally than institutional funding*

The comparison of FP funds and national funding of intergovernmental research with total civil R&D expenditures financed by governments is not entirely appropriate. National funding of civil research includes both institutional funding (of universities and other public research organisations) and competitive project-based funding (see Figure II.4.1), while the EU FP funding and intergovernmental research programmes are above all competitive project-based, the institutional part of the EU FP being limited to the budget dedicated to the Joint Research Centre. Institutional funding includes mainly salaries of researchers and other R&D personnel, capital expenditures and recurrent funding of laboratories. It constitutes over half (and up to 80%) of total government funding of R&D in most European countries (see section 4.1.1), although the share of project-based funding has been increasing in most of them in recent years.

Compared to project-funding, only a small part of this institutional funding can easily be trans-nationally coordinated, i.e. mainly the national funding to large trans-national research infrastructures. Therefore, a large share of (civil) R&D expenditure financed by government displayed in Figure II.4.3 cannot easily be subject to trans-national coordination. The project-based part of national funding can be more easily used for trans-national public R&D programmes. However, actions such as the European Metrology Research Programme (EMRP[247]) Art.185 initiative (which shared some EUR 60 million over 2008 and 2009), the European Research Infrastructure Consortia (ERIC) or the recently launched European Energy Research Alliances[248], suggest that such coordination of institutional funding is starting to follow the path pioneered by CERN in the 1950s.

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[244] These were estimated to account for less than 1% of total national GBAORD in most countries by the first data collection of Eurostat (2010) on GBAORD to trans-nationally coordinated research.

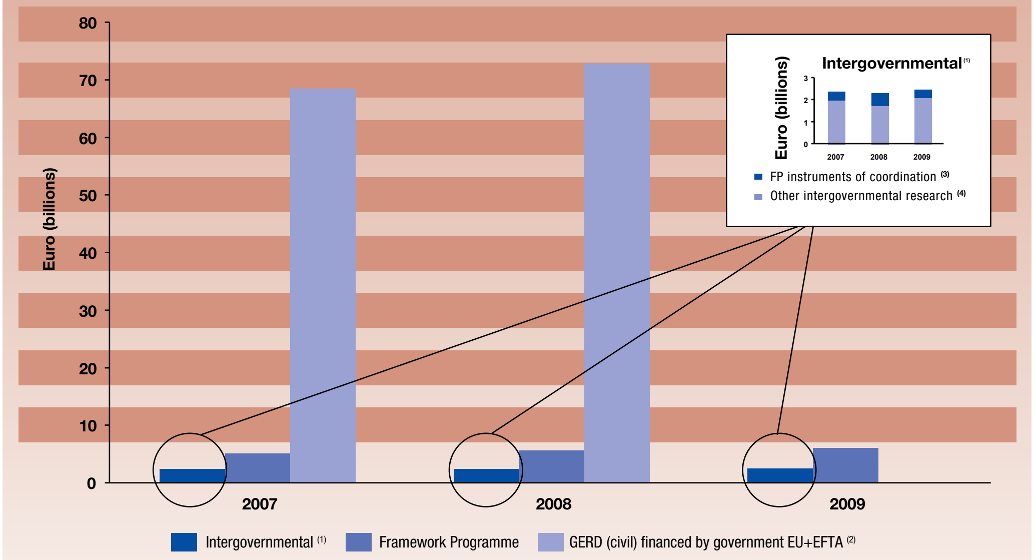
[245] Research, Technology, Development and Innovation.

[246] ftp://ftp.cordis.europa.eu/pub/fp7/docs/fp6-era-net-study-summary-web-version_en.pdf

[247] http://www.emrponline.eu

[248] http://www.eera-set.eu

FIGURE II.4.3 **Public funding of R&D in Europe, 2007-2009**



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*Source*: DG Research and Innovation
*Data*: DG Research and Innovation, Eurostat
*Notes*: (1) Intergovernmental includes the budget contributions from the EU Member States, EFTA countries, Israel, Candidate countries (Croatia, The former Yugoslav Republic of Macedonia, Turkey) to ERA-NET, ERA-NET+, JTIs (Artemis, ENIAC), Art 185 (EMRP, EUROSTARS, AAL, EDCTP), CERN, EMBL, EMBO, ESA, ESRF, ESO, ILL, ESF, COST and EUREKA.
(2) GERD (civil) financed by government was estimated by DG Research and Innovation.
(3) FP instruments of coordination: ERA-NET, ERA-NET+, JTIs, Art. 185.
(4) Other intergovernmental research: CERN, EMBL, EMBO, ESA, ESRF, ESO, ILL, ESF, COST and EUREKA.

When compared to project-based government funding alone, FP funds appear much more considerable: in certain Member States, the EU FP represents more than 20% of the project-based funding available[249]. In total, according to the first Europe-wide estimations, the EU FP represents some 20% to 25% of all project-based funding in Europe[250]. Therefore, if national governments ensure the basic recurrent funding of laboratories in terms of salaries and infrastructures, EU FP funds may be of significant importance for their actual functioning and the development of their research projects.

### *Joint Programming Initiatives are being launched to address major societal challenges through jointly programmed public research*

A Joint Programming Initiative (JPI) is a partnership[251] between the Member States involved, facilitated by the support of the European Commission, and aimed at addressing major societal challenges through jointly programmed public research and related actions.

A pilot JPI on Neurodegenerative diseases (including Alzheimer's disease) was launched in December 2009. Three additional Joint Programming Initiatives were launched in 2010: (1) Agriculture, Food Security and Climate Change, (2) Cultural Heritage and Global Change: a new challenge for Europe, (3) A Healthy Diet for a Healthy Life.

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[249] Lepori B., van den Besselaar P., Dinges M.,van der Meulen B., Poti B., Reale E., Slipersaeter S., Theves J., (2007), *Comparing the evolution of national research policies: what patterns of change?*, Science and Public Policy Vol. 34, No 6, pp. 372-388.) (see also http://www.enid-europe.org/funding/CEEC.html).

[250] European Commission's estimations.

[251] Joint Programming Initiatives are not an instrument.

National funding to trans-nationally coordinated research is, therefore, expected to increase substantially in the coming years, probably more so than EU funding for research. The increase in EU funding for research, although important between FP6 and FP7, is necessarily limited in comparison to what can be achieved with the coordination (and opening up) of national research programmes which continue to provide the bulk of public research in EU-27 as shown in Figure II.4.3.

### *On average, about 4.5% of EU Member States' R&D budget was directed to 'trans-nationally coordinated research' in 2008*

Figure II.4.4 below presents the experimental results of the first ever data collection[252] on 'national public funding to trans-nationally coordinated research', defined as the total of budget funded by the government (state, federal, provincial, as measured by GBAORD[253]) which is directed to the three categories of R&D performers and programmes spelled out (Box II.4.1), namely:

- (i) trans-national public R&D performers[254] located in Europe;
- (ii) Europe-wide trans-national public R&D programmes[255];
- (iii) bi- or multi-lateral public R&D programmes established between Member States' governments[256].

While the first category often implies cross-border flows of funds (the trans-national R&D performer located in one country is located 'abroad' for all the other contributing countries), it is not the case of the second and third categories which may or may not imply cross-border flows of funds. In most trans-national R&D programmes, there is actually no cross-border flow of funds, and each country funds its own participants.

Figure II.4.4 does not include national contributions to the FP funding which comes from the overall national contributions to the total EC budget[257].

Trans-nationally coordinated research is not meant to be limited to European coordination only. Non-European countries participate in research activities performed in trans-national public R&D performers located in Europe. Multilateral public R&D programmes between European countries can (and often do) include non-European countries.

In 2008, for the 18 countries providing this data (except Belgium), the share of the total R&D budget (GBAORD) that was used to fund 'trans-nationally coordinated research' ranges from 1.03% in Poland to 5.45% in Germany (Figure II.4.4), with an EU aggregate of 4.49%[258]. Belgium stands out as an exceptional case with 12.13% of its R&D budget directed to trans-nationally coordinated research in 2008.

### *The share of countries' R&D budget directed to 'trans-nationally coordinated research' increased slightly in 2008 compared to 2007*

The share of R&D budget directed to 'trans-nationally coordinated research' did not change much in most countries between 2007 and 2008, except in Cyprus (+56%) and in Poland (-32%). At EU aggregate level[259] it increased by 5.2%, from 4.27% in 2007 to 4.49% in 2008. In nominal terms, national public funding to trans-nationally coordinated research increased in all countries except in Slovenia and Poland.

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[252] This data collection was conducted for the first time in 2010 by National Statistical Institutes under the guidance of Eurostat. As it is the first data collection of this kind, the figures have to be considered with the greatest caution and will be subject to revision in the coming years. Eighteen European countries (among them fifteen EU Member States) provided all the data on this indicator.

[253] Government Budget Appropriations or Outlays for R&D.

[254] 'Trans-national public R&D performers': CERN, EMBL, ESO, ESRF, ILL, JRC. See Methodological Annex.

[255] 'Europe-wide trans-national public R&D programmes': EUREKA, COST, ESA, ERA-NETs, ERA-NET+, EFDA, EUROCORES, Art 185 initiatives (Europe-Developing Countries Clinical Trials Platform, Eurostars and Ambient assisted living for the elderly), Joint Technology Initiatives (public funding part: ENIAC, ARTEMIS). See Methodological Annex.

[256] And with candidate countries and EFTA countries.

[257] See Part III, Chapter 2 for total EU funding for RTDI.

[258] This EU aggregate is based on the 15 Member States that provided all the data on this indicator for 2008.

[259] This EU aggregate is based on the 15 Member States that provided all the data on this indicator for 2007.

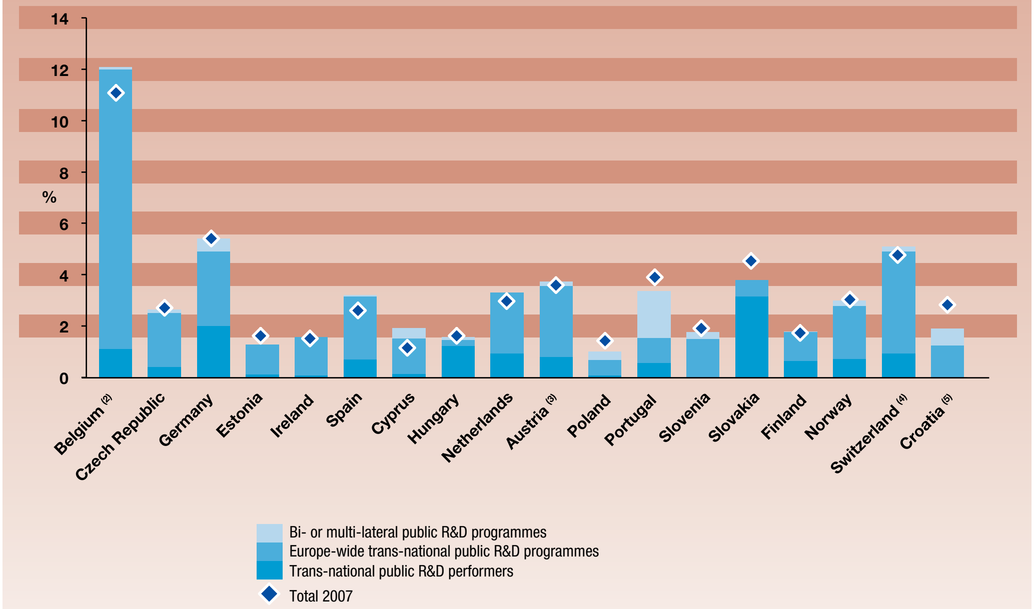
### *FP instruments of coordination of national R&D programmes and other Europe-wide R&D programmes are a major driving force for trans-nationally coordinated research activities*

In almost all countries that provided the data, the largest part (more than two thirds) of the national contributions to ‘trans-nationally coordinated research’ goes to the category ‘Europe-wide trans-national public R&D programmes’. The dominant category in Hungary and Slovakia alone is the ‘trans-national public R&D performers’, and in Portugal, ‘bi- or multilateral public R&D programmes’. In all countries except in Portugal, less than 1 % of GBAORD is directed to ‘bi- or multilateral public R&D programmes’.

Even if this first data collection underestimates the amount of national funding directed to the third category (bi- and multilateral R&D programmes), these observations show the great importance of Europe-wide programmes in steering the coordination of R&D programmes in European countries. The use of FP instruments of coordination in particular (participation in ERA-NETs, European Technology Platforms, Joint Technology Initiatives) and the coordination under the ESFRI Roadmap, are mentioned in all countries as major vehicles for implementing S&T and research coordination[260].

FIGURE II.4.4

**National public funding of trans-nationally coordinated research by category(1), as a% of total national GBAORD, 2008**



*Source*: DG Research and Innovation
*Data*: Eurostat
*Notes*: (1) Experimental data.
(2) BE: Data of some regional authorities in Belgium is probably not included.
(3) AT: federal or central government only.
(4) CH: 2007 value uses 2006 GBAORD as denominator.
(5) HR: 2007 value uses 2008 GBAORD as denominator.

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[260] *Monitoring progress towards the ERA*, European Commission, ERAWATCH Network, 2009. Available at: http://cordis.europa.eu/erawatch/index.cfm?fuseaction=reports.home

## 4.2. Has there been progress in the development of pan-European research infrastructures?

### *Coordinated and joint R&D activities take place in existing large pan-European research infrastructures*

Coordinated and joint R&D activities take place in a number of existing medium- to large-scale research infrastructures (RIs) in Europe, i.e. medium- or large-scale, single-sited, distributed or virtual facilities or joint resources that provide unique access and services to research communities in both academic and technological domains. These facilities typically have investment, operating or maintenance costs that are relatively high in relation to research costs in their particular field. RIs play a central role in the advancement of knowledge and have a structuring effect in their respective scientific fields. Each of them is by nature a focal point of intensive trans-national research cooperation, for both its construction and its regular operation. RIs allow the performance of major trans-national frontier research projects with the most advanced equipment and instruments. RIs, therefore, play a central role in the trans-national coordination of research activities.

### *Large pan-European research infrastructures foster international cooperation in science and achieve world-class scientific and technological excellence in interdisciplinary fields*

EIROforum is a partnership of European Intergovernmental Research Organisations (EIROs). The EIROforum partners design, construct, operate and exploit large RIs on behalf of the user communities of their member countries and beyond, covering disciplines ranging from particle physics, space science and biology, to fusion research, astronomy, and neutron and photon sciences.

The EIROforum currently comprises:

- CERN European Organisation for Nuclear Research
- EFDA-JET European Fusion Development Agreement-Joint European Torus
- EMBL European Molecular Biology Laboratory
- ESA European Space Agency
- ESO European Organisation for Astronomical Research in the Southern Hemisphere (European Southern Observatory)
- ESRF European Synchrotron Radiation Facility
- XFEL European X-Ray Free-Electron Laser Facility
- ILL Institut Laue-Langevin.

EIROforum RIs operate in a competitive global environment, attracting users from all over the world to the very best scientific and technological resources. They are centres of excellence for the development of some of the world's most advanced technologies, and interact with European industry. They, therefore, play a crucial role in the innovation process, whilst enabling Europe's researchers to maintain scientific leadership in their fields. National contributions from European countries[261] to EIROforum organisations amounted to about EUR 1.6 billion in 2009[262].

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[261] EU-27 Member States, EFTA countries, Israel, Candidate Countries (Croatia, The former Yugoslav Republic of Macedonia, Turkey).

[262] Not including national contributions to XFEL which has joined EIROforum only recently.

## Europe's intergovernmental research infrastructures:

- conduct and support world-leading research;
- pool resources to enable large-scale research endeavours;
- provide unique services and facilities to the scientific community;
- promote scientific expertise by training and investing in Europe's scientists;
- foster collaboration and networking with national and international partners;
- showcase European scientific excellence and competitiveness.

### *European countries are jointly deciding and funding the construction and major upgrade of 51 pan-European research infrastructures in all main scientific fields for an estimated total construction cost of about EUR 22 billion.*

In October 2006, the European Strategy Forum on Research Infrastructures (ESFRI)[263] published the first ever European 'roadmap' for building new and upgraded pan-European research infrastructures. This roadmap provides an overview of the needs for research infrastructures of pan-European interest for the next 10 to 20 years. After its revision in 2008, it contained a description of 44 large-scale, world-class research infrastructures in 7 scientific domains. Participating countries pull funds together to cover the often large construction costs; they will also share the future annual operational costs. Six additional research infrastructures projects have been added to the ESFRI roadmap in 2010: three in the field of energy and three in the field of life sciences.

Table II.4.1[264] gives an overview of the main characteristics of the 10 research infrastructures which are already in their implementation phase.

Table II.4.2 gives a synthetic view of the 38 European research infrastructures on the ESFRI Roadmap update 2010. In addition to its contribution to the preparatory phases of these research infrastructures, the EU is funding part of the preparatory phases of three research infrastructures of the European Strategy for Particle Physics, as approved by the CERN Council:

- ILC-HiGrade – Preparatory phase for the International Linear Collider,
- SLHC – Preparatory phase for the Large Hadron Collider Upgrade,
- TIARA – Test infrastructure and accelerator research area

The estimated total construction cost of these 51[265] European research infrastructures is EUR 22 billion to be shared between participating countries.

### *Ongoing FP activities give more than 6500 researchers each year direct access to existing research infrastructure not located in their own countries*

FP6 and FP7 projects allow trans-national access to research infrastructures in Europe, i.e. access of a researcher to a research infrastructure that is not located in his/her country of residence. The funding support covers the travel costs of the researcher from the country of his/her host institution to the country hosting the research infrastructure, as well as the user fees of the research infrastructures, i.e. the scientific, technical and logistic supports that are related to the use of the research infrastructures.

Germany is by far the first country of destination for the use of research infrastructures under FP6[266] (7 334 incoming researchers, almost one third of the total number of visiting researchers in all countries, purple bar in Figure II.4.5). Italy comes second, followed by Switzerland, which has been hosting more incoming researchers than France and the United Kingdom, despite its small size relative to these two countries. Together, these five countries have been hosting three quarters of the visiting researchers under FP6. This shows that these countries host most of the research infrastructures of pan-European interest.

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[263] In 2002, the European Strategy Forum on Research Infrastructures (ESFRI) was established with the objective of agreeing on the common planning of new large-scale research infrastructures at European level.

[264] In this table, figures and dates are only indicative.

[265] Ten under implementation, thirty-eight in the ESFRI Roadmap, three of the European Strategy for Particle Physics.

[266] Data relating to the trans-national access funded under FP7 is not yet available.

## TABLE II.4.1 ESFRI projects in the implementation phase

| | Projects (in alphabetical order per domain) |
|---|---|
| Social Sciences and Humanities | **CESSDA** |
| | **ESS** |
| | **SHARE** |
| Energy | **JHR** |
| Material Sciences | **ESRF Upgrade** |
| | **European XFEL** |
| | **ILL 20/20 Upgrade** |
| Astronomy, Astrophysics, Nuclear and Particle Physics | **FAIR** |
| | **SPIRAL2** |
| Computer and Data Treatment | **PRACE** |

*Source:* DG Research and Innovation
*Data:* ESFRI Strategy report on research infrastructures, Roadmap 2010
*Note:* (1) Estimated construction cost and Indicative operational cost as known in February, 2011

| | Full name or Short description | Estimated construction cost (million euro)(2) | Indicative operational cost per year (million euro)(2) |
|---|---|---|---|
| | Facility to provide and facilitate access of reseachers to high quality data for social sciences | 30 | 3 |
| | Upgrade of the European Social survey, set up in 2001 to monitor long term changes in social values | 2 | 2 |
| | Data Infrastructure for empiric economic and social science analysis of ongoing changes due to population ageing | 23 | 13 |
| | High flux reactor for fission reactors material testing | 750 | 35 |
| | Upgrade of the European Synchroton Radiation Facility | 238 | 83 |
| | Hard X-Ray Free Electron Laser | 1 082 | 84 |
| | Upgrade of the European Neutron Spectroscopy Facility | 171 | 5 |
| | Facility for Antioproton and Ion Research | 1 027 | 118 |
| | Facility for the production and study of rare isotope radioactive beams | 196 | 10-12 |
| | Partnership for Advanced Computing in Europe | 200-400 | 50-100 |

## TABLE II.4.2 Research Infrastructure projects(1) listed in the ESFRI Roadmap 2010

| | Projects | Construction costs (euro (millions) | Operation costs (euro (millions) per year) | First possible operations or upgrade |
|---|---|---|---|---|
| Social Sciences and Humanities | CLARIN | 104 | 7.6 | 2011 |
| | DARIAH | 20 | 2.4 | 2016 |
| Environmental Sciences | COPAL (ex EUFAR) | 50-60 | 3 | to be defined |
| | EISCAT_3D Upgrade | 60 (up to 250) | 4-10 | 2016 |
| | EMSO | 160 | 32 | 2014 |
| | EPOS | 500 | 80 | 2020 |
| | EURO-ARGO | 3(3) | 8.4 | 2011 |
| | IAGOS | 15 | 5-10 | 2012 |
| | ICOS | 130 | 36 | 2013 |
| | LIFEWATCH | 255 | 35.5 | 2012 |
| | SIOS | 50 | 10 | 2013 |
| Energy | ECCSEL | 81 | 6.3 | 2015 |
| | EU-SOLARIS(2) | 80 | 3 | 2015 |
| | HiPER | under discussion | under discussion | 2028 |
| | IFMIF | 1 000 | 150 | 2020 |
| | MYRRHA(2) | 960 | 46.4 | 2020 |
| | Windscanner(2) | 45-60 | 4 | 2013 |
| Biological and Medical Sciences | ANAEE(2) | 210 | 12 | 2015 |
| | BBMRI | 170 | 3 | 2012 |
| | EATRIS | 20-100 | 3-8 | 2016 |
| | ECRIN | 0(4) | 3,5 | 2011 |
| | ELIXIR | 470 | 100 | 2012 |
| | EMBRC | 100 | 60 | 2014 |
| | Erinha | 174 | 24 | to be defined |
| | EU-OPENSCREEN | 40 | ~40 | 2015 |
| | EuroBioImaging | 600 | 160 | 2013 |
| | Infrafrontier | 180 | 80 | 2011 |
| | INSTRUCT | 300 | 25 | 2012 |
| | ISBE(2) | 300 | 100 | 2017 |
| | MIRRI(2) | 190 | 10,5 | ongoing |
| Materials and Analytical Facilities | EMFL | 115 | 8(5) | 2014 |
| | ESS | 1 478 | 110 | 2019-2020 |
| | EUROFEL (ex-IRUV-FEL) | 1 200-1 600 | 120-160 | 2007-2020 |
| Physical Sciences and Engineering | CTA | 150 | 10 | 2019 |
| | E-ELT | 1 000 | 30 | 2018 |
| | ELI | ~700(6) | ~70 | 2015 |
| | KM3NeT | 220 | 4-6 | 2016 |
| | SKA (GLOBAL) | 1 500 | 100-150 | 2017 |

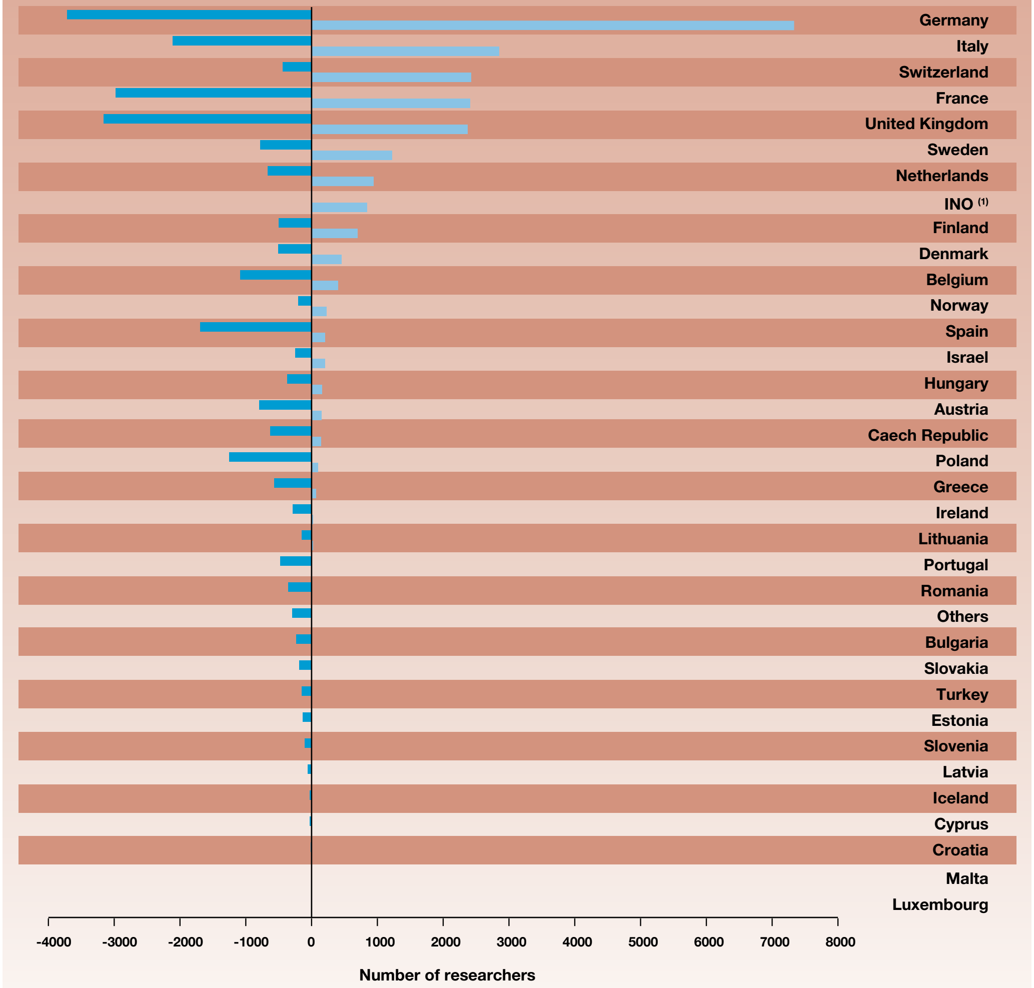
*Source:* DG Research and Innovation
*Data:* DG Research and Innovation
*Notes:* (1) Projects with a green background are facilities likely to be implemented before the end of 2012.
(2) New facility added in 2010.
(3) Preparation costs

| | Description |
|---|---|
| | Research infrastructure to make language resources and technology available and useful to scholars of all disciplines. |
| | Digital infrastructure to study source materials in cultural heritage institutions. |
| | Long range aircraft for tropospheric research. |
| | Upgrade of the EISCAT facility for ionospheric and space weather research. |
| | Multidisciplinary Seafloor Observatory. |
| | Infrastructure for the study of tectonics and Earth surface dynamics. |
| | Ocean observing buoy system. |
| | Climate change observation from commercial aircraft. |
| | Integrated carbon observation system. |
| | Infrastructure for research on the protection, management and sustainable use of biodiversity. |
| | Upgrade of the Svalbard Integrated Arctic Earth Observing System. |
| | European Carbon Dioxide and Storage Laboratory infrastructure. |
| | The EUropean SOLAR research InfraStructure for Concentrating Solar Power. |
| | High power long pulse laser for fast ignition fusion. |
| | International Fusion Materials Irradiation Facility. |
| | Multipurpose hYbrid Research Reactor for High-technology Applications. |
| | The European Windscanner Facility. |
| | Infrastructure for Analysis and Experimentation on Ecosystems. |
| | Bio-banking and biomolecular resources research infrastructure. |
| | European advanced translational research infrastructure in medicine. |
| | Pan-European infrastructure for clinical trials and biotherapy. |
| | Upgrade of the European Life-science infrastructure for biological information. |
| | European marine biological resource centre. |
| | Upgrade of the High Security Laboratories for the study of level 4 pathogens. |
| | European Infrastructure of Open Screening Platforms for chemical biology. |
| | Research infrastructure for imaging technologies in biological and biomedical sciences. |
| | European infrastructure for phenotyping and archiving of model mammalian genomes. |
| | Integrated Structural Biology Infrastructure. |
| | Infrastructure for Systems Biology – Europe. |
| | Microbial Resource Research Infrastructure. |
| | European Magnetic Field Laboratory. |
| | European Spallation Source. |
| | Complementary Free Electron Lasers in the Infrared to soft X-ray range. |
| | Cherenkov Telescope Array for Gamma-ray astronomy. |
| | European Extremely Large Telescope for optical astronomy. |
| | Extreme Light Intensity short pulse laser. |
| | Kilometre Cube Neutrino Telescope. |
| | Square Kilometre Array for radio-astronomy. |

(4) Actual construction costs absorbed by the update and certification of national IT components.
(5) Additional to current operation costs.
(6) Includes costs of three Regional Partner Facilities.

FIGURE II.4.5

## Visiting researchers by operator country versus outgoing researchers by country of residence in research infrastructure projects funded by FP6



*Source*: DG Research and Innovation
*Data*: DG Research and Innovation, Eurostat
*Note*: (1) INO: International organizations and research infrastructures not based in a single country.

🟦 Outgoing researchers
🟦 Visiting researchers

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The researchers benefiting from this FP trans-national access to research infrastructures are based on a permanent basis in all Member States (blue bars in Figure I.4.5). Researchers based in Germany, the United Kingdom and France are the most numerous in benefiting from this trans-national access, in accord with the size of the researcher population of these countries. Germany, Italy, Switzerland, Sweden, the Netherlands, Finland and Norway are net receivers of researchers through this FP6 scheme: more researchers are coming to these countries to use their research facilities than leaving them to use research facilities located in other countries. All other countries are net providers of researchers.

### *In absolute terms, the circulation of researchers is highly concentrated in flows between France, Germany, Italy, the United Kingdom and Switzerland*

Table II.4.3 shows that flows of researchers converge on Germany, Italy and Switzerland for the use of research infrastructures. Most of these researchers come from France, Germany, Italy and the United Kingdom, indicating that, in absolute terms, the circulation of researchers within these four countries and Switzerland accounts for much of the trans-national use of research infrastructures in Europe.

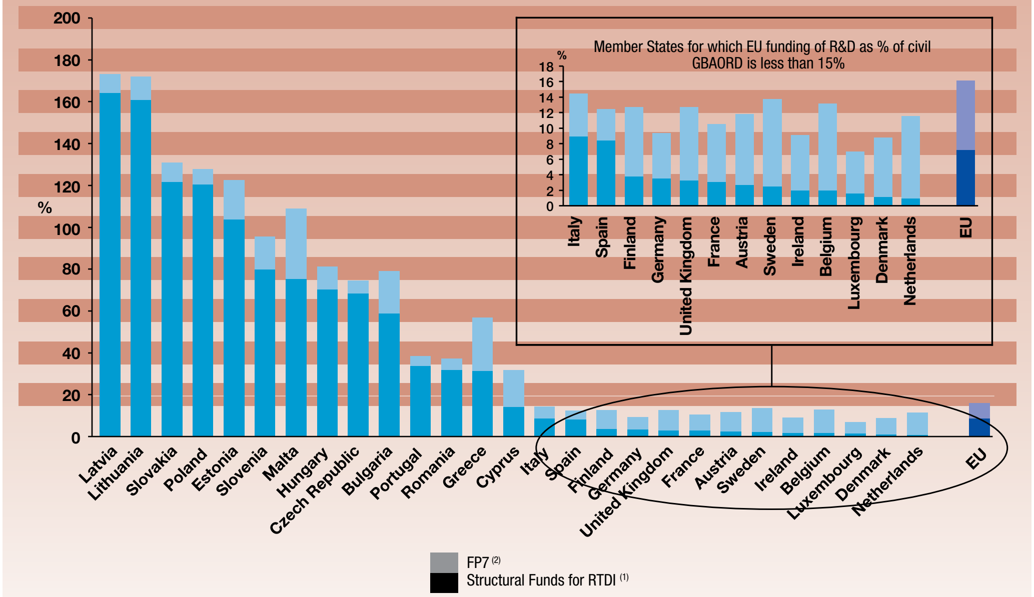
This is of course linked to a large extent to the size of these countries, apart from Switzerland, whose equipment in research infrastructures of pan-European interest is exceptional given the size of the country. If we normalise the figures with the total number of national researchers, it appears that Central and Eastern European countries and other smaller countries benefit most from trans-national access to research infrastructures. Even in absolute terms, the flows from Poland, Belgium and Spain to Germany are among the ten highest flows of FP research infrastructure users.

TABLE II.4.3 **The ten biggest tans-national flows of research infrastructure (RI) users in FP6**

| ORIGIN | DESTINATION | Number of RI users |
|---|---|---|
| Country of home institution | RI operator country | |
| Germany | Switzerland | 1 265 |
| United Kingdom | Germany | 977 |
| France | Germany | 905 |
| Italy | Germany | 846 |
| Germany | Italy | 684 |
| Poland | Germany | 671 |
| France | Italy | 671 |
| France | Switzerland | 654 |
| Belgium | Germany | 620 |
| Spain | Germany | 542 |

*Source:* DG Research and Innovation
*Data:* DG Research and Innovation

FIGURE II.4.6 **EU funding of R&D as % of civil GBAORD, 2007-2009 (annual average)**



*Source*: DG Research and Innovation
*Data*: DG Research and Innovation, DG REGIO
*Notes*: (1) Initial allocation of 2007-2013 Structural Funds to RTDI activities, annual average.
(2) Received FP7 funding up to 2009, annual average.

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## 4.3. Are the EU Framework Programme and Structural Funds contributing to the building of a European Research Area?

In this section the role of Framework Programme and Structural Funds in building a European Research Area is looked at from the perspective of funding and integration (universities' participation and cooperation, collaborative links between countries, access to research infrastructures and international cooperation)[267].

### 4.3.1. Size and focus of the European Commission funding instruments for research and innovation

***In 2008–2009, national funding directed to FP instruments of coordination (ERA-NET, ERA-NET+, JTIs, Art. 185) represented 20% of national funding directed to intergovernmental research***

The first FP instruments of coordination of national funds for R&D were created with FP6. Figure II.4.3 shows that in a short number of years, these instruments have become an important vector of coordination of national public funding of R&D, since they account for about one fifth of intergovernmental public R&D funding.

***EU funding of R&D reaches 16% of total national civil R&D budgets in EU-27***

EU funding of R&D has considerably increased over the last 25 years (see Chapter 3 in Part I). In 2007–2013, Structural Funds are a major source of funds for R&D in EU-12 Member States where they often represent more than 100% of their own national civil R&D budgets, up to 165% in Latvia (Figure II.4.6)[268]. In EU-15 Member States (except Italy and Spain), the Framework Programme

---

[267] The role of the EC Framework Programme on researcher mobility in Part II, Chapter 5.

[268] In these countries, although "abroad" is an important source of funds for R&D, it may not appear as large as these Structural Funds figure would indicate. This is due to three main reasons. First, all Member States do not record EU Structural Funds for RTDI in the "abroad" source of funds. For better data comparability across Member States, Eurostat recently instructed Member States to do so in the future. In practice, in some cases, this may turn out to be difficult as R&D performers may not be able to identify the ultimate source of funds when they receive the funds from the government. Second, the RTDI category in Structural Funds taxonomy is broader than R&D: it covers many innovation activities which are not covered in official data on R&D expenditure by source of funds. Third, these figures concern Structural Funds earmarked for RTDI at the beginning of the period 2007-2013 (annual average). The amount of Structural Funds for RTDI actually spent in 2007-2008 (2008 is the latest year for which we have data on the "abroad" source of funds) in these countries may be much smaller than this.

### Box II.4.2 – Re-allocation of Structural Funds to R&D in Slovenia

In 2010, Slovenia proceeded to transfer of EUR 88.7 million in favour of R&D within the Operational Programme for Strengthening Regional Development Potentials 2007–2013 (OP SRDP within the EU structural funds). Of this EUR 88.7 million for the period 2011–15, EUR 19.9 million is planned to be used in 2011 and the rest in the following years until the close of the actual financial perspective. This increase will trigger, in the five-year period, an additional EUR 35.5 million for R&D from enterprises (40% of co-funding according to state aid rules). Another increase of EUR 5.3 million is planned in the 2011 government budget for the development of human resources from the Operational Programme for the Development of Human Resources 2007–2013. In total therefore, this re-allocation of structural funds gives an increase of EUR 25.2 million (or 0.07% of GDP) in the 2011 government R&D budget.

remains the first source of funds for R&D from the European Commission. Together with Structural Funds, they represent around 8%–10% of their national civil R&D budgets.

### *The most intensive use of Structural Funds for RTDI and enterprise environment occurs in less research intensive regions of old Member States*

Relative to the size of the national R&D budget (GBAORD), the amount of Structural Funds for RTDI in EU-12 Member States is considerable (Figure II.4.6 above). In several of them, Structural Funds for RTDI are doubling, in some cases (Latvia and Lithuania) almost tripling, the national budget for R&D. Structural Funds, therefore, appear as a determining funding instrument for research and innovation capacity building in these countries.

These considerable amounts of RTDI Structural Funds with respect to the national R&D budgets of these countries represent only 20% or less of the total Structural Funds they receive (Figure II.4.7 below[269]).

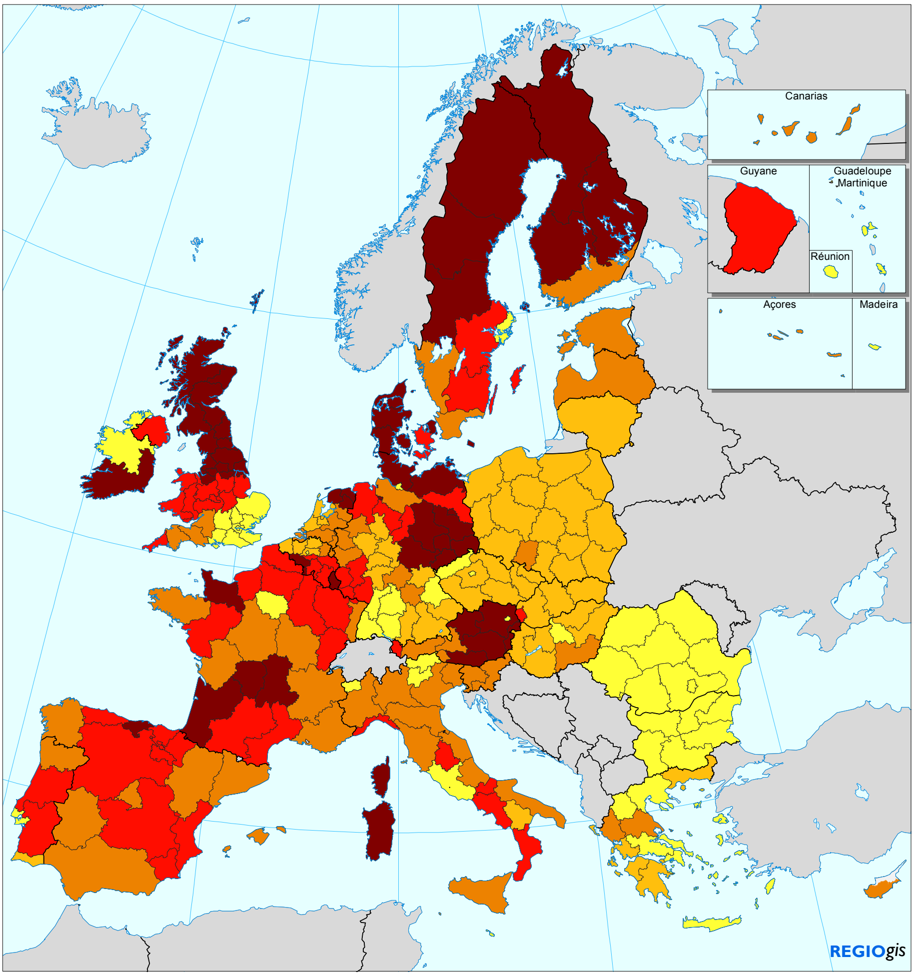
In EU-15 Member States, a higher share of Structural Funds can be devoted to RTDI and enterprise environment (Figure II.4.7 below). Interestingly in these countries, although there are some exceptions, regions that are less research-intensive have higher shares of Structural Funds devoted to RTDI and enterprise environment. In contrast, research intensive regions use in general less than 20% of their Structural Funds for RTDI and enterprise environment. As far as the Western part is concerned therefore, the map below is to some extent the negative image of the regional research intensity map in Figure I.1.8. in Part I, Chapter 1. This highlights the important role of Structural Funds in developing further the research and innovation capacity of less research intensive regions.

---

[269] In Figure II.4.7, the map includes Structural Funds for RTDI and for enterprise environment, i.e. about EUR 79 billion. For the whole EU as indicated in the legend of the map. Structural Funds for RTDI only represent EUR 48.5 billion for the whole EU.

FIGURE II.4.7

## Regional structural funds:
## Planned investments in research and innovation



**Planned investments of Cohesion Policy in RTD, innovation, enterprise environment, 2007-2013**

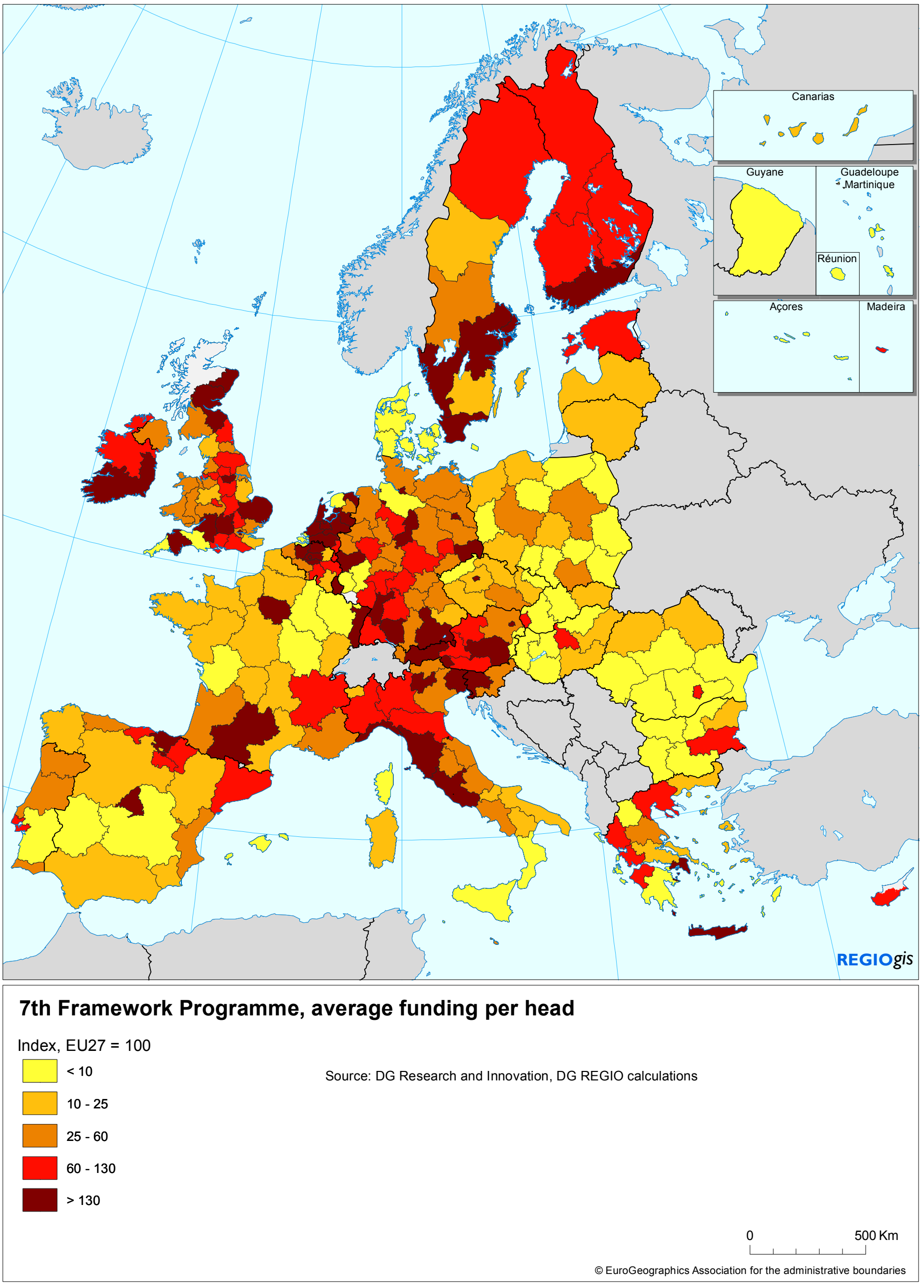
% of total funding

- 🟨 <19.2
- 🟧 19.2 - 21.6
- 🟧 21.6 - 27.5
- 🟥 27.5 - 34.2
- 🟫 > 34.2

EU27 = 23.0
Funding for RTD, innovation and enterprise amounts
to some €79 billion
Source: DG REGIO

0 500 Km

## FIGURE II.4.8 7th Framework Programme, average funding per head, 2007-2009

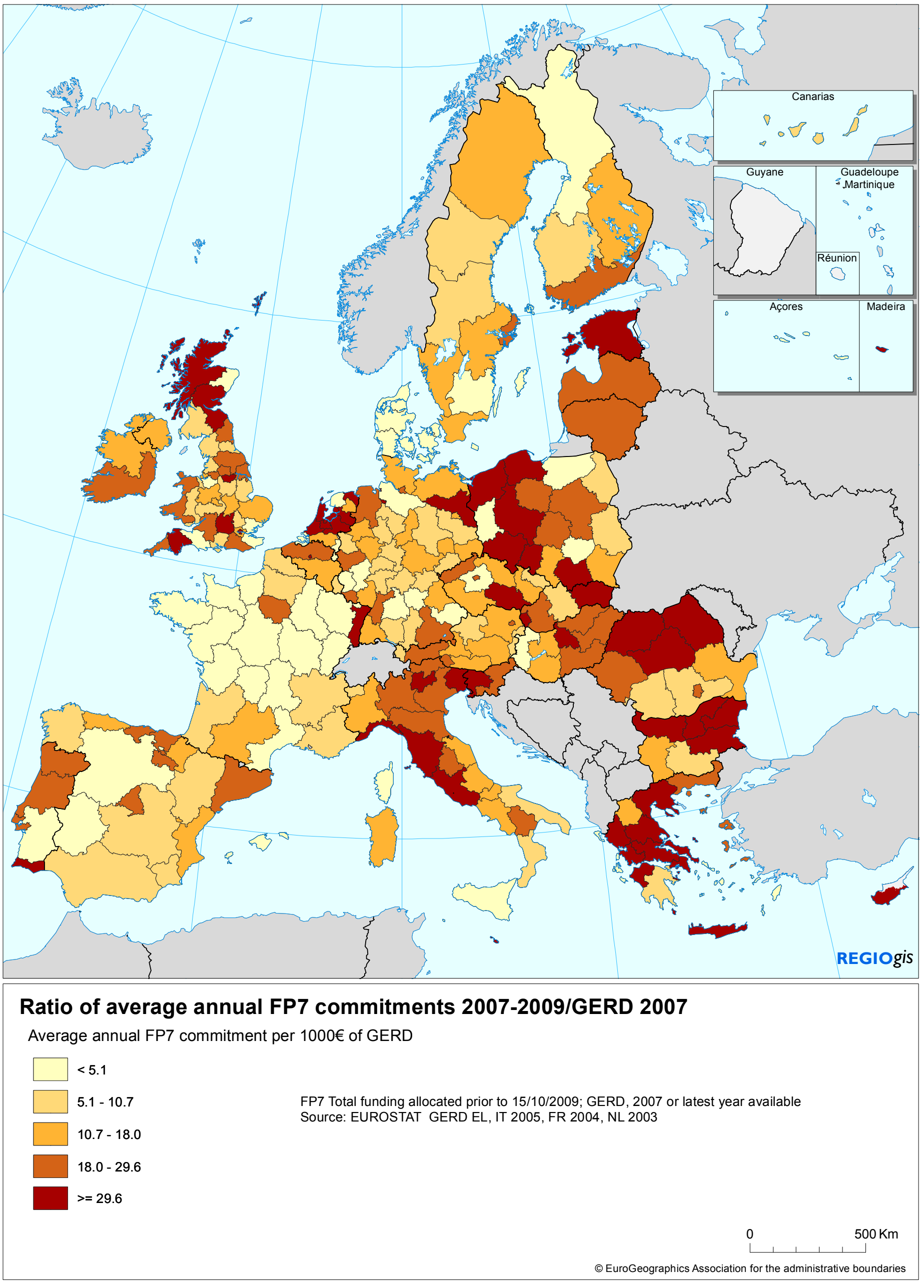


Source: DG Research and Innovation, DG REGIO calculations

© EuroGeographics Association for the administrative boundaries

FIGURE II.4.9

## Ratio of average annual FPR commitments 2007-2009 per 1000 GERD 2007



FP7 Total funding allocated prior to 15/10/2009; GERD, 2007 or latest year available
Source: EUROSTAT GERD EL, IT 2005, FR 2004, NL 2003

© EuroGeographics Association for the administrative boundaries

## 4.3.2. European integration through the European Commission funding instruments

### *The average FP funding per head in regions is well correlated with the regional R&D intensity*

A comparison of Figure II.4.8 with Figure I.5.3. in Part I, Chapter 5 (representing regional business R&D intensity, which is highly correlated with regional total R&D intensity) shows that overall the regions which receive on average more FP7 funding per capita are regions with high R&D intensity. The same observation can be done with FP6 funds, whose regional map looks very similar (not shown). This is to be expected as regions with more R&D resources and a larger R&D capacity necessarily have many more opportunities and actors to apply for funds from R&D programmes, including the FP. In addition, it is likely that the success rate of applicants will be higher in high R&D intensity regions, although this cannot be concluded from this map. Altogether this observation shows that larger volumes of FP funds go to regions with larger volumes of R&D activities.

### *Relative to their R&D expenditure level, convergence objective regions' benefit more from FP7 funding than regions with higher R&D intensity*

The ratio between average annual FP7 funding in 2007-2009 received and total annual R&D expenditure (2007) is often higher in regions of Bulgaria, Greece, Romania, Poland and the Baltic States (Figure II.4.9). This shows that these regions can benefit from FP7 funding to a relatively satisfactory level given their level of R&D expenditure. In relative terms, FP7 funding is, therefore, more important in those regions than in more research intensive regions.

### *The scale of participation in the FP relative to the size of the country is larger in smaller countries*

Figure II.4.10 shows the number of participations in FP6 and FP7 per thousand researchers for each country[270]. This gives an indication of the propensity and ability of research institutions from a given country to utilise the European funding instruments.

Unsurprisingly, the propensity to participate in FP6 and FP7 is highest in the smaller countries[271], although not in all of them. Lower shares of the German, French and UK research systems participate in the FP, while Greece, Switzerland, Estonia, Slovenia, the Netherlands and Belgium show a high participation of their research institutions when normalised by the population of its researchers. This implies that a larger part of the population of researchers in these countries is involved in FP-funded projects. FP funding plays, therefore, a bigger role in these countries. This is also reflected in the fact that received FP funding represents a higher share of the national civil GBAORD in these countries (Figure II.4.6 above).

If the size of the country is an important determinant of the number of FP participations per researcher, it is not the sole factor explaining the differences observed across countries. There are important differences among small countries of similar size as well, which can be explained by several factors, in particular the amount of national public funding available, the degree of internationalisation of the research system and the quality (success rate) of the proposals of the country's research institutions.

As a consequence of their higher number of participations per domestic researcher, small countries also have a higher number of FP collaborative links[272] per domestic researcher with other countries (see Figure II.4.13).

### *FP6 networks are characterised by a core–periphery structure dominated by a small number of close-knit organisations*

The European Commission launched a project conducted between 2007 and 2009[273] to study the impact of EU funding on research and technological development networks in Europe. More specifically, one of the objectives was to conduct in-depth quantitative and qualitative network analyses of the RTD collaborations resulting from EU FP6 funded projects

---

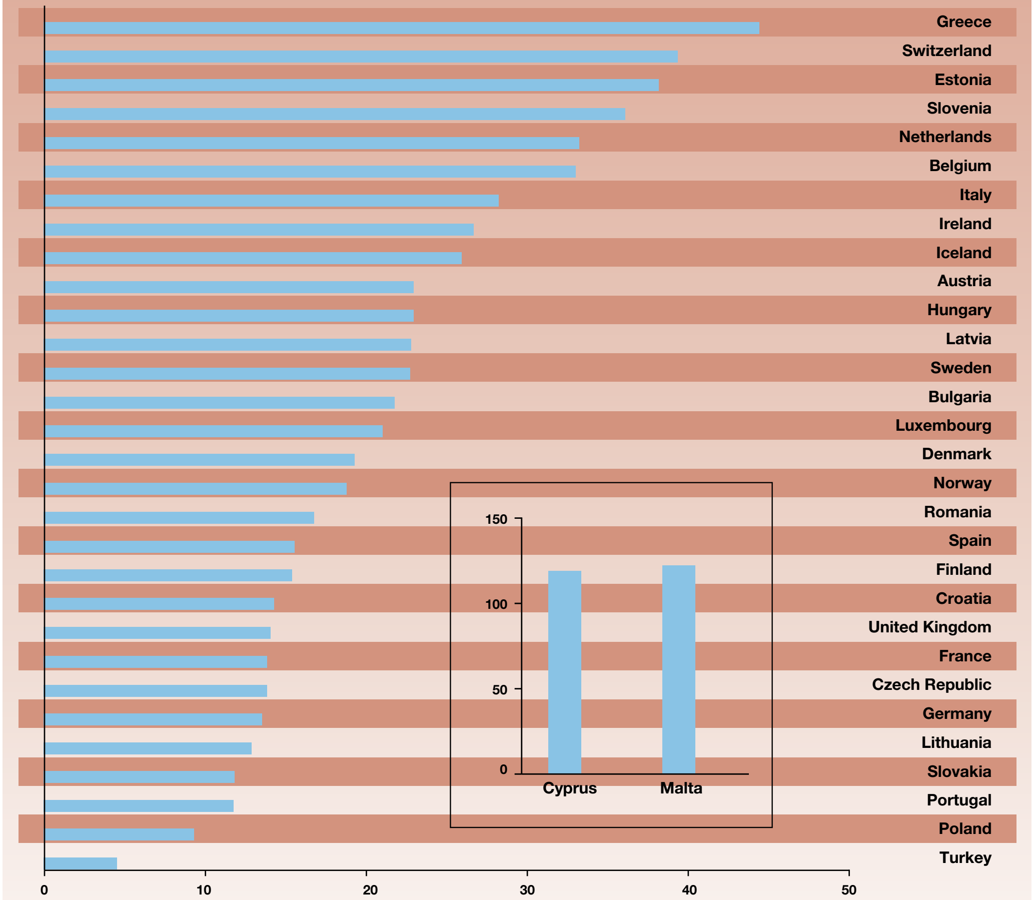
[270] The whole is multiplied by one thousand. It is to be noted that only the FP7 figures cover only 2007–09, with very few contracts signed in the first year of FP7 (2007), while the FP6 figures cover the whole of FP6, hence the higher values of FP6 figures.

[271] Given the very small number of researchers in Malta and Cyprus, the number of participations in FP from these countries represents a very large share of the total number of researchers in each of these two countries.

[272] In an FP project, for a given participant, there are as many collaborative links as there are other participants in the project.

[273] 'Structuring Effects of Community Research – The Impact of the Framework Programme on Research and Technological Development (RTD) on Network Formation (NetPact)', Final Report, April 2009.

## FIGURE II.4.10 Number of participations(1) in FP7(2) per thousand researchers (FTE)



*Source*: DG Research and Innovation
*Data*: DG Research and Innovation
*Notes*: (1) A participating institution or firm is counted as many times as it is funded in different projects.
(2) FP7 covers only the years 2007-2009.

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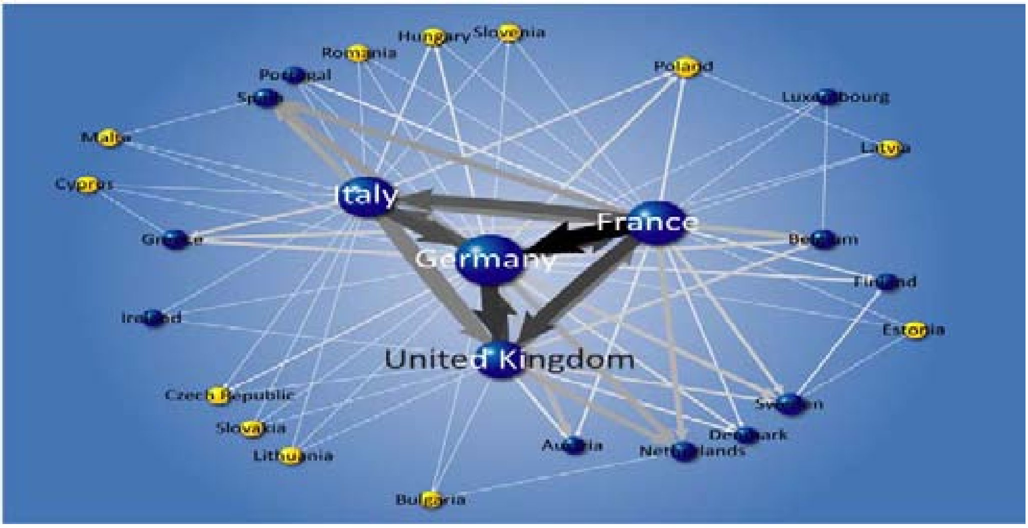
FIGURE II.4.11 **Integration of EU Member States in FP6 research networks**



*Source:* DG Research and Innovation

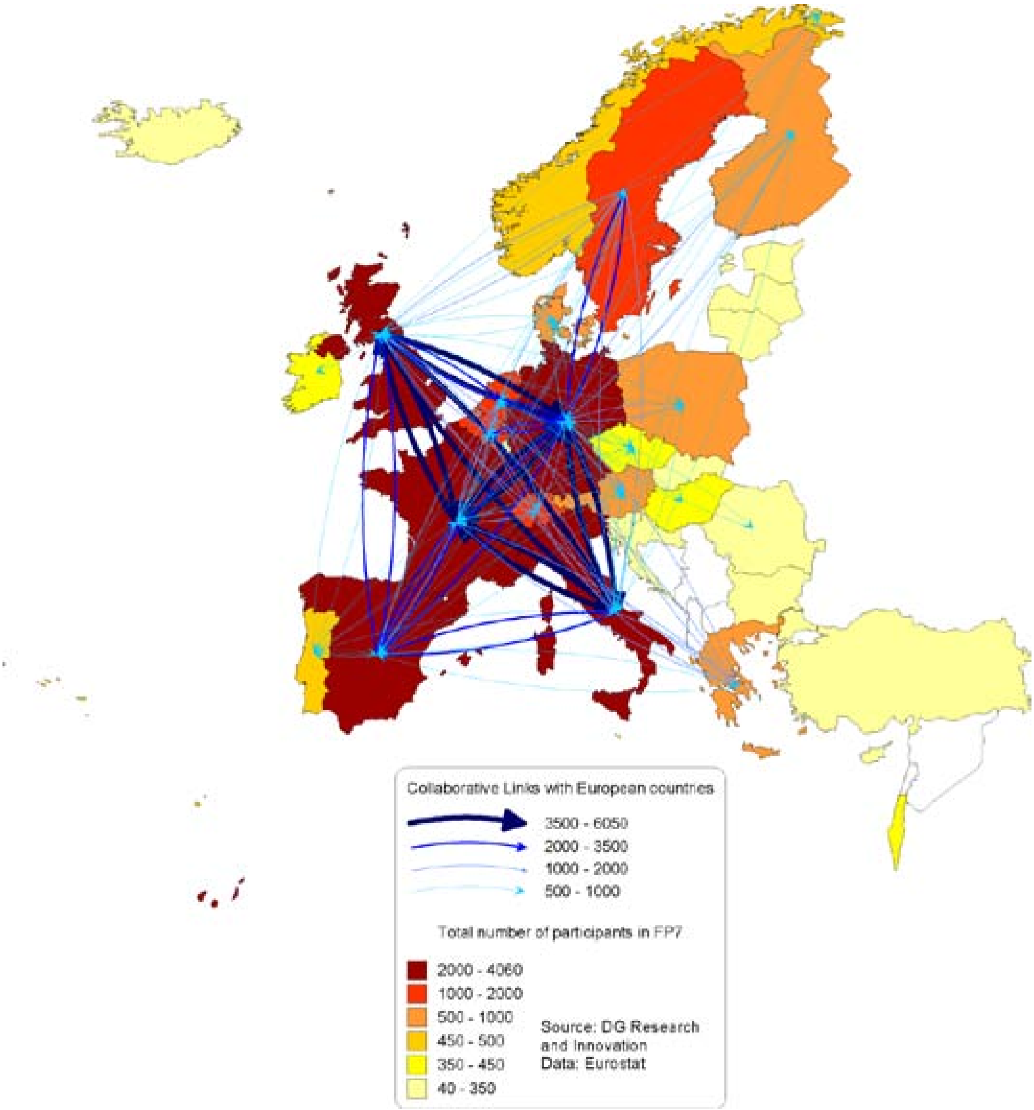
in five identified fields, with a focus on investigating the relationships between structural network characteristics and performance.

The FP6 networks are highly connected to one another through several projects, while the remaining organisations are on the network periphery and are only connected to the core and not connected to one another. The central actors which coordinate the projects are primarily large national research associations (e.g., Fraunhofer Gesellschaft, CNRS, INSERM) and universities in all thematic areas, except in Information Society Technologies (IST) where industry also plays central roles.

***In absolute numbers, scientific cooperation mainly takes place between four larger member states, with stronger integration of Spain, Sweden, Belgium and the Netherlands***

One of the major outcomes of the study was that the FP6 marked the beginning of long-term collaborations in which partners continued to collaborate in projects. In addition, improved reputation creates attraction, i.e. high impact organisations and researchers within their field attract highly skilled researchers from around the world, clearly increasing the competitiveness of the EU through both skills as well as connections to other areas of the world through these researchers' networks. Both the study on FP6 and an analysis made by the Commission services on FP7 data (see map below) show that the integration of EU-12 Member States is still weak. Poland, Hungary and to a lesser extent the Czech Republic are the most integrated countries in the European cooperation. As illustrated in Figure II.4.11 and in Figure II.4.12, in absolute terms, the cooperation still takes place mainly between the EU-15 Member States, with the big four countries – Germany, France, Italy and the United Kingdom – playing the role of central links, while Germany takes a strong gatekeeper position. However, comparison of this networking analysis with those of Webometrics or

## FIGURE II.4.12 **FP7 collaborative links between European countries**

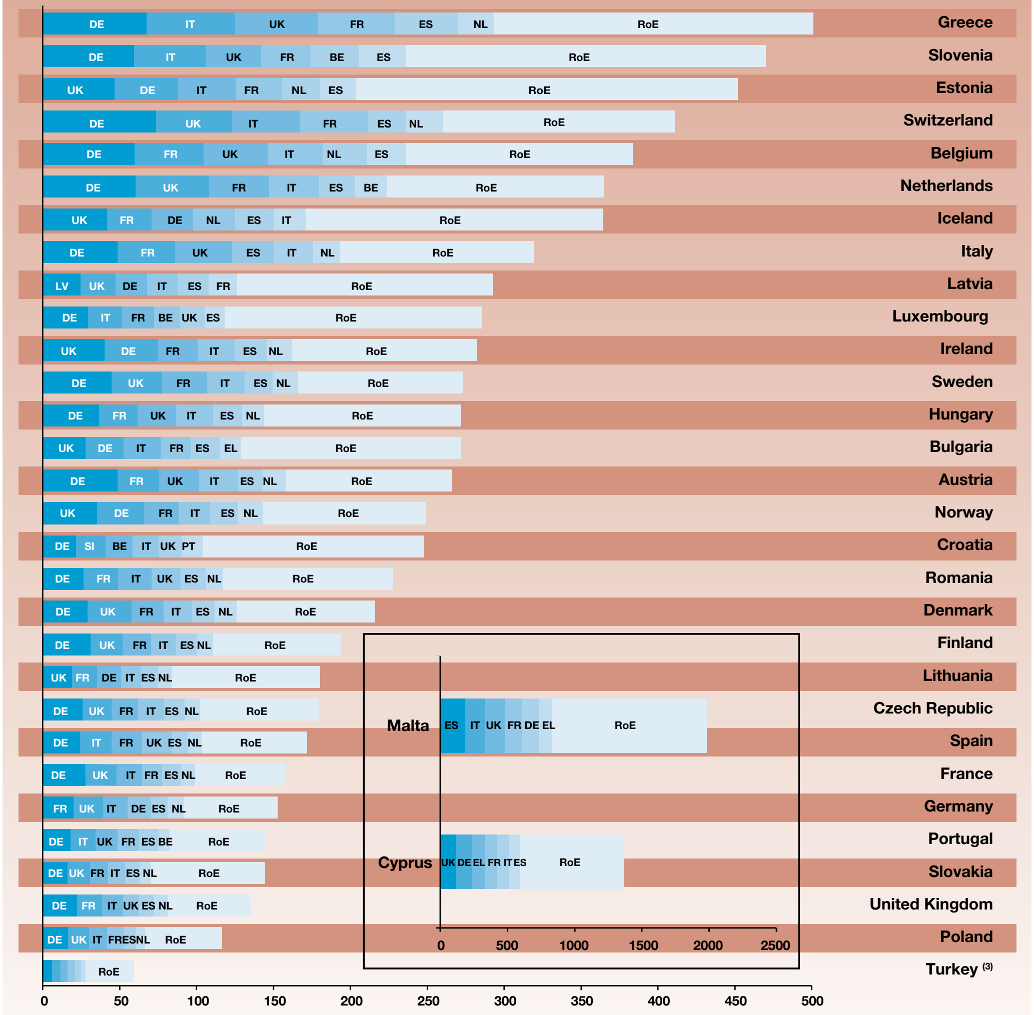


Source: DG Research and Innovation
Data: Eurostat

*Note:* A collaborative link between two countries is counted each time participants from two countries participating in a FP7 collaborative project

FIGURE II.4.13

## FP7(1) collaborative links with European countries per 1 000 researchers (FTE)(2)



*Source*: DG Research and Innovation
*Data*: DG Research and Innovation, Eurostat
*Notes*: (1) Signed grant agreements as of 15 October, 2009.
(2) Researchers refer to 2008 with the exceptions of CH: 2004; EL, FR: 2007.
(3) TR: IT, DE, UK, FR, ES, EL (from left to right).

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co-publications, indicates that countries in Eastern and Southern Europe are closer integrated through the cooperation funded by the EU FP[274].

***Researchers in smaller European countries, including new Member States, have a higher integration propensity in the scientific cooperation funded by the Framework Programme***

As a consequence of their higher number of participations per domestic researcher, small countries also have a higher number of FP collaborative links[275]

---

[274] See also data and analysis on European scientific cooperation in Part II, chapter 6.2 in this report. Additional information on structural network features of FP1-FP6 are in the forthcoming JRC scientific and technical report. Heller, B., Barber,M., Henriques,L., Paier, M., Pontikakis, D., Scherngell, T., Veltri, G.and Weber, M.: "Analysis of networks in European Framework Programmes (1984-2006), February 2011, Seville.

[275] In an FP project, for a given participant, there are as many collaborative links as there are other participants in the project.

per domestic researcher with other countries (Figure II.4.13). Figure II.4.13 also shows that for most countries the first partner country in FP7 projects is Germany followed by the United Kingdom and France, then by Italy, Spain and the Netherlands. In all cases, these six partner countries together represent more than half of the collaborative links a country has in FP7 projects[276]. This order of partner countries in FP7 is to a large extent a reflection of the size of the research systems of these countries. However, for several countries, one observes a different order of partner countries which reflects particular geographical, cultural and/or linguistic ties between certain countries (e.g. Croatia–Slovenia, Luxembourg–Belgium, Slovenia–Italy).

Finally, it is interesting to see that due to the cross-border nature of collaboration in FP7, the number of domestic FP7 collaborative links ranks first for no country, except Latvia. Domestic partners are among the first six partners in FP7 only in the case of Germany, France, the United Kingdom, Italy and Spain – once again a reflection of the size of these countries.

#### *Knowledge flows through the FP enhance skills and technological knowledge relevant for SMEs*

Results of impact assessment reports[277] have demonstrated that SMEs were the largest community of participants in both FP5 (35.9%) and FP6 (37.8%), and that the most visible effects of their involvement in the projects is an increase in S&T knowledge and R&D capability, besides the previously discussed aspects of intensification of networking and international collaboration. Economic and commercial benefits are less tangible but, on the other hand, an upgrade in in-house skills is noticeable. From the perspective of SMEs, the FPs are perceived as good opportunities to incorporate knowledge and improve skills' capabilities but not as an instrument to innovate. Nevertheless, their contribution to the research projects they are involved in is considered complementary, with specific and unique assets and technical know-how. Considering the typology profile of the SMEs participating in the FPs, two different groups can be defined: the Technology Developers, which are SMEs that enter the FP projects with the purpose of developing a specific technology, and Technology Networkers, who consist of SMEs that use FP projects to fulfil secondary strategic objectives and extend their networks. When it comes to the R&D intensity of the SMEs participating in the thematic programmes of the FPs, the picture is broader: approximately half of the SMEs spend less than 10% of their turnover on R&D while the other half is more R&D intensive. Among this second group, 25% represent high R&D intensity, spending more than 30% of the annual turnover on R&D.

### 4.3.3. Opening up of the EC Framework Programme to international cooperation

The international dimension in FP7 has been growing in volume and focus in relation to previous FPs. Third countries' participations in FP7 represent 6% of all participations, compared to 2.9% and 5.3% in FP5 and FP6, while Associated Countries increased their participation from 5.3% in FP5 to 7.7% in FP7 (Figure II.4.14).

#### *The main cooperation links with countries outside Europe are made with Russia and China, followed by the United States*

As illustrated in Figure II.4.15, the EU framework programme offers cooperation with several partners outside Europe. It is noticeable that it is Russia and China which have the highest number of participants in FP projects, followed by the United States. The evolution from FP5 to FP7 illustrates a large relative increase in the number of participants from the most research-intensive emerging and industrialised countries.

In FP7, in absolute terms, the largest EU member states also have the largest number of collaborative links with countries outside Europe – Russia, China and the United States (Figure II.4.16). The Netherlands, Spain, Denmark and Belgium also have relatively high collaboration with China through the FP7.

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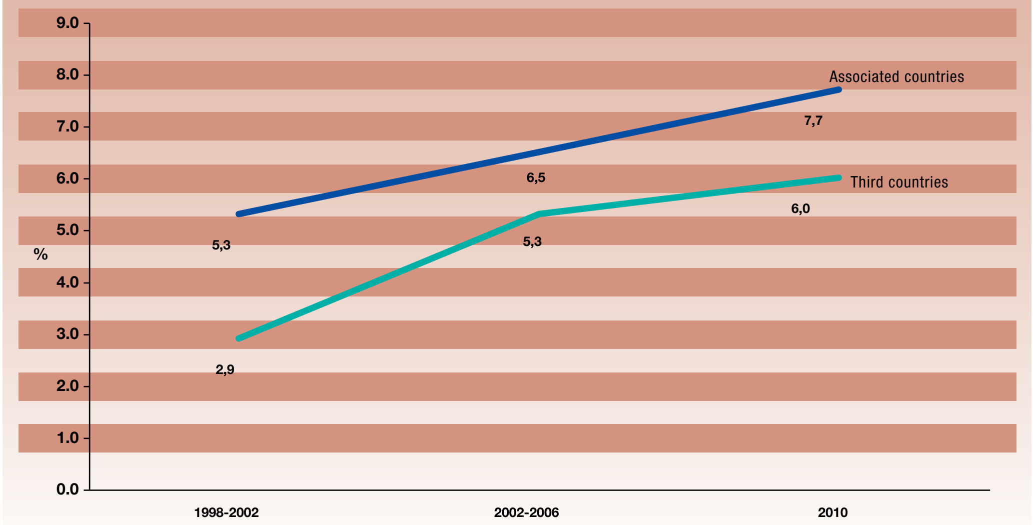
[276] On Figure X, RoE stands for 'Rest of Europe'.

[277] Impact Assessment of SME-specific measures of the Fifth and Sixth Framework Programmes for Research on their SME target groups and Impact Assessment of the participation of SMEs in the Thematic Programmes of the Fifth and Sixth Framework Programmes for Research (DG RTD 2010).

## FIGURE II.4.14 Associated and Third country participations as % of total participations in EU Framework Programmes, 1998-2010



*Source*: DG Research and Innovation
*Data*: DG Research and Innovation

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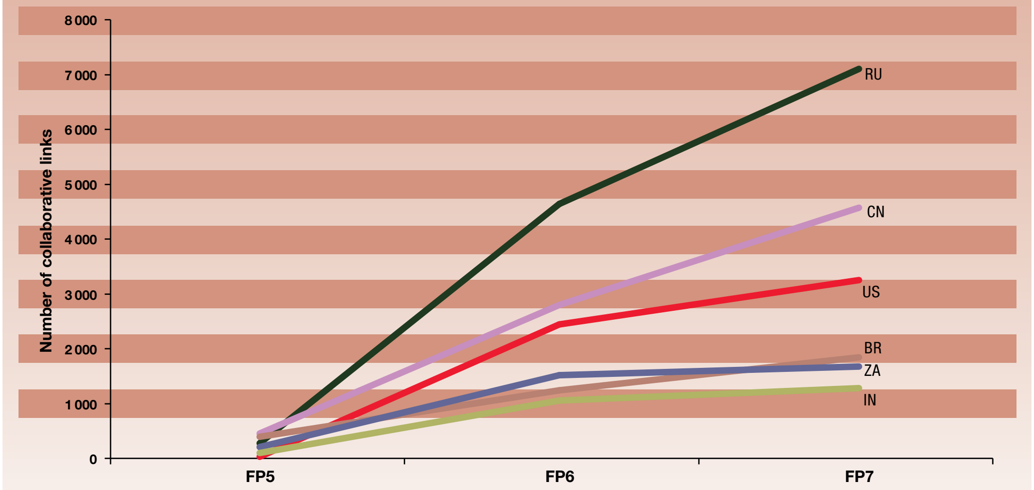
## FIGURE II.4.15 Number of collaborative links$^{(1)}$ between research teams from major third countries particpating in FP activities and EU research teams



*Source*: DG Research and Innovation
*Data*: DG Research and Innovation
*Note*: (1) Every time two countries participate in the same FP project an FP collaborative link is established between the two countries.

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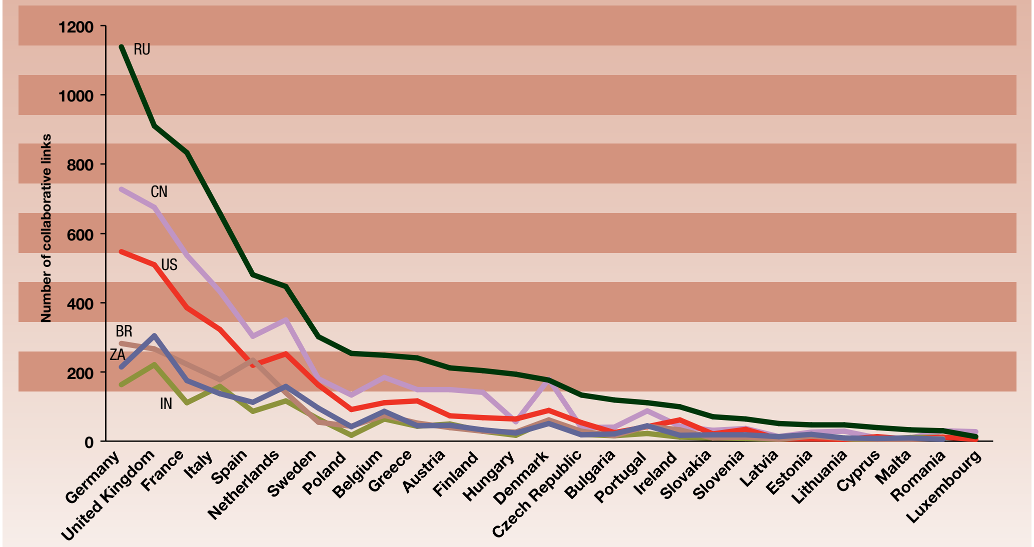
FIGURE II.4.16 **Number of FP7 collaborative links[(1)] between EU Member States and BRIC[(2)] countries, the United States and South Africa**



*Source*: DG Research and Innovation
*Data*: DG Research and Innovation
*Notes*: (1) Every time two countries participate in the same FP project an FP collaborative link is established between the two countries.
(2) BRICs: Brazil, Russia, India, China.

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## 4.4. Are national research programmes opening up to non-resident research teams?

Broadly speaking, the opening-up of a national R&D programme refers to the possibility for non-resident (or foreign-based)[278] research performers to participate in domestic R&D programmes, be they funded or not by these programmes. The rationale for opening up national R&D programmes is the necessity to reach higher degrees of excellence in domestic research activities and complement domestic expertise with other complementary expertise from abroad. Directing national funds to the best research performers, be they located within or outside the national borders, is meant to guarantee a more efficient use of public research funds. It also extends the competition space, hence raises the competition level, which ultimately raises the quality of research in Europe.

***The modalities and conditions for participation of non-resident research performers in national R&D programmes vary across countries and across different types of programme within a country***

These modalities can range from mere acceptance of non-resident partners in research projects, without any explicit selection criterion nor funding associated, to the establishment of compulsory participation of foreign research performers and the allocation of a substantial share of the funds to the latter.

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[278] Non-resident research performers are research performers located outside the country preparing and funding the R&D programme. The criteria here is the location of the research performer (domestic or not), not its nationality or country of ownership. That is why the term 'non-resident' or 'foreign-based' is preferred to the term 'foreign' alone: from the point of view of programme openness, the participation of a foreign research performer located in the country preparing and funding the R&D programme (e.g. an affiliate of a foreign-owned company, foreign researcher in the country) is in most cases not different from a participation of a national research performer.

There are several degrees of openness which are determined as eligibility rules for participation in the programmes[279]. One can usefully distinguish between six broad categories of openness of R&D programmes:

1. ***not open*: programmes that do not allow non-residents to participate;**
2. ***open for sub-contractors*: programmes that allow funding for non-resident research performers as sub-contractors to a national partner;**
3. ***open without funding*: programmes that allow participation of non-resident research performers as partners or leaders without funding;**
4. ***open for national priorities*: programmes that allow funding for non-resident research performers when their activity is proved to strengthen national research;**
5. ***open with budget ceiling*: programmes where non-resident research performers are eligible for funding as a partners but below a financial ceiling;**
6. ***fully open*: programmes where non-resident research performers are eligible for funding as a partner and with no financial ceiling.**

### *There is currently no robust estimation of the share of open programmes among national R&D programmes in Europe*

To capture quantitatively the level of openness of national public R&D programmes in countries, it is useful to distinguish between: i) the number of programmes in the above categories among all R&D national public R&D programmes; ii) the share of national funding directed to these programmes; iii) the actual use of this funding by non-resident researcher performers. None of these three quantities has, so far, been properly estimated[280].

A recent review of R&D programmes in seven European countries[281] found that linking national research programmes to EU priorities under the FP, or planning large infrastructures according to EU directions, and using EU-level instruments such as ERA-NETs, are various ways to encourage international collaboration in R&D. The prevailing national approaches to ERA are to use EU-level instruments (for trans-national coordination of research activities) rather than opening up national funding sources to foreign-based research actors.

The most common situation across the seven countries reviewed is that of R&D programmes which are increasingly open to non-resident participants, but with funding restricted to actors based in the country. The principle 'each agency funds those residing in the country' is the most widespread rule.

Whatever its degree, international openness is in general not limited to European countries (there are some exceptions). The rationale for favouring openness is to enhance research quality, therefore there is no reason to limit the list of eligible countries to European ones.

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[279] See Science, Technology and Competitiveness Key Figures Report 2008/2009, European Commission, p 159, available at http://ec.europa.eu/research/era/publication_en.cfm and Monitoring progress towards the ERA, European Commission, ERAWATCH Network, 2009. Available at: http://cordis.europa.eu/erawatch/index.cfm?fuseaction=reports.home

[280] Work is being undertaken by the European Commission to provide first robust measures on the openness of national R&D programmes in Europe, based on ERAWATCH's Inventory of Research and Innovation Policy and on the ongoing project Joint and Open REsearch Programmes (JOREP).

[281] *Monitoring progress towards the ERA*, European Commission, ERAWATCH Network, 2009, available at: http://cordis.europa.eu/erawatch/index.cfm?fuseaction=reports.home

## Box II.4.3 – A 2009 survey of European research funding bodies

The Danish Business Research Academy surveyed research funders in European countries on their international orientation and trans-national coordination and published the results in 2009. The survey was conducted among 71 research funding bodies in 27 European countries, with a total yearly budget of approximately EUR 20 billion. A total of 33 research funding bodies, representing 48% of the total funds of the 71 research funders contacted, took part in the survey. According to the survey:

- 90% of the respondents participate in bilateral research agreements with funding bodies in other countries;
- 87% participate in multi-lateral initiatives with the EU;
- 60% provide grants for non-resident research participants;
- 64% devote 0 or less than 5% of their budget to non-resident participants[282];
- 23% wish to increase funding for non-residents;
- 37% do not or cannot fund non-resident participants[283];
- 39% cannot participate in common pots[284];

Almost all respondents 'somewhat' or 'strongly' agree that trans-national research coordination allows for joint policy responses to common challenges such as climate change, exploitation of complementary research strengths, increased mobility of researchers and sharing of knowledge and best practices in research funding. The conclusion of the survey is that, although European research funders show some degree of trans-national orientation, there is a significant proportion of research funders whose funds are not, or only limitedly, used for trans-national research projects, contributions to common pots and non-resident research participants. Therefore, there is scope for augmenting the amount of funds in national funding bodies which is used to support trans-national research, i.e. (i) trans-nationally coordinated research programmes with cross-border flows of funds and (ii) national research programmes open to non-residents.

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[282] 17% do not know, hence 19% devote more than 5% of their budget to non-residents research participants.

[283] 13% do not know.

[284] 10% do not know, hence 51% can participate in common pots.

# CHAPTER 5

# Mobility of researchers and human resources

## HIGHLIGHTS

An effective European Research Area will contribute to an internal market for knowledge in Europe, where researchers, science and technologies can circulate freely, thereby optimising knowledge spillovers. To this end, it is not sufficient to enhance the system - research performers and users also need to be stimulated to take up the opportunities offered to them and use the changing structures in view of collaborative knowledge production. An enhanced mobility of students and researchers is crucial in this respect.

The Erasmus and Marie Curie schemes have stimulated the development of mobility within Europe. However, the mobility of researchers across Europe is still limited. Around 7% of all doctoral candidates in the EU are studying in another EU country. 76% are EU nationals studying in their own country while the remaining 17% are citizens from outside the EU.

Moreover, the mobility of researchers is not equally spread over Europe. If flows of students under Erasmus are relatively balanced, this is not so when it comes to researchers. The most important net receiver of doctoral candidates in both absolute and relative terms is the United Kingdom, with a net gain of almost 15 000 doctoral candidates of EU nationality. The other Members States with a net gain are France, Spain, Austria, the Czech Republic, Sweden, Finland and Belgium. On the other end, Italy (3 600), Portugal (2 500) and Romania (1 700) register the largest net-losses in absolute terms in intra-EU exchanges of doctoral candidates.

Europe is opening up in terms of international mobility of researchers. The overall pattern is an inflow of researchers from Asia and an outflow of researchers to the United States. Asia, the Middle East and Oceania are the largest ‘senders’ of doctoral candidates to the EU with 5.8% of doctoral candidates in the EU coming from this broad geographical region.

Among countries outside Europe, China was the most important sender of doctoral candidates to the EU with around 6 500 doctoral candidates in 2007. Three large EU Member States stand out as recipient of doctoral candidates: the UK (with more than 35% of its students coming from outside the EU), France (31%) and Spain (nearly 17%)

In the other direction, the number of doctoral graduates in Science and Engineering in the United States with European citizenship increased from around 1 300 in 1996 to around 1 800 in 2007 (an increase of approximately 38.6%). Among the EU Member States, Germany, Italy, France, Romania, Spain, the United Kingdom, Greece and Bulgaria belong to the top 30 countries with doctorates awarded in the United States. However, the share of overall European doctoral graduates receiving their doctoral degree in the United States remains low (2-3%).

## 5.1. Are students and doctoral candidates studying in European countries other than their own?

Participation in student-exchange programmes is a major predictor of the future mobility pattern of researchers: according to the MORE survey, 32% of mobile researchers had previously taken part in a student exchange programme like Erasmus, compared to only 15% of non-mobile researchers[285]. Put differently – the experience of a stay abroad as a student significantly increases the likelihood of becoming mobile later as a researcher. The Erasmus programme prepares the ground for the mobility dimension of the ERA.

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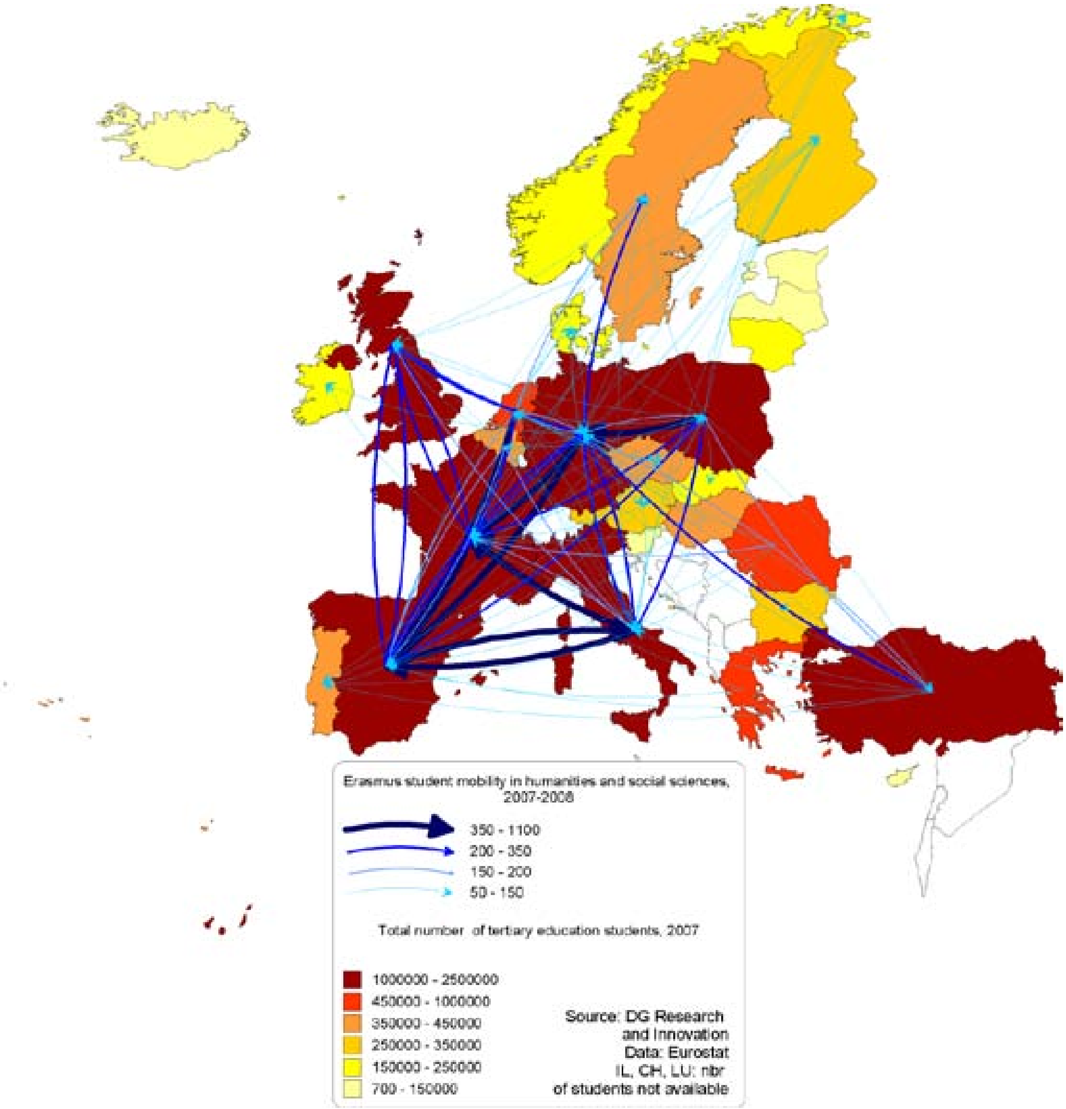
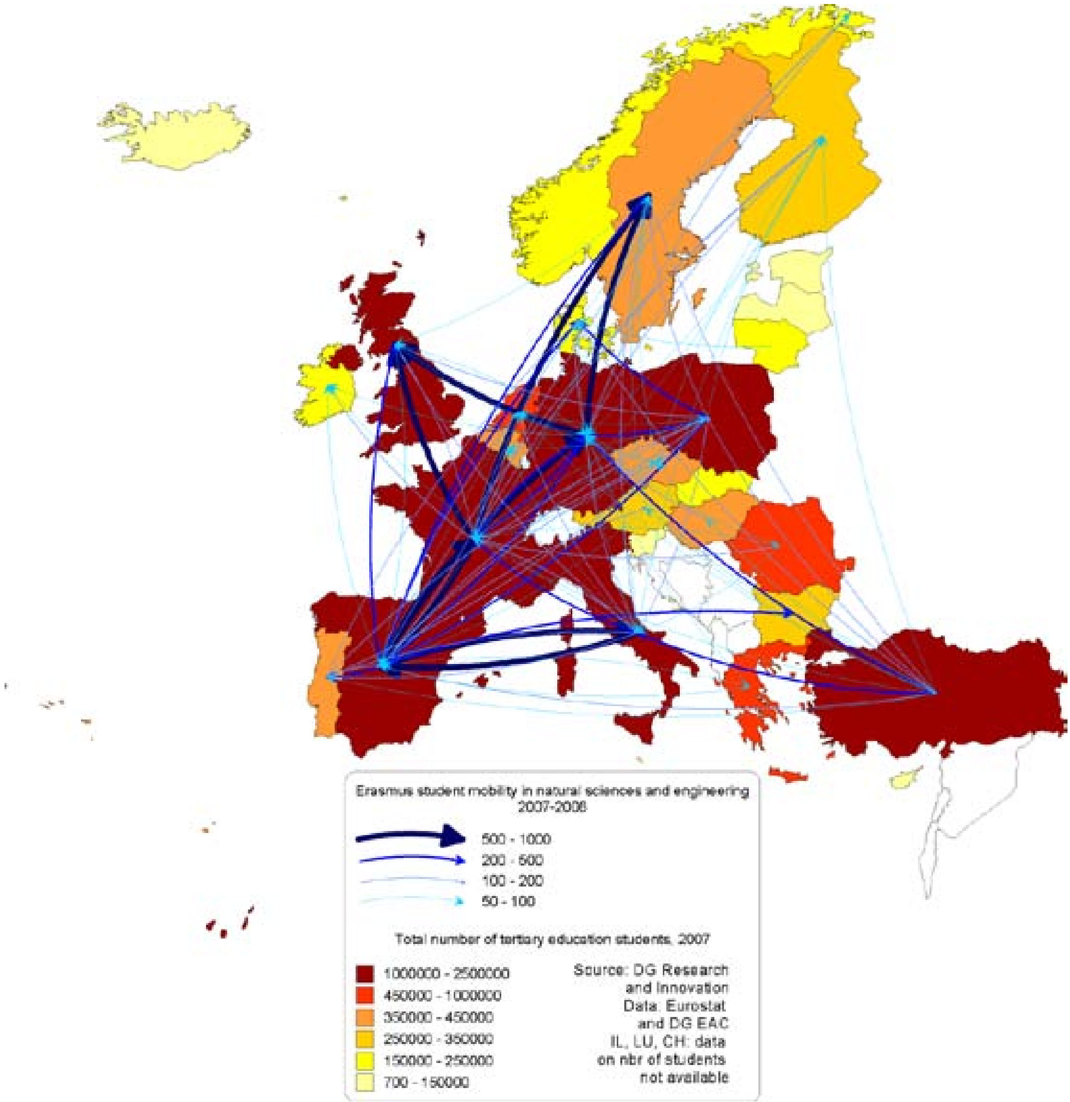
[285] See Intra-Mobility study of MORE.

## FIGURE II.5.1 Erasmus student mobility in humanities and social sciences, 2007-2008



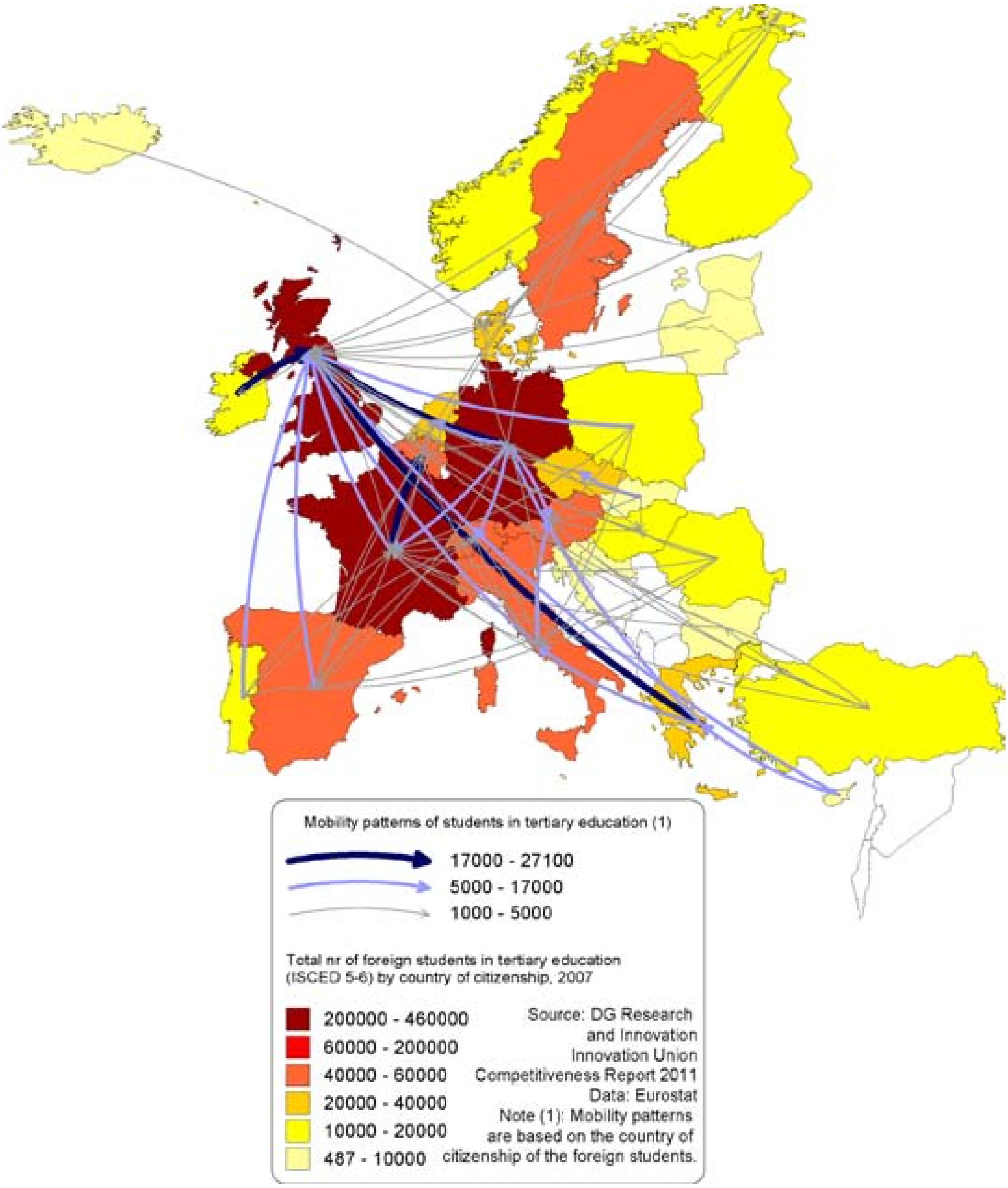
Source: DG Research and Innovation
Data: Eurostat
IL, CH, LU: nbr of students not available

FIGURE II.5.2 **Erasmus student mobility in natural sciences and engineering, 2007-2008**



Source: DG Research and Innovation
Data: Eurostat and DG EAC
IL, LU, CH: data on nbr of students not available

## FIGURE II.5.3 Mobility of students in tertiary education



Source: DG Research and Innovation
Innovation Union Competitiveness Report 2011
Data: Eurostat
Note (1): Mobility patterns are based on the country of citizenship of the foreign students.

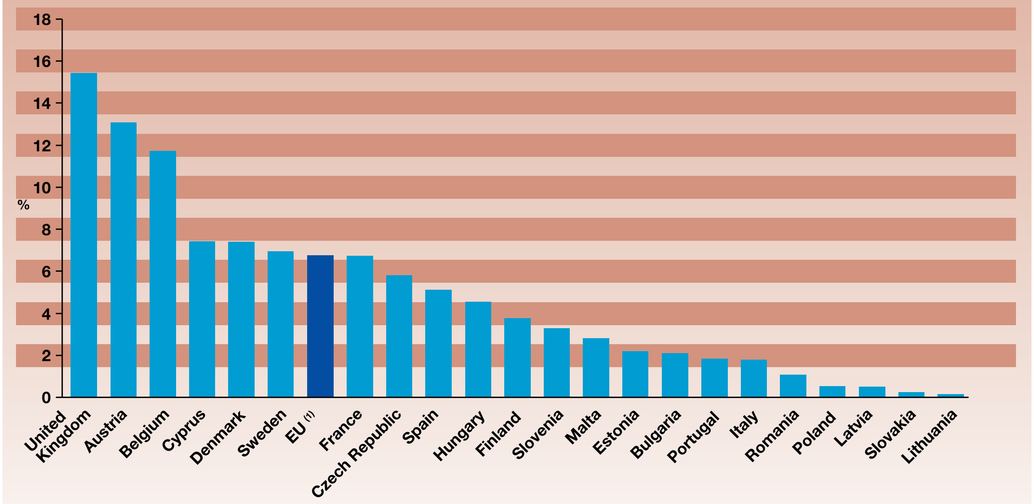
*Notes:* (1) Mobility patterns are based on the country of citizenship of foreign students in countries;
(2) Data for doctoral candidates by citizenship are not available for Germany, Ireland, Greece, Luxembourg and the Netherlands.

### *The mobility of Erasmus Programme students in humanities and social sciences tend to have a north–south movement, while students in science, technology and mathematics have a tendancy of south–north movement*

From the perspective of the European Research Area, the mobility pattern of students is interesting for two reasons: firstly one can use the mobility pattern of students as an indictor of the relative attractiveness of universities. Secondly, the mobility pattern gives a very general indication of the geographical and institutional preferences of future researchers within Europe.

Figure II.5.1.and figure II.5.2. show that there is a tendancy of north–south movement of students in the social sciences and humanities but a tendancy of south–north movements in the MTS subjects. The previous chapter on universities and public research-performing organisations presented the location of major research-intensive universities in Europe[286]. The Erasmus student population cannot be seen as a representative sample of all student mobility in Europe. Nevertheless, making the cross-analysis with the Erasmus student mobility pattern, there seems to be an overall correlation between the location of Europe's top research universities and the mobility of Erasmus students in mathematics, technology and sciences[287].

FIGURE II.5.4 **Doctoral candidates (ISCED 6) with the citizenship of another EU Member State as % of total doctoral candidates in the reporting Member State, 2007**



*Source*: DG Research and Innovation
*Data*: Eurostat, MORE Study
*Note*: (1) EU does not include DE, IE, EL, LU, NL - data for these Member States are not available

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286 See Part II, chapter 1.1.3.

287 However, this overall observation is still to be confirmed. The data on ERASMUS student mobility is at country level and not at institutional level, so a strict correlation can not be established.

### *Student mobility financed by the Erasmus Programme presents a more balanced mobility flow than overall student mobility*

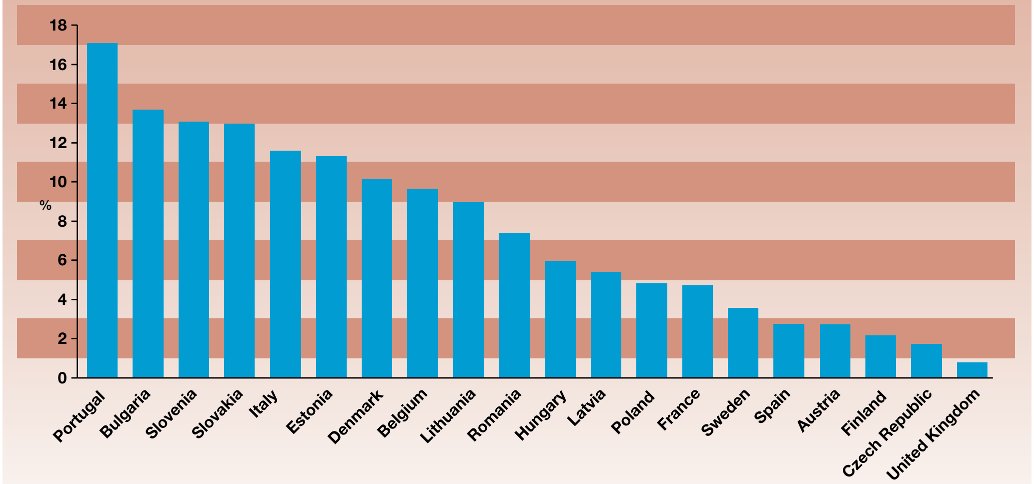
By design, the flow of students within the Erasmus Programme is more or less balanced, as it was originally set up as a student-exchange programme between universities. This becomes clearer when comparing to the total flow of students in tertiary education across Europe, as presented in figure II.5.3. Overall, the United Kingdom is clearly the major attractor within Europe, in particular German, Italian and Greek students are moving to the United Kingdom. Spain attracts a larger number of Portuguese students, Switzerland and Austria observe a massive influx of students from Germany, and the Czech Republic hosts many Slovakian students. In 2008, the Eastern European countries are less integrated in the intra-European flows of students in absolute numbers. Given the importance of experiences of mobility as a student for mobility later on in life, this lower integration may hamper the extent to which future researchers of the EU-12 Member States will participate in the opportunities offered by the European Research Area.

### *The United Kingdom, Austria and Belgium host the highest percentage of doctoral candidates from other EU Member States. Lithuania, Slovakia and Latvia have the lowest share of doctoral candidates from EU Member States*

The quality of education and research at the host institution is decisive for the future career and job prospects of a doctoral candidate. Doctoral candidates will try to get the best quality working conditions and move, if necessary, to another Member State for their research. Hence, the patterns of movements of young researchers are, therefore, indicative about the relative quality of working conditions in research within the European Research Area, although language and cultural factors also influence the mobility patterns. Figure II.5.4 above shows the share of doctoral candidates in the EU Member States with citizenship from another Member State. Of the 22 countries reporting data, the United Kingdom receives the larger number of doctoral candidates from other Member States as a share of the total number of doctoral candidates in the country: 15% of doctoral

FIGURE II.5.5

**EU doctoral candidates (ISCED 6) in EU Member States of which they are not citizens as % of total doctoral candidates of their citizenship in their home Member State, 2007**



*Source*: DG Research and Innovation
*Data*: Eurostat, MORE Study

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candidates in the United Kingdom are citizens of another Member State. Austria and Belgium follow with 13% and 12% respectively. The EU-27 average is 6%. The countries with the lowest inflows of doctoral candidates from other Member States are primarily the new Member States (Lithuania, Slovakia, Latvia, Poland, Romania, Bulgaria and Estonia) and some of the Southern European countries (Italy, Portugal).

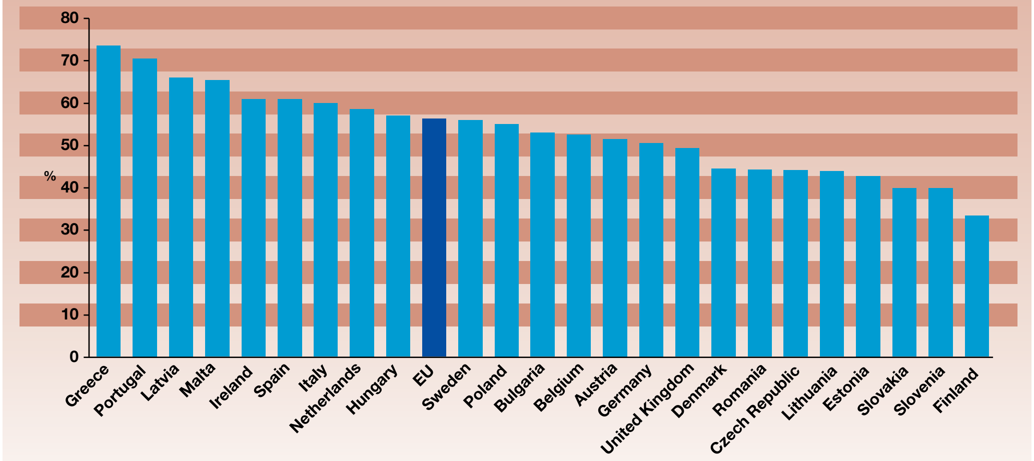
### *In relative terms Portugal, Bulgaria and Slovenia are the biggest exporters of doctoral candidates to other EU Member States, while the United Kingdom exports the lowest share of doctoral candidates*

Figure II.5.5. provides a picture of the intra-EU outflows of doctoral researchers in relative terms, but for a different set of countries. The figure shows the percentage of doctoral candidates of each EU nationality in another EU Member State compared with the total number of doctoral candidates in the country with the reporting country's nationality.

Portugal presents the highest share of doctoral candidates in another EU Member State as percentage of doctoral candidates with Portuguese citizenship studying/working in Portugal (17%). Bulgaria follows with 14% and Slovenia and Slovakia with 13% for each. As mentioned above, although the United Kingdom tops the list of countries with the highest share of doctoral candidates from another Member State, Figure II.5.5. shows that relatively low shares of doctoral candidates with UK citizenship study/work in other EU Member States. The differences between these two indicators may be explained by many factors, e.g. the quality of the education system in the United Kingdom, or the perceptions of foreign students/researchers about the quality of this system. It may also point to the relatively lower language barriers for students/researchers coming into the United Kingdom.

The MORE study on mobility patterns and career paths of EU researchers[288], carried out on behalf of the Commission in 2009–2010, was the first attempt at a comprehensive, pan-European study focussing on

FIGURE II.5.6 **Share of researchers in the higher education sector with international mobility experience (of at least three months duration), 2009**



*Source*: DG Research and Innovation
*Data*: MORE Study

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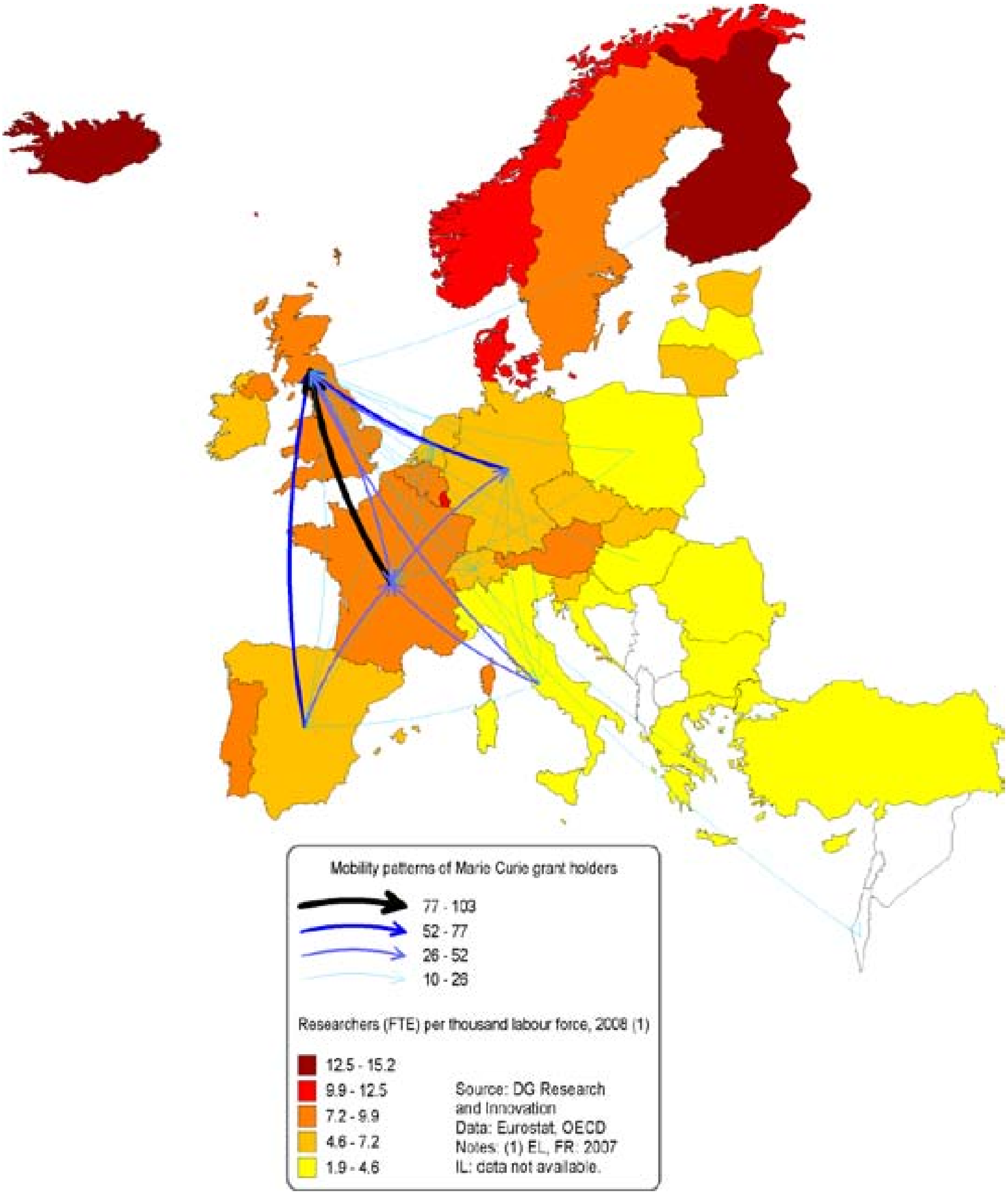
[288] http://ec.europa.eu/euraxess/index.cfm/general/researchPolicies

FIGURE II.5.7 **Mobility patterns of Marie Curie grant holders, 2008**



Source: DG Research and Innovation
Data: Eurostat, OECD
Notes: (1) EL, FR: 2007
IL: data not available.

researchers international mobility. The study included surveys of researchers in Higher Education Institutions, Public Research-performing Organisations and industry as well as a pilot survey of EU–US researcher mobility.

### *Researchers in the Southern European countries are more likely to have been internationally mobile at least once in their career*

MORE revealed that EU-wide, 56% of researchers have been internationally mobile[289] at least once in their careers. Of these researchers, more than half (that is 29% of all EU27 HEI researchers) have experienced international mobility during the last three years. Figure II.5.6. shows a clear north–south split with researchers in Greece, Portugal, Spain and Italy reporting the highest levels of mobility. Among those researchers who had been internationally mobile, 80% believed that their mobility experience had had a positive impact upon their career. Moreover, 64% had ‘actively considered’ further mobility in the future. The survey also looked at the extent to which researchers are currently engaged in ‘formal collaboration’ with researchers from other countries. Although no cause and effect was identified, it is interesting to note that 65% of the researchers who had been internationally mobile reported ongoing collaboration with colleagues in other countries, compared with 54% of non-mobile researchers.

### *The United Kingdom is the main attractor of Marie Curie Fellows*

Applications for Marie Curie Fellowships are evaluated according to the quality of the applicant and of his/her research project (50%) and the quality of the host institution (50%). Hence the movement of Marie Curie Fellows is an indicator of the relative attractiveness of research conditions, including the possibility of learning languages commonly used in sciences and engineering. As Figure II.5.7. clearly indicates, the United Kingdom is the main attractor of Marie Curie Fellowships.

### *The share of the participation of women in the framework programme has been quite constant during the last decade*

The framework programme provides interesting insights into the dynamics of women’s participation in research. Taking the available data on percentage of women’s participation in actions supported by the ‘People’ Specific Programme of the Seventh Research Framework Programme, we see, by and large, a constant rate of participation, ranging from 38% in 2003 to 39% in 2009[290].

The MORE survey of researchers in higher education institutions[291] in 2009 showed that male researchers (60%) are more likely than female researchers (51%) to have been internationally mobile. This holds true across all broad scientific domains, but the difference was most marked in the social sciences and humanities (64% versus just over 50%). However, data for international mobility over the last three years suggested that the gap between the sexes had been reduced (31% of males against 28% of females).

## 5.3. Is there a growing mobility of researchers between Europe and the rest of the world?

This section analyses existing data on the EU’s world attractiveness for researchers. Unfortunately, data is still not sufficient to draw any firm conclusions. The section starts with the number of doctoral graduates of European origin in the United States. The United States is the benchmark as the major pool of international talent used to study the relative attractiveness of the European system for researchers. The section continues with data on specific framework conditions, such as salary levels and research conditions visible in data on potential return rates. The last part of the section reviews incoming mobility to Europe from other parts of the world.

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[289] International mobility was defined as having worked in a country other than the country in which the researcher attained his/her highest educational degree. It includes research visits of three months or more.

[290] For a more detailed gender analysis in research and innovation, including the EU research Framework Programme, see Part II, chapter 3.

[291] http://ec.europa.eu/euraxess/pdf/research_policies/MORE_HEI_report_final_version.pdf

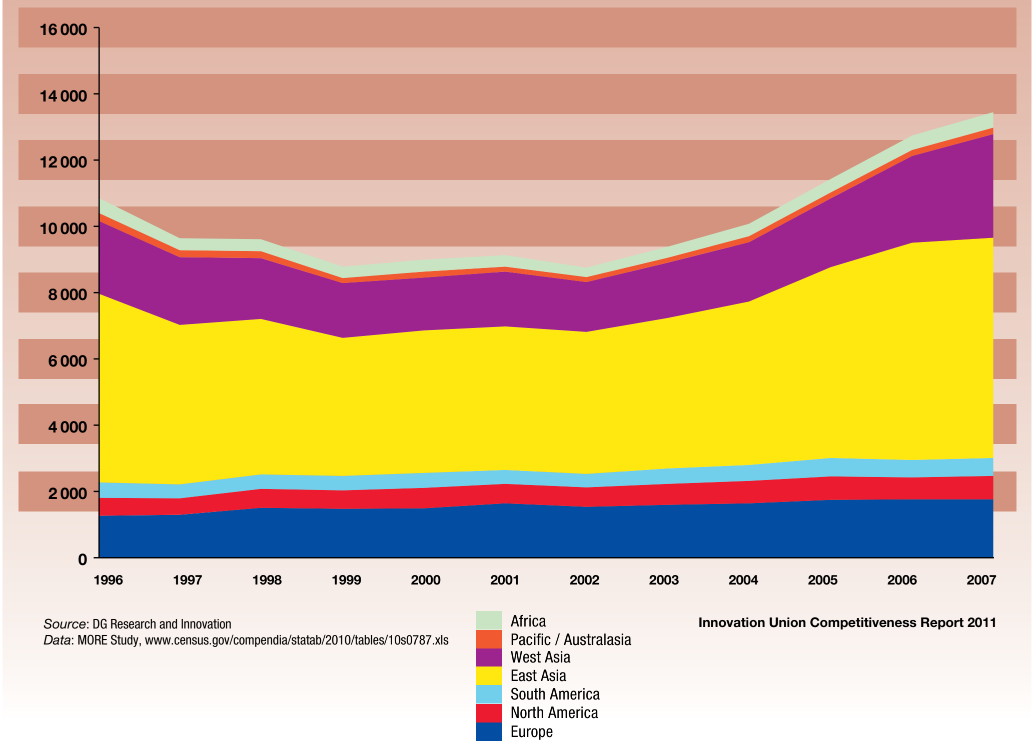
### *The number of European citizens receiving their doctoral degree in the United States increased by almost 40% between 1996 and 2007 but they still represent a relatively low share (2–3%) of total doctoral degrees awarded in Europe*

Figure II.5.8. presents the number of non-US doctoral graduates by main region of origin in science and engineering over time. The number of doctoral graduates in the United States with European citizenship has increased from about 1 300 in 1996 to about 1 800 in 2007, an increase of 38.5%. The number of doctoral graduates in the United States from East Asia is the highest, and equals approximately 6 600 doctorates in 2007.

Figure II.5.9. shows the number of doctoral graduates in science and engineering in the United States holding citizenship of European countries over time, separating Germany, the United Kingdom and France from the rest of Europe. The number of doctoral graduates in the United States originating from Germany, the United Kingdom and France represents 23% of all doctorate graduates in the United States from Europe. The number of doctoral graduates from Germany, United Kingdom and France increased by 12% from 359 in 1996 to 403 in 2007. For the rest of Europe, the number of doctoral graduates in the United States increased more strongly from about 919 in 1996 to 1 368 in 2007 (by 49%).

FIGURE II.5.8

**Non-US citizen doctoral graduates in science and engineering in the United States by main region of origin, 1996-2007**



*Source*: DG Research and Innovation
*Data*: MORE Study, www.census.gov/compendia/statab/2010/tables/10s0787.xls

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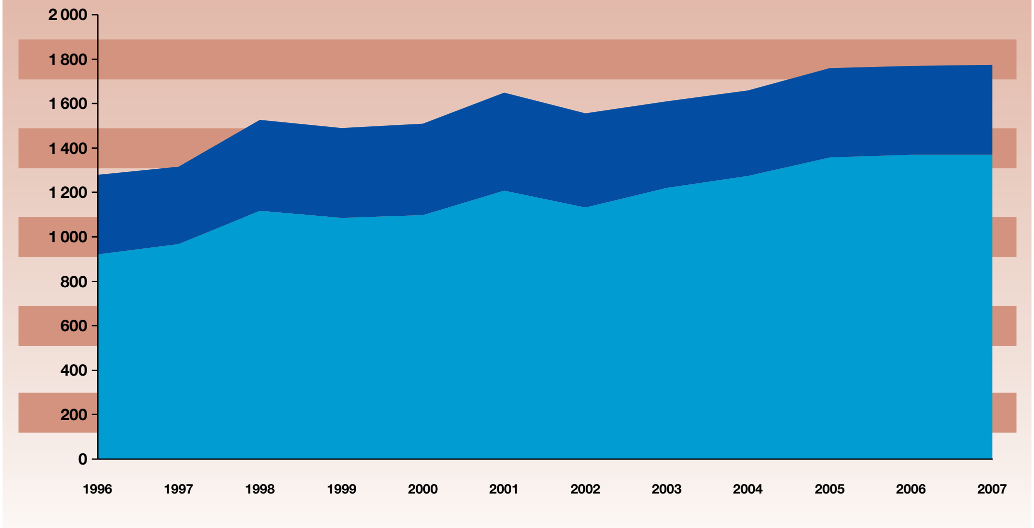
FIGURE II.5.9 European citizen doctoral graduates in science and engineering in the United States, 1996-2007



*Source*: DG Research and Innovation
*Data*: MORE Study, www.census.gov/compendia/statab/2010/tables/10s0787.xls

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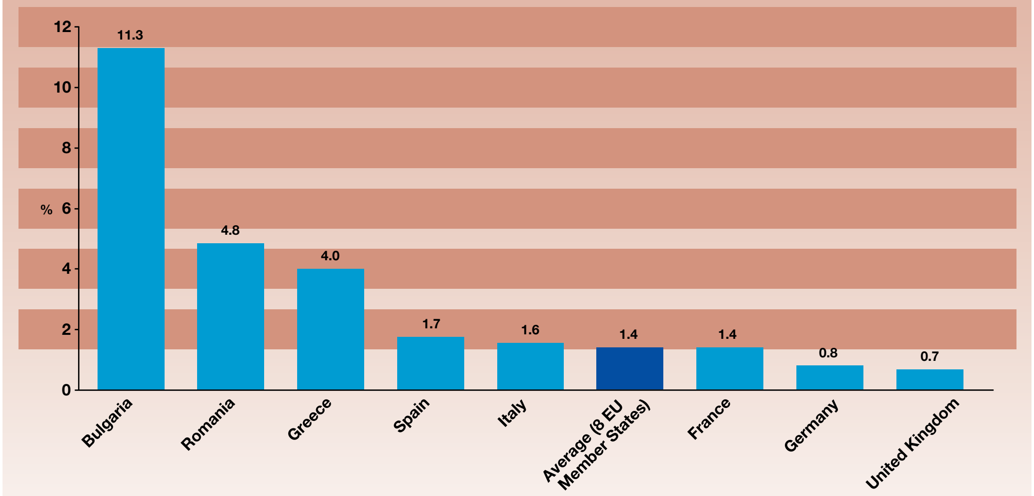
### *Bulgaria, Romania and Greece are the Member States with the highest share of doctoral students having finalised their doctoral degree in the United States*

Figure II.5.10. presents the ratio of non-US citizens earning doctorates in the United States to the number of doctoral degrees earned at home for the eight EU Member States on the top-thirty list (see also the top-forty list in Table 13). The average for these 8 EU countries is 1.4%: on average 1.4 doctorates are awarded to citizens of these 8 countries from US institutions for every 100 doctorates awarded at home. Bulgaria appears to be an outlier with a ratio of 11.3%.

### *US academic research institutions can offer significantly higher remuneration schemes for researchers in specific competitive fields than European academic research institutions*

Researchers, particularly in the fields of natural sciences and engineering, encounter international competition for their talent and skills. An outstanding researcher can be choosy about where he/she wants to work. To estimate the relative attractiveness of European non-private research institution one can use average remunerations as a proper proxy. A survey among researchers in natural sciences in Europe and the United States was made with 6 254 respondents mostly

FIGURE II.5.10 **Number of EU citizens earning doctorates at universities and colleges in the United States(1) as % of total doctoral degrees awarded at home, 2007**



*Source*: DG Research and Innovation
*Data*: Eurostat, NSF/NIH/USED/USDA/NEH/NASA, 2008 Survey of Earned Doctorates
*Note*: (1) Only the eight Member States on the top 40 list of countries are included on the graph.

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from established research institutions in the north and west of Europe with only few respondents from the new Member States (where remuneration levels are significantly lower than in the other Member States). Interestingly, remuneration levels are similar at the level of postdoctoral fellows. When it comes to an advanced academic career, salary levels are significantly higher in the United States than in Europe. The average values hide the way that remuneration can reach extreme levels in the United States when the competition concerns outstanding talents. In contrast, remuneration schemes in Europe tend to be more homogeneous, making it difficult to come up with attractive offers for outstanding talents[292].

### *Chinese students are the most important non-European pool of doctoral candidates in Europe*

Overall, around 17% of doctoral candidates in the EU are citizens from non-EU countries. As Figure II.5.11 shows, among non-European countries, China was the most important sender of doctoral candidates to the EU with around 6500 doctoral candidates in 2007. Mexico and the United States followed with 4000 and 3600 doctoral candidates, respectively.

### *The inflow of doctoral candidates to the EU tends to be linked to language and historical factors*

Figure II.5.12. shows that the Member States which received most foreign (non-EU) doctoral candidates are the United Kingdom, France and Spain, all three receiving around 71000 doctoral candidates from non-European countries (36000, 23000 and 12000, respectively) in 2007. Citizens of countries in Asia, the Middle East and Oceania combined accounted for 51% of foreign doctoral candidates to the United Kingdom. Knowledge of the local language and historical ties seem to be important factors: in Spain, 85% of doctoral candidates from non-European countries come from South America; in France almost one in two doctoral candidates from non-European countries comes from African countries (49%).

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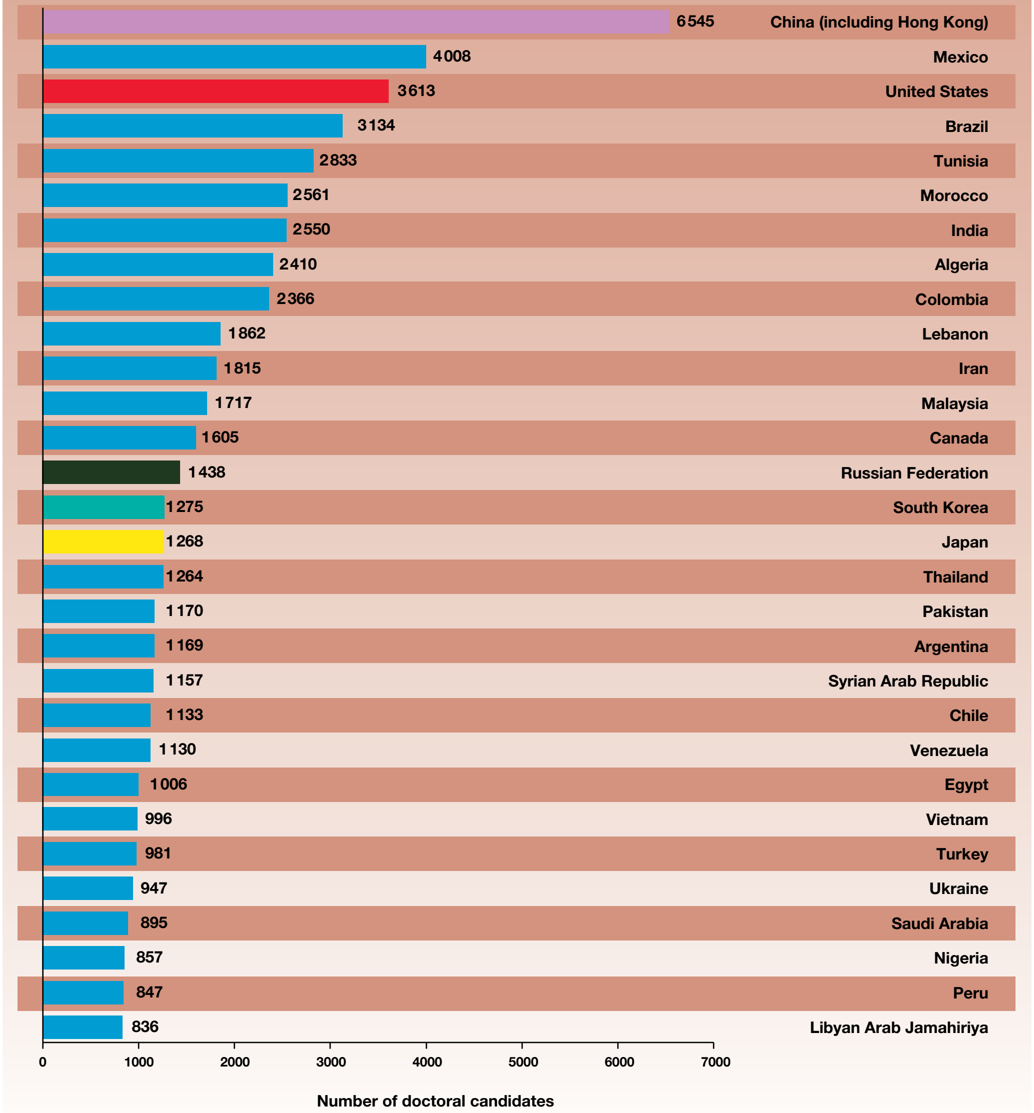
[292] Survey of Naturejobs. See http://www.nature.com/naturejobs/salary/survey/2010/index.html

FIGURE II.5.11 Foreign (non-EU) doctoral candidates (ISCED 6) in the EU(1) – the top 30 countries of origin, 2007



*Source*: DG Research and Innovation

*Data*: Eurostat, MORE Study

*Note*: (1) DE, IE, EL, LU, NL were not included in the calculation as data for these Member States are not available.

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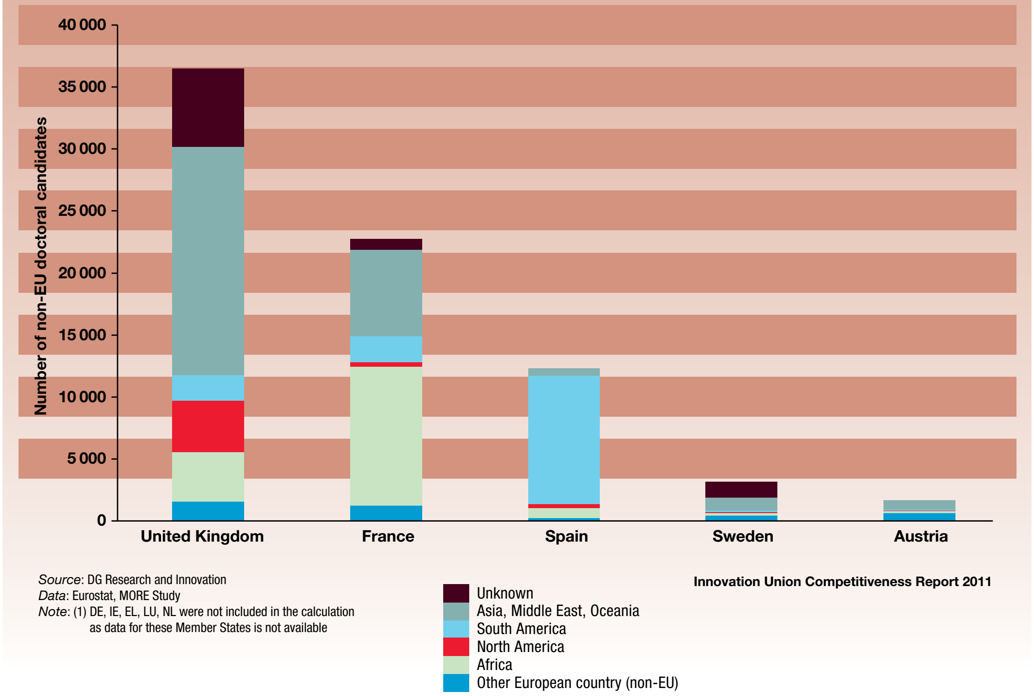
## FIGURE II.5.12 Number of non-EU doctoral candidates (ISCED 6) by region of citizenship – the five Member States receiving the most candidates(1), 2007



*Source*: DG Research and Innovation
*Data*: Eurostat, MORE Study
*Note*: (1) DE, IE, EL, LU, NL were not included in the calculation as data for these Member States is not available

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# CHAPTER 6

# Free movement of science and technology across Europe and beyond

## HIGHLIGHTS

An effective European Research Area will contribute to a single market for knowledge in Europe. To this end, it is not sufficient to enhance the system – research performers and users also need to be stimulated to take up the opportunities offered to them and use the system for collaborative knowledge production. Knowledge circulates between the public and private sector (see chapter II.2), across Europe and between Europe and other parts of the world. Knowledge flows can take different forms: exchange of informal knowledge and information, knowledge embodied in persons (see chapter II.4), concrete cooperation in producing science, and cooperation in the development and ownership of technologies. Evidence shows an increasing integration of science and technology production in Europe. However, this knowledge circulates predominantly within Western Europe, leaving countries in Eastern Europe, and some of the Southern European countries, outside the dominant knowledge flows.

Evidence of electronic infrastructures indicates an increasing flow of informal scientific knowledge. The strong increase in Open Access repositories, journals and articles testifies similar trends towards knowledge sharing driven by mutual benefit. However, much progress remains to be made. Only 20% of the total number of peer-reviewed journals worldwide offer open access to the reader. Scientific integration and cooperation can also be measured by the number of co-publications. In absolute numbers, European researchers co-publish mainly with colleagues from other European countries, and this intra-European co-publication increased by almost 10% between 2003 and 2008. However, a divide appears between an increasingly integrated Western Europe and an Eastern Europe suffering from a lower level of trans-European scientific cooperation – a picture also emerging from data on the mobility of researchers. At the same time, European scientists increasingly co-publish with colleagues from non-European countries: a growth of 8% over the period 2000–2008. The largest growth has taken place in the co-publications with researchers from the most research-intensive Asian countries. However, the EU still lags behind the United States in scientific cooperation with these Asian countries.

Contrary to scientific cooperation, technological cooperation is closely linked to market exploitation and application of knowledge. Worldwide, co-patenting has more than tripled since the early 1990s, with a major role played by the United States. At EU level, the four strongest countries in terms of patent applications (France, the United Kingdom, Germany and Italy) account for 75% of all EU patent applications. However, all Member States increased their co-patenting both within the country and with European or third-country partners. Co-patents with third countries increased more than those within the EU, showing the international and open character of innovation systems but also the need to consolidate the internal market for knowledge. Networks organised around co-patenting collaborations have been growing, usually around a core of key linkages, reinforcing the regions with higher degrees of patenting, which become the regions with stronger co-patenting activities. Germany has been playing a bridge role in this networking. Smaller countries show less integration in the networks. Europe's scientific cooperation divide seems to be visible also in technological collaboration, with an additional peripheral role for some Southern European countries as Portugal, Greece, and to a certain extent, Spain.

A higher integration of EU Member States' research systems is an essential prerequisite of the realisation of the ERA, with the view of avoiding duplication of research results obtained in various Member States, and maximising knowledge spillover. The Innovation Union Initiative emphasises the need to remove obstacles to flows of knowledge and a single market for knowledge. Knowledge flows in transnational collaboration which are disseminated through open access to scientific products also contribute to raising the quality of European science and technology.

This chapter presents cooperation and knowledge flows for the production of science and technology, spanning from information- and knowledge-sharing using information and communication technologies (measured by Webometrics, e-infrastructures and open access to scientific articles), transnational cooperation in the production of knowledge (measured by collaborative links and international cooperation funded through the EU framework programme), cooperation in producing scientific knowledge (co-publications), and cooperation in technology development (co-patenting).

## 6.1. Is there an expansion in electronic infrastructures and open access to scientific articles?

### *The capacity of European e-infrastructures has largely expanded over the last five years*

Normalised networks, the Central Processing Unit (CPU)[293] and computing capacities used in European e-infrastructures and accessible from any country[294] were multiplied by more than 17 times between 2005 and 2010. This network capacity is mainly provided by GEANT, DANTE, CPU and computing capacity by EGI and PRACE. These infrastructures are essential in supporting the exchange of data and information between researchers, universities and research organisations throughout Europe.

TABLE II.6.1 **Normalised network, CPU and computing capacities(1), 2005-2010 (reference: 100 in 2005)**

| | |
|---|---|
| 2005 | 100 |
| 2006 | 158 |
| 2007 | 363 |
| 2008 | 482 |
| 2009 | 908 |
| 2010 | 1 751 |

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*Source:* DG Research and Innovation
*Data:* DG Information Society
*Note:* (1) 1/3 (netcap) + 1/3 (cpucap) + 1/3 (compcap)

### *The use of European e-infrastructures has increased by over three times over the last five years*

Cross-country network traffic represents actual knowledge circulation between researchers, universities and research organisations within the EU and between the EU and the rest of the world. This cross-country traffic was multiplied by more than three between 2005 and 2010.

TABLE II.6.2 **Cross-country network traffic(1), 2005-2009 (reference: 100 in 2005)**

| | |
|---|---|
| 2005 | 100 |
| 2006 | 161 |
| 2007 | 222 |
| 2008 | 274 |
| 2009 | 327 |

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*Source:* DG Research and Innovation
*Data:* DG Information Society
*Note:* (1) 1/2 (traffic EU) + 1/2 (traffic beyond EU)

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293 Central Processing Unit.
294 Purely national resources are excluded.

This considerable expansion of the capacity and actual use of e-infrastructure is partly due to EU funding, but mostly to national funding. In fact, 1.13% of EU FP-7 budget is devoted to e-infrastructures. EU funding to European e-infrastructures represents 5% to 10% of total funding to these infrastructures. The rest is financed by national investments.

### *Dissemination of science through Open Access*

In recent years Open Access (OA) has become an increasingly important tool for the dissemination of knowledge from research to society as shown by the growing number of OA Journals and repositories. OA journals do not differ from the traditional journals in their commitment to peer review or their way of conducting it, but only in their cost-recovery model. The funding model used by OA journals does not charge readers or their institutions for access.

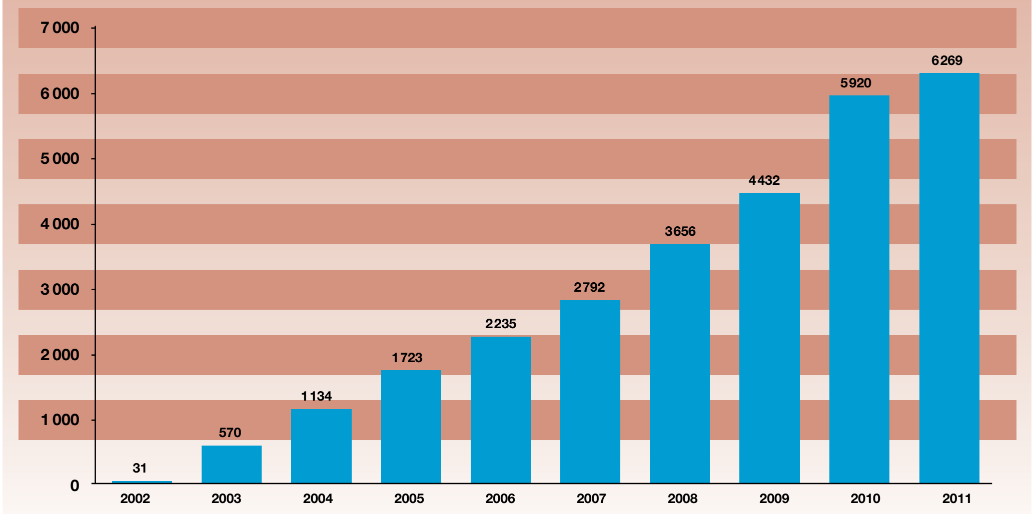
### *The number of Open Access journals and open-access repositories has increased substantially since 2002, with the highest numbers being recorded in European countries*

According to the Directory of Open Access Journals, which covers free, full-text, quality-controlled scientific and scholarly journals, there were 6269 OA journals in March 2011 (Figure II.6.1.). The highest number of Open Access journals can be found in the EU, followed by the United States, Brazil, India, Japan and China.

The increase of OA practice can also be noticed by the growth of the number of repositories (Figure II.6.2.) – the online locus for collecting, preserving, and disseminating the publications in digital form – used for Open Access Self-Archiving.

Yet again the highest number of Open Access repositories can be found in the EU, followed by North America and Asian countries.

FIGURE II.6.1 **Number of Open Access journals, 2002-2011**



*Source*: DG Research and Innovation
*Data*: Directory of Open Access Journals

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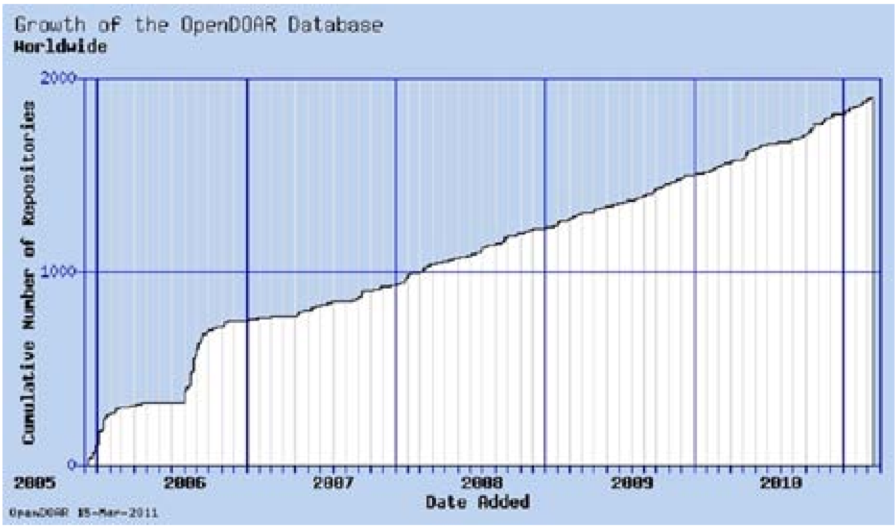
FIGURE II.6.2 **Growth of the OpenDOAR Database**



*Source:* DG Research and Innovation
http://www.opendoar.org

***In 2008, about 20% of peer-reviewed journals worldwide offered Open Access to the reader, a slight increase compared to 2006***

Although these indicators show the important growth of OA over last years, they cannot individually make a comprehensive estimation of the penetration ratio of both OA publishing and Self-Archiving practices. To this end, a more significant indicator of the overall growth of the phenomenon could be the proportion of research literature (articles) available in OA form in OA journals and repositories.

Estimations[295] show a share of OA in the total number of articles published in peer-reviewed scientific journal articles published worldwide in 2006 (approximately 1 350 000) of 19.4%, subdivided as follows: 4.6% immediately openly available, 3.5% available after a one-year embargo period, and 11.3% available in subject-specific or institutional repositories or on authors' home pages.

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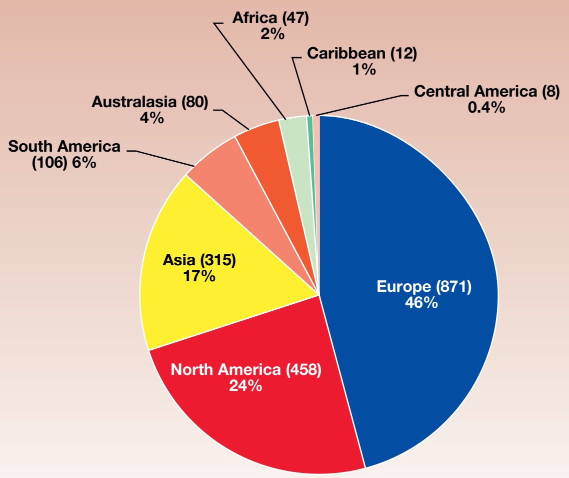
[295] Bo-Christer Bjork et al, Information Research vol. 14 no. 1, March, 2009, 'Scientific journal publishing: yearly volume and open access availability'. http://informationr.net/ir/14-1/paper391.html

FIGURE II.6.3 **Repositories by world region (total = 1897)**



*Source*: DG Research and Innovation
*Data*: www.opendoar.org

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In 2008[296], the overall share of OA literature was 20.4%, of which:

- 8.5% free at the publishers' sites (62% in full OA journals, 14% in subscription journals which make their electronic versions free after a delay, and 24% as individually open articles against payment in otherwise subscription journals).
- 11.9% free in either subject-based repositories (43%), institutional repositories (24%) or on the home pages of the authors or their departments (33%).

## 6.2. Is transnational scientific cooperation growing both within Europe and beyond?

***In 2008, almost half of world publications were made in transnational cooperation. Intra-EU co-publications increased by almost 10% between 2003 and 2008.***

Figure II.6.4. shows the total number of scientific peer-reviewed publications in the EU, the number of scientific publications in each country (single author and domestic co-publications), the number of scientific publications involving authors in at least two EU Member States, and the number of scientific publications in the EU where at least one author is based outside the EU.

Researchers based in the EU are increasingly integrated in transnational networks, as reflected by the higher growth of the number of transnational co-publications (within EU and with non-EU countries) compared to the growth of scientific publications within single Member States over the period 2003–2008: in total,

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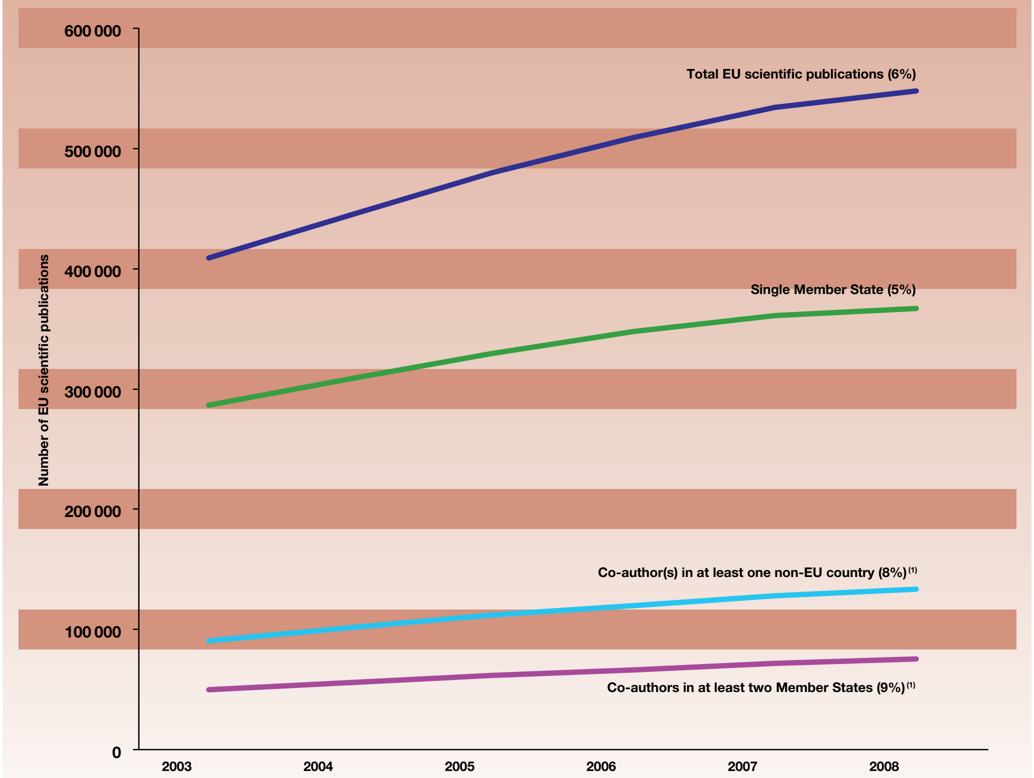
[296] Bo-Christer Bjork, Patrik Welling, Peter Majlender, Turid Hedlund, Mikael Laakso, and Gudni Gudnasson, *Open Access to the Scientific Journal Literature: Situation 2009.*

EU transnational co-publications represented 33.5% of all EU publications in 2008, against 30.5% in 2003, which represents a growth of 9.8%. A similar trend is visible in the opening up of the EU, with an 8% increase of co-publications including authors from at least one non-EU Member State. The figures show, therefore, both a greater EU integration in recent years and an increasing openness of EU research towards the rest of the world.

However, with an average annual growth rate of 8% since 2003, collaboration with non-EU countries has progressed less rapidly than intra-EU cross-border collaboration (average annual growth rate of 9.8%), a sign of a slightly faster integration of scientific activities within the EU than with the rest of the world. Additionally, extra-EU collaboration also involves some intra-European collaboration, namely collaboration with European non-EU countries.

FIGURE II.6.4

**EU collaboration in scientific publications, 2003-2008; in brackets: average annual growth rate 2003-2008**



*Source*: DG Research and Innovation
*Data*: Science Metrix / Scopus (Elsevier)
*Note*: (1) 'EU scientifc publications with co-authors in several Member States and in at least one non-EU country' are included in both of these categories.

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### *Major world scientific cooperation still takes place between the EU and the United States. However, the United States has developed a larger scientific cooperation than the EU with all major Asian research-intensive countries. The EU is catching up*

Figure II.6.5. shows that transnational activity is increasing between all world regions. In absolute terms, the highest level of scientific collaboration by far takes place between the EU and the United States, with over 435 000 joint publications between 2000 and 2009. Far behind, but growing three times faster, the second strongest collaboration links take place between the United States and China (about 95 000 between 2000 and 2009). US scientific collaborations with Japan and South Korea are also more extensive than those of the EU Member States.

Since 2000, China has increased its scientific collaboration with every country at a very rapid pace. China is, therefore, becoming an international partner of primary importance for scientific collaboration. Although counting 17% fewer scientific publications than the EU in total in 2000–2009, the United States has had about 46% more co-publications with China (95 000) than the EU has with China (75 000) since 2000. China is, therefore, a more important partner for the United States than for the EU. However, the collaboration of the EU and the United States with China has progressed at a similar pace (respectively 18.4% and 19.3% per year on average). In addition, European countries are rapidly reinforcing their collaboration also with other countries in the world, such as Japan, South Korea and Brazil. Over the period 2000–2009, the EU has increased its scientific cooperation with the research-intensive Asian countries (Japan, South Korea and China) at, on average, 12.8%, while the United States expanded its scientific cooperation with the same countries by 10.6% over the same period.

### *EU Scientific collaboration seems to be centred among Western European countries, both in scale and scope, with a divide between Eastern and Western Europe*

Within Europe the highest number of cross-border co-publications is registered, as expected, between countries with the highest number of overall publications, namely the United Kingdom, France, Germany and Italy. The collaboration is also generally more intense among Western European countries, where yet again both the number of publications and co-publications is highest. In terms of volume of scientific co-publications, the map below shows a relatively weak link between EU-15 and EU-12[297] (Figure II.6.6).

As expected, the largest countries have the highest number of cross-border scientific co-publications: the United Kingdom, Germany, France, Italy and Spain. In terms of annual average growth rate between 2000 and 2008, beside small countries (Luxembourg, Malta and Cyprus), the highest growth rates are recorded for Portugal (16.3%), Ireland (16.2%), Spain and Slovenia (13.4% each), Greece (12.8%), Romania (12.5%) and Austria (12.1%) (Table II.6.3).

### *Researchers from European countries cooperate most frequently with colleagues from large countries, i.e. the United Kingdom, Germany, France, Italy, Spain, and from countries in geographical proximity*

Within Europe, researchers from most EU and Associated Countries collaborate intensively with colleagues from large countries, i.e. the United Kingdom (Figure II.6.7), Germany and France, followed by Italy and Spain. The large countries collaborate in absolute terms mostly among themselves, but also with Switzerland (consistently the preferred partner for Germany, France and Italy) and the Netherlands (for Germany, the United Kingdom and Italy). Geographical proximity plays a significant role: for instance there is a preferential collaboration between Belgium and the Netherlands, the Czech Republic and Slovakia. Some countries prefer co-publications with colleagues from bigger-performing (or larger) neighbours: Lithuania is a preferred partner of Latvia, whereas Poland is a preferred partner for Lithuania and Slovakia.

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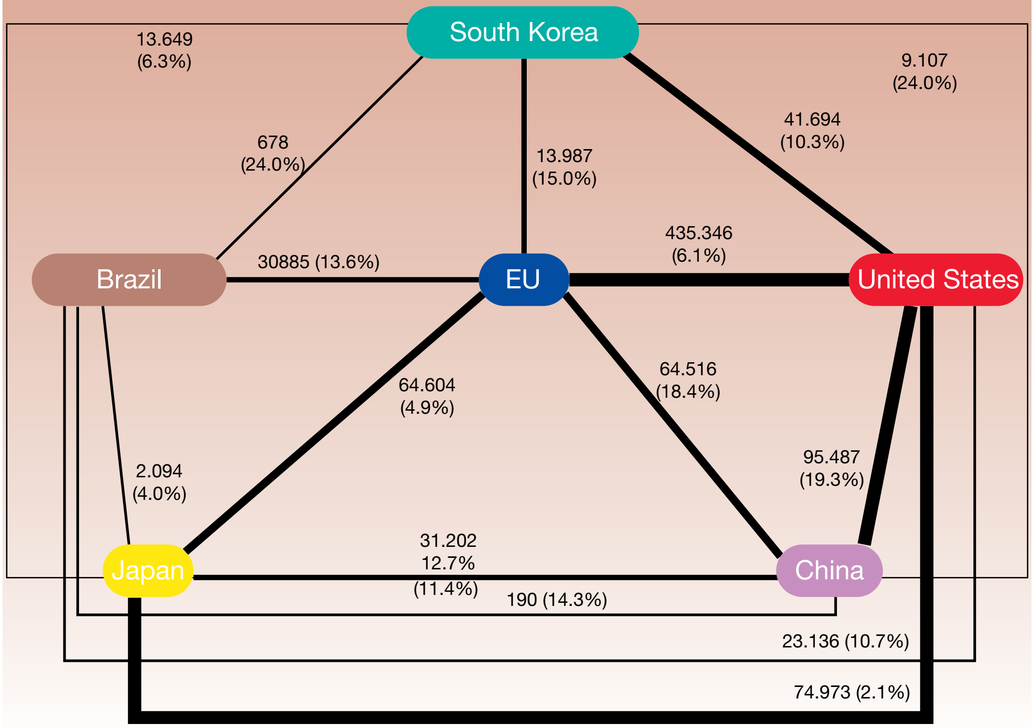
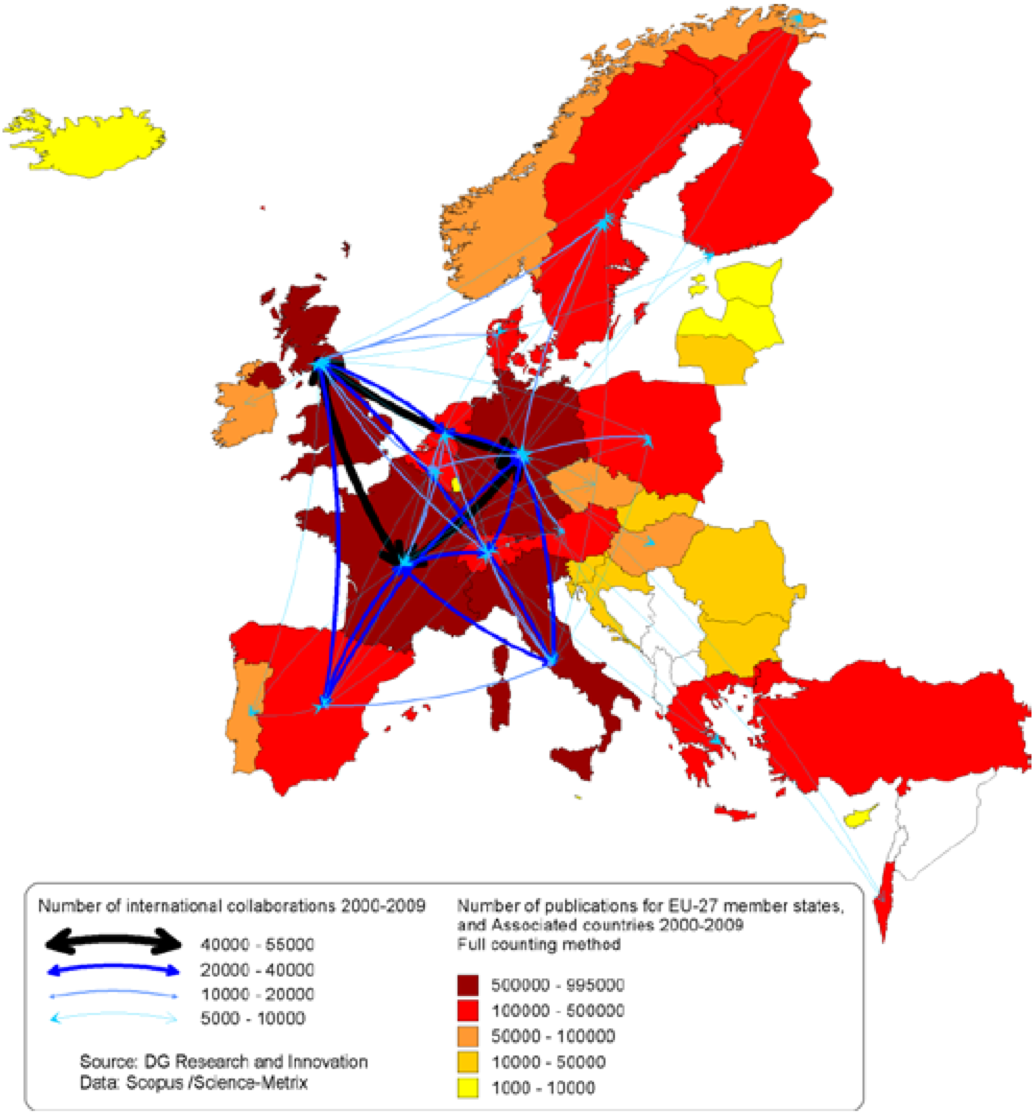
[297] These findings from co-publication data are confirmed by the analysis of intra-European mobility flows of researchers and of skilled human resources (see chapter II.4).

FIGURE II.6.5 **Scientific co-publications between the EU, the United States, Japan, South Korea, China and Brazil, 2000–2009 (in brackets: average annual growth rates (%), 2000–2009)**



*Source:* DG Research and Innovation
*Data:* Science Matrix / Scopus (Elsevier)
*Note:* The thickness of a link between two countries is proportional to the number of co-publications between these two countries between 2000 and 2009.

FIGURE II.6.6 Co-publications(1) between European countries, 2000–2009



Source: DG Research and Innovation
Data: Scopus /Science-Metrix

*Notes:* (1) Threshold for a link between two countries: 6000 co-publications over 2000–2009.
The colour of the country indicates its total number of publications over 2000–2009

## TABLE II.6.3 International scientific co-publications

| | 2000 | 2008 | Average annual growth (%) 2000-2008 |
|---|---|---|---|
| Belgium | 4 784 | 11 071 | 11.1 |
| Bulgaria | 734 | 1 452 | 8.9 |
| Czech Republic | 1 928 | 4 440 | 11.0 |
| Denmark | 3 573 | 7 126 | 9.0 |
| Germany | 24 477 | 48 290 | 8.9 |
| Estonia | 268 | 659 | 11.9 |
| Ireland | 1 183 | 3 937 | 16.2 |
| Greece | 1 881 | 4 924 | 12.8 |
| Spain | 7 303 | 19 927 | 13.4 |
| France | 18 622 | 36 857 | 8.9 |
| Italy | 10 889 | 24 692 | 10.8 |
| Cyprus | 96 | 533 | 23.9 |
| Latvia | 175 | 299 | 6.9 |
| Lithuania | 274 | 669 | 11.8 |
| Luxembourg | 52 | 366 | 27.6 |
| Hungary | 2 148 | 3 298 | 5.5 |
| Malta | 21 | 99 | 21.4 |
| Netherlands | 8 020 | 17 372 | 10.1 |
| Austria | 3 123 | 7 787 | 12.1 |
| Poland | 3 970 | 7 075 | 7.5 |
| Portugal | 1 539 | 5 153 | 16.3 |
| Romania | 987 | 2 540 | 12.5 |
| Slovenia | 550 | 1 507 | 13.4 |
| Slovakia | 856 | 1 798 | 9.7 |
| Finland | 2 888 | 5 902 | 9.3 |
| Sweden | 6 434 | 11 993 | 8.1 |
| United Kingdom | 24 188 | 51 458 | 9.9 |

*Source:* DG Research and Innovation
*Data:* Science Metrix / Scopus (Elsevier)

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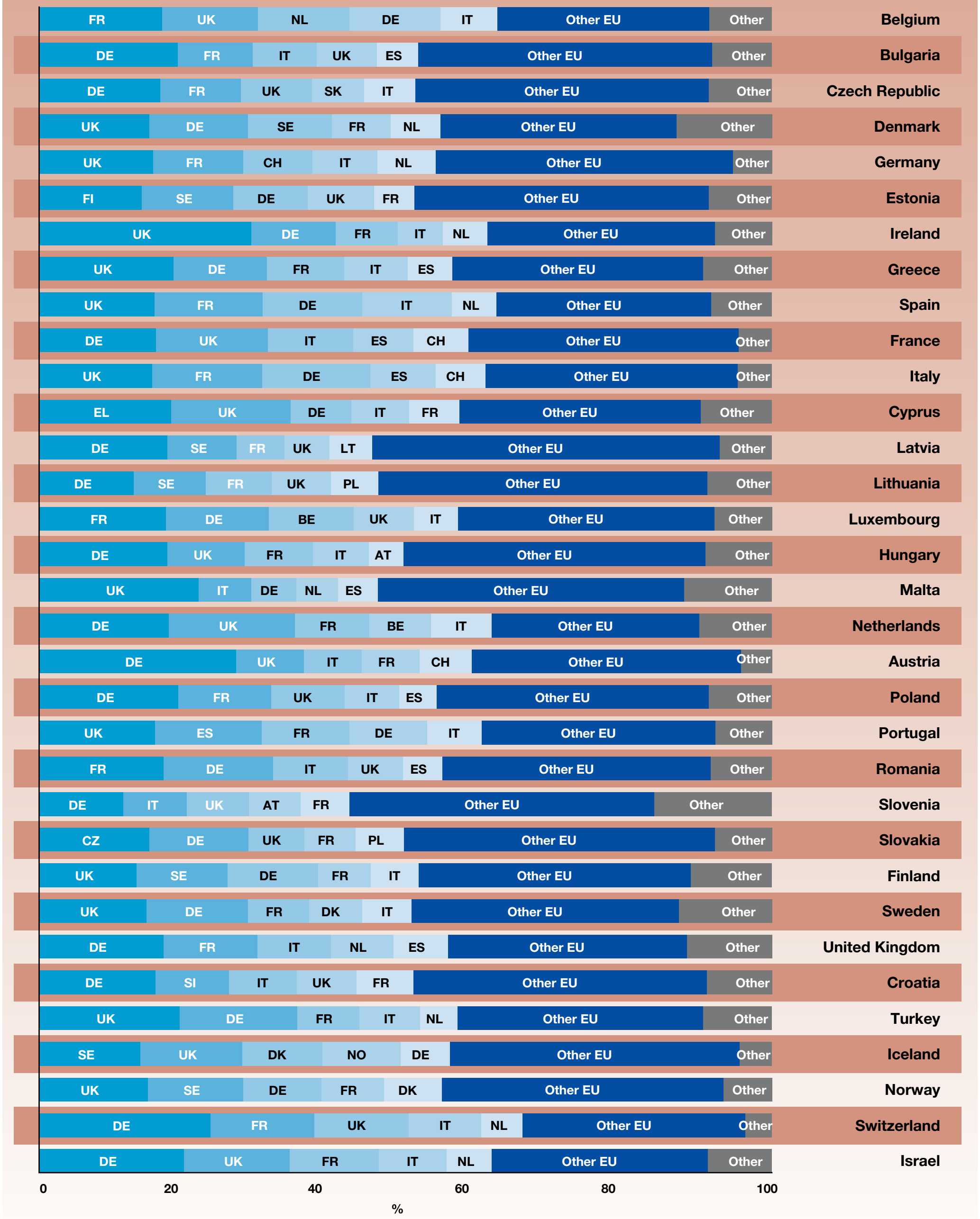
FIGURE II.6.7

## The five main co-publication partners of EU Member States and associated countries[(1)], 2000-2009



*Source*: DG Research and Innovation
*Data*: Science Metrix / Scopus (Elsevier)
*Note*: (1) All EU Member States and IS, NO, CH, HR, TR, IL are covered.

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## 6.3. Is technological cooperation increasing both within Europe and beyond?

### *International co-patents are increasing – but remain at a very low level*

Contrary to the scientific cooperation analysed above, technological cooperation is more closely linked to market exploitation and application of knowledge. During the past two decades, economic globalisation and technological internationalisation have strongly increased, backed up by the possibilities offered by information and telecommunication technologies. Both R&D and technology production are considered key elements in the movement towards opening up and collaborating externally. Collaboration patterns in patenting provide information on how and with whom the technology development process took place, on partnerships, actors and networking. Traditionally, patents are good indicators of the inventiveness of countries or regions, and can provide evidence on technological changes, degrees of specialisation and trends, as well as the role they play in the protection of intellectual assets. More recently, co-patents are being increasingly used either in the context of quantifying university–industry partnerships, or in econometric studies, to measure research and collaboration in the frame of regional innovation systems.

Different studies[298] suggest that co-patenting at country level is still dominated by multinational companies. However, many other factors also intervene. Smaller or less-developed countries appear more engaged in developing co-inventive activity than large industrialised countries. Cultural and geographical proximity are important factors for international collaboration in patenting, and countries appear to collaborate more in the technology areas in which they are less specialised.

The incidence of co-patenting is determined by a number of factors such as the environment of the researcher/inventor, the composition of his or her research team, the contractual context in which the research is being performed, the degree of internationalisation of the research institution, the region and country as well as the technological field. Patenting is considered to be associated more with certain sectors than others: the propensity of patenting is generally greater in science-based or high-tech areas.

Table II.6.10 and Figure II.6.8 show that over the period 1995–2006 the number of EPO patent applications in which EU inventors were involved was increasing. Transnationally co-invented patents (covering both EU patents with co-inventors from at least two Member States and EU patents with co-inventors in at least one non-EU country) have been growing at a higher rate (average annual growth rate of 9.35% and 9.45%

TABLE II.6.4 **Number of EPO patent applications with at least one inventor residing in the EU, 1995-2006**

| | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|
| **Total** | 31 123 | 36 142 | 40 746 | 44 712 | 48 822 |
| Single inventor | 13 145 | 15 194 | 17 166 | 18 354 | 20 019 |
| Domestic co-inventors | 16 050 | 18 607 | 20 855 | 23 128 | 25 157 |
| Co-inventors in at least two Member States | 961 | 1 164 | 1 314 | 1 617 | 1 770 |
| Co-inventor(s) in at least one non-EU country | 967 | 1 177 | 1 411 | 1 613 | 1 876 |

*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) Values in italics are provisional

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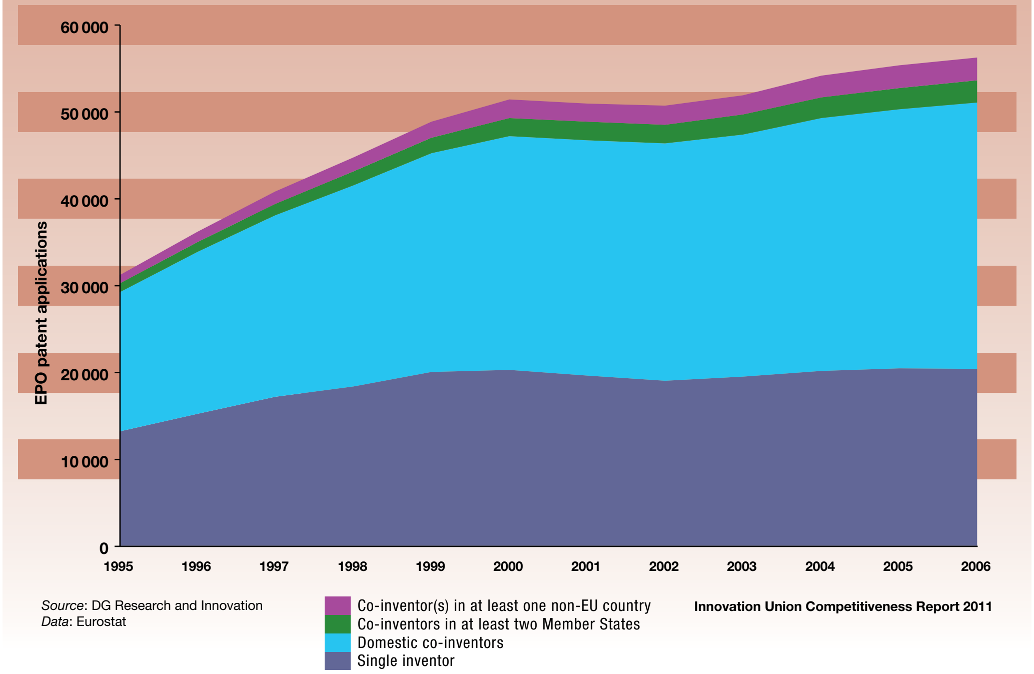
[298] Study prepared for DG RTD by RINDICATE 'The Impact of Collaboration on Europe's Scientific and Technological Performance', Final Report, March 2009 http://ec.europa.eu/invest-in-research/pdf/download_en/final_report_spa2.pdf

FIGURE II.6.8

## Number of EPO patent applications with at least one inventor residing in the EU, 1995-2006



*Source*: DG Research and Innovation
*Data*: Eurostat

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| 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|
| 51 371 | 50 905 | 50 648 | 51 817 | 54 095 | 55 287 | *56 196* |
| 20 245 | 19 568 | 19 012 | 19 475 | 20 143 | 20 389 | *20 356* |
| 26 889 | 27 110 | 27 278 | 27 871 | 29 072 | 29 826 | *30 661* |
| 2 106 | 2 144 | 2 166 | 2 319 | 2 378 | 2 461 | *2 569* |
| 2 131 | 2 083 | 2 192 | 2 152 | 2 502 | 2 611 | *2 610* |

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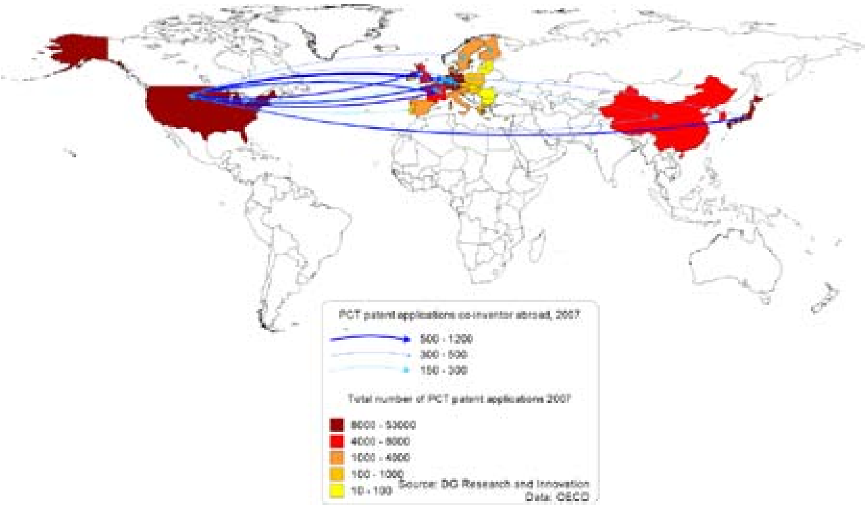
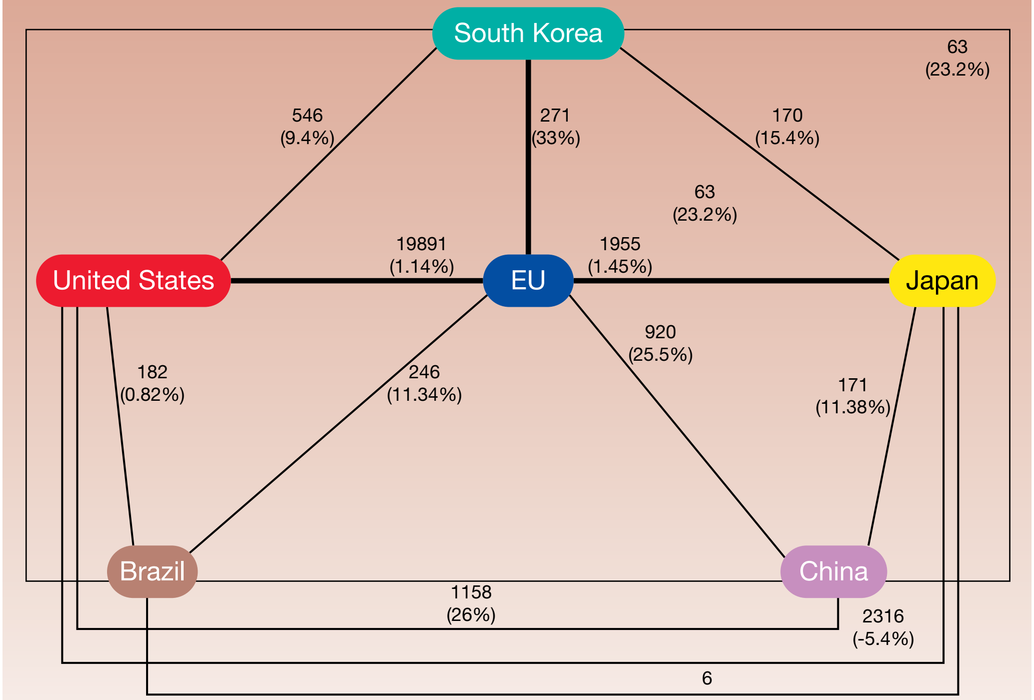
## FIGURE II.6.9 PCT patent applications[1] co-inventor abroad, 2007



Source: DG Research and Innovation
Data: OECD

*Note:* (1) Patent applications filed under the Patent Cooperation Treaty (PCT), by priority year and inventor's country of residence.

FIGURE II.6.10 **Number of transnational co-patents for each pair of countries, 2000-2007; in brackets average annual growth rates (%) 2000-2006[(1)]**



*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) The average annual growth rates were calculated for the period 2000-2006, since the values for 2007 were not consolidated when the graph was produced

respectively) than the total number of patents (average annual growth rate of 5.5%). However, transnational technological collaboration remains relatively modest, and much smaller in size than transnational collaboration in science. This domestic nature of patenting activity is partly linked to the confidentiality required in the invention process.

### *The United States remains the main technological partner for Europe, but closer linkages are being established, both with Asia and with other countries*

From Figure II.6.10 we can see that the United States is the main partner country of the EU in PCT patent applications. Japan and China follow. In 2006, the last year of available data, 2 684 PCT patent applications were filed in the EU with at least one co-inventor based in the United States; the figures are clearly more modest for Japan (247) and China (210). Among the European countries, Switzerland plays a special role in technology collaboration with 1 156 PCT patent applications with co-inventors based in the EU.

### *The EU, the United States and Japan are reinforcing their technological cooperation links among themselves but also with emerging economies*

Transnational technological research cooperation through co-patenting is also an indicator of the degree of international networking giving evidence to the ability of different economies to develop links between themselves. The EU, United States and Japan are competing to increase their links with emerging economies, such as the case of China and Brazil. Figure II.6.10 illustrates that even if the United States is the main partner for the EU, with a total near 20 000 co-patents, collaboration with South Korea, Brazil and China has been increasing over the years.

### *In most European countries, the majority of patents come from either domestic or international collaboration*

Figure II.6.11 illustrates that for most European countries, with the exception of Cyprus and Malta[299], the majority of patents come about via collaboration, either inside the own country or with foreign partners. In most countries, domestic collaboration largely prevails over cross-border collaboration, which remains relatively limited on average in the EU (9.2% of EPO patent applications were invented in the EU). As expected, cross-border collaboration is much more important in smaller countries and more generally in countries with lower levels of patent inventions in absolute terms. This aspect will be discussed further in this part when showing how these collaborations are translated in networks and specific collaboration patterns.

Of the four larger countries, Germany, France, Italy and the United Kingdom, which together account for more than 75% of all the EPO patent applications filed in the EU in 2006, the United Kingdom is the most internationalised (12.6% of the UK inventions submitted to the EPO have a co-inventor abroad), followed by France (9.3%) and Germany (7.5%).

The analysis of data on co-patents can improve the understanding of transnational knowledge flows, especially if we consider the overall specialisation of the different countries in some sectors and technology areas. Despite the relatively small size of Switzerland, this country appears as the first partner in absolute terms for Germany and France, ahead of larger countries like the United Kingdom or Italy (Figure II.6.12). This may be due to the intensive cross-border patenting activity of Swiss multi-national enterprises but also of Swiss higher education institutions. The map also shows that two dimensions have a strong influence on the level of inter-country technology collaboration: the size of the country and its technology development. However, innovation leadership is not particularly related to its propensity to collaborate. Smaller or less-developed countries appear to cooperate relatively more in technology development than large research-intensive countries.

### *For the majority of EU Member States, the transnational co-patenting takes place predominantly with other EU partners*

Figure II.6.13. shows the predominance of EU co-inventors for the majority of the EU Member States, in particular smaller countries. Only Ireland and the United Kingdom (as well as Iceland and Israel) show an opposite pattern, giving preference to technology collaboration with partners located in countries outside of the EU. It is worth noting that among the non-EU partners for EU Member States, Switzerland is one of the prominent partners for joint technology development besides the United States. It is also worth mentioning that, according to different studies[300], collaboration in the co-patenting is based on intensive, consolidated, face-to-face and long-lasting relationships.

A high relevance of intra-EU co-patenting is only observed in a few Member States, occurring more frequently in border areas. Extra-EU co-patenting is not a dominant feature in most countries, with the exception of the United Kingdom and Ireland, due to their links with the United States, and Latvia and Poland for the same reason in relation with Russia.

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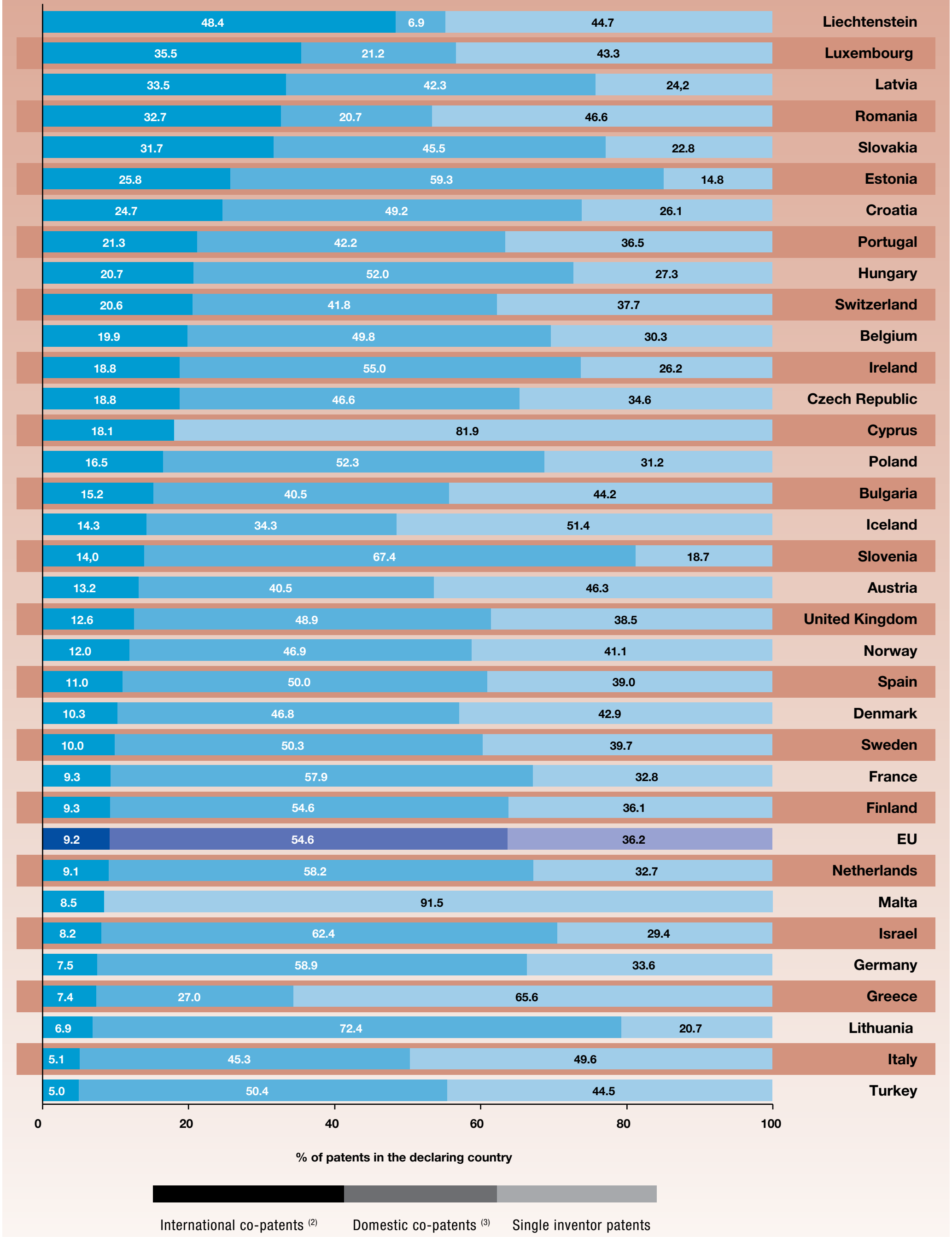
[299] These exceptions are due to the dimension of the research systems and the lack of critical mass in these countries.

[300] See for example 'The Impact of Collaboration on Europe's Scientific and Technological Performance', Final Report, March 2009 http://ec.europa.eu/invest-in-research/pdf/download_en/final_report_spa2.pdf

## FIGURE II.6.11 International and domestic co-patents[1], 2006



*Source*: DG Research and Innovation
*Data*: Eurostat
*Notes*: (1) EPO patent applications by country of residence of the inventor(s).
(2) International co-patents are co-patents with at least one inventor based in another country.
(3) Domestic co-patents are co-patents only involving inventor(s) based in the declaring country.

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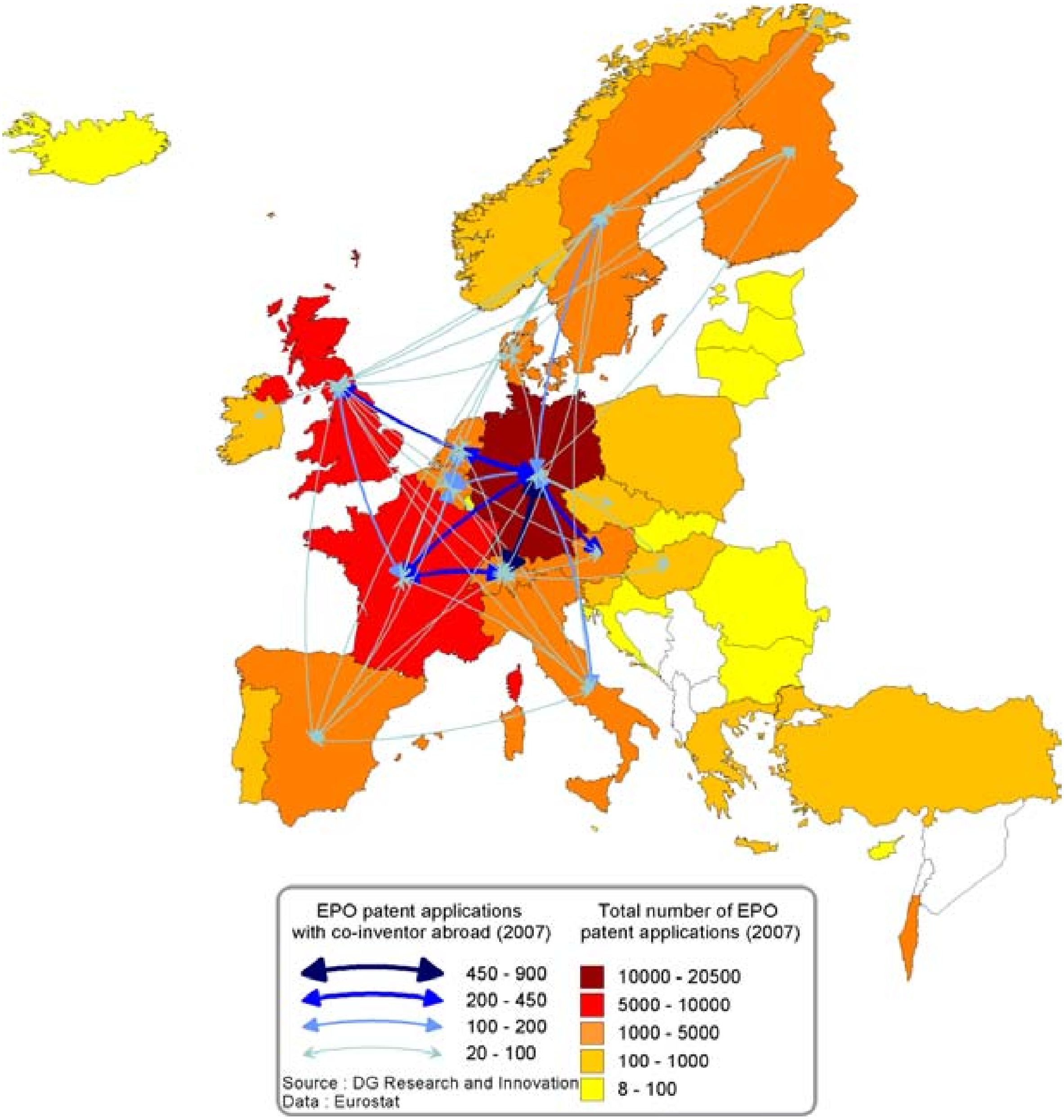
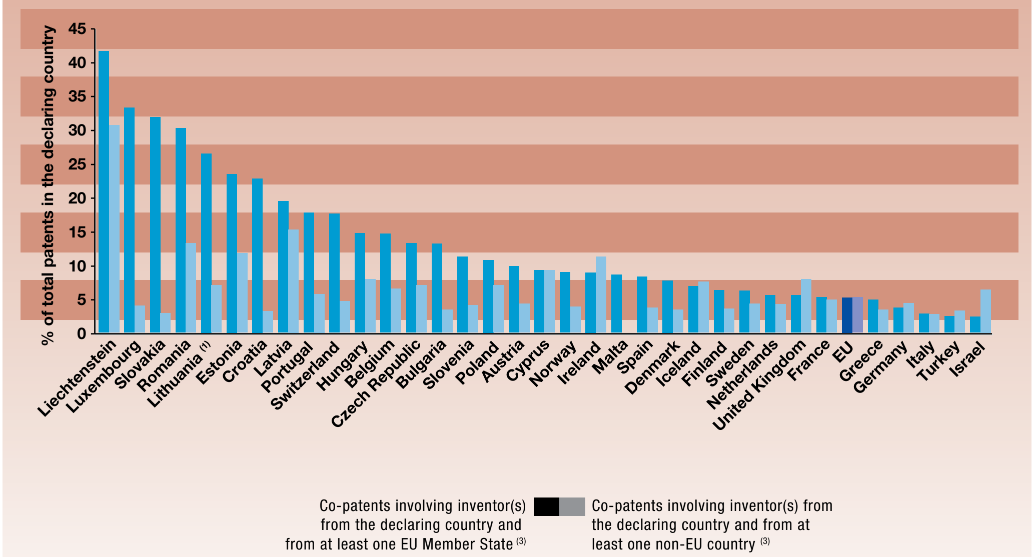
FIGURE II.6.12 EPO patent applications with co-inventor(s) in other European countries, 2007



Source : DG Research and Innovation
Data : Eurostat

FIGURE II.6.13 **Co-patents(1) involving EU and non-EU countries, 2006(2)**



*Source*: DG Research and Innovation

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*Data*: Eurostat

*Notes*: (1) EPO patent applications by country of residence of the inventor(s).
(2) LT: 2005.
(3) The two categories are not mutually exclusive.

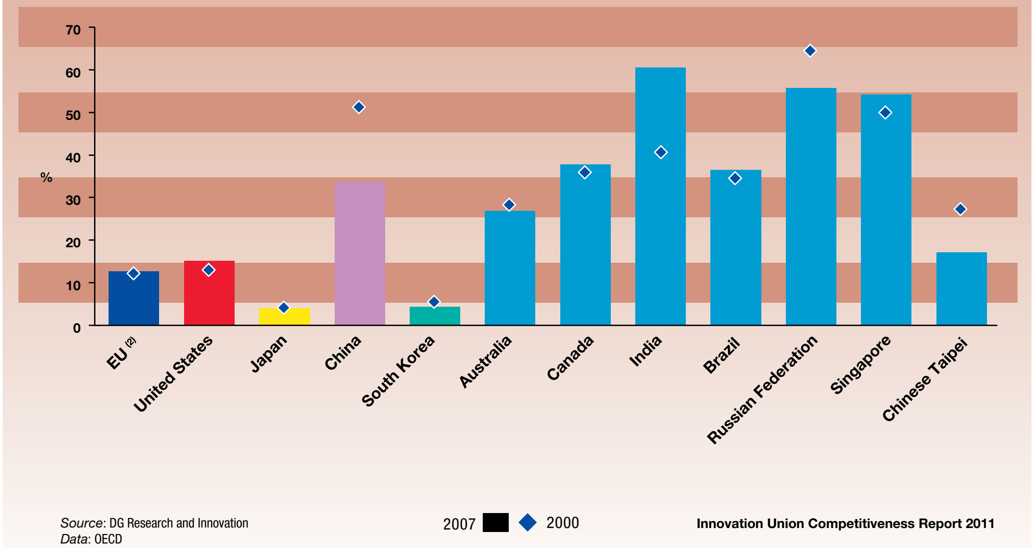
## 6.4. Are European countries absorbing technologies produced abroad?

As knowledge production becomes more distributed in the growing multi-polar world of science and technology, international trade in technologies expands. Knowledge produced in one country is increasingly used and commercialised in another country. Given Europe's shrinking share of world science and technology production, transnational spillover and absorption of knowledge produced outside Europe becomes more important. This is also an important dimension of a European single market for knowledge.

### *Cross border ownership of patents is increasing*

Another indicator on international flows of patents and technologies is based on the distinction between the inventor of a patent and the owner/applicant of a patent. The globalisation of the production of knowledge is reflected in an increasing share of patent applications owned or co-owned by applicants whose country of residence is different from the country of residence of the inventors[301]. Cross-border ownership is often not linked to international cooperation between firms situated in different countries. It is mainly the result of the activities of multinationals: the applicant is a conglomerate and the inventors are employees of a foreign subsidiary. Nevertheless, patent data provides a proxy to track the international flow from 'inventor' countries to 'applicant' countries. This analysis concerns patent applications to the EPO. In 2006, on average 17.6% of all inventions filed at the EPO were owned or co-owned by a foreign resident, compared to 16.3% in 2000 and 10% in 1990.

FIGURE II.6.14 **Foreign ownership (%) of domestic inventions(1), 2007**



*Source*: DG Research and Innovation
*Data*: OECD
*Notes*: (1) The share of domestic EPO patent applications owned by foreign residents.
The patents count is based on the priority date and the inventor's country of residence.
(2) The EU is treated as one entity.

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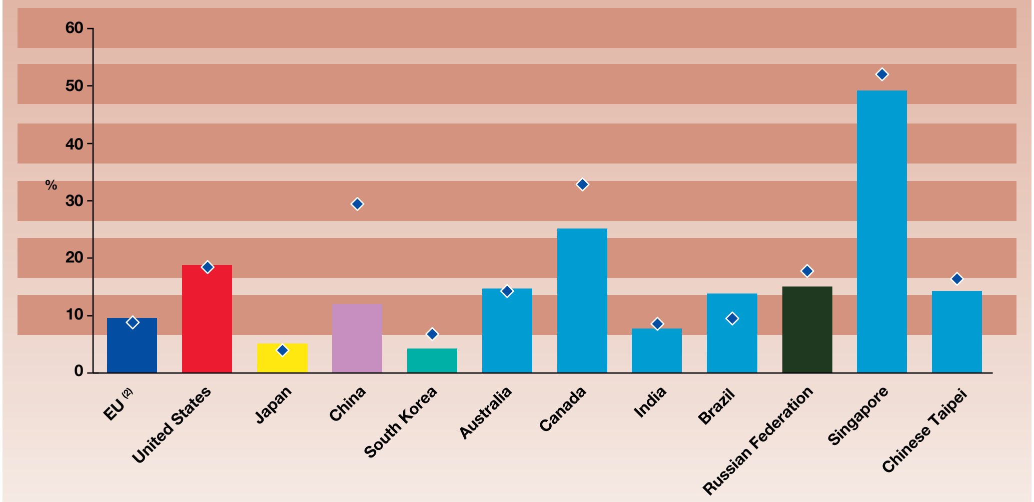
[301] Patent documents specify the inventor(s) and the applicant(s) – the owner of the patent at the time of application – together with their country (or countries) of residence. In most cases the applicant is an institution (either a firm, university, public laboratory) but can also be an individual.

### *Patents originating in the EU are increasingly owned by non-EU firms*

Given that the share of world patents coming from the EU has been decreasing over the years, it is important for EU companies to be able to absorb inventions made abroad and to take part in the expanding transnational knowledge-development chains. However, evidence shows the reverse trend. EU ownership of non-EU inventions is less frequent than the ownership of EU inventions by non-residents, and the gap is growing.

Comparing Figure II.6.14 and II.6.15 below, we see that of all the patents from the EU, the share of patents owned outside the EU (12.4% in 2007, compared with 12.3% in 2000), is higher than the share of non-EU patents which are owned in the EU (9.5% in 2007 compared with 8.7% in 2000). The same situation can be observed in countries like Australia, Canada, India and the Russian Federation. On the contrary, foreign inventions represent a bigger share of the total number of US-owned patents than in EU-owned patents. In 2007, 18.6% of all US-owned patents were inventions made abroad (a slight increase compared to 2000), which is more than the share of US inventions owned outside the United States. Japan and South Korea are good examples of the opposite situation: both are countries in which residents rarely own foreign inventions. The situation in China is particular but interesting, illustrating its economic consolidation. China changes from having a large share of patents invented abroad to having a growing capacity of domestic inventions: in 2000, 29.1% of all domestically owned patents were invented abroad, changing to only 11.8% in 2007. China also seems able to absorb a larger part of its domestic inventions, shifting over the six-year period from over 50% to less than 35% of domestic inventions being owned by foreign firms.

FIGURE II.6.15 **Domestic ownership (%) of foreign inventions(1), 2007**



*Source*: DG Research and Innovation
*Data*: OECD
*Notes*: (1) The number of EPO patent applications owned by country residents but invented abroad as % of total EPO patent applications owned by country residents.
The patents count is based on the priority date and the inventor's country of residence.
(2) The EU is treated as one entity.

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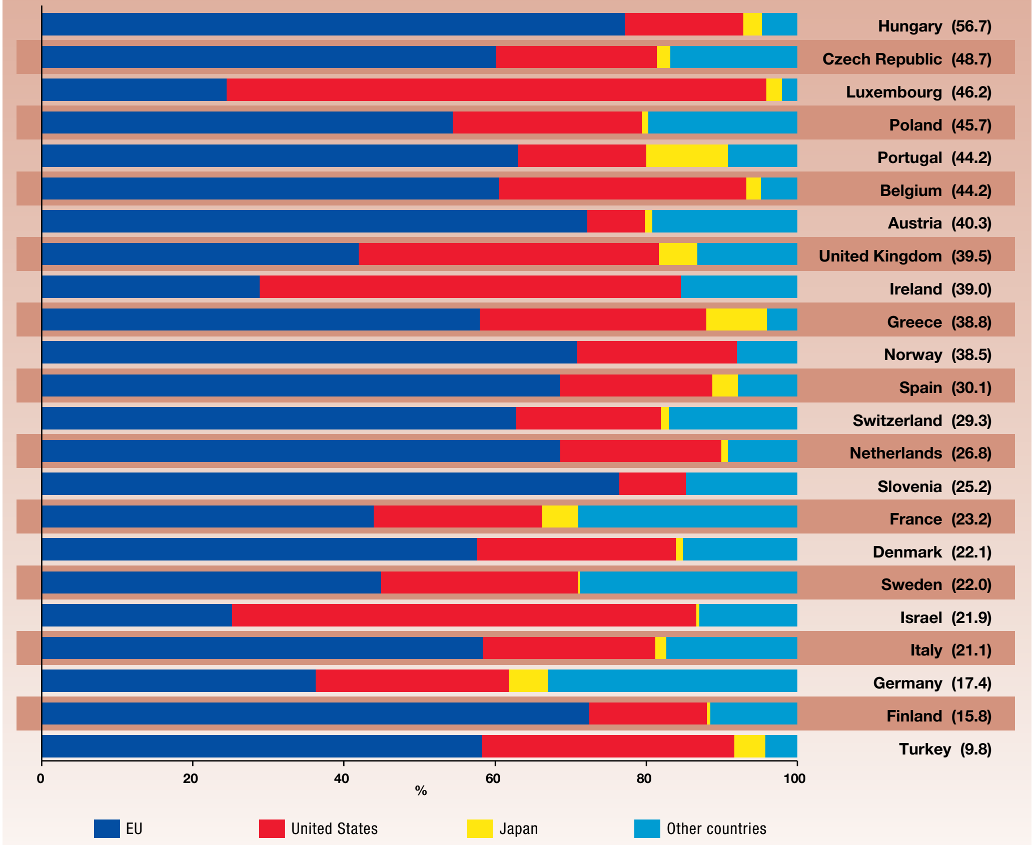
FIGURE II.6.16

## Foreign ownership of domestic inventions[1], 2007; in brackets: the share (%) of domestic patent applications owned by foreign residents



*Source*: DG Research and Innovation
*Data*: OECD
*Notes*: (1) Domestic EPO patent applications owned by foreign residents.
The patents count is based on the priority date and the inventor's country of residence.
(2) In the cases of EU Member States, EU refers to all Member States except the Member State under consideration.

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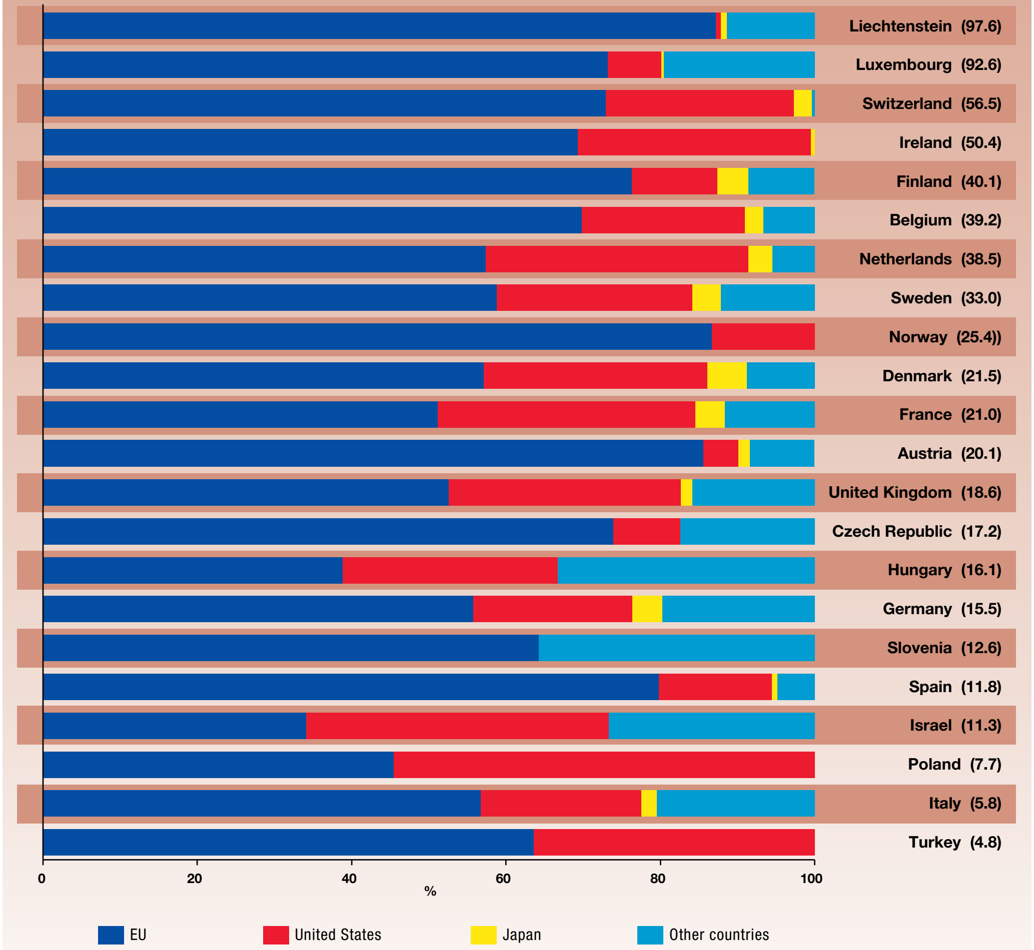
FIGURE II.6.17 Domestic ownership of foreign inventions[(1)], 2007; in brackets: the share (%) of domestic patent applications originating abroad



*Source*: DG Research and Innovation

*Data*: OECD

*Notes*: (1) The number of EPO patent applications owned by country residents but originating abroad as % of total EPO patent applications owned by country residents.
The patents count is based on the priority date and the inventor's country of residence.
(2) In the cases of EU Member States, EU refers to all Member States except the Member State under consideration.

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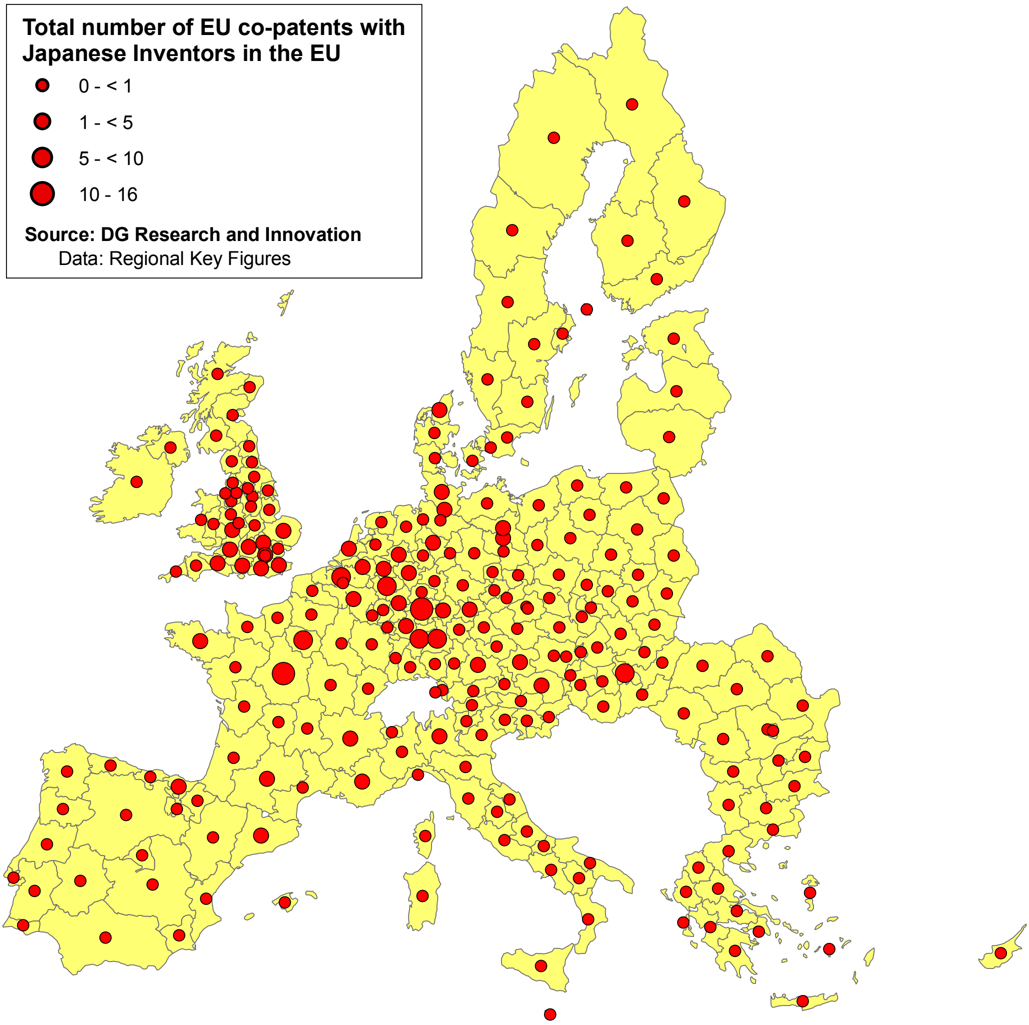
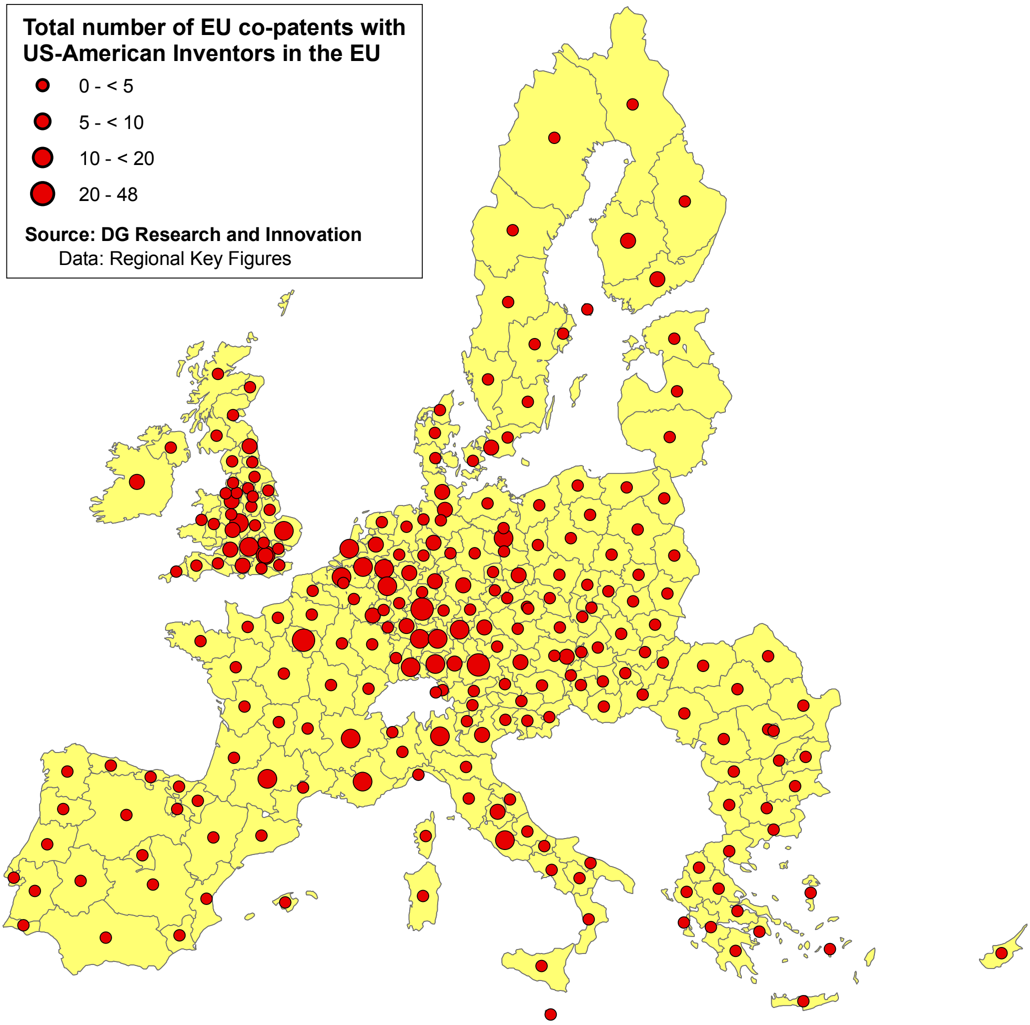
## FIGURE II.6.18 Total number of EU co-patents with Japanese Inventors



*Note:* 'Co-patents' refers to Patent Applications at the EPO, localised by residence of inventor
*Source:* Regional Key Figures, based on EPO Worldwide Patent Statistical Database (PATSTAT); regionalisation by means of OECD REGPAT; Map Basis Eurostat

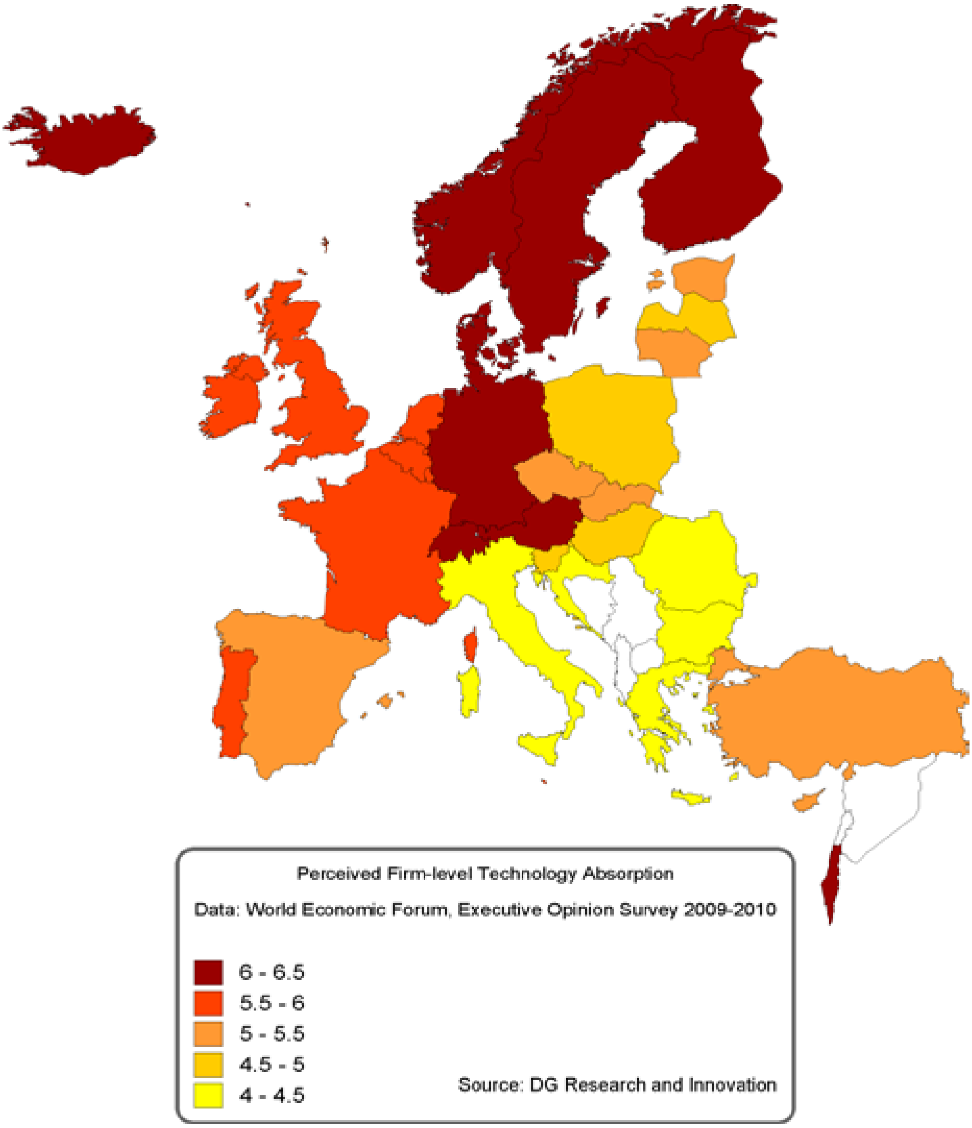
## FIGURE II.6.19 Total number of EU co-patents with US inventors



*Note:* 'Co-patents' refers to Patent Applications at the EPO, localised by residence of inventor

*Source:* Regional Key Figures, based on EPO Worldwide Patent Statistical Database (PATSTAT); regionalisation by means of OECD REGPAT; Map Basis Eurostat

## FIGURE II.6.20 Perceived Firm-level Technology Absorption, 2009



*Note:* Averages; Question: Companies in your country are (1= not able to absorb new technologies; 7 = aggressive in absorbing new technologies)

### *The flow of patents and inventions is more intense within Europe, indicating the existence of a European area for technology development*

Figures II.6.16 and II.6.17 confirm the trend already observed for the period 1998–2003[302]: European inventions and patents flow predominantly within Europe. Foreign ownership of inventions in EU countries is largely intra-European and more evident in smaller countries, like Hungary, Portugal, Austria, Finland or Slovenia; ownership of US inventions is more frequent for Luxembourg, Ireland, Turkey and Israel, and in a lesser degree, also for the United Kingdom.

Similar findings can be seen for the domestic ownership of foreign inventions. For a majority of the European countries, foreign inventions originated in another EU country are registered in over 60% of cases.

### *The capacity to absorb technologies produced outside the EU is concentrated in a few regions*

Co-patenting with third countries can also be a measured at the regional level as an indicator of the technology absorption capacity of a region. The following two maps (Figure II.6.18 and Figure II.6.19) show the total number of co-patents among EU regions with inventors from the United States or Japan. The maps illustrate that it is broadly the same regions that absorb technologies from the United States and from Japan, even though the total number of co-patents with US inventors is higher. Patterns of regional knowledge-absorption coincide mainly with the capacity of the regions to produce knowledge, with the exception of some regions in Sweden, Finland and Italy. Regions in the United Kingdom, Belgium, the Netherlands and western Germany are the largest technology absorbers in technology collaboration with co-inventors from the United States and Japan.

### *The perception of firm-level technology absorption is highest among firms in the Nordic countries, Austria and Germany*

The indicator on the perception of technology absorption by firms gives an estimation of the ease with which companies in a given country incorporate new technologies. Evidence shows that firms perceive highest technology absorption in strong technology producers.

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[302] See European Science, Technology and Competitiveness report 2008/2009.

# Table of contents

# ANALYSIS

## Part III: Towards an innovative Europe - contributing to the Innovation Union

Even if Europe invests in research and increases the efficiency of its public research system and of its interaction with private research, the benefits of these efforts will not be reaped if the private research system itself does not find the right conditions that will maximise its return on investment and create the conditions for a structural change towards a more knowledge-intensive, smart and efficient economy, able to respond to citizens' needs as well as to international competition. This is the perspective of part III, which places some key data related to innovation and entrepreneurship in a research perspective.

# CHAPTER 1

# Fast-growing innovative firms

## HIGHLIGHTS

The emergence and growth of innovative and knowledge-intensive firms is crucial for structural change. At EU level, the births and deaths of companies show a dynamic panorama, more stable in the larger member states, like the United Kingdom, France or Germany, and with higher degree of change in smaller countries. In the United States firm-creation remains stable, and at a higher level than in the EU. In the United States and even more so in the newly emerging Asian economies, young, leading innovative firms are more numerous, especially in high-tech sectors, and they grow faster than in Europe.

Innovative small and medium-sized enterprises spend their resources differently depending on the home-country context. In the more knowledge-intensive economies, SMEs can spend ten times more on innovation than their counterparts in less developed countries. Concerning patenting activities, young firms less than five years old are active, and here Denmark and Norway have a higher patent intensity than the United States. Evidence shows that because of the high costs of patents (which vary from country to country) the SMEs which tend to patent are mainly above a certain threshold of size. However, above a certain number of employees (e.g. 250) size becomes less relevant as a differentiating factor.

Internationalisation activities have proven to be a path to growth and increased competitiveness for the European SMEs. Evidence shows that European firms are more internationally active when compared with firms in the United States and Japan. Size matters for SMEs: the larger the company is, the more international it tends to be.

## 1.1. Are European SMEs increasing their research and innovation?

This section focuses on innovative small and medium-sized enterprises as a key source of structural change in the economy. They represent the biggest share of employment and it has been shown that young and dynamic firms have a positive impact on the evolution towards a more knowledge-based economy.

Compared to the United States, Europe's industrial tissue is dominated by well-established companies that have conquered their specific markets, which they try to expand or diversify. Globalisation and world competition are a permanent challenge, and so far large EU companies are doing well and even surpassing their US competitors. One of the characteristics of large EU firms is that they are generally much older and, as they have not been constantly challenged by emerging and growing competitors as in the US economy, they have undergone fewer changes. But it is the young, innovative and dynamic companies that are considered the motors of growth and that potentially bring about structural change. Creativity and entrepreneurship are key elements which occur more frequently in the United States than in Europe. Fast-growing dynamic firms are also associated with other successful and emerging economies, where they constitute one of the main reasons for the success, especially when they are active in knowledge-intensive sectors.

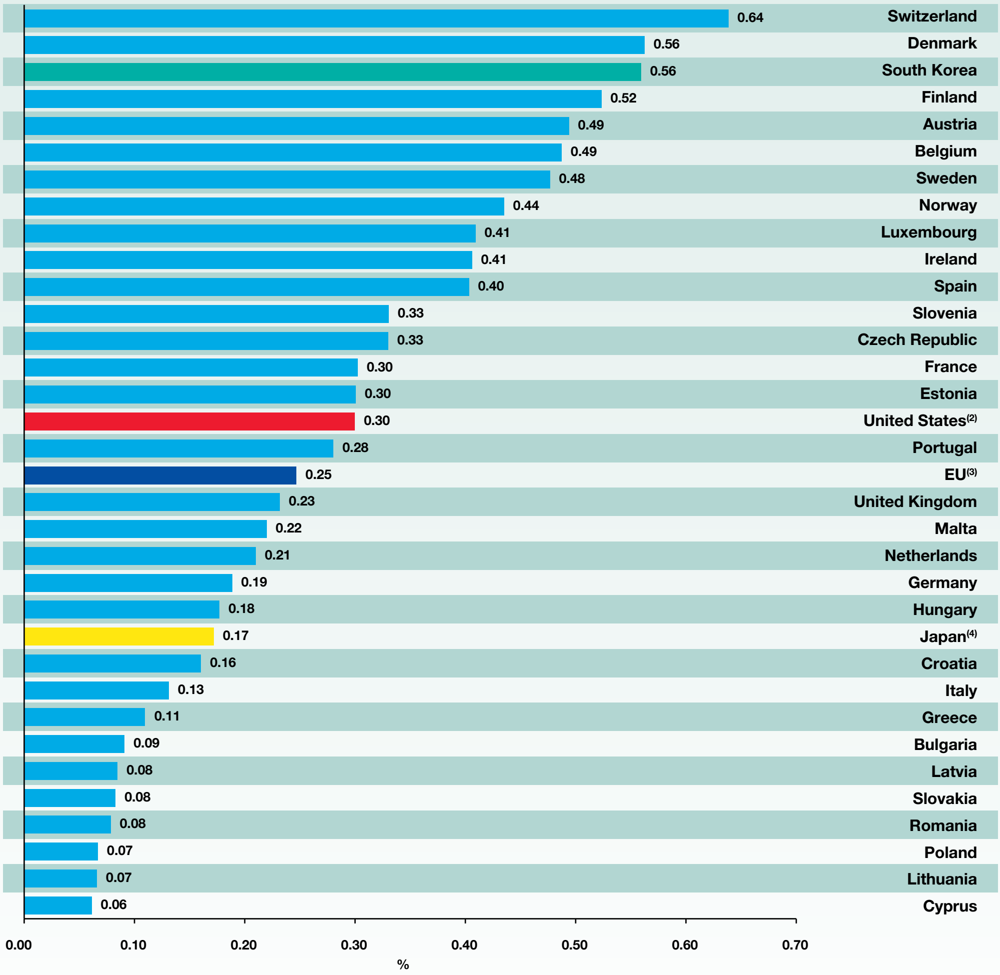
In this chapter we will analyse the degree of research intensity in SMEs and their contribution for the overall BERD as a key indicator for growth. In complement, there is an overview on how SMEs engage themselves in innovative activities (such as patenting, for example) and how they invest their resources to keep competitive and to enlarge their knowledge and markets through internationalisation. Finally, the chapter provides an overview of company dynamics with a special attention to fast-growing companies.

### *The highest research-intensity in SMEs is found in Switzerland and Denmark*

The research-intensity of the SMEs is an essential indicator to understand their potential for growth and impact on the knowledge economy. Many new technologies are adopted and developed into disruptive innovations in the shape of new products and services by dynamic, research-intensive, fast-growing SMEs. The world of ICT provides multiple examples, such as Apple, Microsoft or Facebook in the United States, or Skype in the EU.

In this context, the EU is relatively well placed, only slightly below the levels of the United States and above those of Japan (Figure III.1.1). However, very dynamic economies such as South Korea, the Nordic countries or Belgium, Austria and Switzerland, have much higher levels of business research investments than the EU average or even the United States.

FIGURE III.1.1 **BERD performed by SMEs as % of GDP, 2008(1)**



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*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) EL: 2005; IE: 2006; EU, BE, DK, DE, LU, AT, SE, NO, US, JP, KR: 2007
(2) EU does not include IE, EL.
(3) US: BERD does not include most or all capital expenditure.
(4) JP: BERD by size class is underestimated.

## Box: Denmark supports SMEs

Policy mixes addressing science–industry linkages and the commercialisation of public research results have been at the centre of policy development in recent years in Denmark. Since 2000 there has been an increase of the number of 'gazelle' Danish enterprises (those less than five years old), probably as a consequence of the respective policy measures, but this development was also supported by the favourable economic situation of mid-2000s. Since the newly introduced policy measures are not supported by large budgets and the economic situation is more difficult, it remains to be seen if the R&D intensity of SMEs and the R&D intensity of the business sector in general can continue the positive trend. This includes, as will be presented in this chapter, very dynamic patenting activity from the young Danish SMEs, ahead of similar activity in the United States.

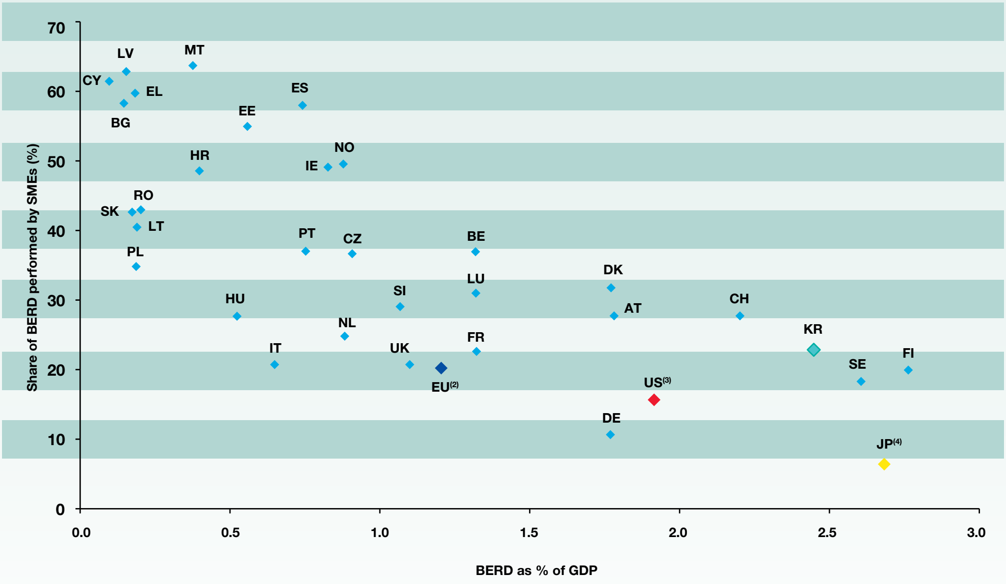
Though R&D investments are still concentrated in the largest companies, as in most other European countries, the share of R&D expenditures by SMEs in Denmark is quite high: 32 % of R&D expenditure in 2007 came from SMEs (with 1–249 employees) in Denmark. Manufacture of pharmaceuticals and medicinal chemistries, software consultancy and supply are the largest sectors regarding intramural R&D expenditures.

### *In the EU, a slightly higher share of BERD is performed by SMEs in comparison to the United States, and this share is also higher still than that of Japan*

Small and medium-size firms perform a higher share of business R&D in the EU than in the United States and Japan, as shown in figure III.1.2. In the EU, the share of BERD performed by SMEs amounts to 19.4 % compared with 15.7 % and 6.4 % respectively for the United States and Japan. South Korea is above the EU with a share of 22.8 %.

Though there are some exceptions, usually the higher participation of SMEs in business R&D is associated with lower R&D intensities of the country, as, for example, in the case of the EU-12 Member States, smaller countries, and also for Spain, Greece, Ireland and Portugal. The EU countries where SMEs only account for around a quarter or less of BERD, like France, the United Kingdom, Germany, Sweden or Finland, are countries at the top of both rankings of business R&D-intensity and innovation performances, and they host many of the large R&D investors and MNEs. Denmark, Belgium and Norway are the exceptions — here, a higher share of BERD performed by SMEs goes hand-in-hand with the active presence of SMEs in research in high and medium high-tech sectors (figure III.1.2 and figure III.1.1). Europe needs an increased contribution to the overall economy of technology-based companies in sectors of high R&D intensity, to counterbalance its structural composition.

FIGURE III.1.2 **BERD as % of GDP and % share of BERD performed by SMEs, 2008(1)**



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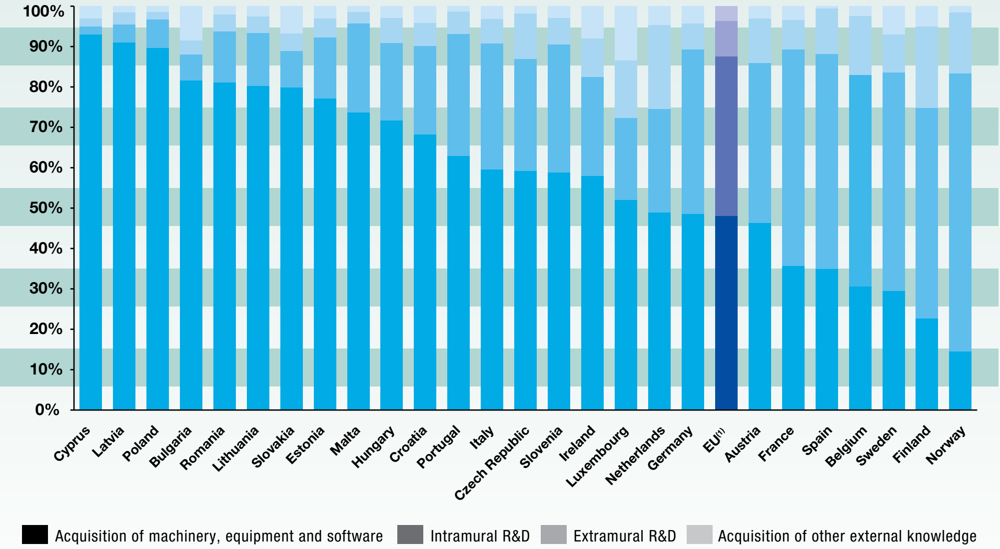
*Source:* DG Research and Innovation
*Data:* Eurostat, OECD
*Notes:* (1) EL: 2005; IE: 2006; EU, BE, DK, DE, LU, AT, SE, NO, US, JP, KR: 2007
(2) EU does not include IE, EL.
(3) US: BERD does not include most or all capital expenditure.
(4) JP: BERD by size class is underestimated.

### *SMEs in more advanced economies invest more heavily in the production and acquisition of new knowledge. SMEs in less developed economies invest more in the acquisition of machinery*

Part II chapter 2 presented the different partners required for the collaboration of innovative firms. In spite of the different situations across countries, in general, suppliers of equipment were considered the most important collaboration partners and also one of the most important sources for new knowledge. Consequently, it is relevant to analyse how innovative SMEs spend their resources, as shown in figure III.1.3. In the EU-12 Member States, and in general in countries with a lower R&D intensity (like Portugal and Italy) SMEs dedicate over 60 % of their innovation expenditure to machinery, equipment and software. Spain presents a special situation, where machinery, equipment and software correspond only to 35 % of the innovation expenditure compared with 53 % for intramural R&D — values very similar to those registered for France. The Netherlands also present a large share of innovation expenditure dedicated to R&D, at 47 %, but with the particular characteristic that only 26 % is intramural and the other 21 % performed extramural. SMEs in Germany, though investing the same 47 % in research, give preference to intramural R&D with a share of 40 %. In Belgium, Sweden, Finland and Norway, SMEs dedicate more than 50 % of their innovation expenditure to intramural R&D. In fact, in these last two countries total expenditure in R&D passes 72 % and 84 % of their innovation investments, respectively.

Figure III.1.3. also shows the internal structure of the SMEs in the different countries. SMEs which are in the more research-intensive countries and are better innovation-performers rely more on their internal resources to innovate and are less dependent on external sources.

FIGURE III.1.3 **SMEs – Distribution of innovation expenditure by type of activity, 2006-2008**



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*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) EU does not include DK, EL, UK.

***Relative to their turnover, companies in knowledge-intensive economies can spend up to ten times more on innovation than their counterparts in less developed countries***

How much of their turnover do companies spend in innovation activities?[303] Data availability does not cover all the EU Member States, but gives a sufficiently diversified panorama within the set of countries shown in figure III.1.4. More knowledge-intensive economies, like Sweden and Finland, invest three times more than other less R&D-intensive and less innovative countries. Estonia and Malta show a very high ratio and Belgium, Romania, France, Latvia and the Netherlands have similar values well above the EU average. Well below the average, are Italy, Lithuania, Portugal, Spain, Slovakia and Luxembourg. These figures, however, have to be interpreted with care as the definition of innovation expenditures (in particular non-R&D innovation expenditures) can still be interpreted very differently by respondents to the Community Innovation Survey. Cross-country comparability is not assured.

These figures should be interpreted together with the data presented in the second chapter of Part III which concerns venture capital and the different policies, framework conditions and public support existing in each EU country. Considering the differences between countries regarding venture capital investment in the early stage (EU-27 average is about 0.2 per thousand GDP compared to the United States with 0.5 per thousand of GDP (figure III.2.4)), innovative companies in Sweden, Finland or Belgium, might more easily invest a bigger share of their turnover in innovation. Another aspect is the patterns of specialisation as shown in chapter 2 of part New Perspectives, where the differences in the economic structure of the EU, the United States and Japan are made visible and compared. In this context, the EU is lagging behind its main competitors in terms of specialisation in high-technology knowledge.

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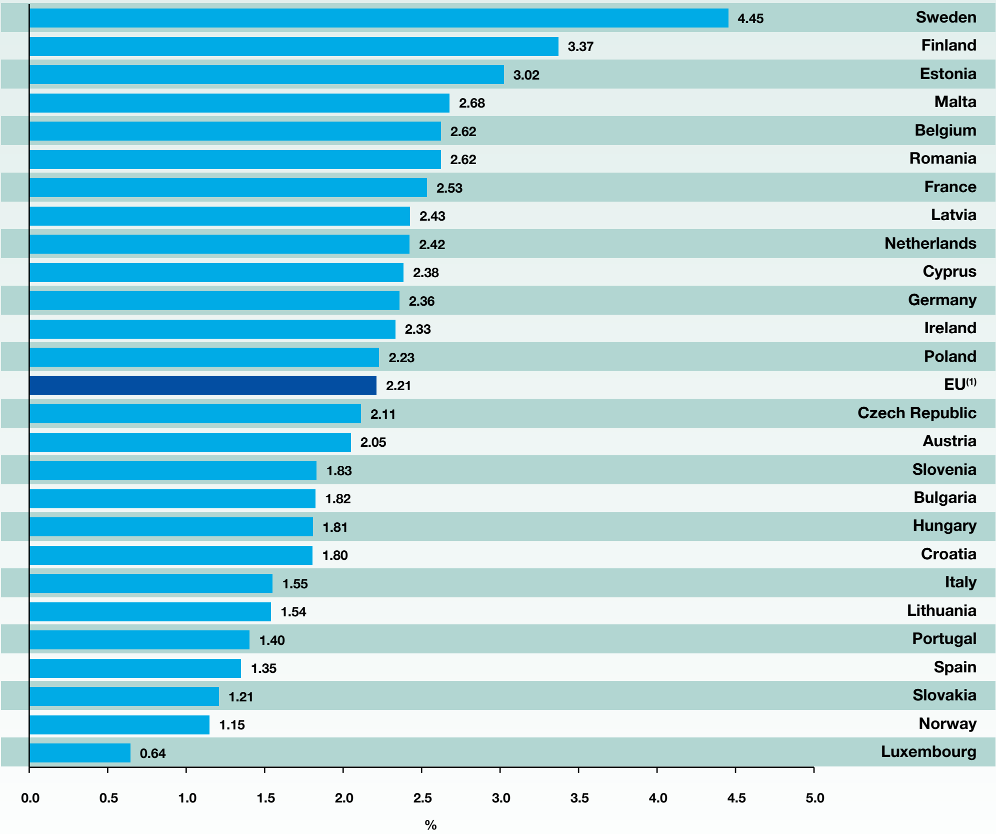
[303] Community Innovation Survey: the innovation activities comprise not only R&D, but also activities such as technology acquisition, training, product design and introduction (know-how and other knowledge is relevant for companies in the high R&D intensity sectors, especially pharmaceuticals & biotechnology and healthcare equipment).

FIGURE III.1.4 **Enterprises with innovation activities – Innovation expenditure as % of turnover, 2006-2008**



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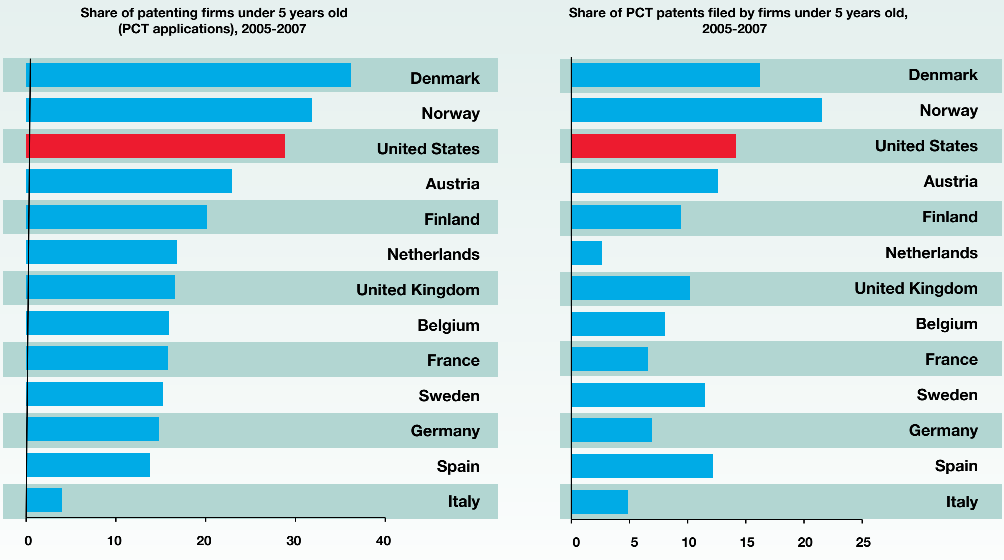
*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) EU does not include DK, EL, UK.

### *Young firms (less than five years old) are active in patenting, with Denmark and Norway ahead of the United States)*

Young firms that want to protect their innovations face several barriers, most of them linked to the size of the company. Framework conditions, access to venture capital and the high costs involved are aspects affecting the act of patenting. Very different situations can be observed when comparing European countries. Figure III.1.5. (left panel) shows the share of young firms that filed a PCT application(s) with priority date in 2005–2007: the highest share of (PCT) patenting young firms is to be found in Denmark and Norway, (36.2 % and 31.8 % respectively), above the United States with 28.8 %. Young firms in Austria and Finland are also relatively active in patenting. Italy is the country where young companies are less active in patenting: only 4 % of them having filed a PCT patent with priority date in 2005–2007. The right panel of the figure III.1.5 presents the share of PCT patent applications with priority dates in 2005–2007 that were filed by young companies in all PCT patent applications filed by companies in the country. There is some positive but not strong correlation between the right and the left panels. Values in the right panel also depend on the patenting activities of the firms older than five years. Older firms in Denmark are obviously more active in patenting than older firms in Norway, hence a smaller share of patents by young firms in Denmark than in Norway, despite the higher share of young firms that patent in Denmark. The same remark applies to the Netherlands where the share of patents filed by young firms is small in comparison to the share of young firms that file patents in that country.

FIGURE III.1.5 **PCT patent applications by young firms (< 5 years), 2005-2007**



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*Source:* DG Research and Innovation
*Data:* OECD, HAN Database, October 2009 and Bureau Van Dijk Electronic Publishing, August 2008.

### *Box: Can SMEs afford to patent? Different countries need different policies to address the issue*

(Some insights from the IRMA-Industrial Research Investment Monitoring project — DG JRC and DG RTD — on the effect of size in the propensity to apply for a patent)

Costs associated with the application of a patent and its maintenance are extremely high for SMEs in general. So, what is the minimal firm-size, a threshold to be achieved, in order to allow an SME to engage itself in protecting its innovations? The literature agrees on the fact that propensity to patent increases with firm size.

Further investigation conducted in the frame of the IRMA project, shows some evidence on the subject and presents a few conclusions, also directly connected with the framework conditions that favour innovation. (other parameters, besides the costs involved, should be considered as supporting policies and programmes such as regional innovation programmes, programmes addressed to SMEs, support from structural funds, etc). The first one is that the size threshold beyond which SMEs use the patent system differs widely across countries. For example, this critical size is between 40 and 50 employees in Switzerland, Sweden and Belgium but is much higher in Germany or Italy. The second conclusion is that size only matters up to a point. Beyond 250 employees, the propensity to patent is largely independent of the size of the firm.

In conclusion, supporting policies intended to help SMEs to patent have to address different sizes of companies in accordance with the country.

### *Internationalisation activities have proven to be a way for growth and increased competitiveness for European SMEs*

Internationalisation is a way for SMEs to increase performance and reinforce growth, strengthening their competitiveness and the basis for a sustainable development. In this way, the EU Single Market has enlarged the opportunities portfolio for SMEs with the chance of expansion beyond their home market. However, according to recent data, 75 % of SMEs still depend entirely on their home markets.

Part II, chapter 6 of this report presented a positive trend in what concerns the degree of technology absorption of EU companies, based on increasing ownership of cross-border patents, as a sign of the capacity of European firms to absorb knowledge produced abroad. In addition, the increased participation of SMEs in European R&D programmes and other initiatives launched in the context of the ERA (like international networks) have positively contributed to giving the SMEs an international dimension[304].

Different studies have been launched by the Commission on the degree of internationalisation of SMEs and its impact in the future development of the companies. The most recent one, based on a survey launched during spring 2009 of almost 9 500 questionnaires completed by SMEs (micro, small and medium), covering 26 different sectors in 33 European countries[305], presents new conclusions relevant to the situation, drivers and effects on business performance in the period 2007–2009. In this study, internationalisation is used in the broad sense to refer not only to exports but to all activities that place the SMEs in a business relationship with a foreign partner: exports, imports, foreign direct investment, international subcontracting and cooperation.

The main results confirm that 25 % of EU SMEs export or have exported during the last three years and that the partner countries are mostly other EU countries, with the exception of imports from China (all the relations with BRICs are still underdeveloped and emerging markets such as Brazil, Russia, India and China are only served by 7 % to 10 % of the exporting SMEs). The sectors with the highest percentage of exporting SMEs are: mining (58 %), manufacturing (56 %) wholesale trade (54 %), research services (54 %) and sales of motor vehicles (53 %).

### *European firms are more internationally active by comparison with those in the United States and Japan*

Companies involved with e-commerce (with activities based in internet) are more internationally active and, when considering export–import activities, these companies increase in intensity in direct proportion to the age of the SME. The main factor for internationalisation seems to be company size. Not surprisingly, there is a negative correlation between the population size of the SME's home country and its level of international activity (meaning that SMEs in Estonia or Denmark tend to be more international than SMEs in Germany, France, Italy, Spain, the United Kingdom or Poland) and the proximity of a SME to a national border does not seem to have great relevance to the level of its internationalisation.

### *The internationalisation of SMEs is linked to higher growth of turnover and employment*

There is a direct correlation between the level of internationalisation and the size of the company: the larger the company is, the more international it tends to be (whether measured by exports, imports or FDI, according to the previously mentioned report)

Other strong correlations observed:

- Internationalisation and higher turnover growth: more than 50 % of the SMEs that invest abroad or are involved in international subcontracting reported increasing turnover from 2007–2008, whereas the average value for all SMEs is around 35 %.
- Internationalisation and higher employment growth: SMEs with international activities reported in general a higher employment growth (10 % increase for SMEs both importing and exporting) than other SMEs, whose average increase was 3 %.
- Internationalisation and innovation: 26 % of the SMEs with international activities succeeded in introducing new products for their sector in their home country (the average value for other SMEs is 8 %).

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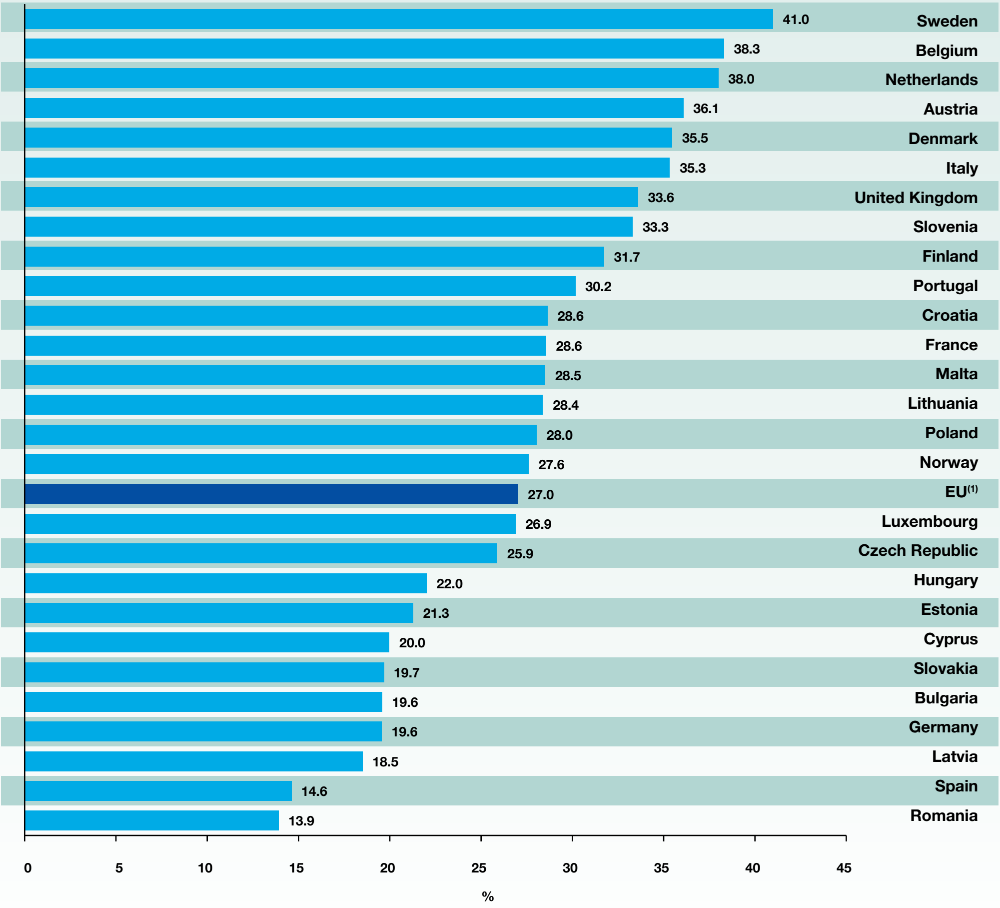
[304] See also Part III, Chapter 2.1.5

[305] Internationalisation of European SMEs, Final Report, DG ENTR, June 2010.

FIGURE III.1.6 SMEs with new or significantly improved products new to the market as % of all SMEs with innovation activities, 2006-2008



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*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) EU does not include IE and EL.

### *A high rate of development by SMEs of new-to-the-market or significantly improved products can occur in all types of economies*

Figure III.1.6. shows to what degree innovative SMEs can present products new to the market, and develop new products or processes. The panorama is diverse, and higher rates are achieved both by countries that perform highly in innovation (Sweden, Belgium and the Netherlands) and less highly (Italy, Portugal and Slovenia). In general, the correlation is surprisingly weak between this indicator and the level of R&D intensity of a country or of its SMEs. If one assumes that cross-country comparability is effective on this indicator, this shows that the impact of a knowledge environment with positive spillovers and the presence of favourable framework conditions for innovation (as described in chapter 2 of this Part III), are undeniably positive inducers for innovation. A very positive finding shows that in countries not yet at the highest levels of R&D intensity and innovation performance, innovative SMEs can have the similar performances to those in a more knowledge-intensive environment or region.

## 1.2. Is Europe creating new and rapidly growing firms?

### *Firm demography does not show dramatic changes over time*

The birth of a business enterprise consists of the founding of a company. The death of a business enterprise consists of the extinction of a company, for the year in reference.[306]

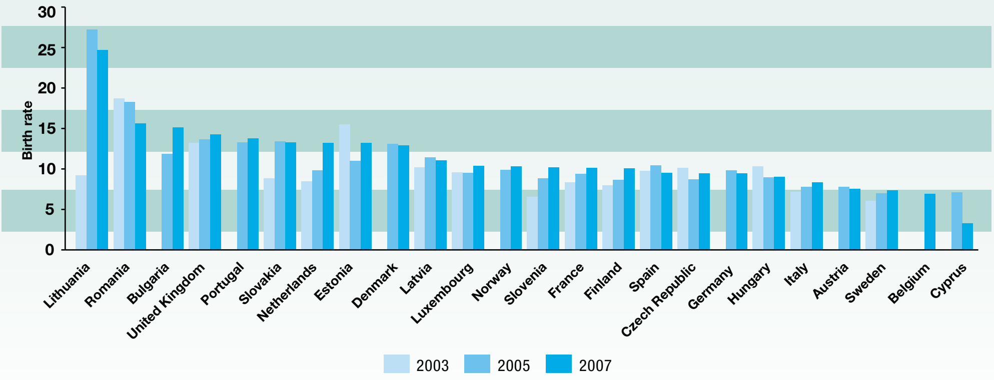
Figure III.1.7. presents the birth rate of business enterprises in Member States providing this data for the years 2003, 2005 and 2007. Except in Lithuania where the increase is dramatic, the birth rate of businesses has remained relatively stable in these countries. Unsurprisingly, catching-up countries (Lithuania, Romania and Bulgaria) top the ranking among the Member States that provide this data. Among larger countries, the birth rate of businesses is highest in the United Kingdom where new businesses represent close to 15 % of all enterprises. France and Germany are at the same level with a birth rate of about 10 %, while Italy is closer to 8 %. In these countries, with the exception of Germany, the slight progression of the businesses' birth rate since 2003 has been of similar magnitude.

Figure III.1.8. illustrates the death rates of business enterprises. In Portugal, Slovakia and the Czech Republic, the death rate has increased substantially between 2003 and 2007 (before the crisis) and is larger than the birth rate, indicating that the number of enterprises in these countries has been decreasing. However, in most of the other countries providing this data, the birth rate has been higher than the death rate, indicating that more business enterprises have appeared than disappeared over the period 2003–2007.

### *The survival rate of enterprises in Europe has not changed significantly over recent years*

Another perspective of business performance is given by the survival rate of companies two years after their creation. This aspect is particularly relevant due to the important role in economic growth played by young companies. The first years are crucial for start-ups and

FIGURE III.1.7 **Birth rate of business enterprises(1)**



**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) The number of enterprise births divided by the number of active enterprises.

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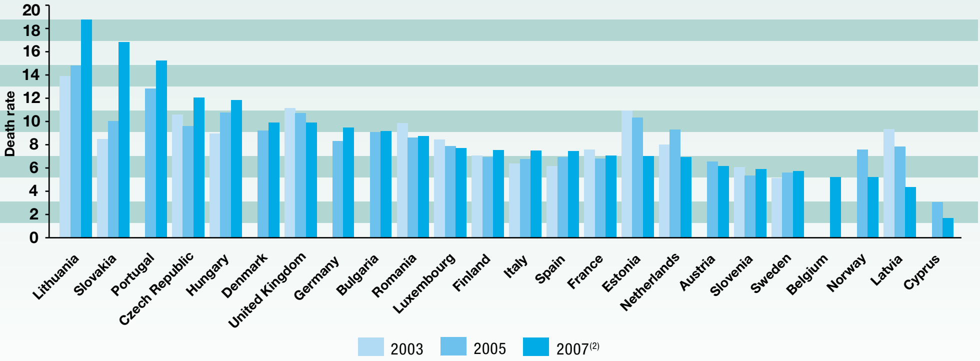
[306] The birth and death rates are calculated by dividing the number of births and deaths of enterprises by the total number of enterprises active in the country.

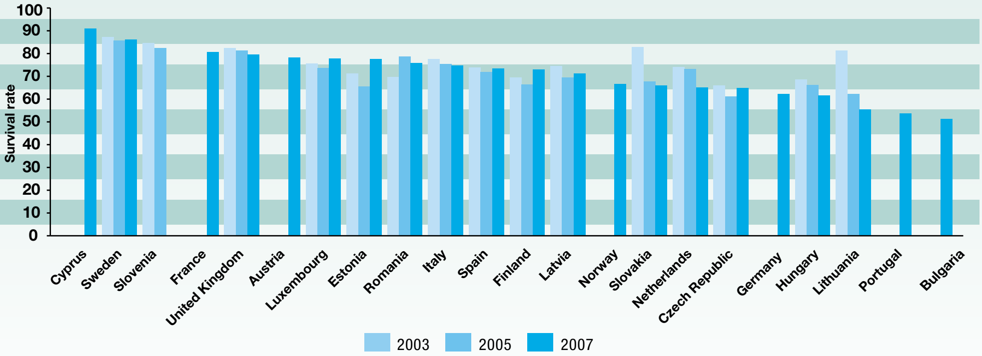
## FIGURE III.1.8 Death rate of business enterprises[1]



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) The number of enterprise deaths divided by the number of active enterprises.
(2) BE, BG, CZ, DK, DE, EE, CY, LV, LT, HU, NL, PT, FI, SE, UK: 2006.

## FIGURE III.1.9 Survival rate of business enterprises[1]



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) The number of enterprises in the reference period (t) newly born in t-2 having survived to t divided by the number of enterprise births in t-2.

depend on internal factors but also on external factors: a favourable environment, a positive economic cycle and the sector of the company. Survival is, in general, higher in manufacturing than in services sectors.

Only 14 Member States provide the data for all the reference years 2003 to 2007. A group of 9 countries, including both catching-up and more economically advanced Member States, has had a survival rate in the range of 70–80 % between 2003 and 2007. Another important group of 7 Member States is in the 60–70 % range, but with higher fluctuations over time. Only 4 countries have a survival rate above 80 % and 3 below 60 %. The largest variations of the survival rate over time are observed in catching-up countries, in particular in Lithuania, Slovakia, Hungary, Estonia, and Romania. This may reflect a less stable economic situation within these countries, but these higher fluctuations also have a statistical origin in the smaller number of enterprises in these countries.

In general in business demographics, the services sector undergoes more turmoil than the manufacturing sector, where the birth and death rates of companies are lower. This fact is directly related to the shift that occurs in most EU countries towards a larger share of services sectors in the economy (see also Part III, chapter 3). Another factor that has to be taken into consideration is that the effect of the economic and financial crisis cannot be observed yet in these graphs as the last year available for business demography data was 2007.

### *The higher share of fast-growing enterprises in catching-up countries is a sign of their economic development towards a more knowledge-intensive economy*

An economy can move towards more and larger knowledge-intensive sectors only with the emergence of new and fast-growing firms. The presence of (young) high-growth enterprises in a country is a sign of the successful development and dynamism of innovative entrepreneurial activities. Unfortunately statistics on the share of high-growth enterprises in all enterprises are available only in a limited number of countries.

In Europe, the share of enterprises growing fast (the number of enterprises with a 20 % growth rate in employment[307] per annum during 3 consecutive years, and with 10 or more employees[308] at the beginning of the observation period as a percentage of the population of enterprises with 10 or more employees) is the highest in catching-up countries. Among the more research-intensive countries, only the Nordic countries and the Netherlands provide statistics on high-growth enterprises (figure III.1.10). These countries have similar shares of high-growth enterprises (3–4 %) and are all surpassed by catching-up countries. While this observation is not surprising, it is still encouraging for the knowledge- and economic-convergence in the EU. In all European countries providing this data, high-growth enterprises represent less than 10 % of all enterprises, and young high-growth enterprises (less than five years old, also called ‘gazelles’) less than 1 %, except in Bulgaria, Lithuania, and Latvia. The group of young high-growth enterprises therefore represents 10 to 15 % of all high-growth enterprises. Catching-up countries are also those where the share of young high-growth enterprises is the highest.

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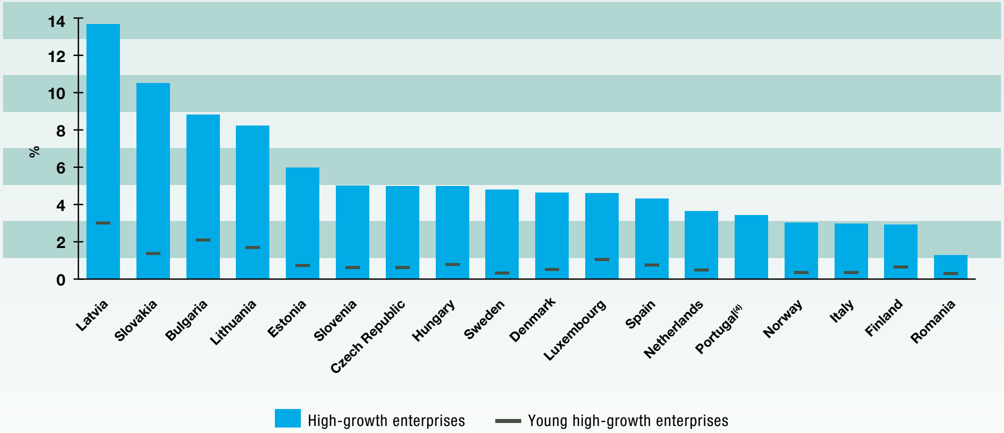
[307] Alternatively, high-growth enterprises can also be defined in terms of turnover.

[308] A size threshold of 10 employees was set to avoid having the growth of very small enterprises distort the picture. The 10-employees threshold is low enough to avoid excluding too many enterprises.

FIGURE III.1.10 **High-growth(1) and young high-growth(2) enterprises as % of total enterprises, 2007(3)**



**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) Enterprises of more than 10 employees with an average annual growth in employment of more than 20% per annum over a three year period.
(2) Enterprises up to 5 years old of more than 10 employees with an average annual growth in employment of more than 20% per annum over a three year period.
(3) LT, FI: 2005; BG, ES, NO: 2006.
(4) PT: Data are not available for young high-growth enterprises.

When high-growth is defined in terms of turnover, the share of high-growth enterprises is significantly higher than when it is defined in terms of employment in all countries. This is due to the relatively high costs of labour[309]. Enterprises therefore reach the 20 % growth-rate during three consecutive years for turnover more easily than for employment, which indicates that many enterprises grow faster in turnover than in employment.

### *The US business environment is more fertile for the growth of innovative firms*

As analysed in the 2010 EU Industrial R&D Investment Scoreboard, it appears that the main reason for the R&D intensity gap between the EU and the United States has its origins in a smaller number of young innovative companies in high R&D intensity sectors (mostly ICT).

As seen in Part I chapter 5, the difference in industrial structure (i.e. the fact that EU high-R&D-intensity sectors are much smaller relatively than those of their US counterparts) explains most of the R&D-intensity gap with the United States, namely in the corporate part. By increasing the number of large European companies in high-R&D-intensity sectors the overall EU R&D-intensity targets would be more easily reached. If we take into account the age of the Scoreboard companies, the analysis provides additional insights concerning the origin of the EU's R&D intensity gap. Younger companies (i.e. those created after 1975 but not acquired by other companies) show a higher R&D intensity than older ones, and are much more numerous in the US than in the EU (54.4 % versus 17.8 %). The younger companies based in the EU are less R&D intensive than their US counterparts (4.4 % versus 11.8 % (figure III.1.11)).

These differences in the rates of formation and growth of companies may be a major cause of the smaller size of these sectors in the EU compared to the United States, which proves to be a friendlier environment for the growth of companies. To add to this situation, there is a "sectoral" specificity: there are sectors, like biotechnology, internet, software, computer hardware and services and telecoms equipment, that evidence an above average share of R&D performed by young

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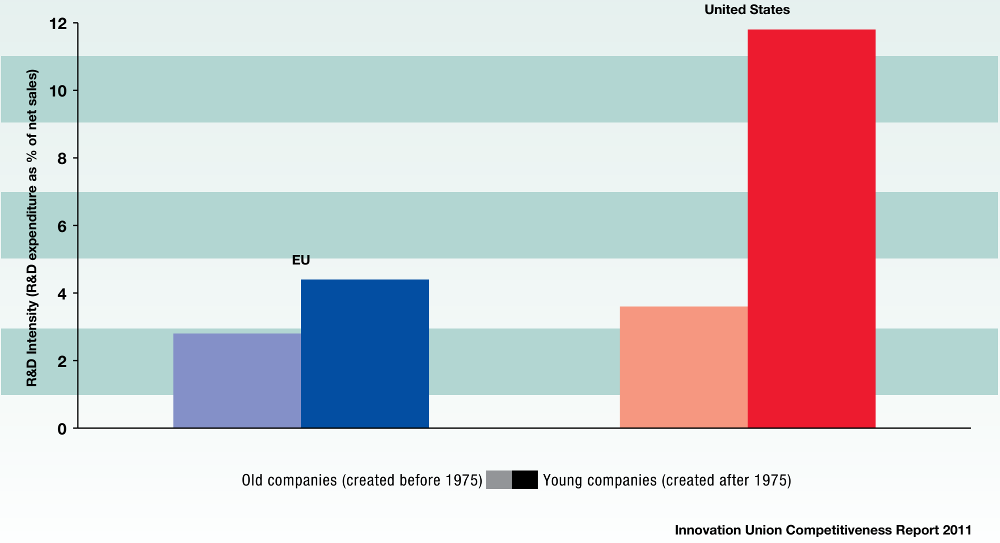
[309] See "Measuring Entrepreneurship. A Collection of Indicators", OECD, 2009

FIGURE III.1.11 **R&D Intensity for the EU and US *Scoreboard* companies by age of company(1)**



*Source:* DG Research and Innovation, JRC-IPTS
*Data:* The 2010 EU Industrial RD Investment Scoreboard
*Note:* (1) The share of young companies in the total number of companies: EU: 17.8%; US 54.4%.

companies[310]. They are called the “young sectors”. For most of these sectors, the United States have a bigger share in their economy than the EU.

In this chapter we analysed the contribution of SMEs to R&D investments and innovation, as well as firm dynamics. Innovation and growth of firms are essential elements for progress towards a more knowledge-intensive economy. The chapter showed that the EU is still well placed compared to its world competitors, only slightly below the United States on the research intensity of SMEs. For the European SMEs to realize their full potential for innovation and growth, besides the R&D intensity, it is essential that they have the right legal, financial and commercial framework conditions. The next chapter will analyse these aspects.

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[310] See the Working Paper issued in the context of the Industrial Research Monitoring and Analysis (IRMA) "Young Leading Innovators and EU' R&D intensity Gap", October 2010, M.Cincera and R. Veugelers.

## CHAPTER 2

# Framework conditions for business R&D

## HIGHLIGHTS

Given the key role of research in fostering innovation, it is important to see what conditions exist in Europe for developing research-based innovation and promoting R&D investment by firms. Whatever policies are implemented by Member States, the framework conditions are critical in determining the final effects of these policies in the market. Figures show that business R&D investment is lower in Europe by comparison to its main competitors. Also, the rate of return-to-R&D of firms from European countries has been generally lower as compared to that of US firms in the period since the mid-1990s. In addition, policy documents such as the Innovation Union Flagship Initiative point out that framework conditions for business R&D are rather unfavourable in Europe. Analysis in this chapter shows that framework conditions for business R&D vary considerably across European countries and the need for harmonisation appears rather obvious. The Northern European countries hold the top positions on many indicators quite systematically. Many initiatives are also in place at Community level and already show some concrete results. However, further efforts seem to be needed.

**Supply-related framework conditions** supporting R&D and knowledge transfer vary across countries. Regarding public funding of business R&D, the United States, Germany, and Finland prefer direct funding, while Belgium, Denmark, Hungary, Ireland, the Netherlands and Portugal opt increasingly for tax incentives. There are also a few Member States that place very little emphasis on publicly funded business R&D: Poland, Slovakia and Greece. At the Community level, the most concrete measurable results are the increase in direct public funding of SMEs in the Seventh Framework Programme, with a share of SME participation reaching 15 % in FP7. Concerning the availability of private financial services, venture capital is most available in the United Kingdom, Sweden, and Switzerland, after the United States. Early-stage venture capital is also significantly used in the other Northern European countries, Belgium, the Netherlands, and in Portugal. Venture capital is perceived most accessible by the end user in the Northern European countries. Private credits are generally both available and perceived as accessible in small Member States such as Luxembourg, Malta and Cyprus. The need to harmonise the supply-related framework conditions across Europe is sufficiently clear, the most striking confirmation being the total cost of patenting and of maintaining a patent for 20 years, which is 20 times higher in Europe than the United States (40 times higher in the case of SMEs) — most of the difference coming from the maintaining cost of patents.

**Demand-side policies** can shape direct public demand through, for instance, public procurement. Policies can also lay the framework for stimulating private demand, through systemic policies such as the Lead Market Initiative, or standard setting. Demand-side policies at European and Community level are quite numerous and already show some concrete results, such as the increased number of standards issued by European Committee for Standardisation (CEN) over recent years or the fact that Lead Market Initiative and innovation-friendly regulations at EU level are being developed in sectors generally related to fast-growing S&T fields. This shows a political will at European level to facilitate the transfer of knowledge from research to technology and towards the market. Demand-side framework conditions for business R&D are yet again diverse at country level, and generally more developed in the major research-intensive countries outside Europe. When considering public demand stimulation, Luxembourg and the Northern European countries are the best places for public procurement of advanced technologies within Europe. Local competition (i.e. at national level) is overall perceived to be more intense in EU-15 old Member States compared to EU-12 Member States, and particularly strong in Germany, Austria and the Netherlands. At the same time, the countries most involved in foreign competition appear to be Belgium and the Netherlands. When looking at the private side of demand, firm-level technology absorption appears at its highest yet again in Northern Europe, Austria and Germany. While user confidence in innovation is greatest in India, Spain, Ireland, China and the United States, the capability of consumers to absorb new technologies is most developed in Japan, the United States, China, South Korea, and in European countries such as Sweden, Denmark, the United Kingdom, Belgium, the Netherlands and Switzerland. The EU has fewer entrepreneurs compared to China and the United States, with Finland leading within Europe in terms of entrepreneurial activity. About half of Member States have raised the level of their entrepreneurial activities between 2004 and 2009. The highest fear-of-failure rate when starting a business is perceived in Romania, France, Greece and Spain, and lowest in Norway and Finland. The regulatory environment appears to be most conducive to the operation of business in the United Kingdom, Ireland and the Northern European countries. Countries that experience the least easy conditions in which to do business are Greece, Italy, Czech Republic and Poland.

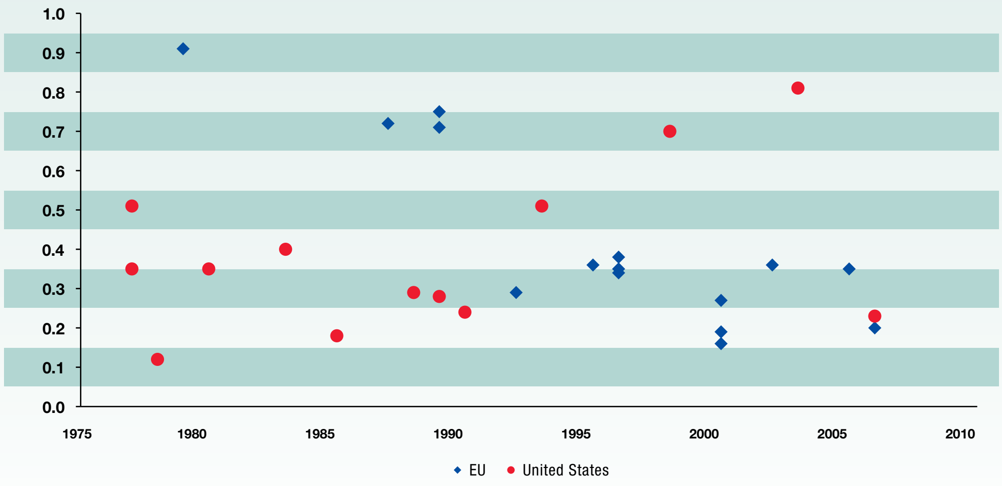
Research-based innovation is one of the main sources of innovation in the world. Although in absolute terms non-technological innovation appears to have a greater weight in the economy[311], a significant part of non-technological innovation would not be possible without technology obtained through the exploitation of research results. For instance, the 'general purpose technologies' commonly affect an entire economy and have an impact on the pre-existing economic and social structures. Examples of innovation based on general purpose technologies include steam engines, electricity, railroads, automobiles, electronics, the computer and the Internet. The most-used recent example is certainly that of information technologies, which penetrated the whole economy and have triggered changes in the business models of many services sectors (e.g. banking, creative industries, etc.).

In addition, many countries in Europe and beyond Europe are considering further developing their manufacturing industries, with an important share of high-tech and medium high-tech manufacturing[312]. Manufacturing industry has an important place in the economy in countries such as Germany. France is constantly concerned not to de-industrialise/ or de-manufacture the country[313]. Another example is the United Kingdom - a highly services-oriented economy, which has lately published its intentions of strengthening the national industrial policies[314].

Given the key role of research in fostering innovation, it is important to see what conditions exist in Europe for developing research-based innovation and promoting R&D investment by firms. Data indicate that business R&D investment is currently lower in

FIGURE III.2.1

**Cross-sectional estimates of the private firm-level rate of return to R&D**



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* B.H. Hall, J. Mairesse, P. Mohnen (2009), 'Measuring the returns to R&D' in The Handbook of the Economics of Innovation, Amsterdam, Elsevier.

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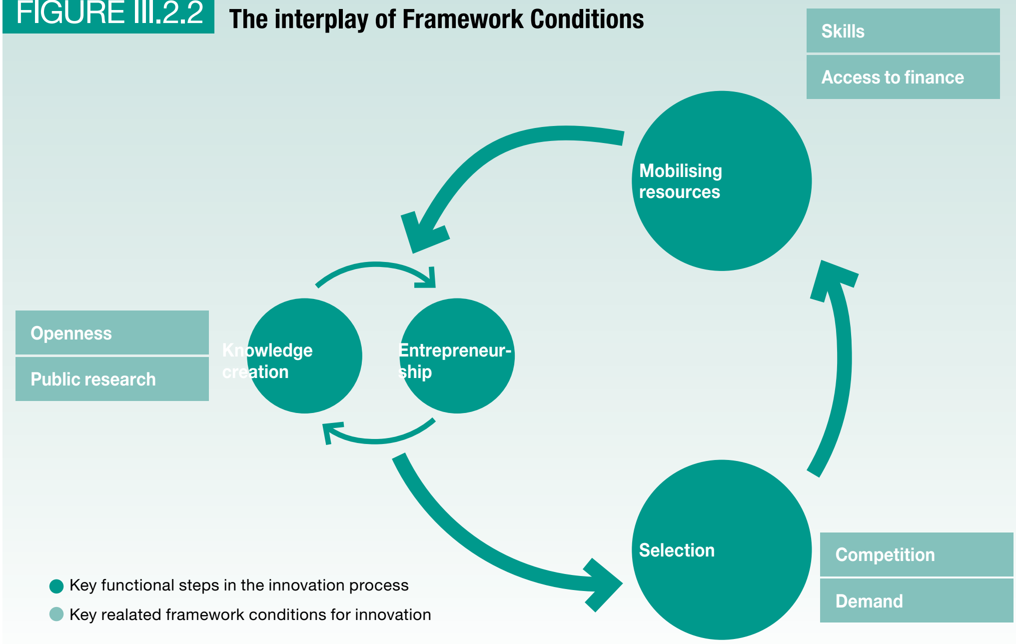
[311] In terms of economic structures, the current weight of the services sector in the European economy is estimated at around 70 %. It is well known that that innovation in services is rather non-technologically oriented.

[312] According to Eurostat figures, the added value of high-tech and medium high-tech manufacturing industries count for nearly half (46.4 %) of the manufacturing value added in EU-27.

[313] See for instance 'Etats Généraux de l'Industrie' organised in 2009, http://www.ladocumentationfrancaise.fr/rapports-publics/104000021/index.shtml.

[314] UK, Her Majesty's Government, *New Industry, New Jobs: Building Britain's Future*, April 2009, http://www.bis.gov.uk/files/file51023.pdf.

FIGURE III.2.2 **The interplay of Framework Conditions**



*Source:* MILES, I., BLEDA, M., J., C., EDLER, J., P., S. & WILKINSON, C. 2009. *The wider conditions for innovation in the UK. How the UK compares to leading innovation nations*. NESTA Index Report; quoted in NESTA , Measuring Wider Framework Conditions in the UK, 2010

Europe (1.04 % of GDP) than in Japan (2.68 %) and the United States (1.85 %). Economic analysis shows that business R&D spending can be low for two main reasons, which can occur simultaneously[315]— these being supply and demand shortfalls. Whereas the supply problems could be too high a cost of capital or too low quality R&D, demand shortfalls refer to firms finding market opportunities too small compared to their costs. From a policy point of view, the rate of return to R&D is therefore a key concept. Figure III.2.1. shows that the rate of return to R&D of firms from a number of European countries (France, Germany, Italy, Denmark, and the United Kingdom) has been generally lower compared to US firms in the period since the mid-1990s.

In line with the evidence presented above, recent important European policy documents such as the Innovation Union Flagship Initiative[316] point out the unfavourable framework conditions for research and innovation in Europe and therefore the need to improve them. The Innovation Union Initiative highlights the fact that private investment in research and innovation is currently held back both by supply-side conditions such as poor availability of finance in many countries and costly patenting arrangements, and demand-side policies related to market fragmentation, slow standard-setting and the lack of strategic use of public procurement. Consequently there is a need to address the bottlenecks which exist on the path from idea to market, in order to get research and innovation to flourish in all areas.

It has to be mentioned that in technologically weak countries, low business R&D spending cannot always be explained solely by supply or demand shortfalls and/or low rates of return to R&D. In these countries there is often no real interest and demand for domestic R&D or innovation, hence there is no related market for such activities which could support or even create rates of return. In weak technological and innovation systems more structural factors are at work: insufficient knowledge, weak technological capabilities at the firm level, sectoral specialisation patterns, the lack of sufficient clusters and networks, the absence of critical firm size, and weak supportive policies. The consequence is that in these countries, research and

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[315] Bronwyn H. Hall and Jacques Mairesse, Corporate R&D Returns, in *Knowledge for Growth, Prospects for Science Technology and Innovation*, selected papers from Research Commissioner Janez Potocnik's Expert Group, European Commission, 2009.

[316] Europe 2020 Flagship Initiative: Innovation Union, 2010.

innovation activities of firms cannot be explained solely by supply and demand factors and that more structural concepts have to be taken into account as well. In such a context, the very concept of structural change as a driver of R&D and innovation can be a complementary variable to understand the problems at stake. From this point of view, chapter 3 in part III on structural changes can be considered as complementary to this chapter.

This chapter on framework conditions for business R&D will provide an overview both of policies for supply-side conditions and policies for demand-side conditions which aim to increase the benefits for firms to invest in R&D, and therefore to boost investments in R&D by firms.

There are numerous factors which can be included in the two categories. Figure III.2.2. helps to identify their interplay, being a useful way to look at both the key functional steps in the innovation process (dark shading), and the key related framework conditions for innovation (lighter shading). Following the logic of supply and demand, the supply framework conditions would include access for business both to finance and to human resources, but also issues such as patent costs and appropriate ICT infrastructure such as broadband. Demand side framework conditions will encompass both public and private demand, as well as competition in the market and for the market. Finally, entrepreneurship and an excellent science base, as well as its propensity to work with innovation firms, create valuable opportunities for innovation and contribute to the capabilities of firms to innovate.

The chapter is grouped into three parts: supply and demand factors, and a section on entrepreneurship. In particular, this chapter further analyses several parts of the public financing of business R&D which are not covered in part I, chapter 3, namely State aid (section 2.1.4), European Commission funding of R&D firms through the Framework Programme (section 2.1.5) on a supply side and public procurement (section 2.2.2) on a demand side. It has to be mentioned that the choice of instruments in the overall public financing of business R&D is a matter of Member States' own decisions and there is no straightforward interpretation that more - of any type of instrument - is better.

## 2.1. What are the framework conditions for the supply of business R&D?

As mentioned above, supply framework conditions include access of business both to finance and to human resources, as well as patent costs and appropriate infrastructure such as broadband. All these elements will be analysed below, apart from human resources for R&D and S&T graduates, which can be found in chapter 4 in Part I.

### 2.1.1. Access to finance

The existence of and access to financial services by firms are crucial when it comes to the supply of research and technology innovation by private firms - especially SMEs. This is clearly recognised by the latest policy documents at EU level. The Innovation Union Flagship Initiative stresses that 'access to appropriate forms of finance continues to be one of the most serious constraints on innovation by firms'. A company can generally accumulate its capital from two sources - equity and debt - as well as internal finance (particularly relevant for large firms). Whereas the large multinational companies are generally provided with finance by large banks and big finance companies, in addition to shareholders and lenders, the SMEs are more likely to encounter financing gaps due to the investment risk associated with new and young businesses that need to find their way to the market.

SME financing needs vary according to the stages of the cycle of life of the SME. These stages include the seed and start-up phases, the early development phase, and the growth and maturity phases. Also the source of finance[317] will differ according to the stage of development of the firm (see figure III.2.3.). Typically the funding sources for the seed and start-up stages are informal equity and loans from the founder and associates, as well as bank loans if available. Formal venture capital funds are likely to invest more in the more developed stages of a firm's existence, as at the early stages the profit expectations are less clear and the risk related to investment is higher. This is why the informal venture capital market has an important role in the start-up phases of a business, through *business*

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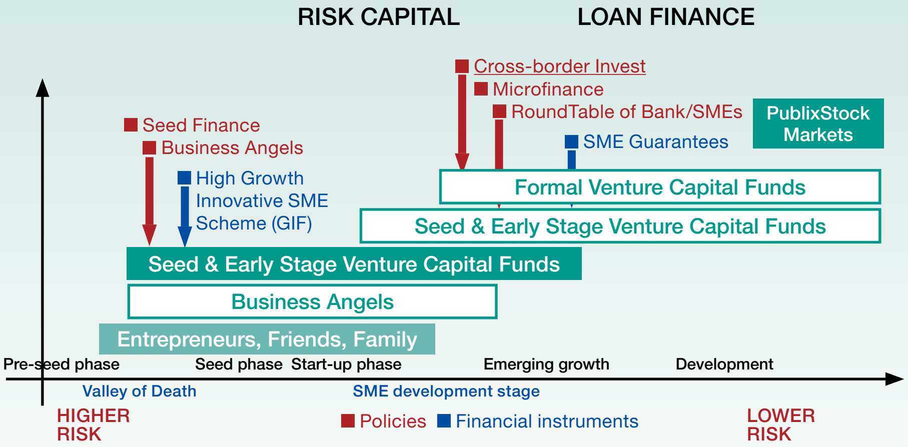
[317] Source: European Venture Capital Association (EVCA), quoted in Ruis, A., van Stel, A., Tsamis A., Verhoeven W., and Whittle M., *Cyclicality of SMEs finance*, DG Entreprise and Industry, 2009.

FIGURE III.2.3 **The SME life cycle and financing needs**



*Source:* DG Entreprise, Financing innovation and SMEs: sowing the seeds; main findings of four workshops, 2007

*angels* i.e. individuals who provide risk capital directly to new and growing businesses with which they had no previous relationship. At the expansion stage, the SME will usually access equity from original sources, plus trade investments or venture capital, loans from banks, leasing and factoring and retained profits. Replacement capital includes trade investment, venture capital and IPO (initial public offering).

The investment risk across all the stages indicated above can produce financing gaps in various stages of the SME's development until the product is brought to the market and commercially sold. These gaps between development and commercial sales are often being referred to as the '*valley of death*'. Generally, Government support tries to help overcome financing gaps of companies in various ways, such as acting through grants or acting as guarantors for loans through programmes addressing young small- and medium-sized firms.

As indicated in chapter 1 of Part III, Europe has fewer young fast-growing innovative companies, often because of the financing gaps in various phases of firm development. Firstly, on the seed and start-up phases — where public research grants stop and private finance cannot be attracted — public support across Europe currently appears too fragmented. Secondly, at the expansion phase, innovative companies with high potential lack access to growth finance, in particular from venture capital funds. And finally, both large and small established innovative companies often face a shortage of higher risk loans to complement venture capital.

On one hand, venture capital is an important source of funding at the seed, start-up and growth phases, especially for young firms which are technology-based, with high growth potential. Venture capital investment focuses on high-potential companies, either those which are in new technology fields and therefore rapidly developing, or those where market or operational inefficiencies can be improved and thus enhance the competitive situation of existing businesses. Venture-backed firms bring more radical innovations to the market, at a faster rate than lower-growth businesses which rely less on venture capital and more on other types of finance. On the other hand, banks play an instrumental role in the financing of innovation in more mature firms (as compared to high-tech start-ups). An important measure of the availability of credit for private firms is the ratio of private credit granted to the private sector relative to GDP by deposit-taking financial institutions. Private credits include loans, trade credits and other receivable accounts that establish a claim for repayment.

Banks have a key role to play in countries where there is neither a functioning venture capital market nor a functioning capital market in general. This is particularly true for many EU-12 Member States. One of the problems is that start-ups or small innovative companies have no rating and, in the beginning, no track record and therefore are often cut off from the financial markets. For certain banks and funds it is difficult to give a loan or to invest in these companies. Companies with a very small equity base, however, fully depend on external funding until they generate cash flows.

### 2.1.2. Availability of venture capital and private credit

***The United States has considerably higher rates of venture capital investments than the EU, both in early and expansion stages. The EU Member States with highest venture capital investments are the United Kingdom and Sweden***

Venture capital data are broken down into two investment stages: early stage[318] (seed and start-up) and expansion and replacement[319] (expansion and replacement capital). Early stage is important because venture capital firms not only fund but also support the creation of highly skilled employment in new and innovative areas where other sources of finance are hard to access. Overall investments in the early stage are lower compared to those in the expansion and replacement phase (the EU average is 0.21 per thousand GDP for early stage compared to 1.05 for the replacement stage (figure III.2.4 and figure III.2.5)). This is because venture capital is very sensitive to market cycles both in terms of the amounts they invest and the stages at which they invest it. Venture capital funds are likely to invest more in the later stages of development, as at the early stages the profit expectations are less clear and the risk related to investment is higher[320].

***Early-stage venture capital is mostly used in Luxembourg, Switzerland, Belgium and the Northern Europe***

Early-stage investments are generally dominated by Switzerland, the Nordic countries and Benelux, with France and Germany only around the EU average (figure III.2.4). All the Nordic countries for which data are available are above the EU average. Portugal is the only Southern European country with a level of early stage investments above the EU average. Bulgaria is the leading country within the EU-12 Member States. However, these countries generally register lower levels.

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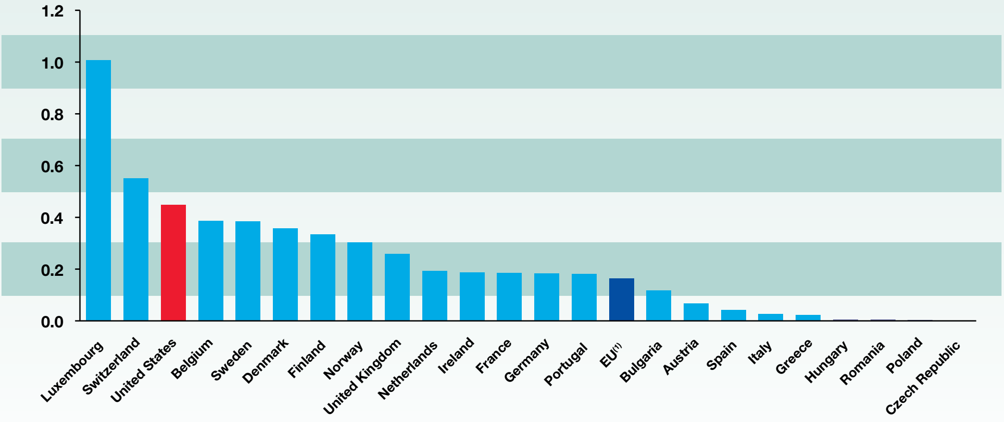
[318] Seed is defined as financing provided to research, assess and develop an initial concept before a business has reached the start-up phase. Start-up is defined as financing provided for product development and initial marketing, manufacturing, and sales. Companies may be in the process of being set up or may have been in business for a short period of time, but have not sold their product commercially.

[319] Expansion is defined as financing provided for the growth and expansion of a company which is breaking even or trading profitably. Capital may be used to finance increased production capacity, market or product development, and/or provide additional working capital. It includes bridge financing for the transition from private to public quoted company, and rescue/turnaround financing. Replacement capital is defined as the purchase of existing shares in a company from another private equity investment organisation or from another shareholder(s). It includes refinancing of bank debt.

[320] The OECD Innovation Strategy: Innovation to Strengthen Growth and Address Global and Social Challenges, 2010.

FIGURE III.2.4 **Venture Capital – Early stage (seed + start-up) per thousand GDP, 2009**



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*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) EU does not include EE, CY, LV, LT, MT, SI, SK in respect of which data are not available.

## Box: Venture capital in the United Kingdom

The United Kingdom was a pioneer in providing support from government for the development of an informal venture capital market in early 1990s, targeting the increase of private equity funds at the seed and start-up phases of a business. Its example was followed by other countries in Western Europe in the late 1990s, whereas in Eastern Europe this practice is still very little developed. Among various forms of intervention, the UK Government, in cooperation with the business sector, was the first to create ‘business angel’ networks[321] in 1997.

By the mid-1990s the UK Government had also introduced numerous and generous schemes of fiscal incentives for investors, aiming to increase the level of private equity funds. The policy focus has since (in early 2000) shifted from tax incentives and regulatory policies to initiatives aimed at increasing the access of technology SMEs to private equity funds, in a rather de-centralised manner — therefore encouraging the formation of regional clusters. Regional and local private–public funds have been established, such as the Regional Venture Capital Fund (RVCF), which was set up in 2001 and used to cover all nine regions of England. Regional Venture Capital Funds made their final investments in 2008 and have now been replaced by Enterprise Capital Funds. Devolved administrations (Scotland, Wales and Northern Ireland) were encouraged to develop and put in place their own mechanisms of support for private investment and entrepreneurship.

*Sources:* 1) G. Avnimelech, A. Rosiello and M. Teubal, Evolutionary interpretation of venture capital policy in Israel, Germany, UK and Scotland, in Science and Public Policy, 37(2), March 2010
2) Colin M. Mason, Public policy support for the informal venture capital in Europe: a critical review, in International Small Business Journal, vol. 27, 2009
3) http://www.bis.gov.uk/policies/enterprise-and-business-support/access-to-finance/enterprise-capital-funds

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[321] Business angel networks aim to enable investors and entrepreneurs to find one another early on.

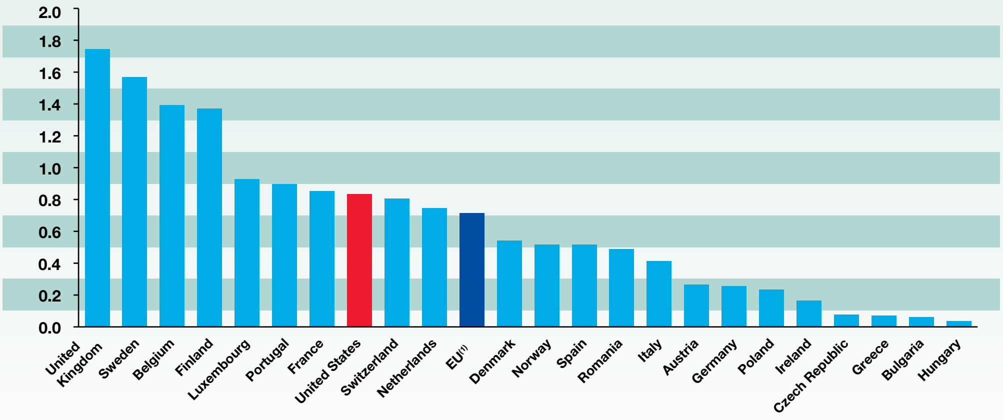
### *The United Kingdom and Sweden are leading investment in venture capital at expansion and replacement phase*

The two countries well above both the United States and the EU-27 average in terms of venture capital investments at expansion and replacement phase are the United Kingdom and Sweden , followed by Belgium and Finland (figure III.2.5). At the other end of the scale are Bulgaria and Hungary. Romania shows the highest figures in Eastern Europe.

### *Private credits are noticeably available in several Northern European countries, the United Kingdom, Ireland, the Netherlands, Spain, Portugal and some small Member States. The EU values are more than double those of the United States*

In terms of availability of credit for private firms, the countries above the EU average of 1.27 % of GDP are: Denmark (2.19 %), Cyprus (2.17 %), Ireland (2.17 %), the United Kingdom (2.10 %), Spain (1.98 %), Luxembourg (1.97 %), the Netherlands (1.93 %), Portugal (1.80 %), Switzerland (1.68 %), Sweden (1.30 %), and Malta (1.28 %).[322]

FIGURE III.2.5 **Venture Capital – Expansion and replacement per thousand GDP, 2009**



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*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) EU does not include EE, CY, LV, LT, MT, SI, SK in respect of which data are not available.

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[322] IMF, 2007

In conclusion, there are significant variations between countries regarding investments in venture capital, both in absolute and relative terms. In absolute figures, the United States and the United Kingdom invest the most funds in venture capital. As a percentage of GDP, the United Kingdom is leading, closely followed by Sweden. The United States and Switzerland follow at a greater distance. France's position is around the EU average, whereas Germany registers lower values. Overall the Nordic countries, Belgium and the Netherlands register significant figures, whilst Eastern Europe invests less in venture capital. Among Southern European countries, Portugal depicts the highest numbers for the expansion and replacement phase and for early-stage venture capital.

Private credit is available to a significant extent in Denmark, followed at a certain distance by Sweden. It is also available in some smaller countries such as Luxembourg, Malta and Cyprus. Considerable values are recorded in Ireland, the United Kingdom and the Netherlands, and also Southern European countries (Spain and Portugal). EU-12 Member States record rather low levels of private credit (apart from Cyprus and Malta).

Whereas the United States has considerably higher values than the EU concerning venture capital investments in both early-stage and expansion phases, EU private credits values are double those of the United States.

### 2.1.3. Ease of access to finance

Accessibility of finance, along with the presence of financial services as such (or even size and depth of the financial system as a whole) has an important effect on a country's real activity, economic growth and overall welfare. Therefore the simple fact that the financial services exist per se does not automatically imply that they are accessible to all the interested users within an economy[323].

A certain amount of data in chapter 2 (starting with this very section) is based on the World Economic Forum (WEF) survey on the perception of users on various innovation dimensions for which there are no other reliable data sources. The WEF data has both advantages and disadvantages. Firsty, it is a regular source of data, published yearly. Secondly, the survey covers a broad range of countries. The main disadvantage is however that it surveys the perception of users and therefore reports on their subjective assessments (although these perceptions nevertheless guide their decisions).

***Overall, several of the Nordic countries and small European Member States are perceived to offer easier access to finance for businesses operating within the country. Sweden has the highest position both in terms of investment in venture capital and access to it by firms. Despite having the highest level of investment in venture capital among European countries, access to this capital in the United Kingdom is not perceived to be easy***

Sweden has one of the strongest positions in terms of users' access to the available venture capital (average rank: 4.3) (figure III.2.6). This is not the case, however, for the United Kingdom, Belgium, France, and Germany, with lower positions in comparison with the Nordic countries and the Netherlands. This implies that even though the investment of venture capital is highest in the United Kingdom and more moderate in France and Belgium, the end users in these countries do not perceive that they have appropriate access to it.

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[323] World Economic Forum, *The Financial Development Report 2008*, Geneva 2008, available at: http://www.weforum.org/pdf/financialdevelopmentreport/2008.pdf, quoted in NESTA, *The wider conditions for innovation in the UK: How the UK compares to leading innovation nations*, London, 2009, available at: http://www.nesta.org.uk/library/documents/wider-conditions.pdf.

## Risk Sharing Finance Facility (RSFF)

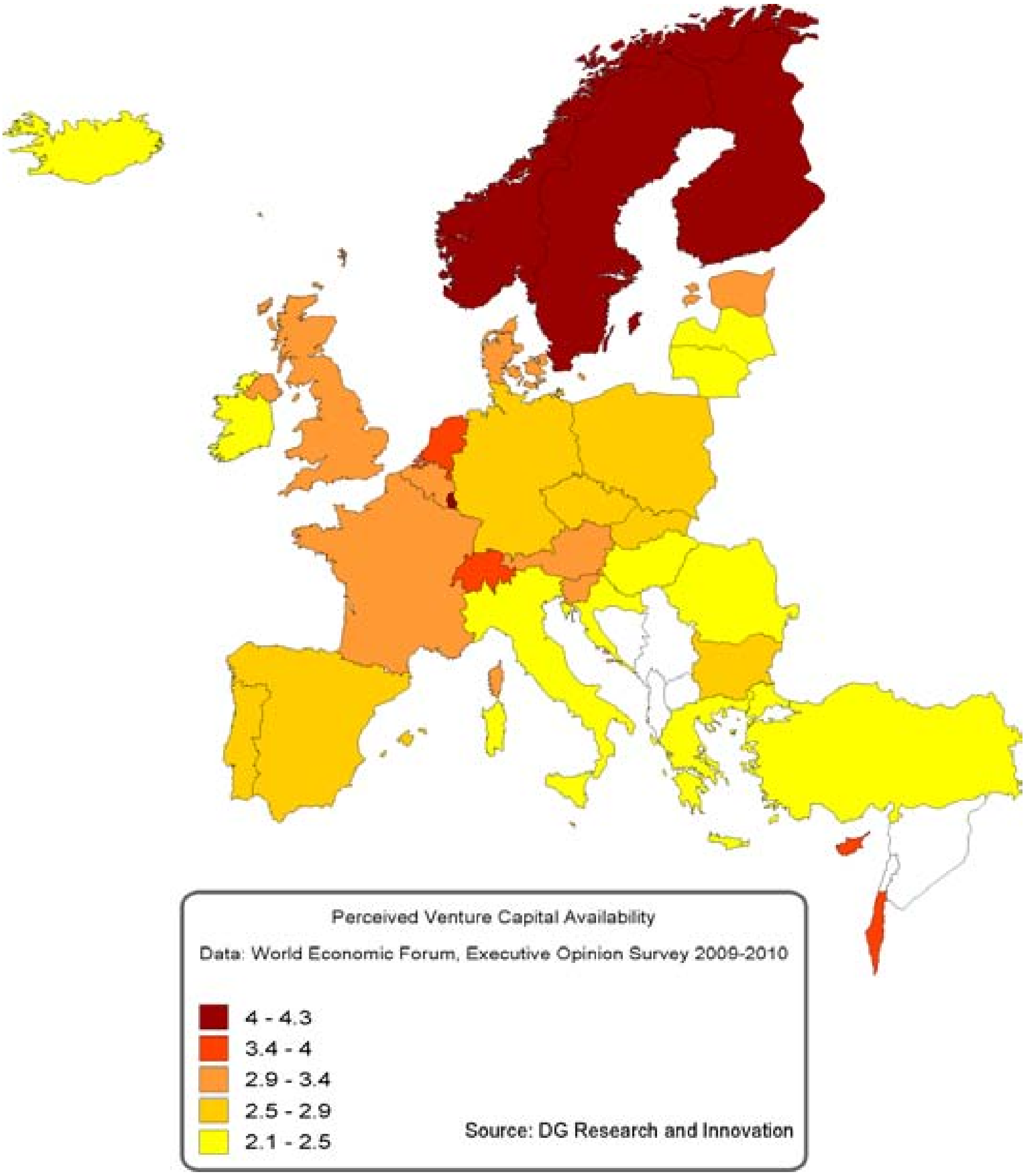
RSFF is a European instrument that facilitates access to funding by companies — more precisely by improving access to debt financing for promoters of research and innovation investments.

The RSFF is built on the principle of risk sharing between the European Union and the European Investment Bank (EIB). It covers, through capital allocation and provision, the credit risks borne by the EIB when lending to a project promoter for investment in research, development and innovation (RDI), or when guaranteeing loans made by commercial banks and other financial intermediaries for RDI projects.

The European Union — through the Seventh Framework Programme of the European Community (FP7-EC) — and the EIB each provide up to EUR 1 billion for the period 2007–2013 (the EU contribution of EUR 500 million for the period 2011–2013 is subject to an interim evaluation). Through a leverage effect, this will enable the EIB to lend more than EUR 10 billion for high-risk/high-reward RDI investment.

The RSFF is designed for private and public legal entities promoting activities in the field of RDI, including small- and medium-sized enterprises, larger companies, universities and research organisations. The RSFF extends the ability of the EIB to provide loans or guarantees to entities with a low or sub-investment grade credit rating that the Bank would not normally be able to finance. In addition, it facilitates financing for commercial banks and other financial intermediaries that are willing to extend their lending capacities to RDI promoters. Finally, it can be used by projects resulting from European research initiatives, such as Research Infrastructures, European Technology Platforms, Joint Technology Initiatives and Eureka.

**FIGURE III.2.6** **Perceived Venture Capital Availability**



*Note:* Averages; the indicator measures the ease with which entrepreneurs with innovative but risky projects can find venture capital in a country (average rank: 1 = not true; 7 = true) (2009-10 weighted average)

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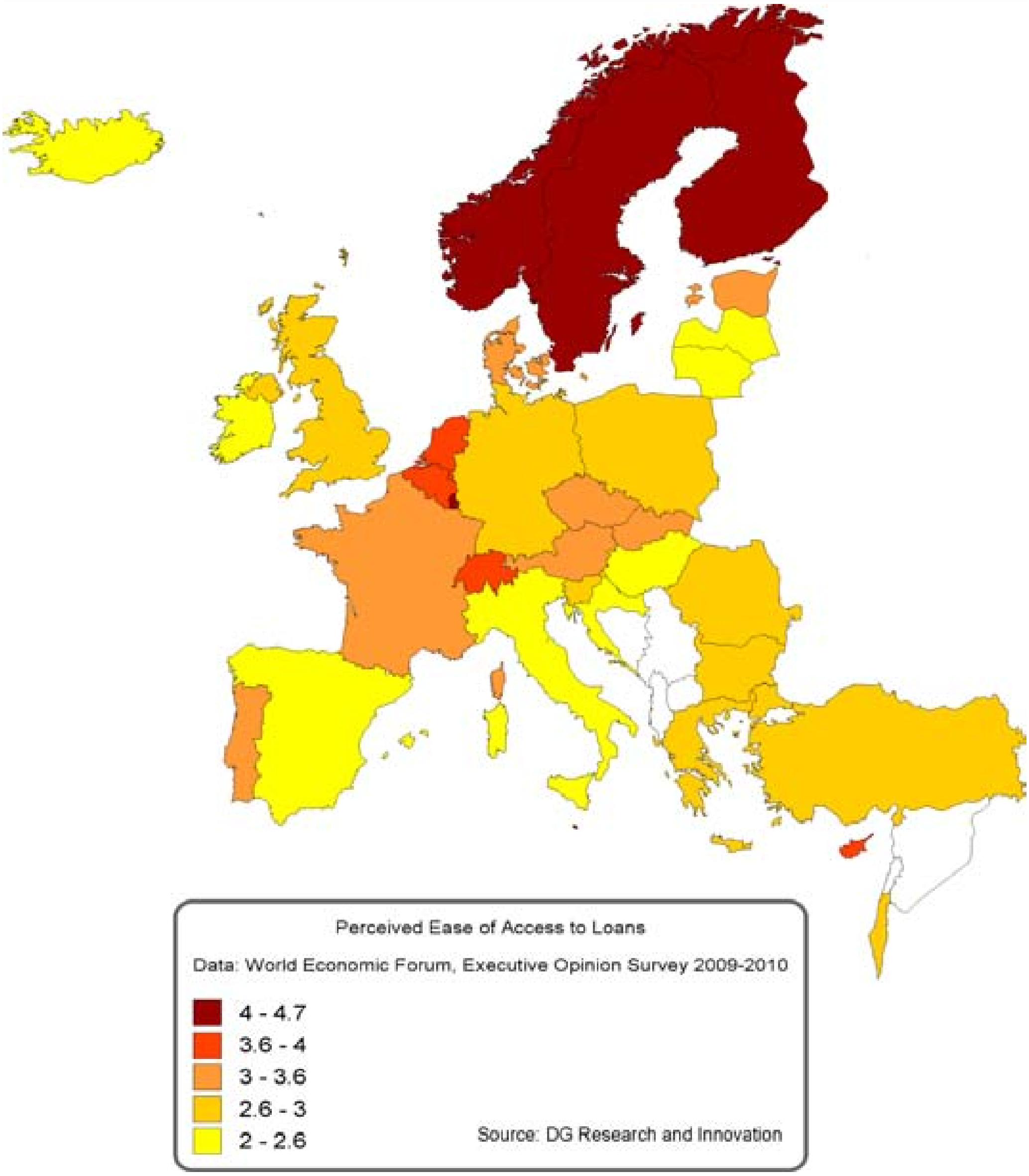
***In smaller countries, firms have relatively easy access to loans within the country, particularly in the Nordic countries***

Luxembourg has the highest relative position in terms of access to loans, followed yet again by Nordic countries (figure III.2.7). Cyprus and Malta also record remarkable scores. Once more the United Kingdom, Germany and France are well below the Nordic countries, Belgium, the Netherlands as regards the ease of obtaining a bank loan within the country with only a good business plan and no collateral.

FIGURE III.2.7 **Perceived Ease of Access to Loans**



*Note:* Averages; the indicator measures how easy is to obtain a bank loan in a country with only a good business plan and no collateral (average rank: 1 = not true; 7 = true) (2009-10 weighted average)

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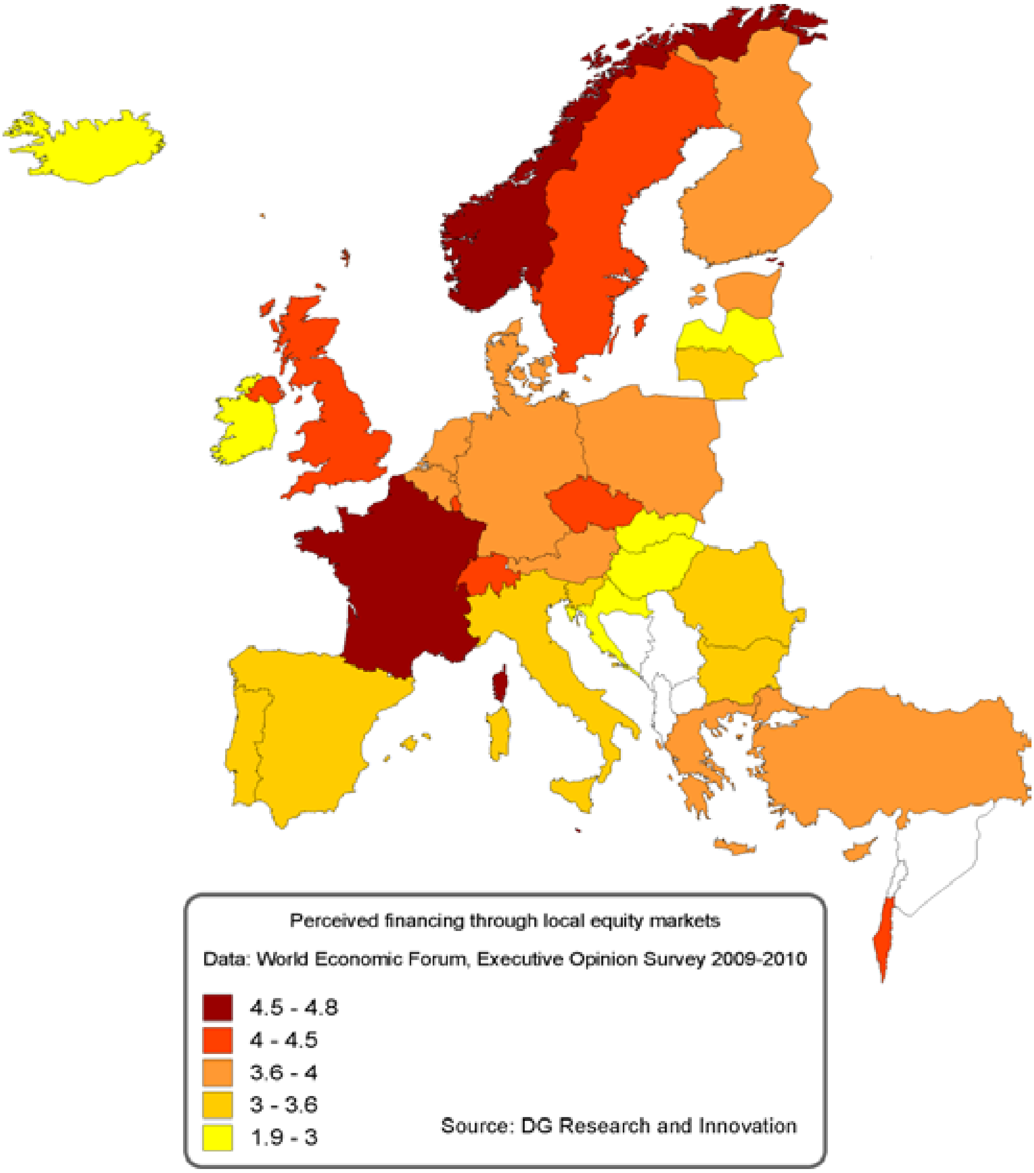
### *Among European countries, France is leading in terms of access to local equity markets*

Financing through local equity markets is perceived to be highly accessible in France, as well as in several Nordic countries (Sweden and Norway) and small countries like Malta (figure III.2.8). It appears to be common in other regions of the world such as India, the United States, Japan and South Korea.

FIGURE III.2.8 **Perceived financing through local equity markets**



*Note:* Averages; the indicator measures the ease with which entrepreneurs with innovative but risky projects can find venture capital in a country (average rank: 1 = not true; 7 = true) (2009-10 weighted average)

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To conclude, the countries where financial services both exist at a significant level and are accessible to the end users are generally most Nordic countries (led by Sweden) and some small Member States — Luxembourg, Malta, Cyprus (noticeably in terms of private credits). The case of the United Kingdom is a special one: with the highest level of venture capital investments in the EU both in absolute and relative terms, as well all significant values of private credits, it seems that the financial services do not sufficiently reach the end business user. Among the big countries, France is systematically around the middle of the scale both in terms of existence of financial services and access of firms to these services, whereas Germany's position is rather weak in both areas. Spain and Portugal record somewhat significant figures on the existence of some financial services, but the access to them is not perceived as high by firms. Overall, new Member States' figures are fairly low (except for those of Malta and Cyprus).

### 2.1.4. State aid in the context of overall public financing of business research

In accordance with article 107 of the Treaty on the Functioning of the European Union (TFEU): "*Save as otherwise provided in the Treaties, any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort competition by favouring certain undertakings or the production of certain goods shall, in so far as it affects trade between Member States, be incompatible with the internal market.*" Nevertheless, "*aid to promote the execution of an important project of common European interest*" and "*aid to facilitate the development of certain economic activities or of certain economic areas, where such aid does not adversely affect trading conditions to an extent contrary to the common interest*" may be considered to be compatible with the internal market.

Therefore, even if TFEU sets out a general prohibition on State aid, it leaves room for Member states to use State aid measures when pursuing certain policy objectives. State aid for horizontal objectives (i.e. aid that is not granted to specific sectors) and concerning for example R&D&I or support to SME's is usually considered as being better suited to address market failures and thus less distortive for competition than sector aid.

As matter of principle, Member States shall notify State aid measures to the Commission and they shall not implement such aid unless approved or deemed approved by the Commission with the exception when such measures are covered by De-minimis Regulation[324] or General Block Exemption Regulation[325] (GBER).

State aid may be provided "in any form whatsoever", it encompasses therefore a wide range of instruments, such as: contributions of capital and assumption of losses, provision of other cash benefits (loans, subsidies), assumption of potential liabilities (guarantees, securities), sale of purchase of equity shares, reduction or exception from taxes, fees, social security contributions etc. Subsidies granted to individuals or general measures open to all enterprises do not constitute state aid[326].

Looking at the share of state aid for R&D out of total state aid provided in a given country (Figure III.2.9), Luxembourg (62.8) and Belgium (46.2) appear to be in first position, having awarded around half or more of its state aid to R&D. The share of state aid to R&D was also relatively high in Bulgarian (39.8), the Czech Republic (36.5), Austria (31.1) and Finland (30.8). At the contrary, Greece and Poland granted 1.5% or less of their state aid to research and development.

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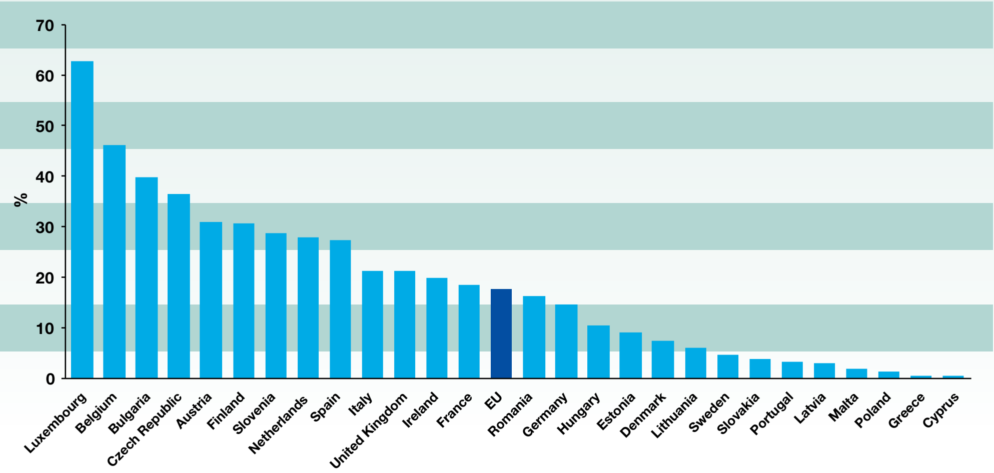
[324] Commission Regulation (EC) No 1998/2006 of 15 December 2006 on the application of Articles 87 and 88 of the Treaty to de minimis aid. OJ L 379, 28.12.2006, p. 5.

[325] Commission Regulation (EC) No 800/2008 of 6 August 2008 declaring certain categories of aid compatible with the common market in application of Articles 87 and 88 of the Treaty (General block exemption Regulation), OJ L 214, 9.8.2008, p.3.

[326] http://ec.europa.eu/competition/state_aid/overview/index_en.html.

## FIGURE III.2.9 State aid for R&D and innovation as % of total aid, 2009



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*Source:* DG Research and Innovation
*Data:* DG Competition

Yet again, it cannot be concluded that the higher the share of a given instrument, the better (in this case state aid). The figures simply give a picture of the various modalities chosen by Member States to provide public financing to firms performing R&D.

### 2.1.5. Participation of industry and SMEs in the European Framework Programme

***The number of firms participating in FP7 has increased considerably by comparison with FP6***

In total, 26.4 % of the participants in FP7 are companies (table III.2.1), and they have a similar share of the budget (23.7 %). Both shares indicate a significant increase to FP6, where the participants from companies represented 19.6 % of total number of participants, receiving 18.6 % of FP6 funds.

## TABLE III 2.1 Share of companies in total FP7 particpants and total FP7 EC funding

| | Total | of which: companies | |
|---|---|---|---|
| | | Total | % |
| FP7 participants | 30518 | 8072 | 26.4 |
| FP7 EC financial contribution (euro) | 9 216 412 790 | 2 185 584 133 | 23.7 |

*Source:* DG Research and Innovation
*Data:* DG Research and Innovation

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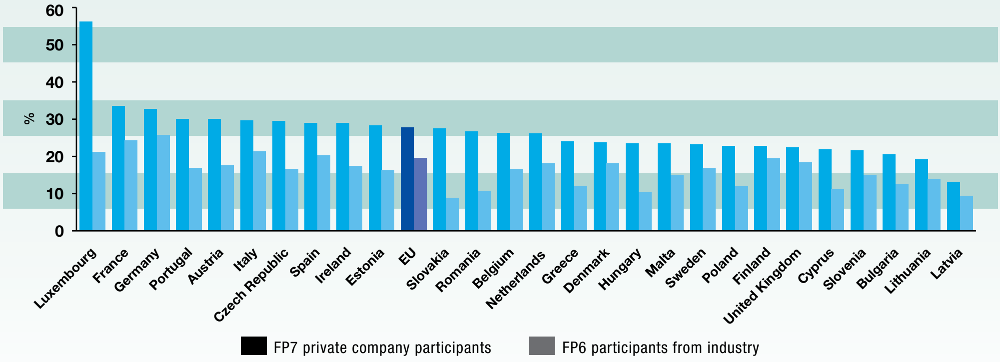
***Share of private companies' participation in the FP7 as % of all participants is highest in Luxembourg, followed by large Member States (France and Germany)***

Analysing shares at national level, over 55 % of Luxembourg participants in FP7 are companies (figure III.2.10). A high share of participation by private firms is also found in France (33.6 %), Germany (32.7 %), Portugal (30.3 %), and Austria (30 %). At the other side of the scale, Lithuania and Latvia register less than 20 % company participation. The highest increases can be seen in Luxembourg, Slovakia, Romania, and Hungary (with more than double the share of companies in FP7 compared to FP6).

FIGURE III.2.10 **Private company (industry) participants in FP6 and FP7 as % of total participants**



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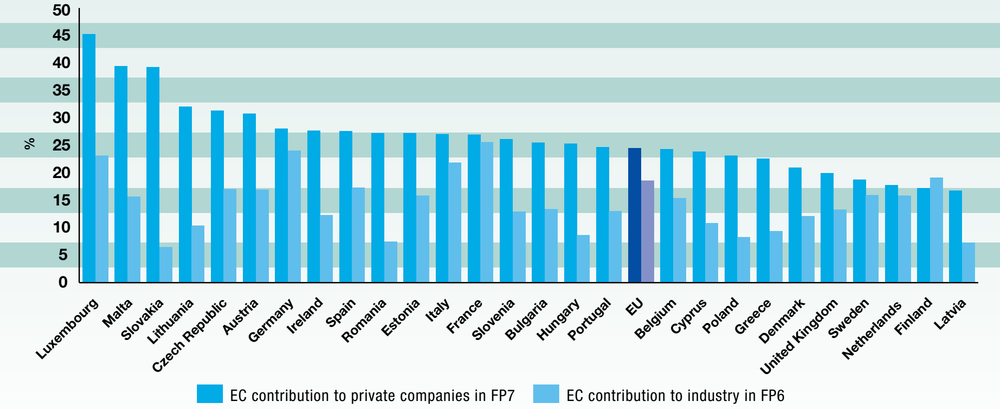
*Source:* DG Research and Innovation
*Data:* DG Research and Innovation

### Small Member States have the highest share of EC financial contributions to companies compared to other type of participants

Luxembourg is in the lead also regarding the EC contribution for firms (45.3 %) compared to other types of participants in FP7, followed by Malta (39.4 %), Slovakia (39.3 %) and Lithuania (32.1 %) (figure III.2.11). Among countries with the highest increases between FP6 and FP7 are Slovakia, Lithuania, Romania and Hungary.

FIGURE III.2.11 Share of EC financial contribution allocated to participants from industry in FP6 and FP7



*Source:* DG Research and Innovation
*Data:* DG Research and Innovation

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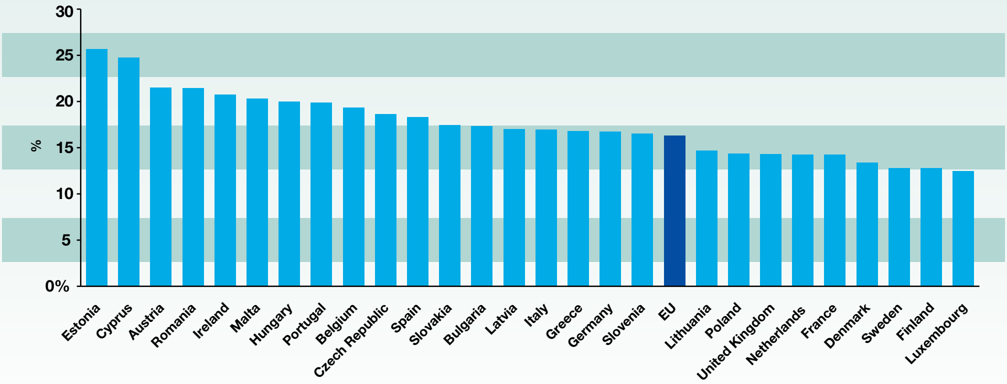
### Small Member States also lead in terms of SMEs' share in total number of FP7 participants

Countries with the highest share of SMEs in the total number of FP7 participants are Estonia (25.7 %), Cyprus (24.8 %), Malta (20.3 %), as well as Romania (21.9 %), Austria (21.5 %), Ireland (20.8 %), and Hungary (20 %) (figure III.2.12).

FIGURE III.2.12 Share of SMEs in the total number of FP7 participants



*Source:* DG Research and Innovation
*Data:* DG Research and Innovation

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In conclusion, overall firm participation in the Framework Programme has considerably increased in FP7 across EU Member States in comparison to FP6. There is a general difference between large and small Member States in terms of size of companies participating in FP7, with a higher participation of SMEs from small Member States, probably due to the structure of their economies.

### 2.1.6. Patent costs

The Innovation Union Flagship Initiative points out the cost and complexity of patenting as a critical issue and considers the absence of a cheaper and simpler EU patent to be a *de facto* tax on innovation. While it is not a tax per se (nobody collects income out of it), the complexity of European patent system is in fact an additional cost in comparison for instance to the system in the United States. It may reduce the efforts to patent, especially those of the SMEs who have low resources.

The number of patents matter because patents allow firms to appropriate the returns from their R&D investments. Patent information also provides an important source of additional/codified knowledge in that specific technological area for other firms and research activities. Patents represent a knowledge pool which increases the efficiency of technological (and implicitly scientific) efforts. If the EU had a patent system which cost less there would be more patents and more cross-border knowledge could be diffused from the information. These patents would provide conditions for a European licence market (as part of cross-border technology markets). Increased licensing would mean that more technological opportunities are turned into economic activities. This additional aspect shows the huge economic cost of inefficient exploitation of the existing knowledge, non-exploitation of existing technological opportunities and of lost economic opportunities to satisfy needs.

***The cost of obtaining and maintaining a patent across Europe for 20 years is almost 20 times higher than in the United States and almost 27 times than in Japan, mainly due to maintenance costs. Furthermore, the cost of obtaining and maintaining European patents for SMEs over 20 years is 40 times bigger in Europe compared to the United States***

As can be seen in table III.2.2. an EPO[327] patent covering 27 countries appears to be almost 20 times more expensive than an USPTO[328] patent, almost 27 times more than a Japanese patent and over 34 times more expensive than a KIPO[329] patent if procedural fees and maintenance fees for up to 20 years are considered (translation and services costs excluded). The main source of the higher patent cost in Europe compared to the United States is not so much the procedural cost of obtaining a patent (estimated at EUR 5 200 in 2010), but more the maintenance costs in the national patent offices which count for 97 % of the total costs of European patents maintained for 20 years in 27 Member States. Thus a major barrier to valorising EU inventiveness is the high cost of patent applications and especially the maintenance cost in a large number of countries in Europe. SMEs are particularly affected by the costs of patents as they are not able to spread the costs and risks of a broad portfolio of patents. In addition, there is no cost difference in Europe between large firms and SMEs, whilst in the United States the cost of patenting is 50 % less for an SME. This makes the relative cost for an SME EPO application 40 times greater than the cost of an SME applying at the USPTO. The same stands for the JPO, which applies certain reductions for SMEs.

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[327] European Patent Office.
[328] US Patent and Trademark Office.
[329] National Patent Office of South Korea.

## TABLE III.2.2

## Cost of obtaining and maintaining a patent per billion GDP (PPS€) at the EPO(1), USPTO(2), JPO(3) and KIPO(4)

| | EPO (EU) |
|---|---|
| Type of firm | all |
| Median number of claims (6) | 18 |
| Designated countries for protection | 27 |
| Procedural Fees | PPS€ |
| Filling fee | 105 |
| Search fee | 1105 |
| Designation fee for one or more Contracting States | 525 |
| Renewal fees of the application for the 3rd year (7) | 420 |
| Renewal fees of the application for the 4th year | 525 |
| Examination fee | 1480 |
| Fee for grant | 830 |
| Claims Tax (8) | 210 |
| TOTAL PROCEDURAL COSTS *without translation* | 5200 |
| Maintaining costs for 20 years | 162598 |
| TOTAL including Maintaining Costs for 20 years | 167798 |
| TOTAL including Maintaining Costs for 20 years per billion GDP | 14.21 |

Source: JPO

*Data:* EPO, USPTO, JPO, KIPO, National law relating to the EPC (14th edition), Bruno van Pottelsberghe and Didier Francois, 'The cost factor in patent systems', Solvay Business School, Université Libre de Bruxelles, 2009

*Notes:* (1) 2010 Procedural Fees where the European patent application is filed online on or after 1 April, 2009 and has a maximum 35 pages (source: EPO).

(2) Procedural Fees effective October 2, 2008, where the US patent application is filed on or after 8 December, 2004 and has a maximum 100 pages (source: USPTO).

(3) Procedural Fees effective 1 April, 2009, where the Japanese patent application is filed on or after 1 April, 2004. Source: JPO

(4) Procedural Fees effective from 1 July, 2009.

(5) The JPO grants an exemption from or a 50% reduction of examination request fees and / or an exemption (from the first year to the third year, in some cases to the sixth year), a grace period of three years, or a 50% reduction for individuals, companies or R&D oriented SMEs that lack funds, if they comply with certain requirements.

(6) For EPO an extrapolation from the estimation for EPO – 13 calculated in Bruno van Pottelsberghe (2009) was used. For USPTO for SMEs an extrapolation from the estimation for large companies in Bruno van Pottelsberghe (2009) was used. For JPO the value in Bruno van Pottelsberghe (2009) was used. For KIPO the value was provided by KIPO. The median number of claims is relevant for the calculation of claim tax.

(7) For USPTO the renewal fee is due at 3.5 years. For JPO the renewal fees are included for years 1-3.

(8) The cost per claim is 210 euro for the 16th and each subsequent claim up to the limit of 50 in an EPO patent application; US$ 52 if more than 20 claims are included in an USPTO patent application; and 4000 Yen for the claims included in a JPO patent application.

| USPTO | | | | JPO | | KIPO | |
|---|---|---|---|---|---|---|---|
| large | | sme | | all (5) | | all | |
| 23 | | 23 | | 7 | | 10.34 | |
| 1 | | 1 | | 1 | | 1 | |
| US$ | PPS€ | US$ | PPS€ | JP Yen | PPS€ | KRW | PPS€ |
| 330 | 258 | 165 | 129 | 15000 | 98 | 38000 | 39 |
| 540 | 422 | 270 | 211 | | | | |
| | | | | | | | |
| 980 | 765 | 490 | 382 | 11100 | 73 | 448260 | 461 |
| | | | | 7100 | 47 | 267480 | 275 |
| 220 | 172 | 110 | 86 | 168600 | 1106 | 543600 | 558 |
| 1510 | 1179 | 755 | 589 | | | | |
| 156 | 122 | 78 | 61 | 28000 | 184 | | |
| 3736 | 2916 | 1868 | 1458 | 229800 | 1508 | 1297340 | 1333 |
| 7570 | 5909 | 3785 | 2954 | 830000 | 5446 | 4065000 | 4176 |
| 11306 | 8825 | 5653 | 4413 | 1059800 | 6953 | 5362340 | 5509 |
| | 0.78 | | 0.39 | | 2.24 | | 5.08 |

## Progress and difficulties in the reform of the European patent system

The reform of the European patent system aims to make it cheaper and easier to protect new inventions in the EU. The reform encompasses two main elements – the creation of a patent with unitary effect in the EU and the setting up of a unified and specialised patent court. Such a reform would remove a competitive handicap suffered by Europe's innovators and stimulate investment in research and development.

The Commission first proposed a Regulation for a Community Patent in August 2000 ("EU Patent" after the entry into force of the Lisbon Treaty). After a Council Common Political Approach in 2003, negotiations stalled and a final agreement was not reached. On the basis of an extensive consultation in 2006, the Commission adopted a Communication 'Enhancing the patent system in Europe' in April 2007. This re-launched the patent reform debate in the Council.

In 2007-2009, the Council discussed the draft Agreement creating a specialised patent court with competence for current European and future EU patents. In June 2009, the Council submitted a Request to the European Court of Justice on the compatibility of the draft Agreement with the EU Treaties. Without prejudice to this request, in December 2009 the Council adopted conclusions which cover the main features of the unified patent court. However, an opinion of the Court of Justice of 8 March 2011 concludes that the draft Agreement, as it stands, is incompatible with the EU Treaties. The draft Agreement therefore has to be amended in the light of the opinion of the Court of Justice.

Despite the general approach on the EU patent agreed in December 2009, the Council was not able to reach a unanimous agreement on the translation arrangements that would be applicable to such EU patents. As a result, in November 2010 the Council concluded that the objective of an EU patent may not be attained now or in the foreseeable future. On the basis of a request of a group of Member States, the Commission proposed to launch the procedure of enhanced cooperation in the area of unitary patent protection. On 10 March 2011, 25 Member States were authorised by the Council to establish such an enhanced cooperation between them. Proposals for regulations necessary to implement the enhanced cooperation were proposed by the Commission on 13 April 2011.

*Source:* EC — DG MARKT, http://ec.europa.eu/internal_market/indprop/patent/index_en.htm#patent

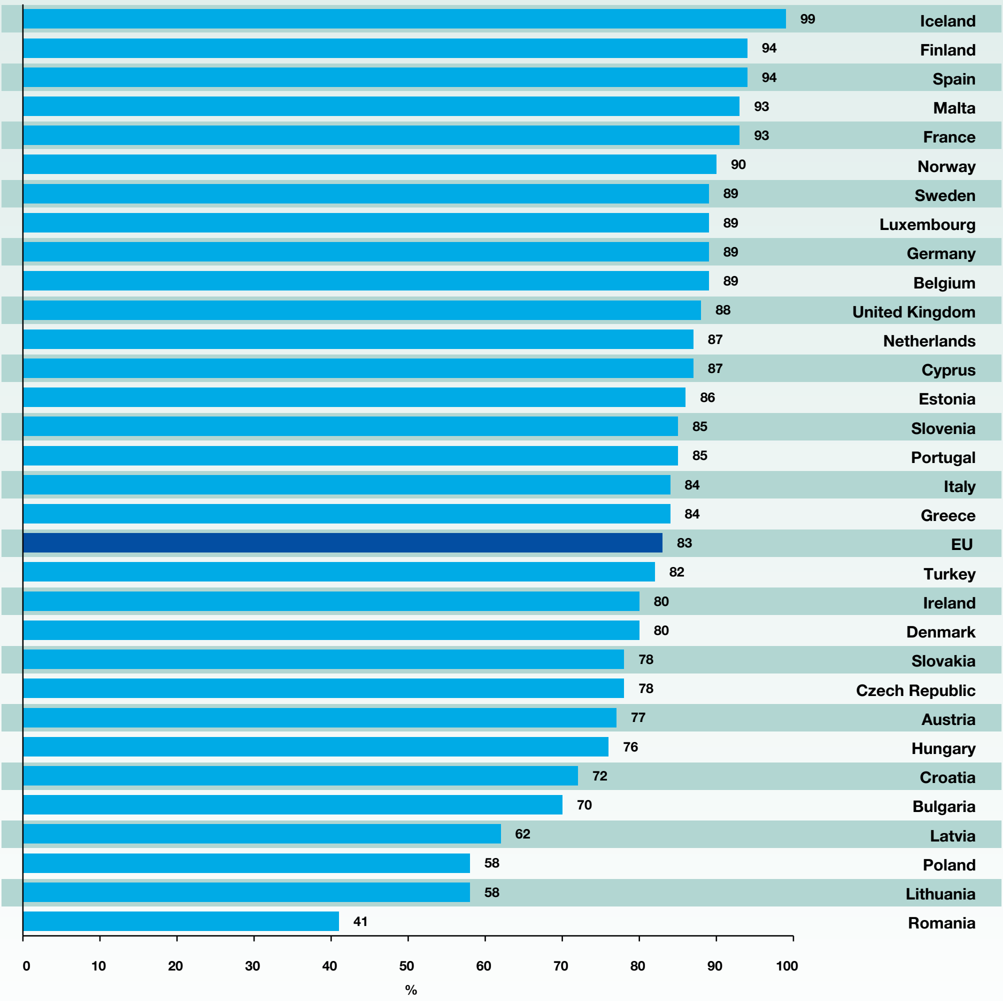
### 2.1.7. Broadband access by firms

From the perspective of innovation, it is crucial to understand the extent to which advanced ICT infrastructure is available to the business world. Both the scope of connections of a typical business and the speed of these connections drive innovation and influence the very way businesses innovate. With various new and improved infrastructures, of which ICT plays a central role, ideas and innovations can be more easily transferred from the firm to its environment and the other way round. In addition, broadband access contributes to enabling content and skills to leverage infrastructure.

#### ***Broadband penetration among businesses is generally higher in old Member States***

Broadband penetration among businesses can be measured by the share of enterprises with broadband access. Most EU-15 Member States situate themselves above or at least around the EU average of 82 % (figure III.2.13). Finland, Malta, Spain and France are all above 90 %. The lowest level of broadband penetration among businesses is registered in Romania (40 %).

FIGURE III.2.13 Share of enterprises(1) with broadband access (%), 2009(2)



*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) Enterprises (not including the financial sector) with 10 or more employees.
(2) TR: 2007; IS: 2008.

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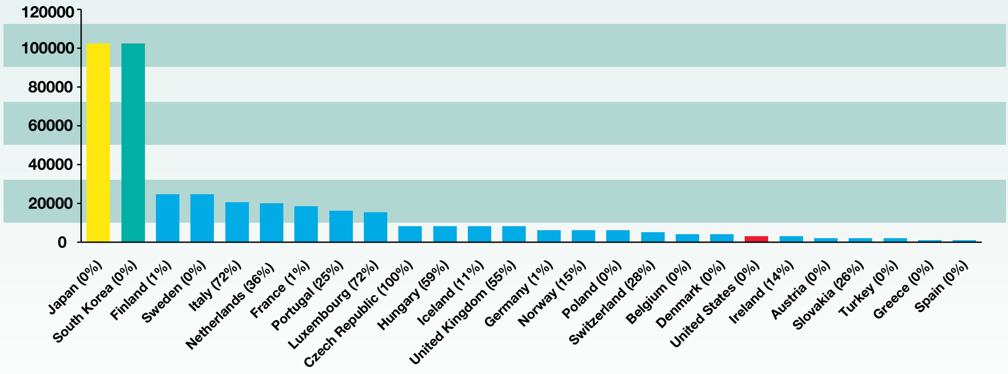
Broadband speed seems equally important to innovation as is broadband penetration. The higher the broadband speed, the better the capacity of a country's ICT infrastructure to transmit big volumes of digital data in a given period. Increased broadband speed will provide businesses with the possibility of strengthening existing innovation processes and/or launching new ones.

### *Broadband speed is highest in Japan and South Korea, accompanied by most competitive prices*

The 2008 data on broadband speed shows Japan in first place together with South Korea, followed by Finland and Sweden (figure III.2.14). Lowest speeds are found in Spain, Greece and Turkey. Highest improvements between 2005 and 2008 are registered in the Czech Republic (100 %), Italy (72 %), Hungary (59 %), the United Kingdom (55 %), as well as substantial increases in the Netherlands (36 %), and Portugal (25 %).

FIGURE III.2.14 **Speed of a typical broadband subscription (kbits per second), 2008; in brackets: average annual growth, 2005-2008**



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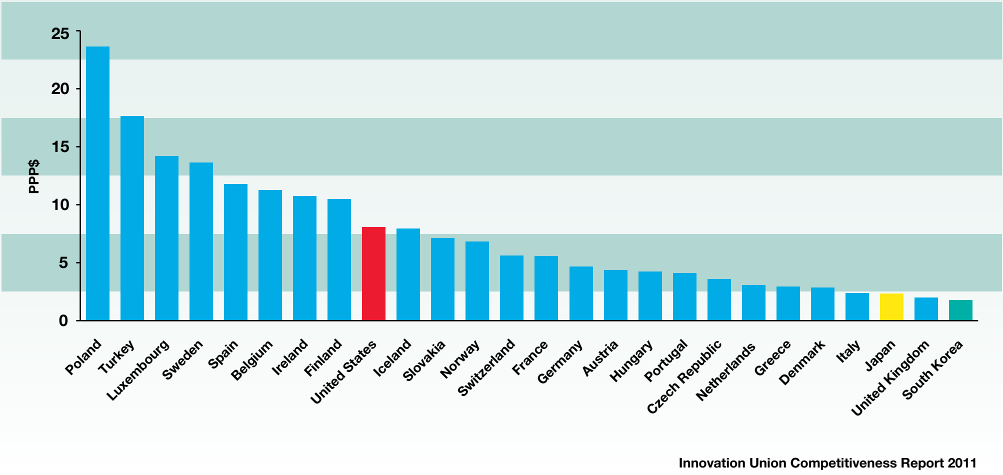
*Source:* DG Research and Innovation
*Data:* OECD Broadband Portal

### *In the EU broadband prices are most competitive in the United Kingdom, Italy, Denmark, and Greece*

Finally, broadband prices are also important as they affect the rate and extent of take-up of new generation ICT infrastructure. The existence of a substantial difference between countries on this issue is translated into national advantage or disadvantage. South Korea and the United Kingdom appear to have the most competitive prices: less than $ 2 for a Mbit/s a month (figure III.2.15). They are followed closely by Japan, Italy, Denmark and Greece, each of them with less than $ 3 per month. The highest prices are found in Poland and Turkey.

To conclude, businesses' broadband penetration is generally higher in EU-15 Member States compared to the UE-12 Member States ones. Broadband speed is far higher in Japan and South Korea compared to Europe and the United States. The high speed in these countries is accompanied by very competitive (i.e. low) prices. Within the EU, despite the lower level of broadband penetration in comparison with the old Member States, some EU-12 Member States have seen high improvements in the broadband speed. This applies at least to the Czech Republic and Hungary.

FIGURE III.2.15 **Average broadband monthly prices per advertised Mbit/s, PPP$, October, 2009**



*Source:* DG Research and Innovation
*Data:* OECD Broadband Portal

## 2.2. What are the framework conditions driving the demand for research-based products?

Demand-side framework conditions in this chapter will encompass both public and private demand. In addition, this section will look at competition in the market and for the market, and standardisation-related costs.

Demand-side framework conditions provides incentives for innovation and reduces uncertainty for innovators. In addition, innovative firms are sustained by demanding consumers. The demand can both trigger innovation (its' signals producing a reaction from the supply side), and be responsive to innovation (being ready to absorb innovations once they are produced)[330]. Public demand has a special role in triggering innovation (for instance through public procurement), as well as laying the framework for private demand through policies such as the Lead Market Initiative at the EU level.

### 2.2.1. Private demand for innovation

Private responsive demand is comprised of firms' adoption of innovation (measured by indicators such as absorption of technology by private companies) and end-user demand (good proxies being consumer confidence in innovation and buyer sophistication). Consumer demand for innovation is important in defining markets where companies want to situate their innovation because of the presence of lead users who may provide feedback and have a high propensity to take up innovations.

The available statistical evidence from the executive opinion survey of the World Economic Forum shows that firms' capacities to absorb new technologies are highest in Japan, Switzerland, the United States, Sweden, Denmark, Finland and Austria, followed by Germany and South Korea.

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[330] NESTA, 2010.

### *Consumer confidence in innovation is highest in Spain and Ireland, and outside Europe in India, China and the United States*

Along with access to finance, consumer confidence in innovation is of particular importance. It is generally recognised that the knowledge economy is driven largely by technological advance and rising prosperity as it increases the demand for knowledge-based services. In addition, the ideas for innovation do not stem only from public research or firms, but also from the end users' demand. Statistical evidence is however scarce. There are not many indicators available for measuring consumer demand. The two indicators presented below provide a first proxy.

The consumer confidence index[331] measures user confidence in innovation and the willingness of users to adopt innovations (being a proxy of the uptake of innovation from firms). The higher the index, the more likely it is that people are buying and using innovations and perceive that innovation would improve their life. Table III.2.3. shows that the consumer confidence index is highest in Spain and Ireland, and outside Europe in India, China and the United States. Interestingly enough, Finland and the Netherlands appear to have relatively lower consumer confidence, although it is higher than that of Japan. A possible explanation for high confidence in innovation of consumers currently in locations/markets that are not as developed could be their potential expectation that all innovation should be good.

TABLE III.2.3 **Consumer confidence index (1)**

| Country | 2007 (rounded) | 2008 (rounded) |
|---|---|---|
| India | 73 | : |
| Spain | : | 66 |
| Ireland | 66 | 65 |
| China | : | 60 |
| United States | 58 | 60 |
| Italy | 54 | 56 |
| Iceland | : | 53 |
| United Kingdom | 55 | 50 |
| Slovenia | 48 | 47 |
| South Korea | : | 44 |
| Finland | 44 | 42 |
| Netherlands | 38 | : |
| Japan | : | 24 |

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*Source:* DG Research and Innovation
*Data:* Levie (2009)
*Note:* (1) Levie's survey is applied on a sample of private consumers in 30 countries. The questionnaires comprise three questions to which respondents have to answer on a five point scale, ranging from strongly agree to strongly disagree: (i) In the next six months, are you likely to buy a new product or service? (ii) In the next six months, are you likely to try products or services with new technology? (iii) In the next six months, will new products or services improve your life? The confdence index is the average percentage of people that agree or strongly agree to each of the three statements.

### *Consumers in Sweden, Switzerland, Norway, the United Kingdom, the Netherlands and Luxembourg have the highest propensity to absorb new technologies*

Buyer sophistication indicates the capability of consumers to absorb new technologies, and also their capacity to understand their own needs and to indicate them to the producers. The assumption at stake is that the buyers will buy more innovation if they understand its added value and how to use it. According to figure III.2.16. buyer sophistication is highest in Sweden, the United Kingdom, the Netherlands and Luxembourg. Outside Europe, buyer sophistication is also high in Japan, followed by the United States, China, and South Korea.

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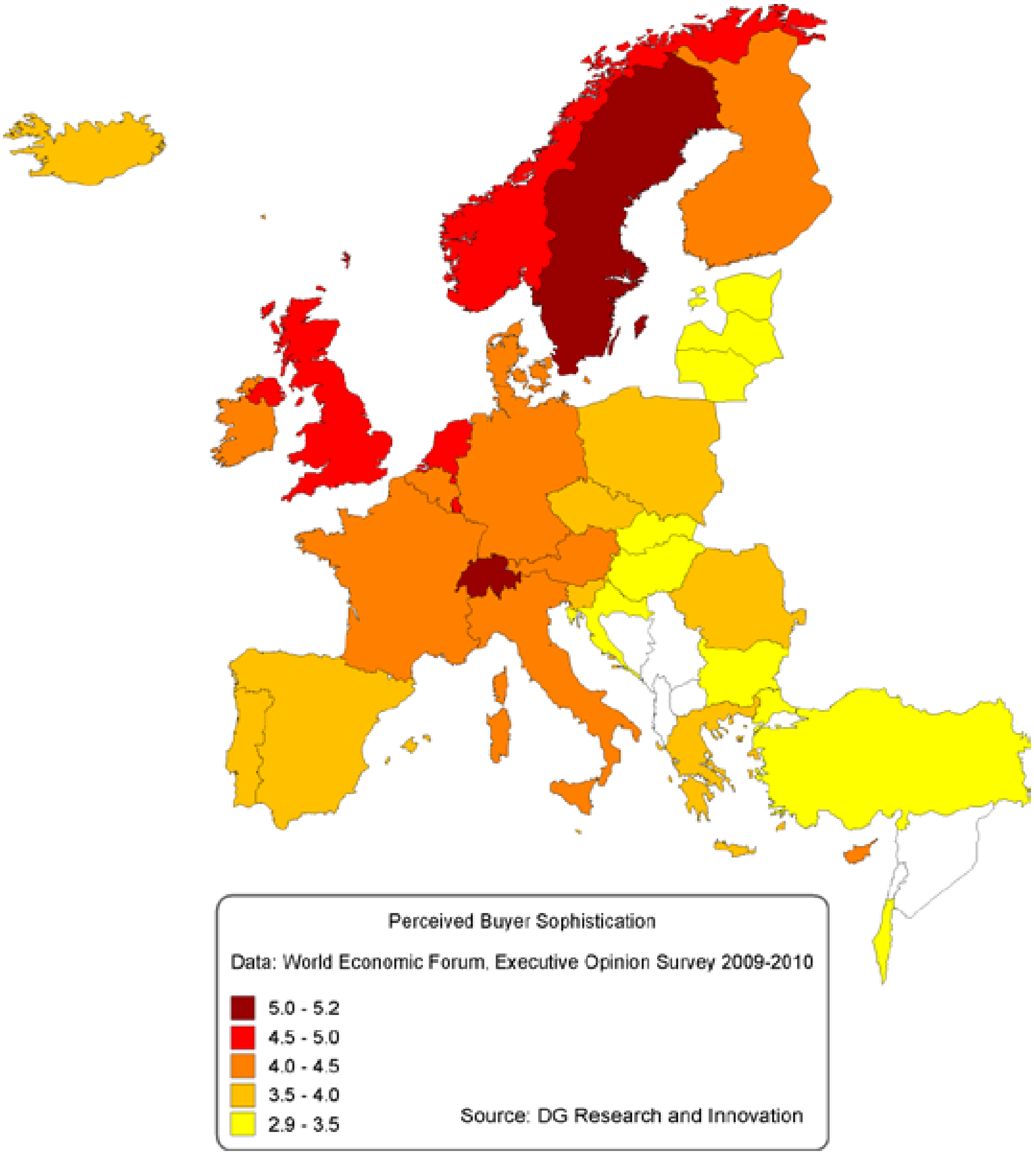
[331] The index was developed by Levie (2009), *The IIIP Innovation Confidence Index 2008*, Glasgow: University of Strathclyde.

## FIGURE III.2.16 Perceived Buyer Sophistication



*Source: DG Research and Innovation* **Innovation Union Competitiveness Report 2011**

*Data:* World Economic Forum, Global Competitiveness Report, 2010

*Note:* Averages; Question: Buyers in your country make purchasing decisions

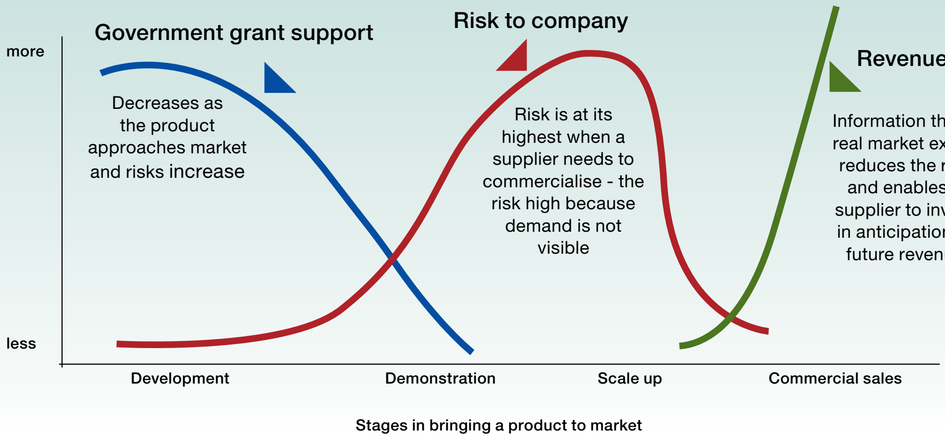
(1= based solely on the lowest price, 7 = based on a sophisticated analysis of performance attributes) (2009-10 weighted average)

## 2.2.2. Strategic use of public procurement as part of public demand for innovation

Public demand for innovation has a role when the risk for innovating companies is high. Governments try to mitigate the firm's risk by providing grants or acting as guarantors for loans. However, these types of government support are granted mainly during the development stage and decrease as the product approaches the market (figure III.2.17.), whereas the investment risk becomes highest in the stages between development and commercial sales, i.e. during the demonstration and scale-up phases. The high risk occurs when a supplier needs to commercialise because demand is uncertain. As a result, many products and companies fail at the demonstration and scale-up stage. The knowledge that a real market for the product exists reduces the risk and enables a supplier to invest in anticipation of future revenues. Providing such information is the role of demand-side measures such as the Lead Markets Initiative, public procurement, etc., which will be dealt with further.

Innovation through public procurement has great potential to trigger innovation in industry[332]: public procurement is an important part of local (national) demand, and local demand is an important factor in the decisions of multinational companies when they choose where to locate their activities and how to generate innovation in the specified location; public procurement can also contribute to redressing market and system failures in creating markets for innovative products which meet specific needs; finally, public demand for innovation contributes to the improvement of public services and especially public infrastructure.

FIGURE III.2.17 **Innovation and risks from the suppliers' side**



*Source:* Fergus Harradence, *Procurement of Innovation in the UK*, A Presentation to the ERA-PRISM Policy Dialogue Workshop, 14 June 2010

***Whereas overall public procurement is highest in EU-12 Member States, in terms of procurement of advanced technologies, Luxembourg, Denmark, Sweden and Finland appear leading***

However, reliable data on public procurement is scarce. Overall, public procurement makes up about 16 % of GDP in the EU. However, the share of GDP which is openly advertised for tender (figure III.2.18.) is much

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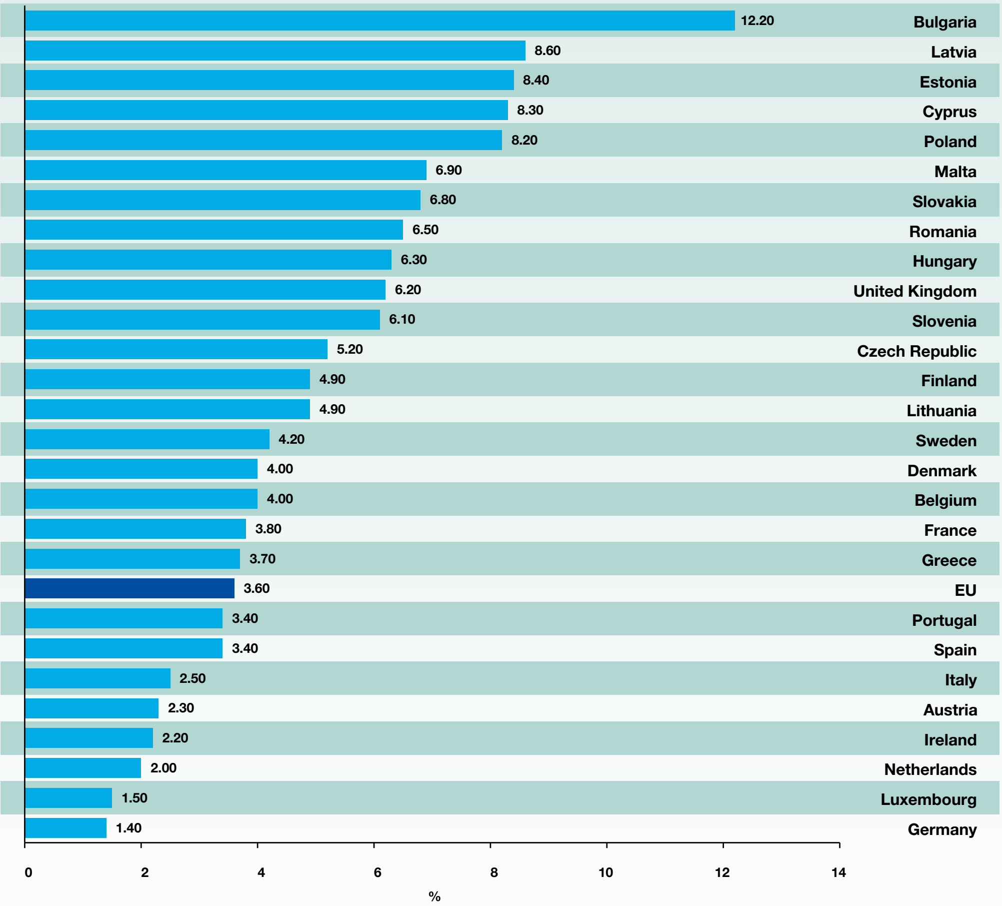
[332] Edler, Jakob and Georghiou, Luke, 'Public procurement and innovation — Resurrecting the demand side', in *Research Policy* 36 (2007) 949–936, www.sciencedirect.com.

FIGURE III.2.18 **Public procurement advertised in the Official Journal as % of GDP, 2009**



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*Source:* DG Research and Innovation
*Data:* Eurostat

lower due to the fact that publication is only required above a certain threshold value.

Most EU-12 Member States register the highest shares relative to GDP of public procurements which are publicly advertised. Therefore the potential for innovation seems to be high in these countries. It is, however, possible that in countries with strong decentralised administrations, like Germany, the number of below-threshold calls will be higher and might cause an underestimation of the shares of public procurement for these countries.

A second indicator measures the perception of suppliers as regards government purchasing of new technology. Public procurement of advanced technologies can boost innovation but it can also concern imported advanced technologies. The two cases obviously have different relevance for policymaking. In the first case, public procurement of new technologies has a concrete effect in enhancing the national innovation efforts. In the second case it enhances the purchase of innovative products through imports. Despite high levels of overall public procurement, EU-12 Member States score rather weakly regarding government procurement of advanced technology products (figure III.2.19). It is Denmark, Sweden and Finland, together with Luxembourg, which are best rated for procurement of advanced technology among EU-27, in line with the United States, China and South Korea.

## Catalytic procurement: the case of Swedish Energy Agency

Catalytic procurement occurs when the state is involved in procurement or even initiates it, but the purchased innovations are in the last instance used exclusively by private end-users.

Introduced around 1990 to promote the emergence of new energy-saving products, technology procurement continues to be part of the tool box of the Swedish Energy Agency today. Among other ongoing policy initiatives, the Agency continues to facilitate market introductions of new energy and environmentally friendly technologies by providing support for technology procurements. It is also considered as a useful tool for the future: the establishment of more ‘Energy Agencies’ is one of the suggestions made for the ongoing Swedish ‘Innovation for Growth’ initiative by the Royal Academy of Science in cooperation with most major policy actors in Sweden. In other words, the aim is to give suitable existing public bodies the task of driving innovation in areas that are deemed socially important.

The general perception of a survey carried out by the ERA–PRISM project (‘Research Policies in Small Member States’, funded within FP7 and coordinated by the Malta Research Council) is that it would be easier to raise innovation on the political agenda if the innovation goal was more often combined with largely accepted objectives such as the ‘green goal’. For instance in Sweden, catalytic procurement for environment continues even after others do not.

## Forward Commitment Procurement used in the United Kingdom

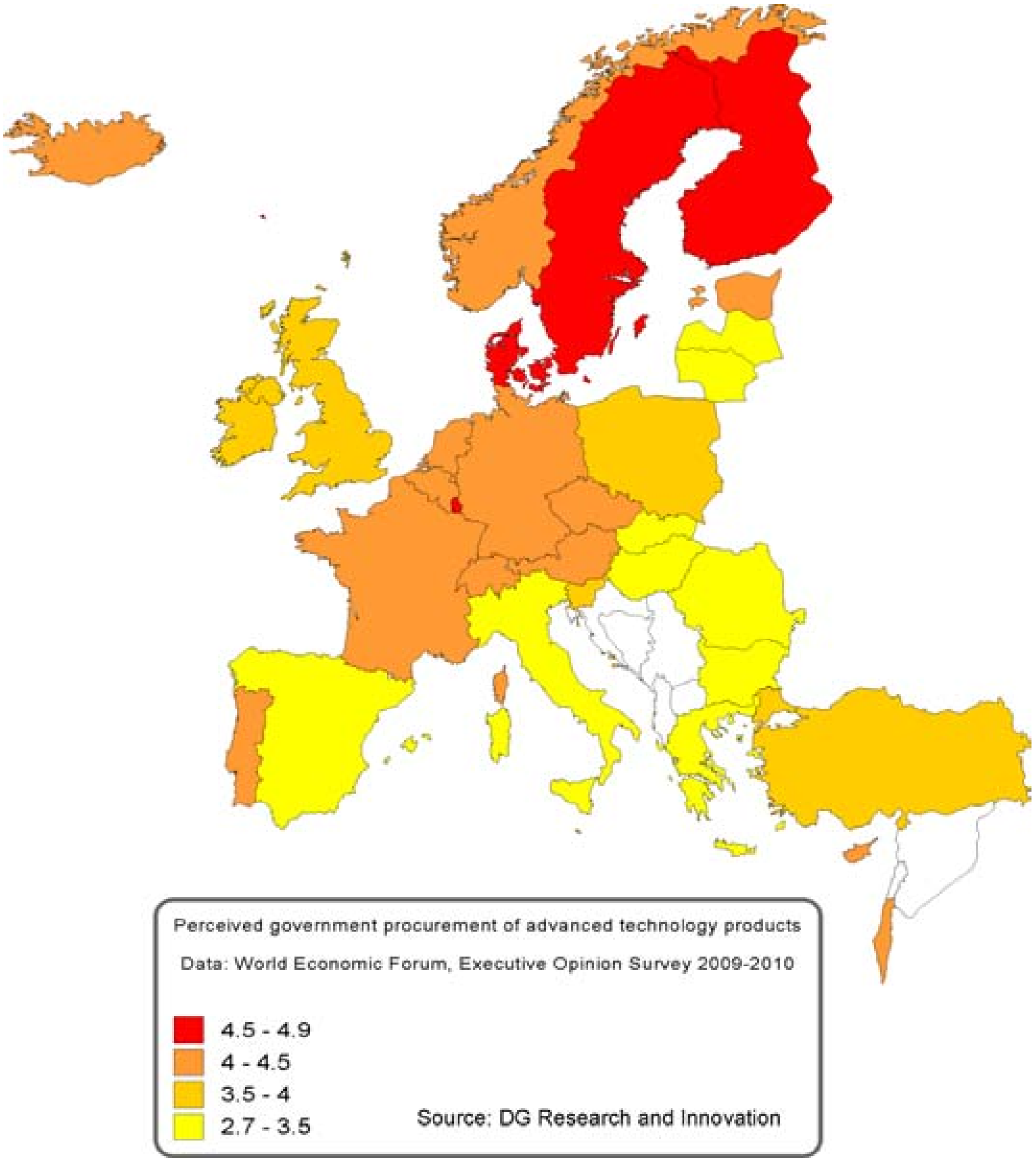
Forward Commitment Procurement harnesses the power of public procurement to transform the market, creating the conditions for investment in the goods and services necessary in the shift towards the low carbon economy. It must be public procurement because of the special role of the public sector as agents for the social good by being a lead market for innovation that society needs.

Conceptually Forward Commitment Procurement is simple:

A public-sector body has an unmet need that current products and services cannot deliver. Rather than compromise, the public-sector body offers to buy in the future a product or service that can deliver what it needs, when it needs it, at a price it can afford. It addresses directly the key issues of information, investment and contractual risks and stimulating investment in innovative goods and services. Transfer market risk stays with the procurer, whereas technical risk remains with supplier. The public sector becomes the supply chain manager for the products and services required to deliver the social or common good

*Source:* Fergus Harradence, Procurement of Innovation in the UK, A Presentation to the ERA-PRISM Policy Dialogue Workshop, 14 June 2010

## FIGURE III.2.19 Perceived government procurement of advanced technology products, perception of suppliers 2009



Source: DG Research and Innovation

Innovation Union Competitiveness Report 2011

*Note:* Averages; Question: In your country, government procurement decisions result in technological innovation? (1 = strongly disagree; 7 = strongly agree) (2009-10 weighted average)

### 2.2.3. Lead markets and innovation-friendly regulations in support of a single innovation market in Europe

Systemic policies such as the Lead Market Initiative are important parts of the public demand for innovation. In addition, lead markets and innovation-friendly regulations can contribute to the activation of a potential single innovation market.

There is a paradox in the European Single Market. The Single Market for products was created in early 1990s and European manufacturing industries were able to grow and gain global leadership in many industries. The paradox lies in the movement of European countries' economies towards services, which has the knock-on effect that only smaller and smaller parts of the economies can then enjoy the benefits of a single market. For instance, the innovative small digital-services companies cannot access the Single Market and, therefore, have great difficulties in growing. They usually introduce their innovations in Europe in their national market first, and then move to the US because the cost of accessing the US market is no more than the cost of accessing other national markets in Europe. This is creating large costs for Europe.

The creation of a single market for innovation in Europe is one of the explicit objectives pointed out by the Innovation Union Flagship Initiative. Without going beyond the scope of this chapter, it has to be mentioned that the same flagship initiative emphasises the importance of pursuing a broad concept of innovation — both research-driven innovation and innovation in business models, design, branding and services — for developing a single innovation market. The creation of a single innovation market demands measures such as an adequate and affordable protection of patents, an increasing share of public procurement for innovation, and modernising standard-setting which enables interoperability and fosters innovation in fast-moving global markets.  All these elements are addressed in various parts of this chapter.

In addition, the Innovation Union Flagship Initiative indicates that the potential of the Single Market should also be activated through systemic policies such as the Lead Market Initiative and innovation-friendly regulations. The improvement of the regulatory framework in key areas such as those linked to eco-innovation and to the European Innovation Partnerships is a specific commitment of the flagship initiative. Beyond their role in creating a single innovation market and therefore helping to address specific bottlenecks from idea to market, systemic policies at European level have a crucial role in addressing some of Europe's major societal challenges. Initiatives such as the Joint Technology Initiatives, Joint Programming and Lead Market Initiative (LMI) have already been established in order to address societal challenges; however, they have tended to operate in isolation. They are all foreseen to operate in the future under the umbrella of European Innovation Partnerships (EIPs), which are instrumental for the implementation of the Innovation Union Flagship Initiative. The partnerships will bring together policies on the supply side (such as R&D funding, Joint Programming, Joint Technology Initiatives, European Technology Platforms[333]), and those from the demand side (such as the Lead Market Initiative, and innovation-friendly regulations such as the Strategic Energy Technology  Plan).

This section will analyse systemic policies at European level, including the LMI and innovation-friendly regulations such as the Strategic Energy Technology or SET Plan. More precisely, it will explore whether these systemic policies are operating in the fast-growing domains in science and technology or if, on the contrary, there is a time lag in the development of policy initiatives compared to the development of science and technology. If the policies are operating in fast-growing domains, it would confirm a natural assumption that advances in S&T are significant drivers of policy developments in the field of research and innovation and it would show a political will at European level towards facilitating the transfer of knowledge from research to technology towards the market.

***European policy initiatives are generally developed in sectors related to fast-growing science and technology fields, but some expanding fields are not covered, including research fields that could generate non-technological innovation (such as business models or branding)***

In comparing the sectors of the European initiatives with the fast-growing science and technology fields, one can

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[333] Thus far JTIs and ETPs have been supply-side policies. They have been advised by various evaluations that they should complement this with demand-side activities.

## Brief history of the EU Single Market

The Single Market is one of the European Union's greatest achievements. Restrictions between member countries to trade and free competition have gradually been eliminated, with the result that standards of living have increased.

The Treaty of Rome (1957) establishing the European Economic Community (EEC) set out four freedoms for Europe: free movement of goods, free movement of services, free movement of capital and free movement of people. The first of these was established relatively quickly. The 1957 Treaty made it possible to abolish customs barriers within the Community and establish a common customs tariff applied to goods from non-EEC countries. This objective was achieved on 1 July 1968.

Progress on the other areas was slower. Given that customs duties are only one aspect of barriers to cross-border trade, other trade barriers hampered the complete achievement of the common market in the 1970s. Technical norms, health-and-safety standards, national regulations on the right to practise certain professions and exchange controls all restricted the free movement of people, goods and capital.

In June 1985 the Commission, under its then President, Jacques Delors, published a White Paper setting out the far-reaching goal to abolish, within seven years, all physical, technical and tax-related barriers to free movement within the Community. The aim was to stimulate industrial and commercial expansion within a large, unified economic area.

The enabling instrument for the Single Market was the Single European Act, which came into force in July 1987, and set a deadline for the gradual establishment of the Single Market for 1992. With the changes brought about by the Single European Act in place, a large number of laws were passed addressing the technical, regulatory, legal and bureaucratic obstacle on the ways to free trade and free movement. The free movement of capital was marked by the Economic and Monetary Union which came into being in 1999.

Nevertheless, the Single Market still has many areas where potential is untapped or not fully exploited. The Commission has also for example focused its attention on opening up the market for services in the last decade. On 13 April 2011, the Commission adopted the Single Market Act, an action plan to further unlock the potential of the single market for economic recovery and growth and to boost citizens' confidence. Through 12 'levers', with a key action for each, the Single Market Act sets out the ambition of the European Union to deliver concrete legislative and policy results in the run up to the 2012 anniversary of the 1992 achievements.

notice that the European policy initiatives are generally developed in sectors related to the fast-growing S&T fields (Table III.2.4).

However, there are a few fast-growing fields which are not represented in any European initiative mentioned above. These are mechanical engineering scientific fields (which have risen with 40.6 % in terms of publications between 2000 and 2006), as well as the technological sectors of thermal processes and apparatus (58.2 %) and engines, pumps, turbines (54.94 %). Another fast-growing field which is partially reflected in only one LMI (sustainable construction) is geological engineering, with a considerable growth rate of 68.8 % between 2000 and 2006.

Finally, the table below does not show any remarkable presence of social sciences as an instrument to understand and shape technologically-related structural change and its extended social and economic implications.

It may also show that the European initiatives analysed in table III.2.4 do not put a great emphasis on non-technological innovation such as business models or branding.

## TABLE III.2.4 Fast growing S&T fields vs. European policy initiatives sectors

| Fast growing scientific fields[333] (growth rates 2000-2006) | Fast growing technological fields[334] (growth rates 2005-2009) | Joint Programming |
|---|---|---|
| Computer sciences 115 % | IT methods for management (72.59 %)<br>Digital communications (62.9 %) | |
| Health sciences 41.9 % | | Neurodegenerative Diseases / Alzheimer's<br>Healthy Diet for a Healthy Life<br>More years, better lives<br>Antimicrobial Resistance |
| Geological engineering 68.8 % | | |
| Civil engineering 64.2 % | Civil engineering (38.7 %) | Urban Europe |
| Environmental sciences 52.4 % | Environmental technology (54.73 %) | Connecting Climate Knowledge for Europe (CLiK'EU)<br>Water Challenges<br>Healthy and Productive Seas and Oceans<br>Urban Europe |
| Materials science 47.3 % | Materials, metallurgy (34.08 %)<br>Micro-structural and nanotechnology (141.73 %)<br>Semiconductors (64.4 %) | |
| Other engineering sciences (41.29 %) | | |
| Mechanical engineering 40.6 % | Thermal processes and apparatus (58.2 %)<br>Engines, pompes, turbines (54.94 %) | |
| Moderate growing scientific fields | | |
| Information and communication sciences (34.41 %) | | |
| Electrical engineering (31.67 %) | Electrical machinery, apparatus, energy (45.57 %) | |
| Fuels and (nuclear) energy (30.45 %) | | |
| Chemistry (28.72 %) | | |
| Agriculture and food sciences (25.78 %) | | Agriculture, Food Security and Climate Change |
| Biological sciences (21.45 %) | | |
| Other social and behavioural sciences (18.9 %) | | Cultural heritage and global change |
| Low growing scientific fields | | |
| Aerospace engineering (1.8 %) | | |
| Plant and animal sciences (no data on growth rate) | | |

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[334] Source: DG Research, Data: CWTS — Leiden University /Web of Science (Thomson reuters).
[335] Source: WIPO — PCT patent applications.

| European Technology Platforms | Lead Market Initiative | JTIs | SET Plan |
|---|---|---|---|
| Embedded Computing Systems (ARTEMIS)<br>Networked European Software and Services Initiative (NESSI) | EHealth (telemedicine/ homecare and clinical information systems) | Embedded Computing Systems | |
| Nanotechnologies for medical applications (NanoMedicine) | | Innovative medicines initiative | |
| European Technology Platform on Sustainable Mineral Resources (ETPSMR) | Sustainable construction | | |
| European Construction Technology Platform (ECTP) | | | |
| European Technology Platform for Wind Energy (TPWind)<br>Photonics21<br>Photovoltaics<br>Renewable Heating and Coolong (RHC)<br>Water Supply and Sanitation Technology Platform (WSSTP)<br>Waterborne ETP (Waterborne) | Recycling<br>Renewable energies | | European wind initiative<br>Solar Europe Initiative<br>$CO_2$ capture, transport and storage |
| Advanced Engineering Materials and Technologies (EuMaT)<br>European Nanoelectronics Initiative Advisory Council (ENIAC)<br>Future Textiles and Clothing (FTC)<br>European Technology Platform on Smart System Integration (EPoSS) | Protective textiles *(partial match)* | Nanoelectronics technologies 2020 (ENIAC) | |
| Future Manufacturing Technologies (MANUFUTURE)<br>Robotics (EUROP)<br>Industrial Safety ETP (IndustrialSafety) | | | |
| | | | |
| | | | |
| Integral Satcom Initiative (ISI)<br>Mobile and Wireless Communications (eMobility)<br>Networked and Electronic Media (NEM) | | | |
| European Technology Platform for the Electricity Networks of the Future (SmartGrids) | | | European electricity grid initiative |
| European Biofuels Technology Platforms (Biofuels)<br>Sustainable Nuclear Technology Platform (SNETP)<br>Zero Emission Fossil Fuel Power Plants (ZEP) | | Fuel cells and hydrogen | Sustainable nuclear fission initiative |
| Sustainable Chemistry (SusChem) | | | |
| Food for life (Food) | | | |
| | Bio-based products | | Bio-energy Europe initiative |
| | | | |
| | | | |
| Advisory Council for Aeronautics Research in Europe (ACARE) | | Aeronautical and Air Transport (Clean Sky) | |
| Farm Animal Breeding and Reproduction Technology Platform (FABRE)<br>Global Animal Health (GAH)<br>Forest based sector Technology Platform (Forestry)<br>Plants for the Future (Plants) | | | |

### 2.2.4 Building competitive and open national markets

Local competition and foreign competition are considered necessary ingredients for innovation[336]. It is broadly considered that competition between firms increases the level of innovation in the economy, although with certain differences between industries. Some evidence cited by the same NESTA report shows that some sectors dominated by large firms achieve high levels of innovation, whereas in industrial sectors dominated by smaller firms with significant competition between them, the innovation level is lower. In addition, foreign competition and foreign ownership have the potential for providing sources for innovative ideas/products to the domestic firms. On one hand, there is the overall competitive pressure of foreign competition. On the other hand, foreign firms operating in a local market, especially the multinational enterprises (MNEs), are able to provide the domestic firm with resources (such as finance, technology, knowledge and managerial expertise) which might not be provided by smaller, domestic firms.

#### *Local competition is perceived to be more intense overall in Western European countries compared to the EU-12 Member States, and is particularly strong in Germany, Austria, and the Netherlands*

The indicator used for the local competition is based on the WEF survey asking corporate CEOs to indicate is the strength of competition between firms within a given country (the sample included between 80 and 100 responses per country). The intensity of local competition is perceived to be very strong in Germany, Austria, the United States, and Belgium. At the other end of the scale there are both EU-12 Member States (Latvia, Lithuania, Romania and Bulgaria) and Southern European countries (Italy and Greece).

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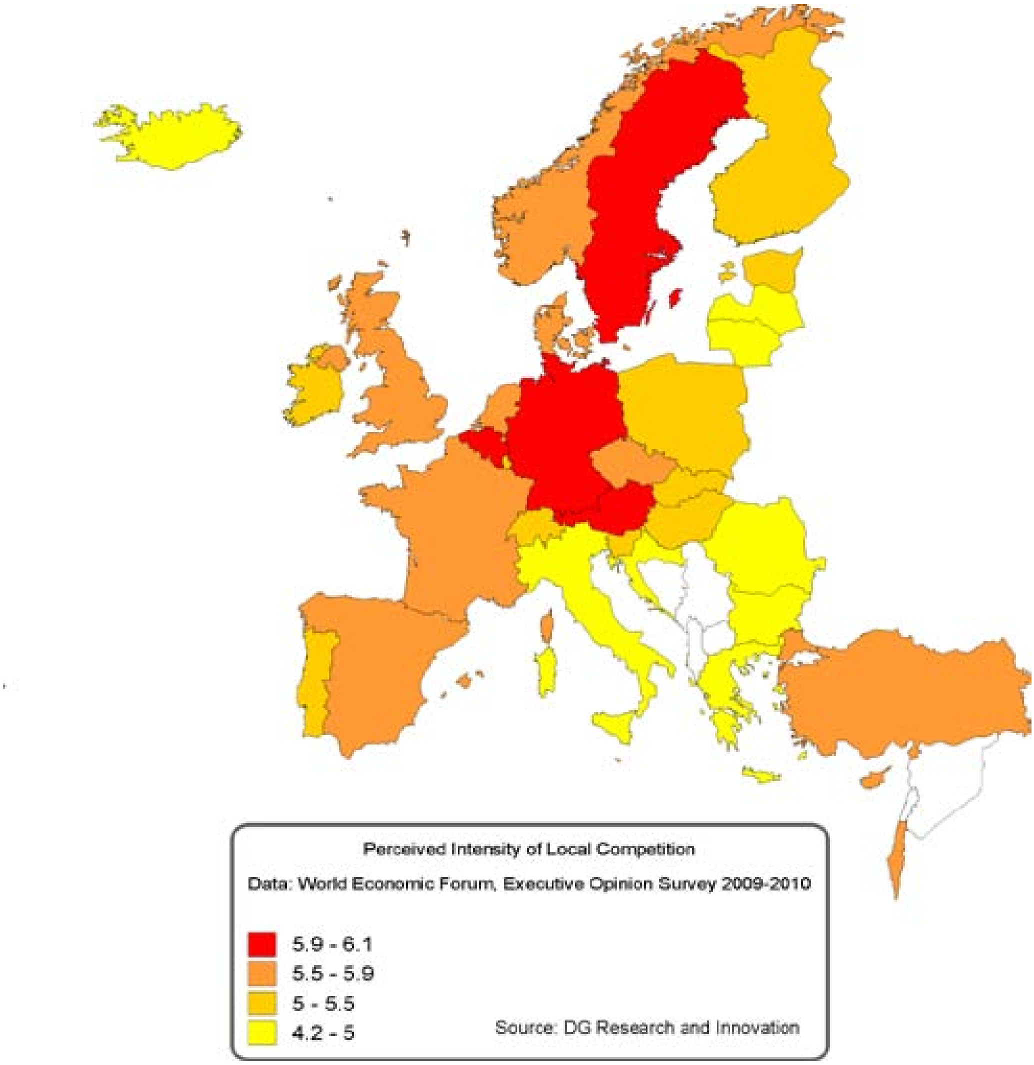
[336] NESTA, *The wider conditions for innovation in the UK*, 2009, pp. 49-52.

## FIGURE III.2.20 Perceived Intensity of Local Competition



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*Data:* Averages; Question: How would you assess the intensity of competition in the local market in your country? (1= limited in most industries; 7 = intense in most industries) (2009-10 weighted average)

In addition to the two indicators above which look at competition within a national economy, other indicators consider the competition of an economy in a broader context. Both trade as percentage of GDP[337] and net FDI inflows relative to GDP are further indicators that show the extent to which a national economy is open to foreign competition. In particular, the level of FDI in a given country reflects overall the attractiveness of that country.

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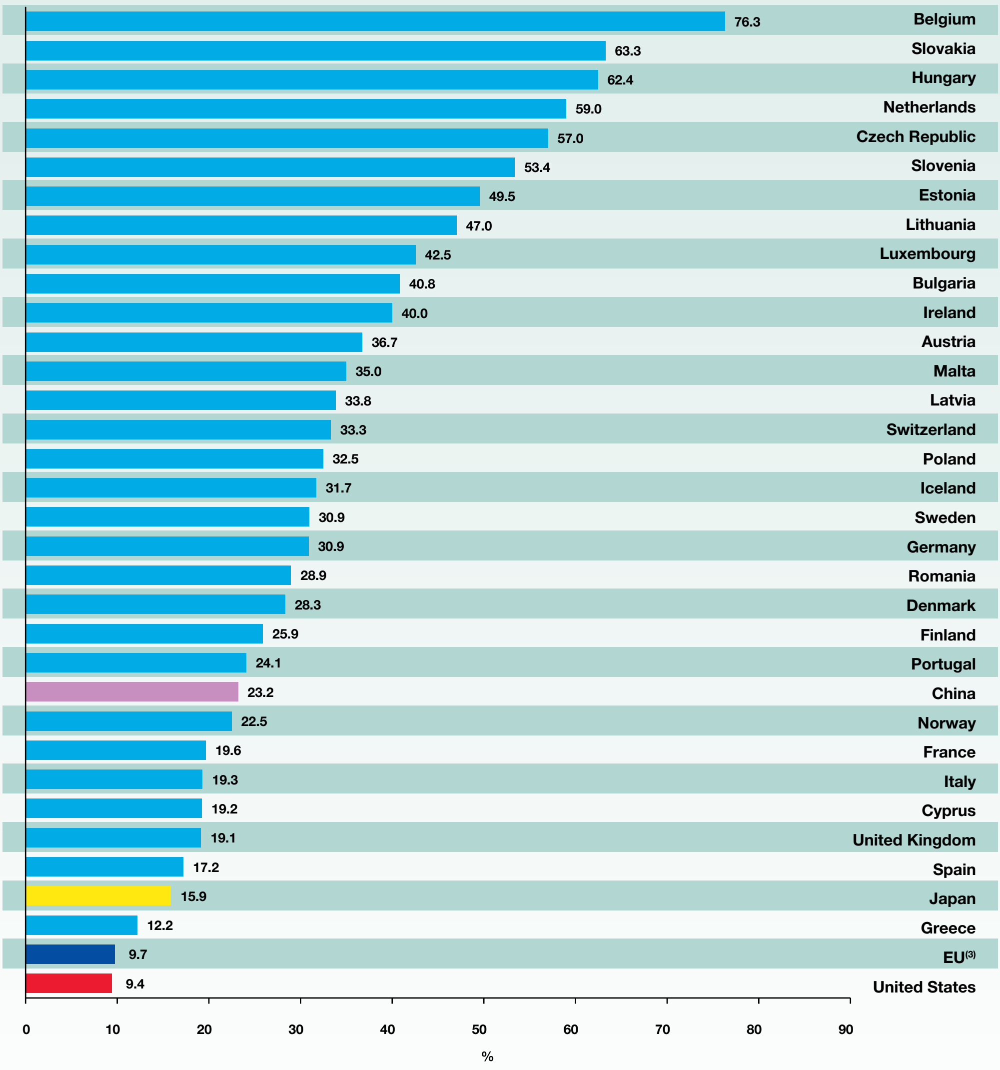
[337] The OECD definition of this indicator is the following: the trade-to-GDP-ratio is the sum of exports and imports divided by GDP. This indicator measures a country's 'openness' or 'integration' in the world economy. It represents the combined weight of total trade in its economy, a measure of the degree of dependence of domestic producers on foreign markets and their trade orientation (for exports) and the degree of reliance of domestic demand on foreign supply of goods and services (for imports). The trade-to-GDP-ratio is often called the 'trade openness ratio'. However, the term openness-to-international-competition may be somewhat misleading. In fact, a low ratio for a country does not necessarily imply high (tariff or non-tariff) obstacles to foreign trade, but may be due to the factors mentioned above, especially size and geographic remoteness from potential trading partners. For example, it is generally the case that exports and imports play a smaller role in large economies than they do in small economies.

FIGURE III.2.21 **Trade(1) as % of GDP, 2009(2)**



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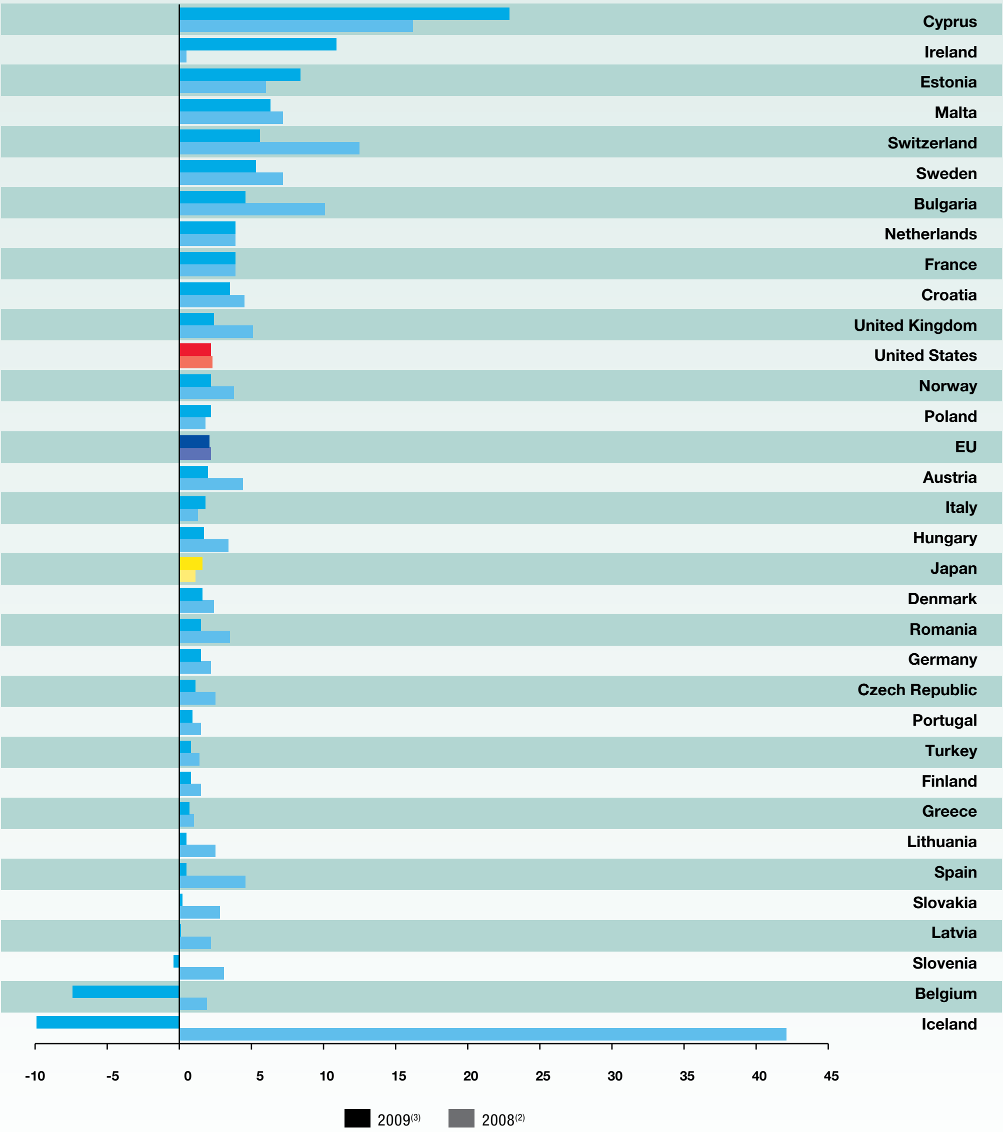
*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) Average value of imports and exports.
(2) JP: 2008.
(3) EU: Trade refers to extra-EU trade for the EU aggregate.

***Whereas the Netherlands is well exposed to foreign competition, the most open economy seems to be Belgium, as reflected both by high exposure to foreign competition and substantial net FDI inflows***

Figure III.2.21. illustrates trade (imports plus exports) as a % of GDP, giving an indication on this exposure.

The values are the highest for Belgium, reflecting the open nature of the economy. Other countries with high values are Slovakia, Hungary and the Netherlands. The ratio is low for the Unites States, Japan and the United Kingdom, but also for Greece and Spain (although the reasons might be very different).

FIGURE III.2.22 **Foreign Direct Investment (FDI) Intensity(1), 2008(2) and 2009(3)**



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) Average value of inward and outward FDI investment flows divided by GDP and multiplied by 100.
(2) NO: 2006; IS, CH, HR, US, JP: 2007.
(3) NO: 2007; IS, CH, HR, US, JP: 2008.
(4) Luxembourg which has an FDI Intensity of 394.7 in 2009 is not included on the graph.

As regards FDI, figure III.2.22. on net FDI inflows relative to GDP (2008) shows that Cyprus – and Ireland – benefited from high levels of FDI in 2009, followed by Estonia. These countries have also experienced high increases of their FDI intensity between 2008 and 2009.

### 2.2.5. Speed and cost of standardisation

Standardisation is an important tool for removing trade barriers for industry and consumers. The use of standards to support innovation is one of the advantages that draw a lot of attention to standard setting. The interest results from the supposition that agreed standards ensure that the risk taken by both innovators and early adopters is lower, due to the fact that they will not develop a redundant technology. Therefore standards help to increase investment in innovation.

However, as an instrument, standards need to be carefully used. The timing of issuing set standards is an important issue: too soon and a technology might be not sufficiently mature to deliver high performance. Too late, and divergence in standards may emerge[338]. While regulation is the responsibility of governments, standard setting is largely the responsibility of industry bodies.

At European level, the European Committee for Standardisation (CEN[339]) is a major provider of European standards and technical specifications in all areas of economic activity with the exception of electrotechnology and telecommunication. The two committees responsible for standardisation in the remaining two fields are the European Committee for Electrotechnical Standardisation (CENELEC[340]) and the European Telecommunications Standards Institute (ETSI[341]). The CEN standards have a unique status: they are also national standards in each of their 31 Member countries (including the EU-27 Member States). Once a standard is set and published (adopted) by CEN, that standard will be adopted by all these countries and every conflicting national standard will be withdrawn. In this way, CEN standards facilitate the reach of a far wider market with much lower development and testing costs.

***The overall number of published standards at CEN increased by over 40 % between 2000 and 2009***

As shown in table III.2.5. the number of published standards has increased from 1 105 in the year 2000 to 1 454 in 2009. The sectors with the highest numbers of standards published in 2009 have been: transport and packaging (260 publications), mechanical engineering — machinery (233 publications), healthcare (166 publications), and building and civil engineering (158 publications).

The sectors with an increasing number of standards publications between 2000 and 2009 are: non-metallic food materials, chemistry, transport and packaging, mechanical engineering — pressure equipment, pipes, tanks and accessories, mechanical engineering — machinery, healthcare. In contrast, *sectors with a decreasing number of issued standards* between 2000 and 2009 are: utilities and energy, general mechanical engineering, metallic materials, health and safety, environment, household goods, sports and leisure, building and civil engineering.

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[338] Luke Georghiou, Demanding Innovation: Lead markets, public procurement and innovation, in *Provocation02,* NESTA, UK, 2007.

[339] www.cen.eu.

[340] www.cenelec.eu.

[341] www.etsi.org.

## Table III.2.5 Number of published standards, 2000-2009

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| Food | 32 | 28 | 15 | 48 | 25 | 24 | 25 | 30 | 40 | 50 |
| Materials — Non-metallic | 48 | 48 | 76 | 89 | 81 | 73 | 74 | 60 | 40 | 61 |
| Utilities and energy — Power engineering | 3 | – | 4 | – | 1 | – | – | – | – | – |
| Utilities and energy — Others | 16 | 9 | 18 | 19 | 8 | 13 | 7 | 6 | 5 | 10 |
| Utilities and energy — Water supply | 21 | 12 | 7 | 22 | 20 | 51 | 34 | 16 | 26 | 17 |
| Mechanical engineering — General mechanical engineering | 40 | 33 | 28 | 75 | 37 | 40 | 24 | 23 | 30 | 26 |
| Chemistry | 53 | 78 | 61 | 87 | 96 | 62 | 115 | 82 | 32 | 72 |
| Information society standardisation system | 97 | 51 | 25 | 81 | 112 | 52 | 57 | 55 | 55 | 44 |
| Heating, cooling, ventilation and air conditioning — Gas appliances | 11 | 20 | 12 | 13 | 11 | 15 | 19 | 13 | 6 | 22 |
| Mechanical engineering — Others | 54 | 34 | 46 | 50 | 50 | 45 | 44 | 41 | 60 | 35 |
| Heating, cooling, ventilation and air conditioning — Others | 12 | 12 | 11 | 22 | 22 | 11 | 11 | 31 | 24 | 11 |
| Services | 3 | 4 | 7 | 16 | 7 | 11 | 14 | 6 | 9 | 5 |
| Transport and packaging | 62 | 302 | 178 | 134 | 169 | 266 | 357 | 231 | 140 | 260 |
| General Standards — Quality | 4 | – | 1 | 2 | 5 | 4 | 3 | 3 | 1 | 2 |
| Utilities and energy — Gas supply | 17 | 7 | 4 | – | 1 | 18 | 7 | 5 | 15 | 8 |
| Mechanical engineering — Pressure equipment, pipes, tanks and accessories | 59 | 55 | 100 | 92 | 60 | 66 | 70 | 53 | 49 | 61 |
| Materials — Metallic | 55 | 56 | 64 | 78 | 60 | 60 | 68 | 42 | 63 | 44 |
| Mechanical engineering — Machinery | 77 | 70 | 34 | 66 | 67 | 76 | 64 | 36 | 156 | 233 |
| Health and safety | 57 | 57 | 73 | 51 | 52 | 66 | 62 | 54 | 79 | 42 |
| General Standards — Measurement | 9 | 8 | 13 | 6 | 2 | 11 | 8 | 22 | 1 | 2 |
| Healthcare | 82 | 31 | 44 | 52 | 61 | 49 | 81 | 48 | 37 | 166 |
| Environment | 22 | 18 | 14 | 19 | 24 | 32 | 58 | 21 | 20 | 16 |
| General Standards — Others | 28 | 25 | 10 | 28 | 30 | 17 | 22 | 15 | 37 | 52 |
| Household goods, sports and leisure | 39 | 52 | 43 | 42 | 84 | 65 | 33 | 38 | 35 | 34 |
| Heating, cooling, ventilation and air conditioning — Oil and solid fuels appliances | 3 | 4 | – | 4 | 5 | 2 | 5 | 6 | 2 | 5 |
| General Standards | – | – | – | – | – | – | – | – | 1 | – |
| Others | 4 | 15 | 10 | 5 | 4 | 17 | 15 | 5 | 8 | 12 |
| Building and civil engineering | 197 | 138 | 161 | 235 | 291 | 274 | 195 | 182 | 170 | 158 |
| **Sub-Total** | **1 105** | **1 167** | **1 059** | **1 336** | **1 385** | **1 420** | **1 472** | **1 124** | **1 141** | **1 448** |
| No defined sector | – | – | – | – | – | – | – | – | 3 | 6 |
| **Total** | **1 105** | **1 167** | **1 059** | **1 336** | **1 385** | **1 420** | **1 472** | **1 124** | **1 144** | **1 454** |

*Source:* DG Research and Innovation
*Data:* CEN

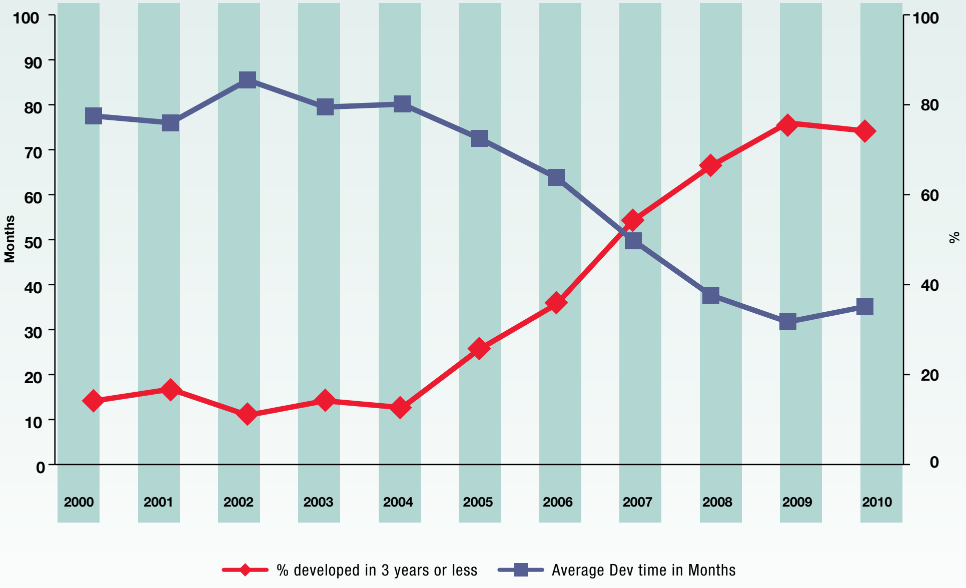
### *The time needed by CEN to get a standard on the market has been reduced by half in the last decade*

Figure III.2.23. shows that the time needed to publish a standard by CEN has decreased from an average of 80 months in 2000 to 40 months in 2010, showing an increase in the efficiency of the standardisation bodies. A large number of standards (75 %) are developed within three years in 2010, from a base of only around 15 % in 2000.

FIGURE III.2.23

**Average Development Times – ENs, 2000-2010**

**excluding Amendments, Corrigenda & Consolidations**



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*Source:* DG Research and Innovation
*Data:* CEN

## 2.3. Enhancing entrepreneurship

The development of human resources with innovation-relevant skills and in particular entrepreneurship, are crucial conditions for the emergence of innovation that can be commercially valorised in the market. Entrepreneurs contribute to the stimulation of new economic activity, due to the fact that they exploit new technological or commercial opportunities that existing firms did not exploit previously.

The main data source in this section is the Eurobarometer survey, which has a relatively small sample size. Therefore, the data on entrepreneurship should be considered as a first estimation which could be benchmarked against other surveys (i.e. the GEM surveys).

### *The EU has fewer entrepreneurs compared to China and the United States. Finland has the highest rate of entrepreneurial activity. At the other end of the scale are Belgium, Denmark, France, Luxembourg, Malta, Slovakia and Slovenia*

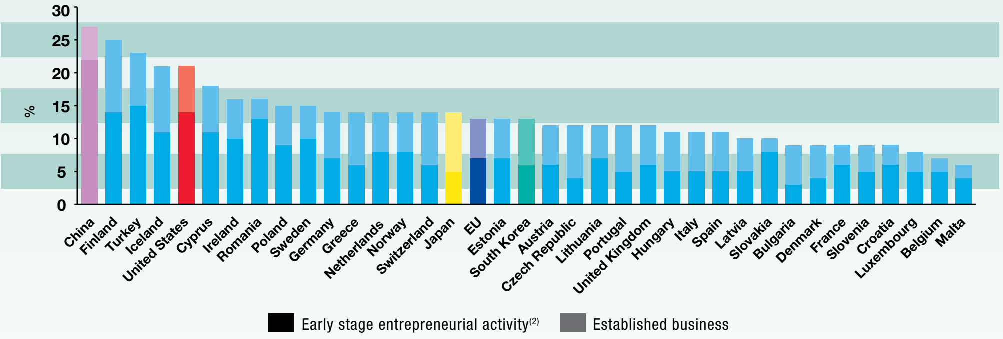
In 2009, 13 % of EU citizens (on average) have been involved in entrepreneurial activities. The EU is significantly surpassed by China (27 %) and the United States (21 %), whereas Japan records similar rates (14 %). The lower levels of entrepreneurial activities in European countries compared to China and the United States reflect the relative risk-aversion of Europeans and their preference for employment over self-employment. It could also show that there are good income alternatives available, through jobs and social security.

Among EU Member States, Finland has the highest rate (25 %) of entrepreneurial activity, followed by Cyprus (18 %), Ireland and Romania (16 % each of them). Belgium, Denmark, France, Luxembourg, Malta, Slovakia and Slovenia, on the other hand, had entrepreneurship rates below 10 %.

### *In the countries with the highest rates of entrepreneurial activity, there is a prevalence of the early-stage over established business*

Early-stage entrepreneurial activity is important due to the fact that it fosters the future output of enterprises. Early-stage entrepreneurial activity (for recently started or taken-over businesses or businesses being started) was somewhat higher in Finland, Romania, Cyprus, Ireland and Sweden (10 –14 %, compared to an EU average of 7 %). In all these countries, there is a prevalence of early-stage entrepreneurial activity over established business.

FIGURE III.2.24 **Share of surveyed respondents engaged in an entrepreneurial activity(1): early-stage(2) and established business, 2009**

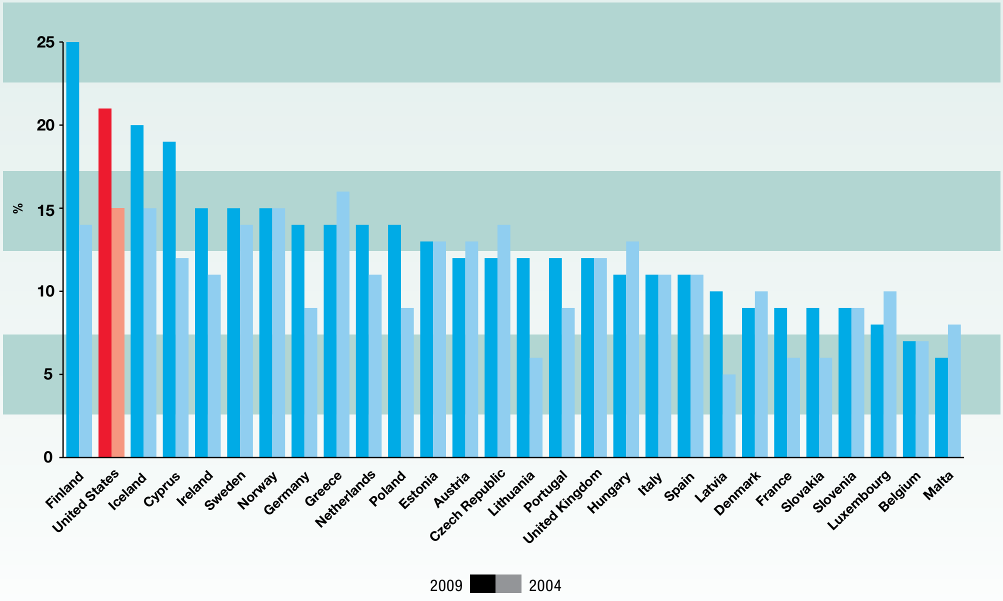


*Source:* DG Research and Innovation **Innovation Union Competitiveness Report 2011**
*Data:* Eurobarometer, Entrepreneurship in Europe and beyond, 2010
*Notes:* (1) Q: Have you ever started a business or are you taking steps to start one?
How would you describe your situation: you are currently taking steps to start a new business;
you have started / taken over a business in the last three years which is still active today;
you have started / taken over a business more than three years ago and it's still active today?
(2) Early stage is the sum of embryonic entrepreneurship (respondents who were taking the necessary steps to start up a business at the time of the survey) and of new business (those who had started or had taken over a business in the last three years and which was still active at the time of the survey).

### *About half of EU Member States raised the level of their entrepreneurial activities between 2004 and 2009*

Some countries have kept relatively similar levels over the two years: Norway, Estonia, the United Kingdom, Spain, Italy, Spain, Slovenia and Belgium. A few other Member States lowered their entrepreneurial activities: Greece, Austria, Czech Republic, Hungary, Denmark and Luxembourg (figure III.2.25).

FIGURE III.2.25 **Share of surveyed respondents engaged in an entrepreneurial activity(1) (total of early-stage(2) and established business), 2004 and 2009**



**Innovation Union Competitiveness Report 2011**

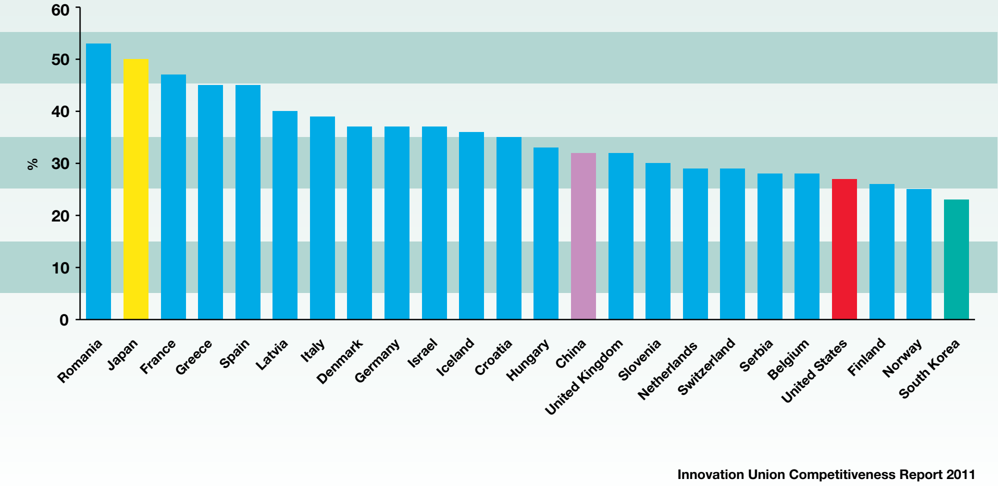
*Source:* DG Research and Innovation
*Data:* Eurobarometer, Entrepreneurship in Europe and beyond, 2010
*Notes:* (1) Q: Have you ever started a business or are you taking steps to start one? How would you describe your situation: you are currently taking steps to start a new business; you have started / taken over a business in the last three years which is still active today; you have started / taken over a business more than three years ago and it's still active today?
(2) Early stage is the sum of embryonic entrepreneurship (respondents who were taking the necessary steps to start up a business at the time of the survey) and of new business (those who had started or had taken over a business in the last three years and which was still active at the time of the survey).

For entrepreneurial activity to occur in a country it is important that individuals perceive opportunities for starting a business and perceive that they possess the capabilities to start a business. Therefore out of all personal entrepreneurial traits, fear of failure is a significant obstacle preventing start-ups, and an indicator correlated closely to firm formation. In addition, the fear of failure can also reflect the different degrees of risk aversion across countries.

### *Entrepreneurs in Finland and Norway have the lowest fear of failure when starting up a business*

The perceptions about business start-ups show that Romania has the highest fear of failure rate (53 % of the respondents), followed by Japan (50 %), France (47 %), Greece and Spain (45 %). The countries where respondents perceive the lowest fear of failure about starting up a business are South Korea (23 %), Norway (25 %), Finland (26 %), and the United States (27 %).

## FIGURE III.2.26 Fear of failure rate(1), 2009

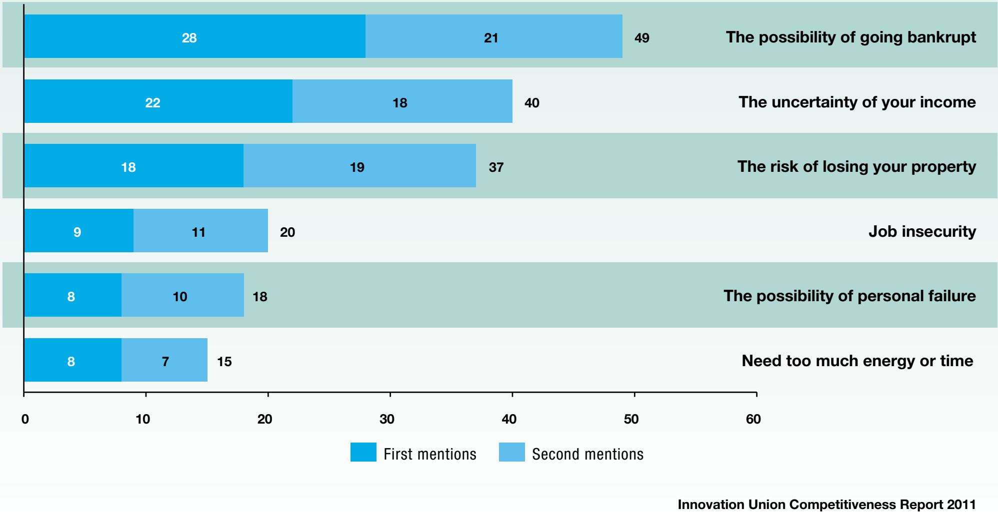


*Source:* DG Research and Innovation
*Data:* Bosma, N.; Levie, J., Global Entrepreneurship Monitor (GEM Survey), 2009 Executive Report
*Note:* (1) Percentage of population aged 18-64 perceiving good opportunities to start a business who indicate that fear of failure would prevent them from setting up a business.

***The greatest fears when starting up a business are the fear of going bankrupt, the uncertainty of not having a regular income, and the risk of losing the entrepreneurs' own property***

Figure III.2.27. below indicates the greatest fears when starting up a business: the possibility of going bankrupt (49 % of the respondents), the uncertainty of not having a regular income (40 % of respondents) and the risk of losing one's own property (37 %).

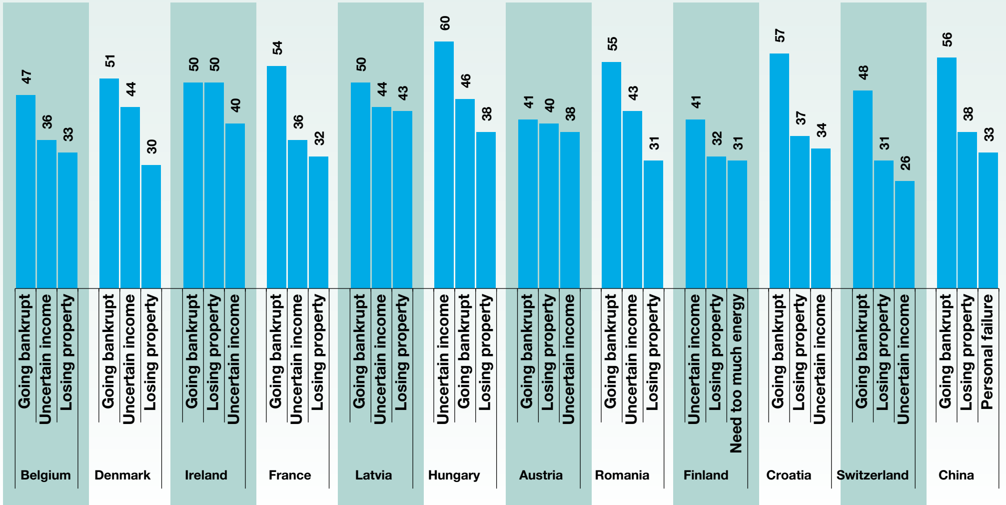
## FIGURE III.2.27 EU - Greatest fears when starting up a business(1), 2009

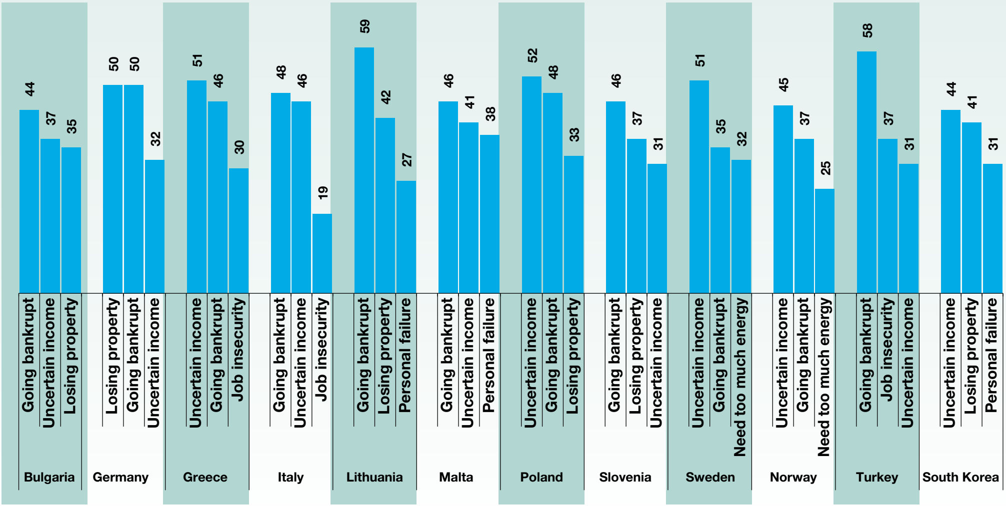


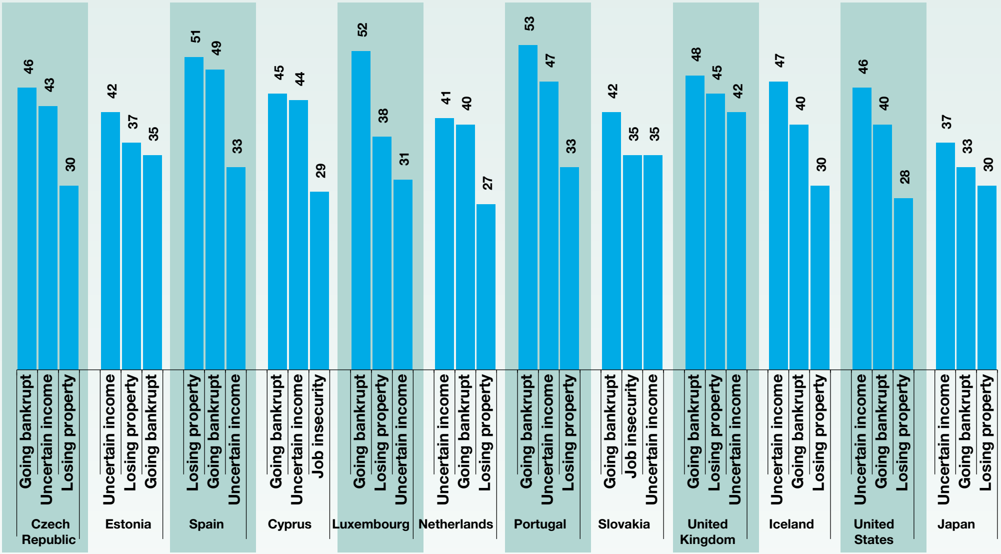
*Source:* DG Research and Innovation
*Data:* Eurobarometer, Entrepreneurship in Europe and beyond, 2010
*Note:* (1) Q. If you were to set up a business today, which are the two risks you would be most afraid of?

In 24 countries, the three fears mentioned above were the most mentioned fears associated with a business start-up. For instance, 55 % of Romanians were concerned about the possibility of going bankrupt, 43 % listed the uncertainty of not having a regular income and 31 % selected the risk of losing their property. In Greece, Italy, Cyprus, Slovakia and Turkey respondents were more likely to be concerned about job security than about losing their property. Respondents in Malta, China, South Korea and Lithuania were the most likely to name the possibility of personal failure, which was named among the top three most mentioned fears associated with a business start-up. Similarly, Swedish, Finnish and Norwegian respondents mentioned as one of their top three fears that a business start-up would require too much time and effort.

FIGURE III.2.28 **Greatest fears when starting up a business(1) (The three most mentioned fears by country), 2009**







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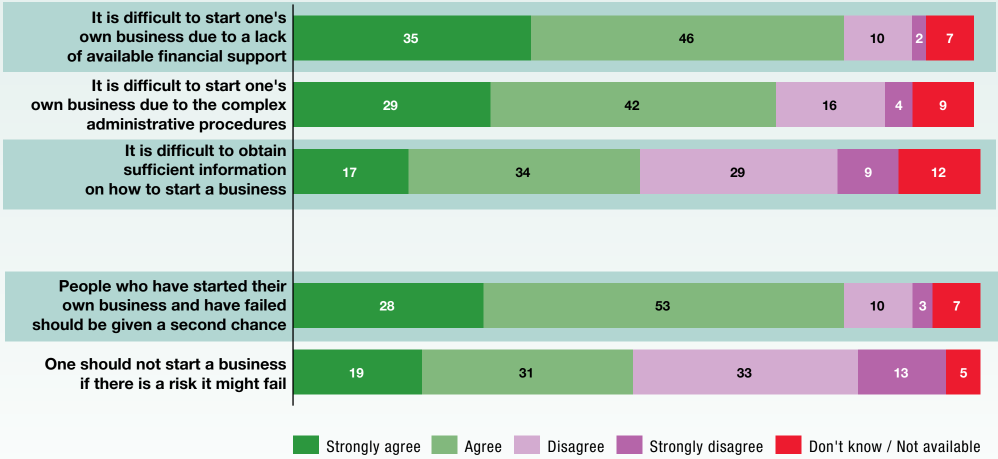
*Source:* DG Research and Innovation
*Data:* Eurobarometer, Entrepreneurship in Europe and beyond, 2010
*Note:* (1) Q. If you were to set up a business today, which are the two risks you would be most afraid of?

***Perceived barriers to entrepreneurship are the lack of available financial support, complex administrative procedures, and difficulties obtaining sufficient information on starting up a business***

Barriers to entrepreneurship run across a number of areas, from lack of available financial support through to regulation and administrative burden. Over 80 % of EU citizens agreed that it was difficult to start up a business due to a lack of available financial support as shown in Figure III.2.29. Of the respondents, 71 % agreed that business start-ups were difficult due to complex administrative procedures. A lower percentage of EU citizens (51 %) agreed that it was difficult to obtain sufficient information about how to start up a business. A total of 81 % agreed that people who had started a business and had failed should be given a second chance. Finally, opinion was split as to whether a business start-up should be avoided if there was a risk that this venture might fail: 50 % agreed and 46 % disagreed.

FIGURE III.2.29 **EU – Barriers to entrepreneurship, 2009**



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*Source:* DG Research and Innovation
*Data:* Eurobarometer, Entrepreneurship in Europe and beyond, 2010

***It is perceived to be easiest to doing business in the United Kingdom, Denmark, Ireland, Finland and Sweden. The regulatory environment is less conducive to the operation of business in Greece, Italy, Poland, the Czech Republic and Romania***

The regulatory environment is also important for the operation of business and for encouraging entrepreneurial activities. The World Bank produces an index on which economies are ranked on their ease of doing business, from 1–183, with first place being best (Table III.2.6). A high ranking on the ease-of-doing-business index means the regulatory environment is conducive to the operation of business[342].

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[342] This index averages the country's percentile rankings on 10 topics, made up of a variety of indicators, giving equal weight to each topic. These topics are: Starting a business, protecting investors, dealing with construction permits, paying taxes, trading across borders, employing workers, registering property, enforcing contracts, getting credit, closing a business.

TABLE III.2.6 **Ease of doing business: World Bank ranking, 2010**

| Economy | Rank | Economy | Rank |
|---|---|---|---|
| Singapore | 1 | Austria | 32 |
| Hong Kong SAR, China | 2 | Cyprus | 37 |
| New Zealand | 3 | Macedonia, FYR | 38 |
| United Kingdom | 4 | Slovakia | 41 |
| United States | 5 | Slovenia | 42 |
| Denmark | 6 | Luxembourg | 45 |
| Canada | 7 | Hungary | 46 |
| Norway | 8 | Spain | 49 |
| Ireland | 9 | Bulgaria | 51 |
| Australia | 10 | Botswana | 52 |
| Finland | 13 | Romania | 56 |
| Sweden | 14 | Czech Republic | 63 |
| Iceland | 15 | Turkey | 65 |
| South Korea | 16 | Montenegro | 66 |
| Estonia | 17 | Poland | 70 |
| Japan | 18 | China | 79 |
| Germany | 22 | Italy | 80 |
| Lithuania | 23 | Albania | 82 |
| Latvia | 24 | Croatia | 84 |
| Belgium | 25 | Serbia | 89 |
| France | 26 | Greece | 109 |
| Switzerland | 27 | Bosnia and Herzegovina | 110 |
| Israel | 29 | Kosovo | 119 |
| Netherlands | 30 | India | 134 |
| Portugal | 31 | | |

*Source:* DG Research and Innovation
*Data:* World Bank, http://www.doingbusiness.org/rankings

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To conclude, whereas the EU has fewer entrepreneurs than China and the United States, Finland is the European country with the highest rate of entrepreneurial activity. This is confirmed by the lowest fear of failure when starting a business in Finland compared to any other EU Member State.

Overall the countries with a high rate of entrepreneurial activity have a prevalence of the early-stage over established business and about half of EU Member States raised the level of their entrepreneurial activities between 2004 and 2009.

The greatest fears when starting up a business are the fear of going bankrupt, the uncertainty of not having a regular income and the risk of losing the entrepreneurs' own property. The most often perceived barriers to entrepreneurship are the lack of available financial support, complex administrative procedures, and difficulties obtaining sufficient information about how to start up a business.

It is perceived easiest to do businesses in the United Kingdom, Denmark, Ireland, Finland, and Sweden. The regulatory environment is less conducive to the operation of business in Greece, Italy, Czech Republic or Poland.

# CHAPTER 3

# Structural change for a knowledge-intensive economy

## HIGHLIGHTS

Structural change in the economy is defined in this part as two disjoint phenomena: a) increase in the share of high and medium high tech sectors (combined with the emergence of new knowledge intensive sectors), and b) increase the intensity of knowledge incorporated in more traditional sectors, including by the emergence of specific specialised sub-sectors.

In the last 15 years, the EU economic structure has been smoothly changing the weight of the manufacturing and services sectors. While manufacturing has been reducing its share in employment, the services increased their share in the overall employment to 70 %. At Member States level, different situations can be observed: the countries with a higher share of employment in the manufacturing sector are either catching-up countries like the EU-12 Member States and Italy and Portugal (where the traditional sectors still play an important role in the overall economy) or the Member States with a highly knowledge-intensive manufacturing sector (Germany, Finland and Sweden).

The growing weight of the services sectors, which in general have a lower R&D intensity, has offset the increasing research-intensity in several manufacturing or in some of the services sectors. However, the gradual evolution towards a higher share of services in the economy is only part of the structural change, as economies around the world are increasingly injecting more knowledge in their activities. This knowledge accumulation can be measured both by the knowledge of the labour force in each sector and by the research intensity of each sector.

Since 2000 the EU economy has become slightly more knowledge-intensive, but the gap with the United States persists. In 2009 knowledge-intensive activities (KIAs) represent 35 % of total employment on average in the EU with no large variation around this rate among European countries apart from few exceptions. Change is taking place at country level in R&D intensity in the manufacturing sector, and overall the EU is showing a structural change towards higher knowledge-intensity in the existing sectors, but with a smaller size of these sectors in the total value-added of the economy. The structural change towards higher knowledge intensity within sectors in the EU has not been sufficient in itself to raise the knowledge intensity of the economy. When benchmarking with the United States, which has a similar share of manufacturing and services in its economy, we see that there is still room for further increases in the research intensity of the high and medium high-tech industries in the EU as well as in services. The structural composition of the economy is another aspect that reinforces this trend, as discussed previously in the chapter on fast-growing companies. The capacity of SMEs and of enterprises of intermediate size to grow and to respond better to the emerging needs, is often instrumental for accelerating structural change both within traditional manufacturing sectors and towards new types of knowledge intensive activities.

Structural change from the perspective of R&D intensity can be analysed at the level of firms. The 2010 European Industrial R&D Investment Scoreboard, covering the 1000 EU top firms in terms of R&D investments (both manufacturing and services sectors), shows that in 2009 the R&D intensity of the EU companies slightly increased reaching 2.4 %.

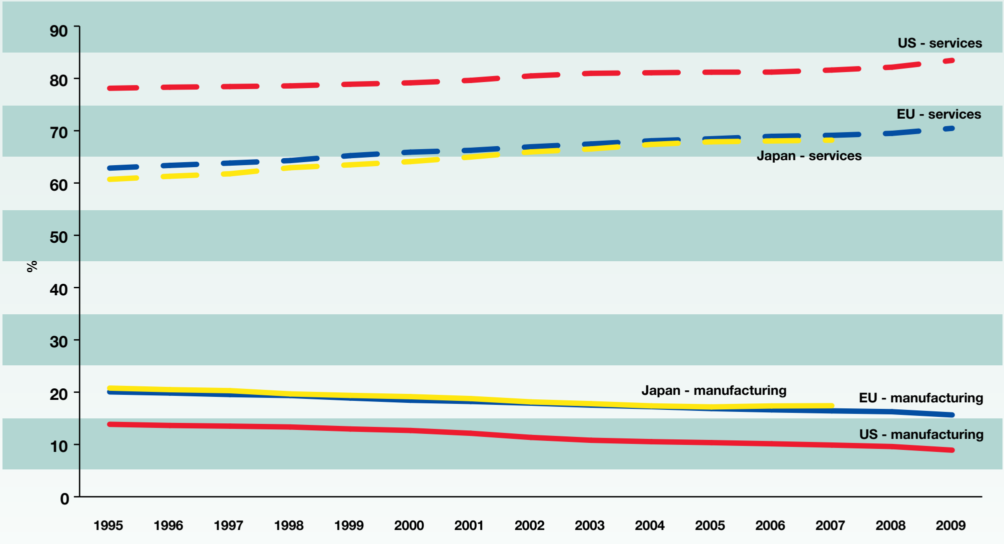
The different strategies and policies that countries and regions adopt can define a framework conducive to the stimulation of structural changes. These strategies and policies may need to be adapted to the specific circumstances of the individual countries, and sometimes they may favour moves towards higher knowledge intensive activities within existing sectors, building on the existing experience, and sometimes they may require a shift towards new sectors.

## 3.1. Is the economic structure in Europe becoming more knowledge intensive?

Structural change has been part of economic analysis since the late 1930s, and several definitions have been discussed[343]. The concept points at a fundamental widespread change of the economic structure which can be influenced by policy decisions, by permanent changes in the resources, or by changes in the education and skills profile of the population of a region/country. In the perspective of the present chapter, structural change implies the transformation of an economy towards higher value creation. In general terms, we can consider two means of structural changes in the economy: (1) increasing the share of high and medium high tech sectors, combined with the emergence of new knowledge-intensive sectors and (2) increasing the incorporation of knowledge in more traditional sectors and the emergence of niches of sub-sectors formed by innovative fast growing firms.

In the last 15 years the overall economic structures of the EU, and those of the United States and Japan, have not changed drastically. Nevertheless, all three are smoothly progressing towards economies with an increasing weight in the services sectors and a corresponding decrease in the manufacturing sectors. This slow trend is visible when one compares the changes in the shares of the EU's employment in manufacturing and services in 1995 (respectively 20.1 % and 62.9 %) and in 2009 (respectively 15.7 % and 70.4 %) (figure III.3.1). The Japanese economic structure shows very similar figures and progress over the 1995–2007 period (2007 being the last year available), with the employment share of the manufacturing sector dropping from 20.8 % to 17.4 % while the share of employment in the services sector increased from 60.7 % to 68.2 %. In 1995, the economic structure of the United States showed a larger share of employment in the services sector. This fact lies in the correspondence between the bigger weight of the ICT services sectors compared to the EU. Back in 1995, the manufacturing sector in the United States had a share of employment of 13.6 % and the services sector a share of 78.2 %. Twelve years later, manufacturing is accounting for less than 10 % of total employment and services have passed 81.6 %.

FIGURE III.3.1 **Employment in manufacturing and services as % of total employment, 1995-2009**



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*Source:* DG Research and Innovation
*Data:* Eurostat, OECD

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[343] Fisher (1939) and Clark (1940) looked at patterns in changes in sectoral employment.

### *Countries with a higher share of employment in the manufacturing sector are either catching-up countries or Member States with a competitive or research-intensive manufacturing sector*

It is interesting to analyse what is happening in the EU at country level concerning the changes in employment in manufacturing and in services. Figure III.3.2. represents the actual share of employment (for the year 2009) in the manufacturing and services sectors, where the Czech Republic is the only EU country with a share of total employment in the manufacturing sector bigger than 25 % (one quarter of total employment). With the exception of Romania, which has a special situation, which will be discussed later in more detail, the services sector is the big employer with shares that range from 39.2% to 80.8 % in the United Kingdom. Different situations can be observed: the countries with a higher share of employment in the manufacturing sector, are either catching-up countries like the EU-12 Member States (the Czech Republic, Slovakia, Slovenia, Hungary, Poland, Romania, Estonia, Bulgaria, and Lithuania) and Italy and Portugal (where the traditional sectors still play an important role in the overall economy) or the Member States with a well-developed and research-intensive manufacturing sector (Germany, Finland and Sweden). Countries like Denmark, Belgium and France have a very similar distribution of employment shares between manufacturing and services, where services represent between 76 % and 78 % of total employment of these countries. The Netherlands and the United Kingdom have a particular sectoral distribution in employment: they mirror the United States' distribution of employment shares. Greece and Ireland are the EU-15 Member States which still have an important share of employment in the primary sector.

### *The growing weight of service sectors, which have a lower R&D intensity, has offset the effect of increasing research-intensity in individual sectors*

Complementing the previous discussion on shares of employment, Figure III.3.3. presents the average annual growth rates of employment in manufacturing and in services between 1995 and 2009. All the growth rates of employment in manufacturing are negative. Figure III.3.3. indicates that the highest growth rates of employment in services are taking place in catching-up economies, or in countries like Ireland, which had an ICT sector boom.

In the period 1995–2009, the EU average annual growth rate of employment in the manufacturing sector was -1.7 %, compared to -1.5 % in Japan and -2.7 % in the United States. In the services sector, the average annual growth rate between 1995 and 2009 was 0.8 %, 1 % in Japan and 0.4 % in the United States. This implies a gradual trend towards a services economy, with a decrease in the manufacturing sector. This fact explains in part (not totally, since other aspects have to be taken into consideration) why the R&D intensity of the EU and the United States have been stagnating in the last decade.[344] Generally, services sectors are less research-intensive. This is aggravated by the fact that in many countries the statistics on R&D in the service sectors are not accurate, nor considered by default. The growing weight (in terms of GDP) for the low R&D-intensive services sectors offsets the effect of increasing research intensities in many individual sectors. Moreover, the increase in research intensity in low-tech and medium low-tech manufacturing sectors has a limited impact on the overall business R&D intensity of the EU, the level of which is predominantly determined by the research intensity and size of the medium high-tech and high-tech industries.

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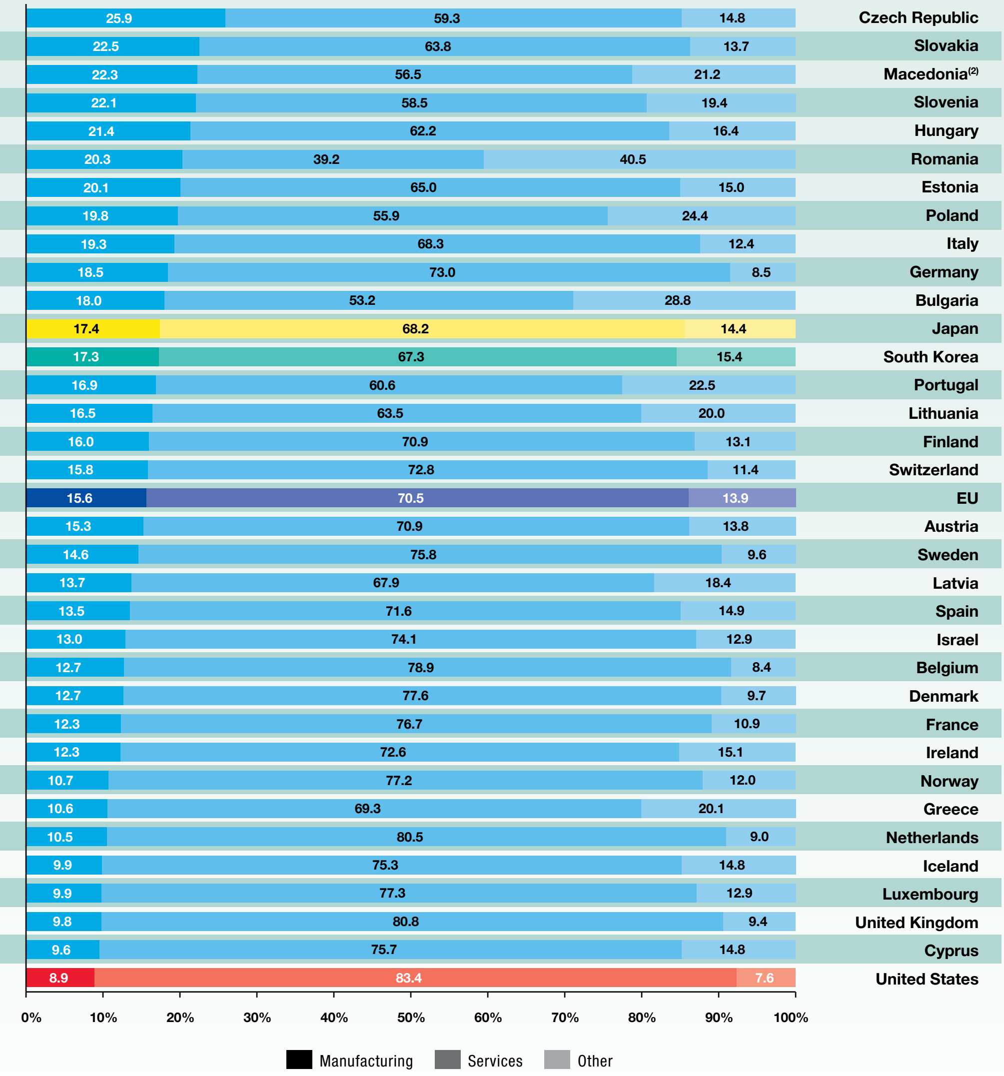
[344] For a comprehensive analysis of the R&D intensity in the EU and the United States, see Part I, Chapter 1, 2, 3 and 5.

FIGURE III.3.2 **Employment by type – % shares, 2009[1]**



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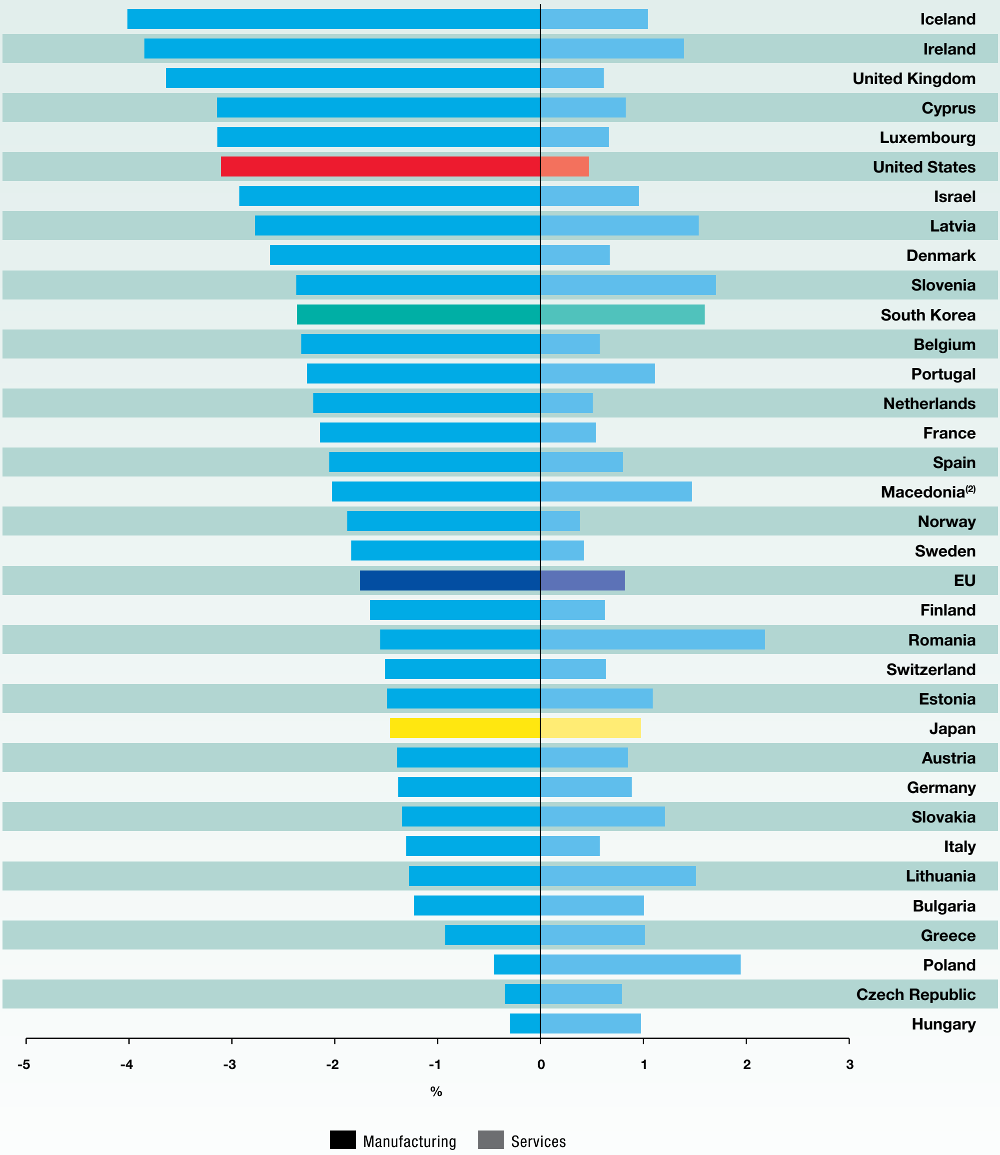
*Source:* DG Research and Innovation
*Data:* Eurostat, OECD
*Notes:* (1) PT, JP: 2007; FR, RO, UK, IS, CH, MK, IL, KR: 2008; BG: 2010.
(2) The former Yugoslav Republic of Macedonia.
(3) Malta is not included on the graph due to unavailability of data.

FIGURE III.3.3

## Share of employment in manufacturing and services – Average annual growth (%), 1995-2009(1)



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD
*Notes:* (1) PT, JP: 1995-2007; FR, UK, IS, CH, IL, KR: 1995-2008; RO: 1996-2008; MK: 1997-2008; IE: 1998-2009; EL: 2000-2009; BG: 2000-2010.
(2) The former Yugoslav Republic of Macedonia.
(3) Malta is not included on the graph due to unavailability of data.

The gradual evolution towards a higher share of services in the economy is only part of the structural change. In parallel, the economies in the world are increasingly injecting more knowledge into their activities. From a statistical perspective, this knowledge accumulation can be measured by two aspects: the knowledge of the labour force in each sector and the research activity of each sector. For the first aspect, a new indicator has been constructed by Eurostat, focusing on Knowledge-Intensive Activities. For the second aspect, the current statistical system focuses on the business R&D intensity using OECD taxonomy of high-tech, medium high-tech, medium low-tech and low-tech manufacturing sectors combined with the classification knowledge-intensive services. The current chapter will explore the data according to both of these aspects, relating them to the economy as share of employment.

Currently the best-known research and innovation taxonomy of industries is the distinction between high-, medium-high-, medium-low-, and low-technology manufacturing industries brought forward by the OECD[345]. In this taxonomy, economic sectors are grouped according to their R&D intensity[346]. This taxonomy is valid only for a small part of the statistical classification of economic activities (NACE[347]), namely the manufacturing industry. It has a strong technological bias and excludes from the 'high-technology' category some of the less R&D-intensive but potentially knowledge-intensive and innovative sectors.

The knowledge economy develops largely through the structural evolution of economic activities towards more knowledge-intensive ones, beyond the R&D-intensive manufacturing sectors. This can be monitored by observing the evolution of the relative weight of the most Knowledge-Intensive Activities (KIAs) in the economy. KIAs are defined as economic sectors in which more than 33 % of the employed labour force have completed academic-oriented tertiary education (i.e. at ISCED 5 and 6 levels). They cover all sectors in the economy, including manufacturing and services sectors, and can be defined at two- and three-digit levels of the statistical classification of economic activities.

### *Over the period 2000–2007, the EU economy has become slightly more knowledge-intensive, but the gap with the United States persists*

In general, the economy is increasing the incorporation of knowledge, making use of more advanced technologies, and increasing the demand on the corresponding skills and education of those using them. As a general movement, the minimal skills required in the labour market, have been growing. The embedding of skilled and highly educated labour into the economic structure is a highly relevant aspect of a knowledge economy. A shift towards a higher incorporation of knowledge in the economy can therefore be measured by the share of employment and the share of value added of the activities with skilled employed persons that have completed ISCED 5 or ISCED 6. This new indicator captures the market demand for innovation and avoids any bias, regarding manufacturing versus services, or technology-oriented versus non-technological innovation. It is also a useful tool to benchmark the potential of a region or country for future innovation.

### *Knowledge-Intensive Activities represent 35 % of total employment on average in the EU. Between 2008 and 2009 there was a slight increase*

Knowledge-Intensive Activities (KIAs) can be measured as a share of employment. In this sense, Europe is becoming more knowledge-intensive since its shares of employment in the knowledge-intensive activities have grown. Central and Northern Europe are more knowledge-intensive, while the Southern European countries and in general the EU-12 Member States have a smaller share of employment in knowledge-intensive activities (figure III.3.4). In 2009, KIAs represented 30–40 % of total employment in the vast majority of countries, and 35 % in the EU on average. Luxembourg stands out with 56 % of employment in KIAs, while Romania and Turkey are below all other European countries, with less than one fifth of total employment in KIA. Apart from the Netherlands and Cyprus, the share of KIAs in total employment increased slightly in 2009 compared to 2008 by 2.4% (Table III.3.1).

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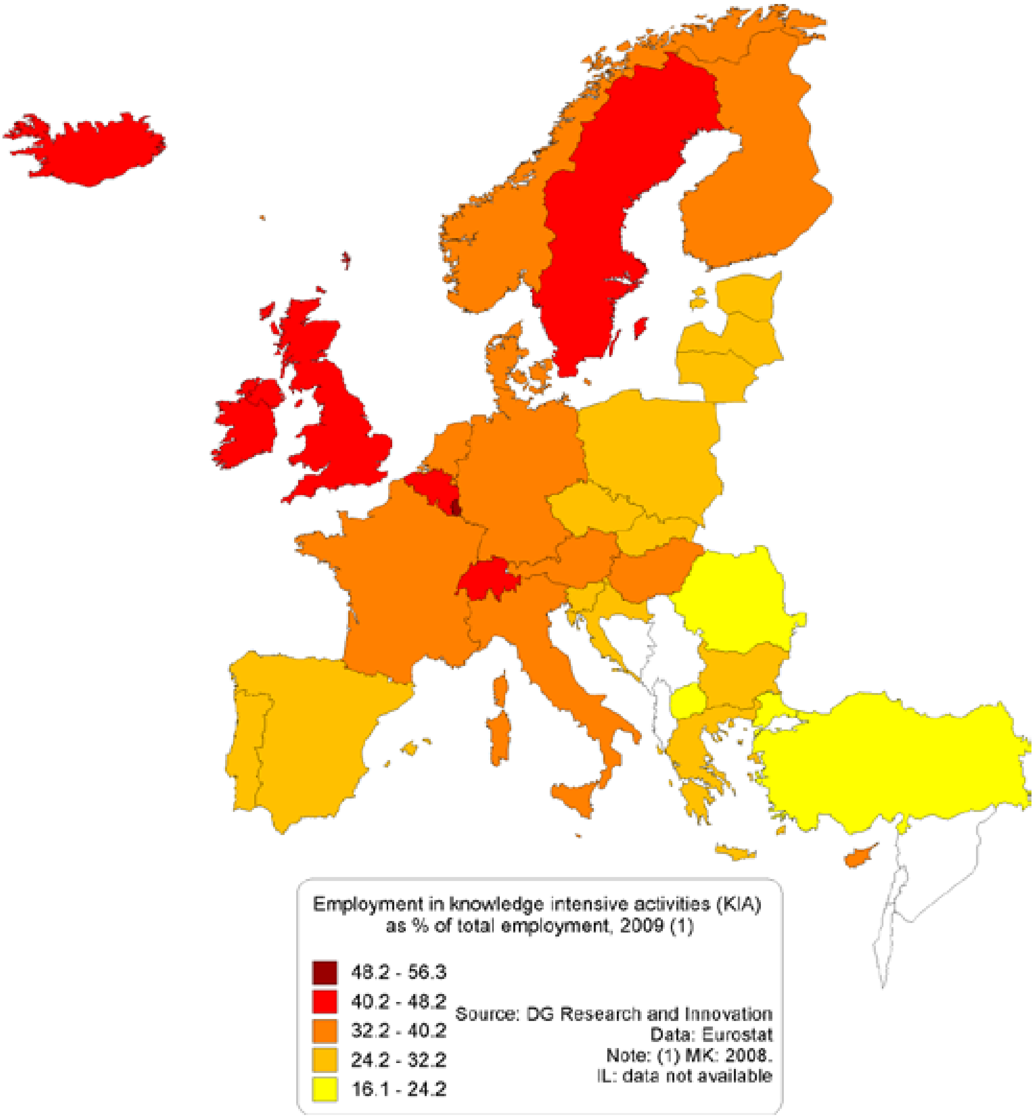
[345] Hatzichronoglou, T. (1997), Revision of the High-Technology Sector and Product Classification, STI Working Papers, Paris. OECD.

[346] More precisely, the direct (production of technology) and indirect (acquisition of technology) R&D intensity of each sector is used.

[347] Nomenclature statistique des Activités économiques dans la Communauté Européenne.

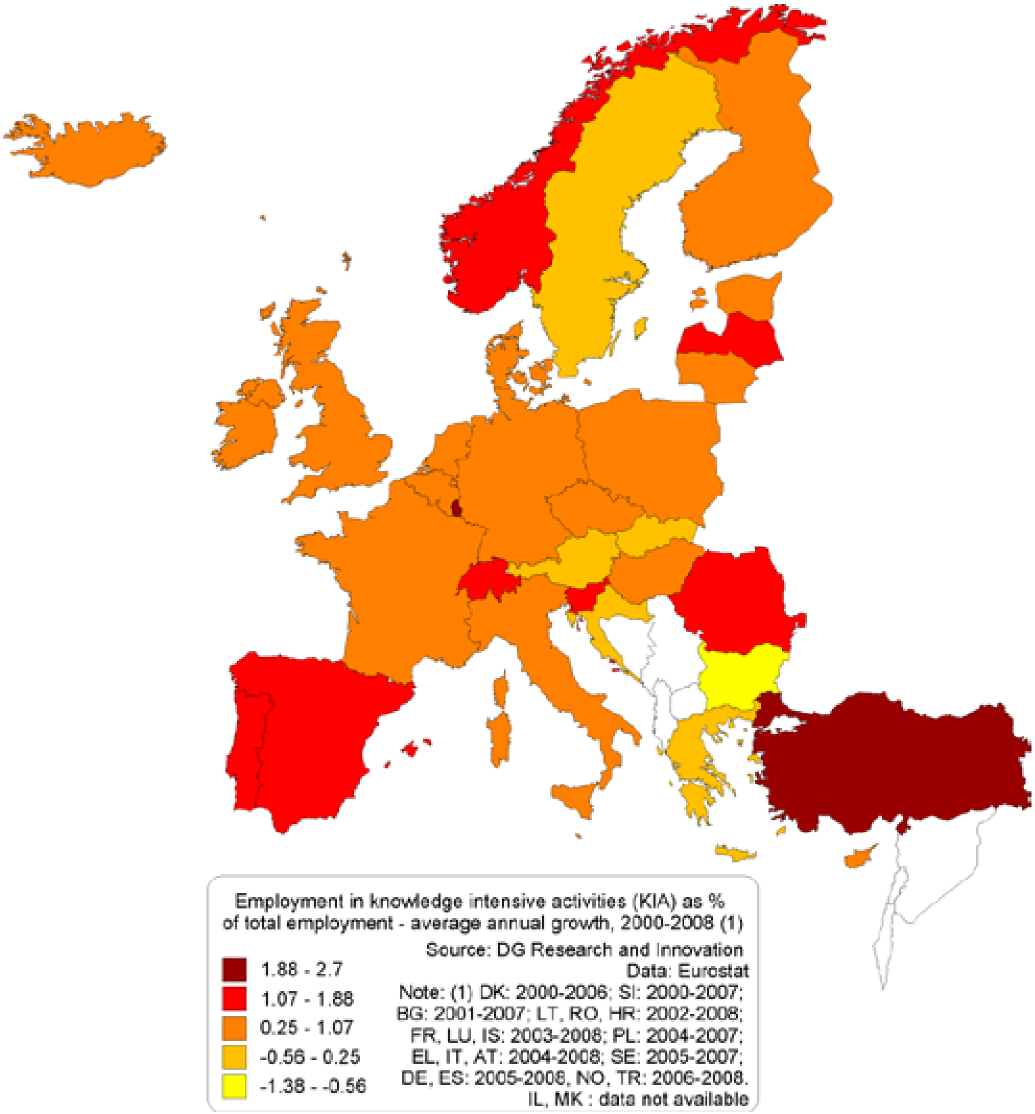
FIGURE III.3.4

## Employment in Knowledge-Intensive Activities (KIA) as % of total employment, 2009



Source: DG Research and Innovation
Data: Eurostat
Note: (1) MK: 2008.
IL: data not available

## FIGURE III.3.5 Employment in Knowledge-Intensive Activities (KIA) as % of total employment – Average annual growth, 2000-2008



Employment in knowledge intensive activities (KIA) as % of total employment - average annual growth, 2000-2008 (1)

Source: DG Research and Innovation

Data: Eurostat

Note: (1) DK: 2000-2006; SI: 2000-2007; BG: 2001-2007; LT, RO, HR: 2002-2008; FR, LU, IS: 2003-2008; PL: 2004-2007; EL, IT, AT: 2004-2008; SE: 2005-2007; DE, ES: 2005-2008, NO, TR: 2006-2008. IL, MK : data not available

The map above (figure III.3.5) shows the growth registered in the KIAs, as a % of total employment, over the period 2000-2008. The Central and Northern countries, with the exception of Norway, Luxembourg and Switzerland, register smaller growth rates, while Portugal, Slovenia, Spain and Turkey show a catching-up progress towards more knowledge intensive economy. In contrast, Bulgaria, Austria, Iceland and Croatia decreased the % of employment in KIA, over the same period. One should note that the two maps (figure III.3.4 and figure III.3.5) are not completely comparable since there is a break in series in the year 2008. The first map uses the definition of KIA based on the NACE Rev. 2 classification while the second map, the growth in KIA from 2000 to 2008, is based on NACE Rev. 1.1.

The analysis can also focus on the knowledge-intensity of the business sector (i.e. excluding KIAs in the public sectors). The table III.3.1 presents the data for KIAs in the business sector (which includes also business services). This breakdown gives also an indication of the market demand for innovation, a very pertinent factor in favour of the sustainable development of innovation.

KIAs in the business sector represent 10–20 % of total employment in the large majority of countries in 2009, with 13.4 % in the EU on average. This share is also in slight progression with a growth of 1.5% compared to 2008.[348]

## TABLE III.3.1

## Employment in Knowledge Intensive Activities (KIA) as % of total employment, 2008 and 2009

| | Total | | | Business industries | | |
|---|---|---|---|---|---|---|
| | 2008 | 2009 | Growth 2008-2009 (%) | 2008 | 2009 | Growth 2008-2009 (%) |
| Belgium | 41.2 | 41.4 | 0.5 | 14.9 | 14.4 | -2.8 |
| Bulgaria | 25.6 | 26.0 | 1.3 | 8.3 | 8.5 | 3.2 |
| Czech Republic | 28.1 | 29.2 | 3.9 | 11.2 | 11.3 | 1.6 |
| Denmark | 37.2 | 39.2 | 5.3 | 15.2 | 15.7 | 2.8 |
| Germany | 36.7 | 37.3 | 1.5 | 15.0 | 15.2 | 1.8 |
| Estonia | 28.4 | 31.8 | 11.9 | 9.5 | 10.2 | 8.2 |
| Ireland | 37.5 | 41.1 | 9.6 | 18.0 | 19.3 | 7.0 |
| Greece | 31.4 | 31.6 | 0.6 | 10.8 | 10.9 | 0.1 |
| Spain | 28.2 | 30.3 | 7.3 | 11.3 | 11.5 | 1.7 |
| France | 39.0 | 39.5 | 1.4 | 13.5 | 13.9 | 2.8 |
| Italy | 33.0 | 33.0 | 0.2 | 13.6 | 13.5 | -0.6 |
| Cyprus | 35.0 | 33.9 | -3.3 | 14.8 | 14.1 | -4.9 |
| Latvia | 28.6 | 30.1 | 5.1 | 8.2 | 9.1 | 11.9 |
| Lithuania | 29.1 | 31.2 | 7.1 | 7.5 | 8.1 | 7.3 |
| Luxembourg | 54.5 | 56.2 | 3.2 | 23.8 | 24.9 | 4.7 |
| Hungary | 33.1 | 33.5 | 1.0 | 12.8 | 12.3 | -3.6 |
| Malta | 38.4 | 38.8 | 1.0 | 15.7 | 16.3 | 3.4 |
| Netherlands | 38.0 | 37.4 | -1.5 | 17.0 | 15.9 | -6.4 |
| Austria | 34.1 | 35.4 | 3.7 | 13.8 | 14.2 | 3.2 |
| Poland | 26.9 | 28.0 | 4.2 | 8.2 | 8.9 | 8.1 |
| Portugal | 27.1 | 27.9 | 2.9 | 8.8 | 8.8 | 0.0 |
| Romania | 19.2 | 19.8 | 3.1 | 5.6 | 5.8 | 3.7 |
| Slovenia | 30.6 | 31.9 | 4.5 | 12.2 | 13.0 | 6.4 |
| Slovakia | 27.9 | 29.1 | 4.2 | 10.0 | 10.1 | 0.7 |
| Finland | 35.7 | 36.5 | 2.1 | 15.2 | 15.2 | -0.2 |
| Sweden | 41.6 | 42.3 | 1.5 | 16.6 | 16.8 | 1.2 |
| United Kingdom | 41.7 | 42.8 | 2.8 | 17.0 | 17.3 | 1.7 |
| EU | 34.3 | 35.1 | 2.4 | 13.2 | 13.4 | 1.5 |
| Iceland | 42.7 | 43.1 | 1.0 | 18.1 | 18.8 | 3.4 |
| Norway | 37.6 | 38.7 | 3.1 | 14.2 | 14.8 | 4.3 |
| Switzerland | 40.2 | 42.0 | 4.6 | 19.5 | 20.0 | 2.7 |
| Croatia | 26.4 | 27.4 | 4.0 | 9.5 | 9.2 | -3.2 |
| Macedonia(1) | 16.1 | : | : | 10.6 | : | : |
| Turkey | : | 18.4 | : | : | 4.8 | : |

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*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) The former Yugoslav Republic of Macedonia.

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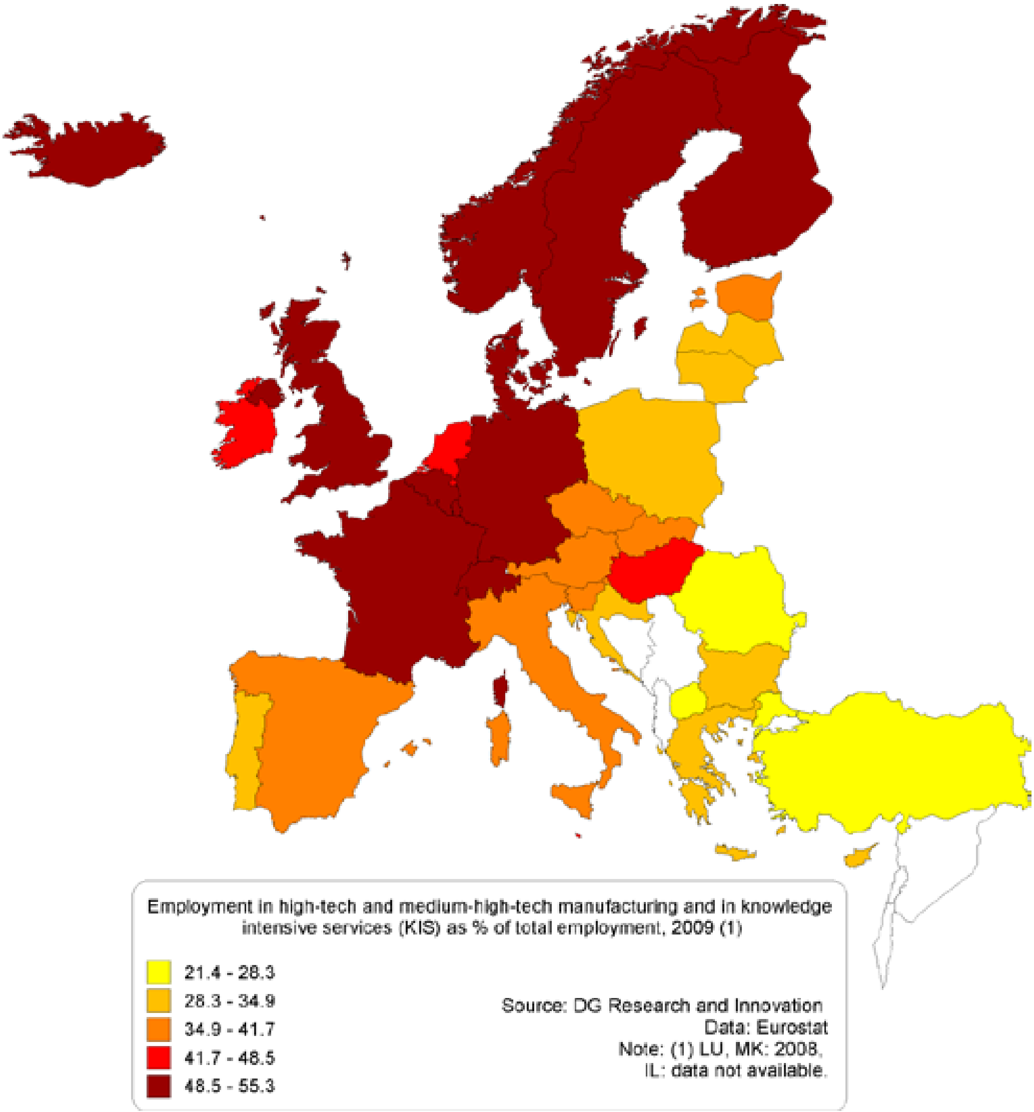
[348] The KIA classification was developed in 2010 by Eurostat on the basis of NACE Rev. 2 currently in use. To have historical values for reference years prior to 2008, the KIA classification is established on the basis of NACE Rev. 1.1.

FIGURE III.3.6 Employment in high-tech and medium high-tech manufacturing and in knowledge-intensive services (KIS) as % of total employment, 2009

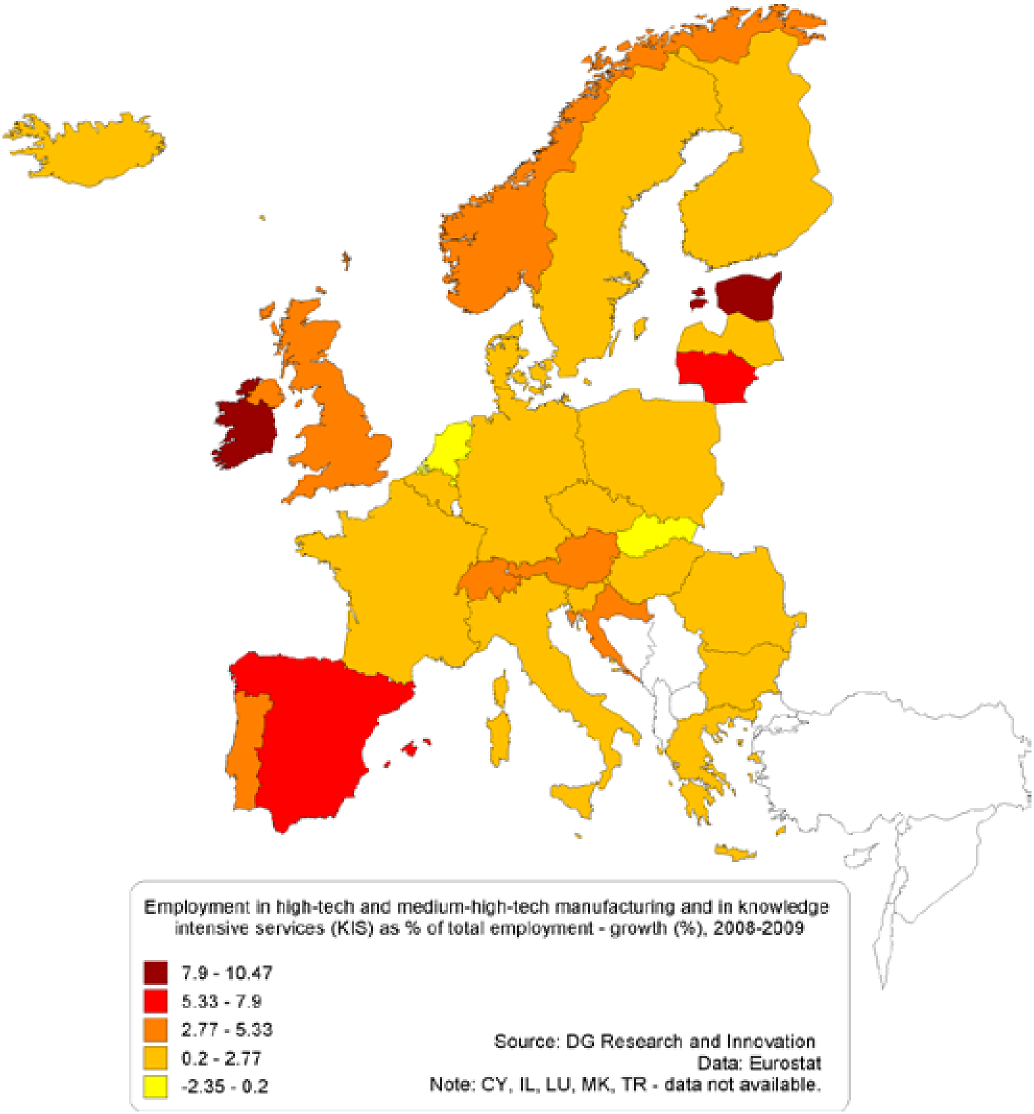


Source: DG Research and Innovation
Data: Eurostat
Note: (1) LU, MK: 2008,
IL: data not available.

### *Employment in high-tech and medium high-tech industries plus in knowledge intensive services (KIS) has in general not increased between 2008 and 2009*

The analysis of KIAs can be complemented by an analysis of structural change building on R&D investment level as main measurement of the knowledge-intensity of the economy. Such an analysis would build on the taxonomy of the OECD, focusing on high-tech and medium high-tech sectors together with knowledge-intensive services. In other words, we can say that while the KIA classification was based on the level of the skills of the human resources working in the sectors, the OECD taxonomy is related with the R&D intensity of the different sectors. Total employment in high-tech and medium high-tech industries and in knowledge intensive services ranges between 30% and 55% of total employment, except for Romania with 24.4% and Turkey with 21.5% (figure III.3.6). Belgium, Luxembourg, Sweden, Denmark, Finland, the United Kingdom, Iceland and Norway evidence a rate of employment in the high-tech and medium high-tech industries and knowledge intensive services well above the 50% of total employment.

FIGURE III.3.7 **Employment in high-tech and medium high-tech manufacturing and in knowledge-intensive services (KIS) as % of total employment – growth, 2008-2009**



Source: DG Research and Innovation
Data: Eurostat
Note: CY, IL, LU, MK, TR - data not available.

Figure III.3.7. visualises the annual growth rates of employment in high-tech and medium high-tech industries and KIS between 2008 and 2009: high growth for Ireland and Estonia, followed by Spain and Lithuania. The Netherlands, Lithuania and Cyprus decreased their share of employment in the same sectors.

## TABLE III.3.2 Employment in high-tech and medium-high-tech manufacturing and in knowledge intensive services (KIS) as % of total employment, 2008 and 2009

| | High-Tech[1] | | | Medium-High-Tech[2] | | | Knowledge Intensive Services (KIS) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2008 | 2009 | Growth 2008-2009 (%) | 2008 | 2009 | Growth 2008-2009 (%) | 2008 | 2009 | Growth 2008-2009 (%) |
| Belgium | 1.4 | 1.2 | -17.7 | 4.5 | 4.1 | -8.7 | 45.3 | 46.1 | 1.7 |
| Bulgaria | 0.8 | 0.8 | 3.7 | 3.6 | 3.0 | -15.7 | 27.1 | 27.7 | 2.2 |
| Czech Republic | 1.5 | 1.4 | -6.1 | 8.8 | 8.1 | -7.4 | 29.7 | 30.8 | 3.7 |
| Denmark | 1.6 | 1.6 | 3.2 | 3.9 | 3.5 | -11.3 | 47.0 | 48.8 | 3.7 |
| Germany | 1.6 | 1.8 | 8.0 | 8.4 | 8.4 | 0.4 | 38.8 | 39.6 | 2.0 |
| Estonia | 1.1 | 1.2 | 14.8 | 3.0 | 2.9 | -4.0 | 31.2 | 34.9 | 11.7 |
| Ireland | 2.9 | 3.0 | 3.1 | 1.8 | 2.0 | 9.3 | 39.0 | 43.2 | 10.6 |
| Greece | 0.5 | 0.4 | -8.7 | 1.2 | 1.1 | -12.1 | 32.4 | 32.7 | 0.9 |
| Spain | 0.7 | 0.5 | -33.8 | 3.3 | 3.2 | -3.9 | 30.6 | 33.1 | 8.2 |
| France | 1.2 | 1.0 | -12.7 | 4.1 | 3.9 | -5.1 | 42.8 | 43.6 | 1.9 |
| Italy | 1.1 | 1.1 | 3.8 | 4.9 | 5.0 | 0.4 | 33.4 | 33.6 | 0.4 |
| Cyprus | 0.4 | 0.3 | -37.5 | 0.4 | 0.5 | 21.1 | 34.5 | 33.7 | -2.2 |
| Latvia | 0.4 | 0.5 | 31.6 | 1.4 | 0.9 | -34.8 | 32.1 | 33.3 | 3.8 |
| Lithuania | : | : | : | 1.8 | 1.8 | -2.7 | 30.5 | 32.4 | 6.4 |
| Luxembourg | : | : | : | 0.7 | : | : | 54.2 | : | : |
| Hungary | 2.8 | 2.5 | -9.6 | 5.8 | 5.4 | -7.8 | 33.2 | 34.2 | 3.0 |
| Malta | 2.7 | 2.6 | -3.0 | 2.2 | 1.7 | -21.4 | 39.6 | 40.5 | 2.1 |
| Netherlands | 0.8 | 0.7 | -9.2 | 2.3 | 2.0 | -13.2 | 45.8 | 45.5 | -0.6 |
| Austria | 1.1 | 1.1 | -1.9 | 3.9 | 3.9 | 0.3 | 34.9 | 36.5 | 4.8 |
| Poland | 0.8 | 0.8 | -3.8 | 4.6 | 4.1 | -11.4 | 28.3 | 29.5 | 4.2 |
| Portugal | 0.6 | 0.6 | -12.5 | 2.4 | 2.5 | 4.2 | 28.4 | 29.3 | 3.3 |
| Romania | 0.6 | 0.6 | 3.6 | 4.4 | 4.0 | -8.8 | 19.0 | 19.8 | 4.5 |
| Slovenia | 1.7 | 1.7 | -1.8 | 7.5 | 6.9 | -8.2 | 31.2 | 32.3 | 3.5 |
| Slovakia | 1.8 | 1.5 | -18.0 | 8.4 | 7.1 | -15.4 | 29.6 | 31.0 | 4.9 |
| Finland | 1.9 | 1.6 | -11.8 | 4.2 | 3.9 | -6.7 | 41.8 | 43.0 | 2.8 |
| Sweden | 0.8 | 0.8 | 5.3 | 4.8 | 4.2 | -12.6 | 49.6 | 50.3 | 1.4 |
| United Kingdom | 1.2 | 1.0 | -12.0 | 3.4 | 2.8 | -17.6 | 45.6 | 48.4 | 6.0 |
| EU | 1.2 | 1.1 | -3.5 | 4.8 | 4.6 | -4.8 | 36.9 | 38.1 | 3.3 |
| Iceland | : | : | : | 0.9 | 1.1 | 27.6 | 48.5 | 49.1 | 1.4 |
| Norway | 0.7 | 0.5 | -21.5 | 2.8 | 3.0 | 5.0 | 47.7 | 50.3 | 5.5 |
| Switzerland | 2.7 | 2.8 | 2.6 | 3.8 | 3.6 | -6.1 | 40.9 | 42.9 | 4.7 |
| Croatia | 0.8 | 0.5 | -35.5 | 3.3 | 3.0 | -9.2 | 27.6 | 29.4 | 6.4 |
| Macedonia[3] | 1.0 | : | : | 2.8 | : | : | 22.0 | : | : |
| Turkey | : | 0.3 | : | : | 2.7 | : | : | 18.5 | : |

*Source:* DG Research and Innovation

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*Data:* Eurostat

*Notes:* (1) The values for EE, HR and MK for 2008 and for EE, CY and HR for 2009 are considered to be unreliable or uncertain.
(2) The values for CY and LU for 2008 and for MT for 2009 are considered to be unreliable or uncertain.
(3) The former Yugoslav Republic of Macedonia.

However, the research-intensity has not grown evenly across the different sectors (Table III.3.2). While in general terms, there is a slight increase in total employment in research-intensive sectors in Europe, it is mostly the research-intensive services that are increasing. Following the general movement of the European economy towards a more service-based economy, the Knowledge-Intensive Services present a positive growth over the period of 2008-2009 (the only exceptions are the Netherlands and Cyprus), while the high-tech and medium-high-tech sectors have experienced a clear negative growth over the same period. The exceptions are Germany, Sweden, Ireland and Italy, countries with a manufacturing sector bigger than the average. For these same countries, the growth of employment in Knowledge-Intensive Services, as share of total employment, remains positive, although more modest.

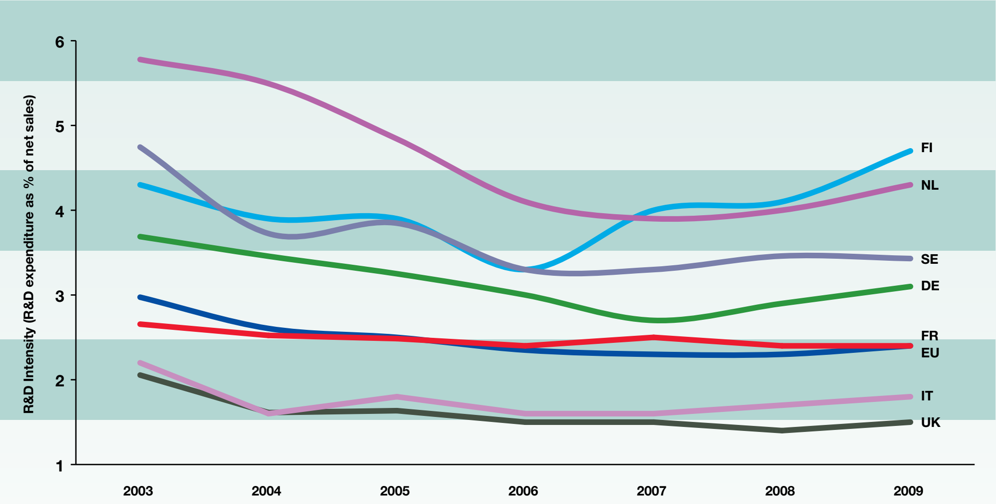
### *Trends in R&D intensities of companies[349] based in selected Member States:*

Finally, structural change from the perspective of R&D intensity can be analysed at the level of firms. The European Industrial R&D Investment Scoreboard analyses data on the 1 000 top EU firms in terms of R&D intensity, covering firms active both in the manufacturing and the services sector.

Worldwide corporate R&D investment growth was high (6.9 %) in 2008, but the trend was decreasing, aggravated by the economic and financial crisis that affected business investment globally — albeit with visible sectoral differences. The 2010 Scoreboard showed that, in comparison with 2008, the EU's growth of corporate R&D investment was higher than that of the United States (8.1 % compared with 5.7 %), and well above the average growth of 6.9 %. Individual sectors contributed differently to the growth: the EU's largest growth came from the medium R&D-intensity sector (automobile and parts sector), while in the case of the United States the sectors with high R&D intensity showed significant growth above the average (5.7 % plus). This confirms the trend observed over the period 2000–2009, showing a strengthening of high R&D-intensity sectors in the United States and a reinforcement of the medium-high R&D-intensity sectors in the EU.

Comparing data from the Scoreboards compiled between 2003 and 2008, the average R&D intensity of the EU-1 000 companies fell because net-sales growth was higher than R&D investment growth (figure III.3.8). In 2009, R&D investment growth was higher than net-sales growth, leading to a small increase in R&D intensity from 2.3 to 2.4 % for the EU-1 000. Higher R&D intensity in 2009 than in 2008 can be observed in most of the countries in figure III.3.8: Finland (continuing the sharp R&D intensity increase due to Nokia largely maintaining R&D despite falling sales), Germany, France and Italy. For companies from the Netherlands and

FIGURE III.3.8 **Intensity trends for EU *Scoreboard* companies**



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*Source:* DG Research and Innovation
*Data:* The 2010 EU Industrial RD Investment Scoreboards (of 2004, 2005, 2006, 2007, 2008, 2009 and 2010).

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[349] R&D intensity is defined as R&D expenditure / sales.

Sweden, R&D intensity fell because net sales developed at a similar pace to R&D investment. This is also the case for UK companies, where R&D intensity has remained unchanged since 2008, and in Italy, where it has stagnated since 2004. However, over the longer time period of 2003–2008, the R&D intensity of firms dropped in all countries except Finland.

## 3.2. Is the manufacturing sector becoming more research intensive?

### 3.2.1. R&D intensity in the manufacturing sector

***The technology gap between the EU and the United States in the manufacturing sectors is growing — in high-tech as well as in medium-high and low-tech industries***

Technological change is a major factor for competitiveness, and in the case of manufacturing industries, for advantage gains. The technology gap is visible in the distribution of manufacturing value added and the average R&D intensity by type of industry for the EU and the United States.[350] These values, as well as research intensity in competing firms, are of a comparable order of magnitude (although not identical) in both economies. The overall level of business R&D intensity in an economy is strongly influenced by the research intensity in high-tech and medium high-tech industries. In chapter 5 of Part I of this report, we saw that in the EU, most of the sectors that perform the majority of BERD, in particular in the high-tech sectors, have become more research intensive during the last decade. But, at the same time, the weight of these same sectors in the EU economy has decreased thus provoking a counter balance effect. And the main reasons for the gap of the EU benchmarked with the United States, Japan or South Korea are a smaller and less research-intensive high tech industry (compared to the United States) and the structure of the economy, more dominated by the services sector (when comparing to South Korea).

***The EU has seen a substantial increase in the R&D intensities of the low- and medium-tech manufacturing sectors***

The knowledge incorporated in the manufacturing industry has increased significantly in all sectors. There has been a drastic change from layout to production chain in the technologies used today, the equipment used in industry, the incorporation of ICT, not to mention managerial and organisational aspects. Consequently, there has been a substantial increase in the R&D intensities of the low- and medium-tech manufacturing sectors at EU level.

### 3.2.2. Knowledge-intensity and economic weight of individual sectors

In order to secure economic competitiveness in high-Value-Added activities, the European Union will have to shift its economic structure to more knowledge-intensive (including research-intensive) activities. The economic structure of the EU and its individual Member States is the result of its competitive position in the global value-added chain of activities. As such, it conditions the levels of R&D investment, primarily in the private sector, as covered in Part I, chapter 5 of this report. In addition, levels of R&D intensity also condition the economic structure, as they reflect the ability of a country to compete internationally in specific sectors or segments of these sectors. In other words, there is a cause–consequence relationship between BERD and economic structure. The existing economic structure affects the BERD investments, which in return affects the resulting economic structure of a country, and its position and capacity to compete in a globalised market.

As a result, it is important to understand the moves of overall BERD investments by discomposing it between increases in BERD intensity and shifts in the economic structure towards more research-intensive activities. Total business R&D intensity is determined by the research intensity of individual economic sectors and by the relative weights of these sectors in the economy. Progress in total business R&D intensity can therefore be obtained through an increased research intensity of individual economic sectors and/or an increase in the share of research-intensive sectors in the economy. Figure III.3.10 and figure III.3.11 depict the impact

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[350] See analysis in Part I, chapter 5.

## Reconversion and modernisation of traditional sectors — The textile industry

Lessons can be drawn from successful reconversions: the EU has a higher ‘technological specialisation’ in textiles compared to its competitors the USA and Japan. How has this transformed the activities in this sector?

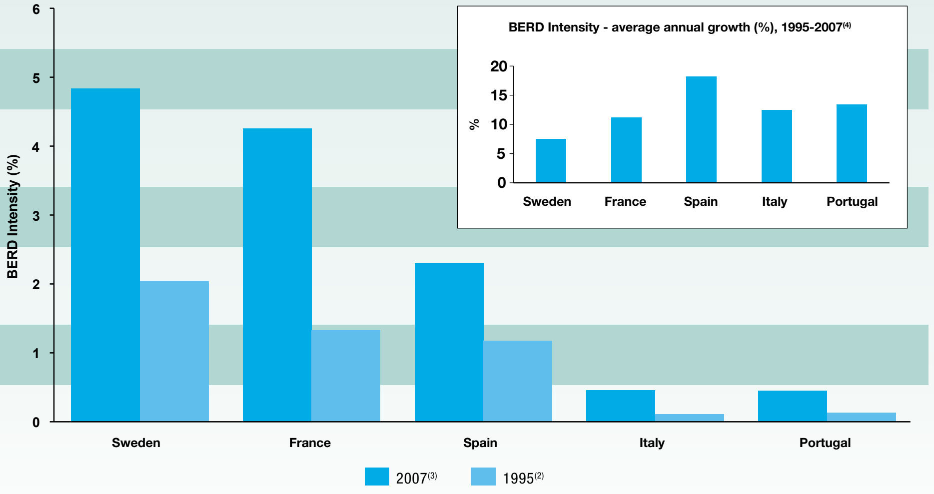
*Case studies on the textile industry: Italy, Spain, Portugal, France and Sweden*

The textile sector is an important part of the European manufacturing industry, playing a vital role in the economy and in social well-being in numerous regions of the EU. In 2006 there were 220 000 companies employing 2.5 million people and generating a turnover of EUR 190 billion. The textile and clothing sector accounted for 3 % of total manufacturing Value Added in Europe. How have countries like Italy, Spain and Portugal, where textiles and clothing are a traditional manufacturing sector, coped with the competition from China and India?

During the 1980s and 1990s, some countries (such as France and Sweden) invested in a technological upgrade of their textile sector so that their 1995 BERD intensity was respectively 2.03 % and 1.33 % — values well above the R&D intensities registered for Portugal, Italy and Spain (respectively 0.13 %, 0.11 % and 0.43 %), as shown in the Figure III.3.9. And even if these three latter countries had strong increases of their BERD intensity of the textile sector over the period 1995–2007, with growth values varying from 12.10 % in the case of Portugal to 16.59 % for Italy, this cannot be compared with the level of incorporated knowledge for the equivalent sectors in France and Sweden, which reached a BERD intensity of 4.26 % and 3.86 % in 2006. Given the global evolution of the textile market, the competitiveness of the textile sectors of Spain, Portugal and Italy are at risk if the BERD intensity is not substantially raised.

FIGURE III.3.9

BERD Intensity (BERD as % of value added) in the textile sector[(1)], 1995[(2)] and 2007[(3)]



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*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) SE: Textiles includes wearing apparel and fur and leather and footwear.
(2) ES: 2002.
(3) PT: 2005; ES, FR: 2006.
(4) PT: 1995-2005; FR: 1995-2006; ES: 2002-2006.

that these two different forces have had in European economies in terms of volumes of private investment over a time spam of more than ten years.

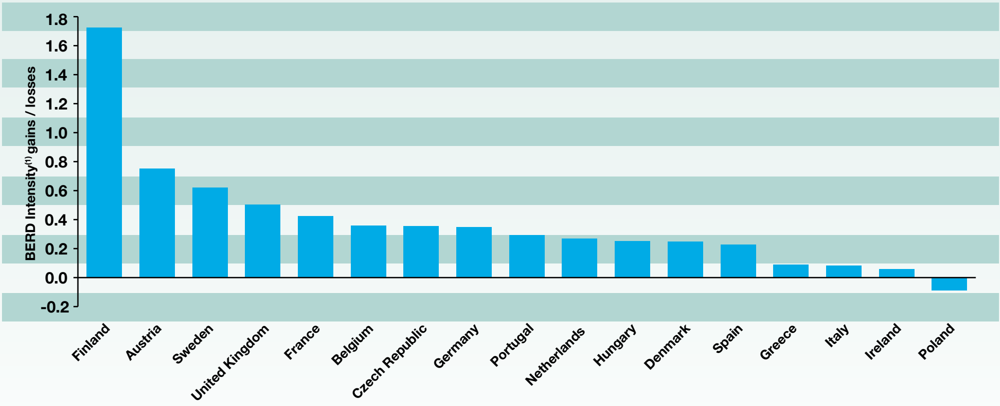
### *Most EU Member States have increased the overall BERD intensity of their economic sectors, while the economic weight of the most knowledge-intensive sectors has decreased*

Figure III.3.10. represents the gains in private R&D based on gains in BERD intensity[351] in economic sectors at country level over the period 1995–2007. As shown, all the countries (with the exception of Poland), registered positive gains, in line with an overall increase of knowledge in the European economy and an increase in R&D intensity at EU level. However, progress was uneven across Member States. Denmark, Finland, Austria and Sweden made higher progress than Germany and Spain. Italy shows more modest progress compared to Austria or the Czech Republic. These data suggest that some countries have intensified their R&D investments in existing sectors, probably to match the tough international competition in high R&D sectors, such as ICT, while some other countries have made more moderate progress.

These increases in BERD intensity can respond to either (1) a strategy to move towards higher-value-added activities within sectors, or (2) a reaction aimed at maintaining its competitive position in view of the increases of foreign competitors.

FIGURE III.3.10

**BERD Intensity(1) gains / losses if the economic structure remains constant over the period 1995-2007(2)**



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*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) For the purposes of this graph BERD Intensity is defined as BERD as % of value added.
(2) IE, EL, PT: 1995-2005; BE, DE, FR, HU, NL, PL, UK: 1995-2006; AT: 1998-2006; DK: 2001-2006; ES: 2002-2006.

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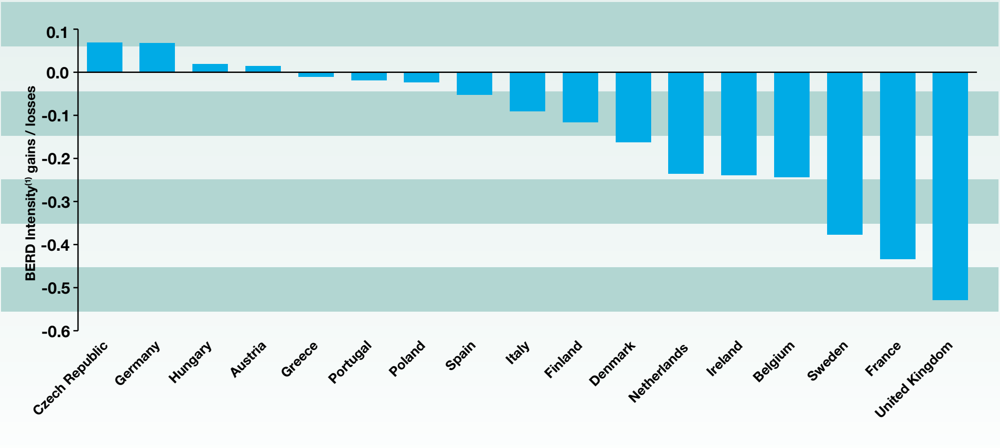
[351] BERD intensity is defined as the value of private R&D investment as a percentage of total Value Added.

FigureIII.3.11. presents the effect on BERD intensity caused by changes in the economic structure over the same period as the previous figure. In other words, it presents the shifts in the economic structure towards more (or less, if negative) research-oriented activities.[352] As in the previous case, European countries differ in their evolution. Overall, most European economies, with the exception of Germany, Austria, Hungary and the Czech Republic, have experienced an evolution towards a lower weight of research-intensive sectors in the economy, mainly due to the long-term shift from manufacturing to services, in, for example Denmark and the United Kingdom, or construction, as in Spain.

While structural change is largely influenced by the evolution of international economic drivers, the strategies and policies that countries and regions adopt can define a framework conducive to the stimulation of structural changes. These strategies and policies may need to be adapted to the specific circumstances of the individual countries, and sometimes they may favour moves towards higher-value-added activities within existing sectors, building on the existing experience, and sometimes they may require a shift towards new sectors. More precisely, in Europe, there are countries which still have margins to increase knowledge-intensity in existing sectors, as their production may focus on low- or intermediary-value added goods or services. Some other countries are close to the 'technological frontier'[353] and therefore may need to change the weights of its sector composition in their economy, favouring the expansion of more knowledge-intensive sectors. Specificities of each country and their different strategies concerning R&D and innovation such as smart specialisation[354], international exports or the creation of clusters are directly connected to these strategies. At this point it should be noted that these strategies should be the result of a wide-ranging

FIGURE III.3.11 The effect on BERD Intensity(1) of changes in the economic structure over the period 1995-2007(2)



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*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) For the purposes of this graph BERD Intensity is defined as BERD as % of value added.
(2) IE, EL, PT: 1995-2005; BE, DE, FR, HU, NL, PL, UK: 1995-2006; AT: 1998-2006; DK: 2001-2006; ES: 2002-2006.

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[352] BERD intensity gains result from calculating the gains due to changes in BERD intensity, if the economic structure had remained constant (BERD intensity 2007 – BERD intensity 1995) *VA 1995. The gains in shifts in the economic structure would result of gains in the difference in the relative importance of each sector in the economy, if the BERD intensity would have remained the same (VA 2007 – VA 1995) *BERD intensity 1995.

[353] The technological frontier is defined as the state-of-the-art level of technological development for one specific sector. The products and services offered at the technological frontier are knowledge-rich and of the highest-value-added.

[354] Foray D, David P A and Hall B (2009): 'Smart Specialisation: the concept', *Expert group 'Knowledge for Growth', May 2009.* See also the section "New Perspectives", chapter 2 in this report.

consultation to identify particular strengths that support strategies in an international competitive contest.

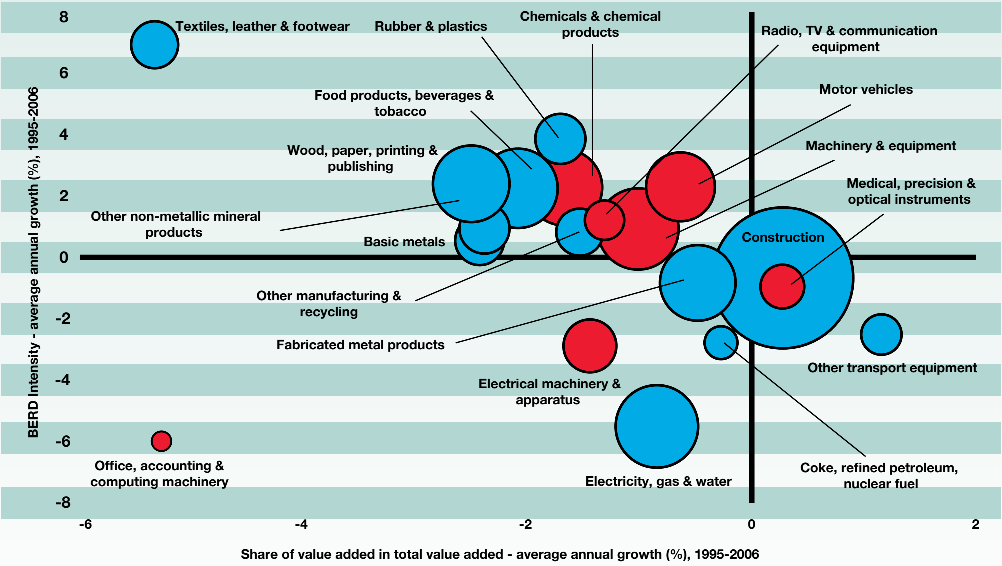
This chapter aims to introduce some insights into the current situation of the EU by analysing the changes that have occurred in the sectoral composition of the EU as a whole by tracking the evolution of each sector over a period of 12 years.

In addition to the overview presented for the EU (together with a breakdown for the EU-15 and the EU-12) similar graphs for each country are included in the country information sheets found at the end of the report they identify potential solutions to stimulate the needed structural shift in the national economies.[355] In order to achieve this goal, this chapter will analyse the changes that the EU, EU-15 and EU-12 experienced in a time span of more than ten years, both in the research intensity of the economic sectors and in the shifts of weight that different sectors carry on the economy. More precisely, four variables will be analysed: (1) changes in R&D intensity, (2) changes in the value added, (3) overall level of R&D intensity and (4) share of the sector in total value added.

The following three graphs show the evolution of the research intensity of individual economic sectors (sectoral research intensity) and the evolution of the weight of individual sectors in the economy (provided by the respective value added). Sectors above the x-axis are sectors whose research intensity has increased between 1995 and 2007 . Sectors on the right-hand side of the y-axis are sectors whose economic weight has increased over the same period of time. The size

FIGURE III.3.12

EU(1) – Share of value added versus BERD Intensity – Average annual growth, 1995-2006



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*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) EU does not include BG, EE, IE, EL, CY, LV, LT, LU, MT, AT, PT, RO, SI.
(2) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.

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[355] See section 'Overall review of the EU Member States and Associated countries' in the end of the report.

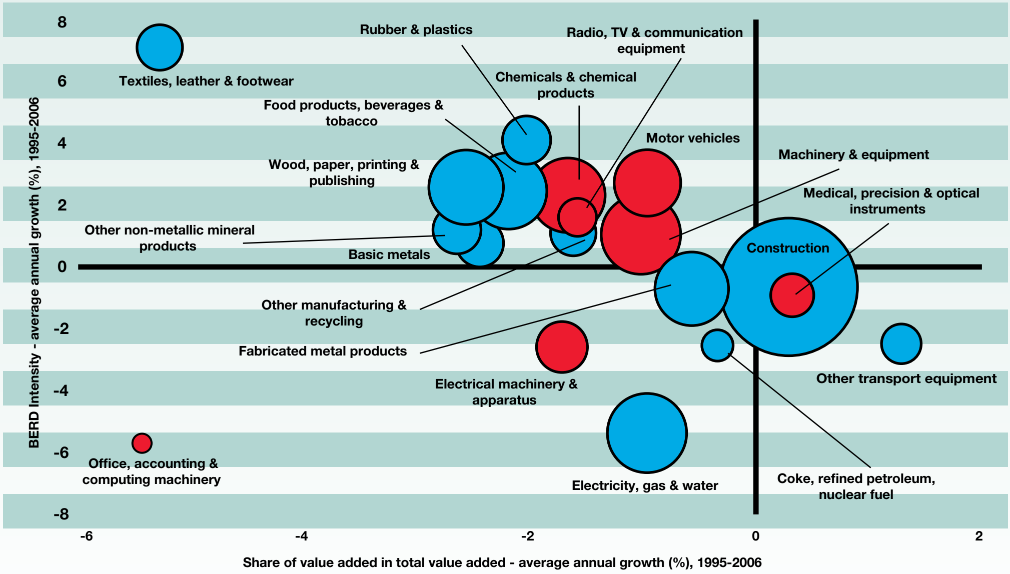
of the bubble reflects the share of the sector (in value added) in the economy. Red sectors are the high-tech and medium high-tech sectors, i.e. the most research-intensive sectors of the economy. The others are represented in blue. The graphs therefore allow rapid identification of the size of research-intensive sectors in the economy of the country, as well as their evolution in terms of research intensity and of their weight in the economy. It also illustrates the internal structural change of some low or medium-tech sectors such as rubber and plastics, or textile and clothing or food products, where the overall R&D intensity has grown rapidely over the period, demonstrating an intra-sectoral specialisation towards more knowledge-intensive activities.

One caveat: the lack of available data for all 27 EU Member States. The main OECD source used[356] only covers 18 Member States. Also, from this perspective, the inclusion of analysis at the level of the services sectors would be desirable, but data availability makes it impossible at this stage.

The first graph (figure III.3.12), in which all the available EU Member States are aggregated, illustrates the decrease of the weight of the manufacturing sectors (by the positioning of the majority of the bubbles in the left side of the graph). It is also clear that most of the high-tech and medium high-tech sectors are in the upper side of the graph, thus showing an increase in BERD intensity. The move towards more research-oriented sectors has some notable exceptions: electrical machinery and

FIGURE III.3.13

**EU – 15 Member States$^{(1)}$ – Share of value added versus BERD Intensity – Average annual growth, 1995-2006**



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) EU: BE, DK, DE, ES, FR, IT, NL, FI, SE, UK.
(2) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.

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356 In order to ensure inter-sectoral BERD comparability, the OECD ANBERD database was used. Available data only allowed for the analysis of 17 Member States, albeit representing around 90 % of the total EU BERD.

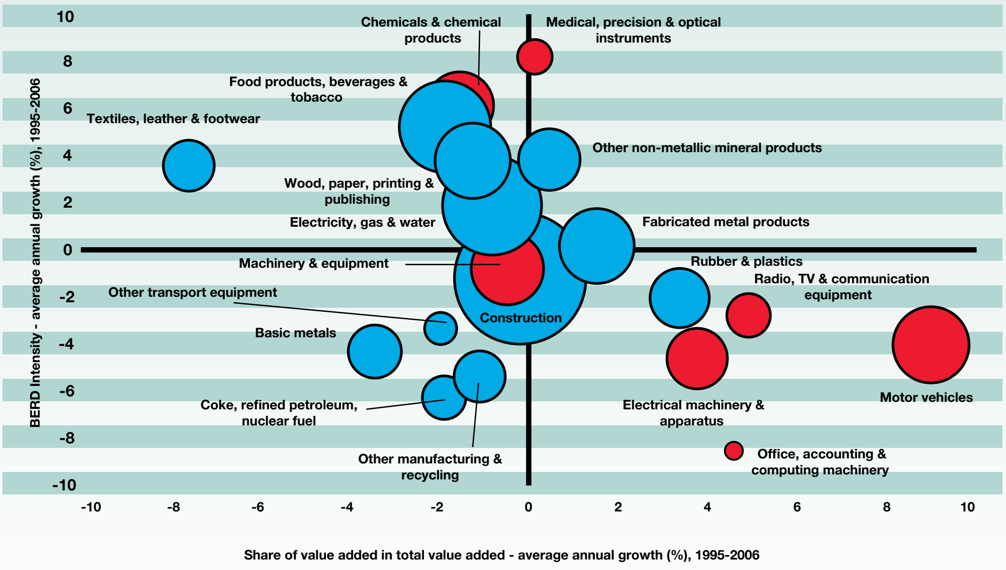
apparatus, medical precision and optical instruments, and office accounting and computing machinery, which reduced the BERD intensity over the period in analysis.

The figure III.3.13 of the EU-15 Member States shows a very similar panorama. In contrast, the third figure (figure III.3.14), of the EU-12 Member States, presents a completely different panorama. This third figure shows the 'catching-up' effect, with a few of the manufacturing sectors still increasing their weight in the overall economy - this partly responds to their capacity to compete internationally in global markets. However, these sectors, mostly high-tech or medium high-tech sectors, have decreased their R&D intensity over the period 1995–2006, weakening their long-term competitiveness. A common feature in both the EU-15 and the EU-12 is the weight of the construction sector.

The structural change towards higher R&D intensity within sectors in the EU has not been sufficient in itself to raise the knowledge intensity of the economy. When benchmarking with the United States, for example, we see that there is still room for further increases in the research intensity of the high and medium high-tech industries. The structural composition of the economy is another aspect, as discussed previously in chapter 1 of Part III on fast-growing companies. This aspect alone is linked to the development of lead markets and obstacles to the growth of new technology-based firms. An economy can move towards more and larger knowledge-intensive sectors only with the emergence of new and fast-growing firms.

FIGURE III.3.14

**EU – 12 Member States(1) – Share of value added versus BERD Intensity – Average annual growth, 1995-2006**



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) EU: CZ, HU, PL, SI.
(2) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.

# CHAPTER 4

# Achieving economic competitiveness

## HIGHLIGHTS

This chapter addresses the different factors conducive to improved competitiveness, in particular labour productivity and the role of high-tech industries and knowledge intensive services, as well as the role of high tech exports in the overall trade balance.

There remains a significant gap between the EU's innovation performance and that of the United States and Japan, as illustrated by the Innovation Union Scoreboard 2010. The EU's innovation performance relative to the United States has been smoothly improving while the performance gap relative to Japan is stable. Compared to China, the EU still has a clear innovation performance lead but it is declining, as China's performance has grown at a faster rate than of the EU.

One impact of the economic and financial crisis has been on EU labour productivity: in 2009 it fell back to the levels of 2000 and is now below the productivity levels of both the United States and Japan. Member States show very different situations. Luxembourg is leader in labour productivity, with almost twice the EU-19 average; the Netherlands, Ireland, Belgium and France have comparable levels as those of the United States.

A feature common to the bigger Member States like France, the United Kingdom and Germany, is the decrease in their share of high tech exports in total exports. This is directly linked to the emergence of the Asian economies which have the largest share of high-tech products in their exports, almost double that of the EU. However it should be noted that high-tech exports do not as such necessarily reflect the knowledge intensity of an economy. A distinction between different types of high-tech exports should be made in what concerns the value added and initial origin of the product.

The regions in Europe are very different and have specific innovation performances even within Member States. The most innovative regions are located in the most innovative Member States: Finland, Sweden, Denmark, Germany and the United Kingdom. But there are regions that are exceptions, since they perform well above the average national environment in what concerns innovation. Large differences in competitiveness among regions are observed in some Member States, e.g. Italy, Spain and Portugal.

## 4.1. Is Europe improving its innovation capacity?

### *The United States and Japan are holding their lead over the EU*

The Innovation Union Scoreboard 2010 (IUS)[357] includes an analysis of EU performance compared with that of the United States and Japan based on a set of 12 comparable indicators. The figure III.4.1. shows that the EU's performance gap relative to the United States has been slightly increasing, while the performance gap relative to Japan is stable. The United States is performing better than the EU on 10 indicators (Figure III.4.2.). In Public R&D expenditure and knowledge-intensive services exports, the EU is performing better. Overall there is a clear performance lead in favour of the United States, although the EU is catching up on several indicators, including scientific excellence and technological performance.

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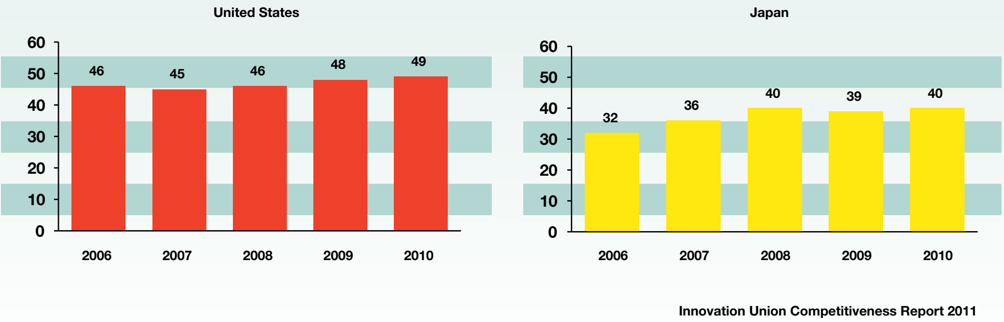
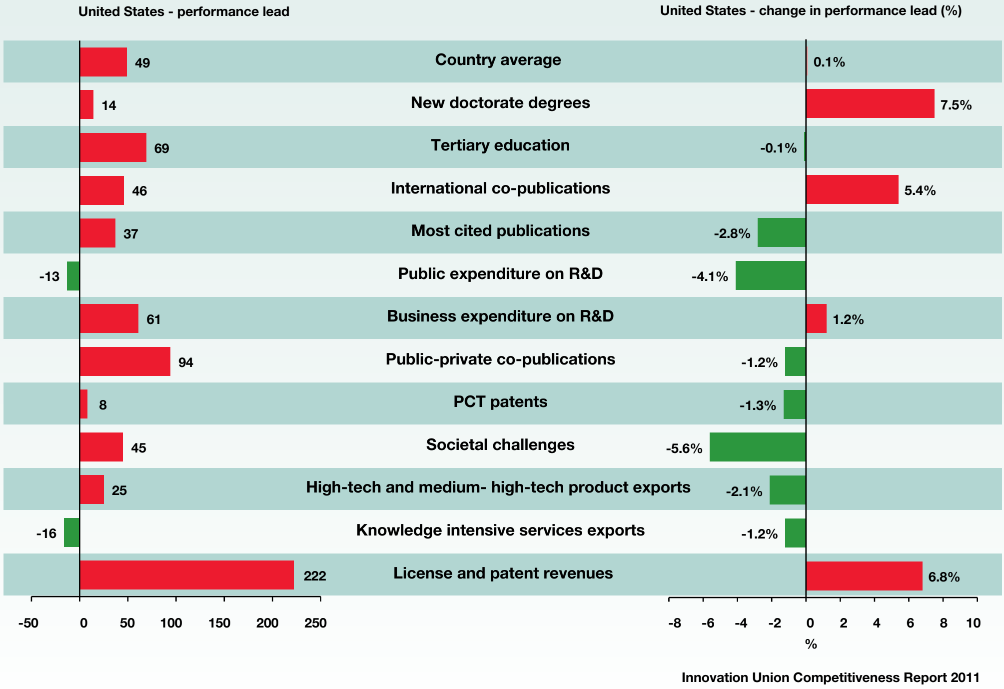
[357] The IUS report, its annexes and the indicators' database are available at http://www.proinno-europe.eu/metrics.

## FIGURE III.4.1 EU innovation performance compared to main competitors[1]



*Source:* DG Research and Innovation, DG Enterprise
*Data:* Innovation Union Scoreboard 2010
*Note:* (1) Performance is measured as 100*(X / EU)-1where X refers to the value for the indicator for the country X and EU to the value for the indicator for the EU. The values in the graphs should be interpreted as the relative performance compared to that of the EU e.g. the United States in 2010 is performing 49% better than the EU.

## FIGURE III.4.2 EU innovation performance compared to the United States



*Source:* DG Research and Innovation, DG Enterprise
*Data:* Innovation Union Scoreboard 2010
*Note:* (1) **Left**: The indicators highlighted in red reflect a performance gap for the EU; those highlighted in green reflect a performance lead for the EU.
**Right**: Relative growth compared to that of the EU. Red coloured bars show that the United States is growing faster than the EU; green coloured bars show that the United States is growing slower than the EU.

### *Though holding its lead over China, the EU is losing ground*

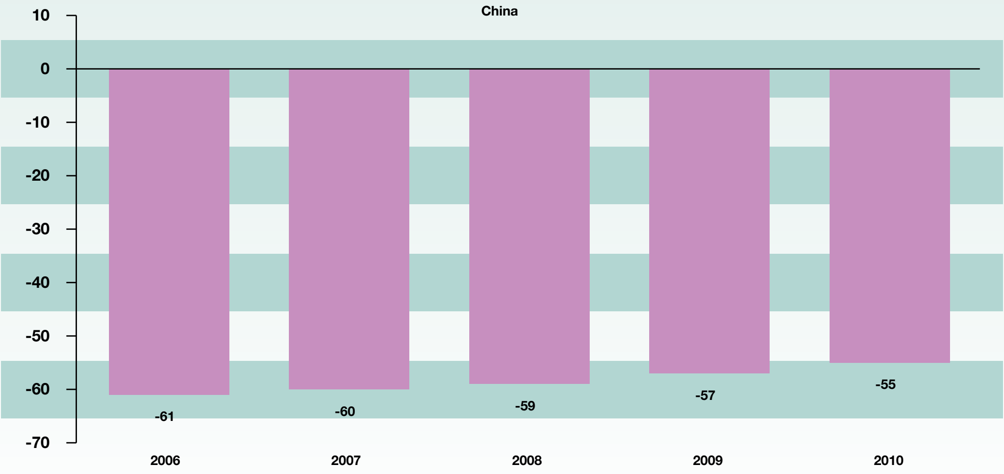
Compared to China, the EU still has a clear innovation performance lead. Using the same set of 12 indicators used for comparison with the United States and Japan (Figure III.4.3.), the EU is performing better than China in most indicators. However, the EU's lead is declining, as China's innovation performance has grown at a faster rate than that of the EU. The EU has increased its lead in most-cited publications and public R&D expenditure.

### *The Regional Innovation Performance Index (RIPI) confirms that the innovative capacity of the EU is concentrated in the most developed countries*

In chapters 3 and 4 of part III, we have analyse different factors conducive to improved competitiveness, such as labour productivity and the role of high-tech industries and knowledge-intensive services. European regions are very different and have specific innovation performances, even inside a single country. Governments are engaged in designing policies which are relevant and adequate at the local level[358], for which it is necessary to know the main determinants of potential growth and why different regions present different performances. The map below (figure III.4.4) shows the innovation capacity of 201 regions of the EU given by the Regional Innovation Performance Index. This figuration has been calculated using a composite indicator based on 16 of the 29 indicators used in the EIS 2009.[359]

The most innovative regions are located in the most innovative countries, as is the case for Finland, Sweden, Denmark, Germany and the United Kingdom. But there are exceptions — regions that perform well above the average environment, such as Lombardy and Emilia-Romagna in Italy, the Basque Country, Navarre, Madrid and Catalonia in Spain, West Slovenia, the capital city regions of Hungary and Slovakia, and Prague.

FIGURE III.4.3 **EU innovation performance compared to China**



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*Source:* DG Research and Innovation, DG Enterprise
*Data:* Innovation Union Scoreboard 2010

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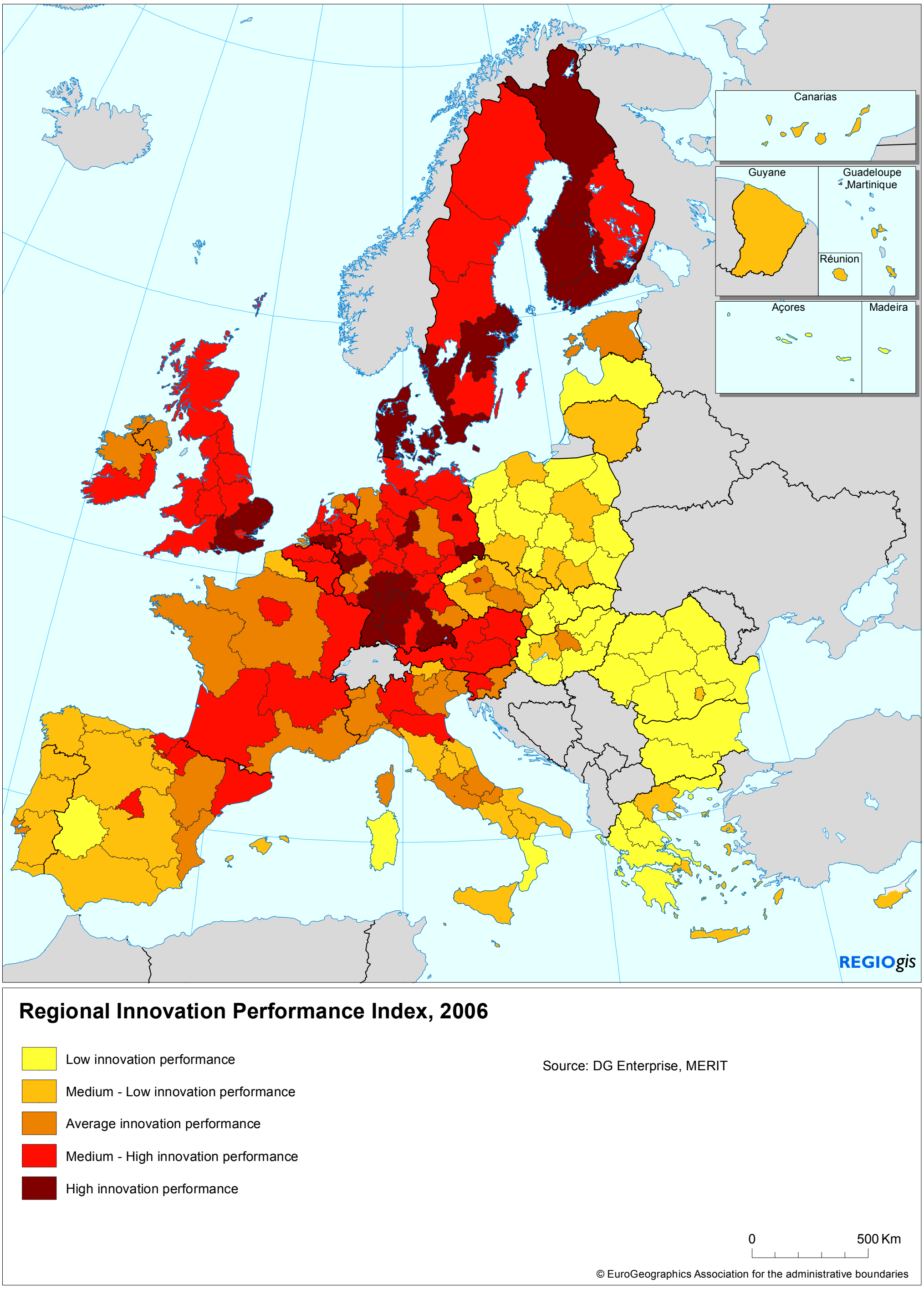
[358] See the Report "Investing in Europe's Future, Fifth Report on Economic, Social and Territorial Cohesion", DG Regional Policy, November 2010

[359] EIS: European Innovation Scoreboard, DG ENTR, 2009.

## FIGURE III.4.4 Regional Innovation Performance Index, 2006



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*Source:* DG Research and Innovation
*Data:* DG REGIO

## 4.2. Is Europe improving its productivity and competitiveness?

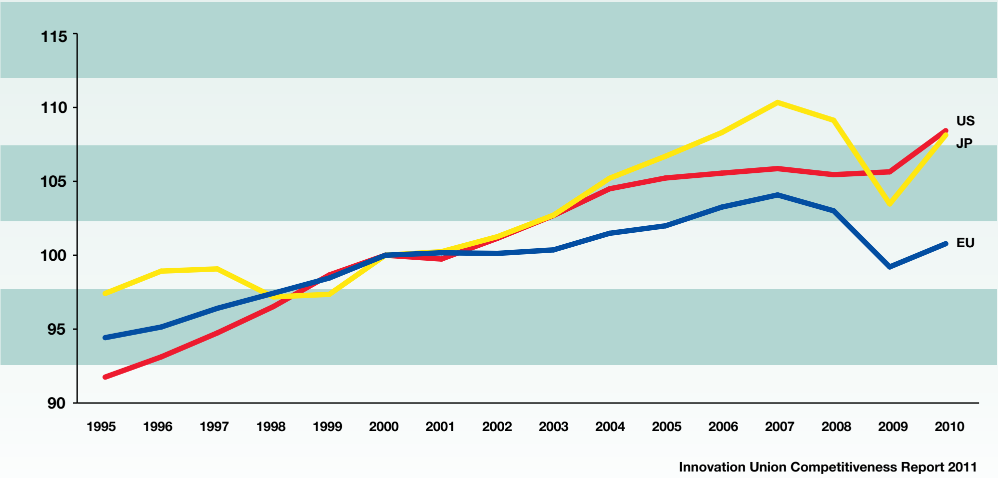
### *In 2009, EU total-factor productivity slowed down to the levels of 2000 and fell well below the productivity level of the United States and Japan*

Since the year 2000, four countries show a negative total-factor productivity growth[360]: Italy, Spain, Portugal and Luxembourg, with stronger decreases for Italy and Luxembourg (figure III.4.7). The other countries have a good position for the last year available, but have registered different evolutions since 2000: Austria, Belgium, Ireland, Denmark, Germany, Finland, Sweden and the United Kingdom increased their productivity up to 2008, showing an abrupt fall for this year, and recovering over 2009–2010 (for values as in 2006). The Netherlands were stable for four years from 2000–2003, growing until 2008 and decreasing afterwards. Two exceptional situations were represented by France and Greece. France, though following a similar trend, experienced only a slight increase in the period 2000–2008 followed by a fall to values above those registered in 2000, and Greece had stronger increases over the same period, and smaller decreases in 2008.

It is interesting to note that the productivity of the United States progressed more than France, Italy or Germany in the period 1995–2000. Japan is evidencing a more limited progress for the same period.

This report has at several places suggested a link between R&D investment and innovation performance, and between total factor productivity of a country and its level of R&D investment. The figure III.4.6 seems to indicate a correlation between the change of the total

FIGURE III.4.5 **Total factor productivity (total economy), 1995-2010 (2000=100)**



*Source:* DG Research and Innovation
*Data:* DG ECFIN

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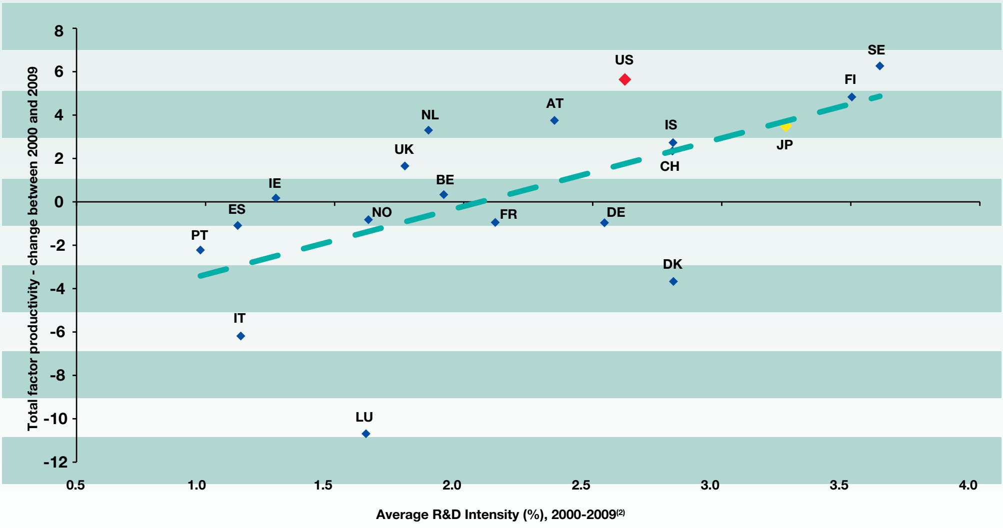
[360] Total Factor Productivity (TFP) is the portion of output not explained by the amount of inputs used in production. As such, its level is determined by how efficiently and intensely the inputs are utilised in production.

FIGURE III.4.6

## R&D Intensity (average) and total factor productivity[(1)] (evolution), 2000-2009



**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat, DG ECFIN
*Notes:* (1) Total factor productivity, total economy, 2000=100.
(2) JP: 2000-2007; IS, CH, US: 2000-2008; NO: 2001-2009; NL: 2003-2009; FR: 2004-2009; SE: 2005-2009; DK: 2007-2009.
(3) EL, LU, IS, CH: R&D Intensity is not available for every year. The R&D Intensity average is the average of the available values.

factor productivity, over the period 2000-2009 and the average level of R&D intensity for the corresponding period.[361] The countries that have achieved higher levels of R&D intensity and are leaders in innovation performance, also achieved higher levels of productivity. This is the case for Finland and Sweden, but also for Japan and the United States. It is interesting to note that the positioning of the different countries is in line with the country grouping model constructed in the part New Perspectives, chapter 1. based on the knowledge capacity and economic structure of each country.

### *Europe has a lower labour productivity growth than the United States*

Though labour productivity is considered to be only indirectly connected to innovation, and even more distant to research investments, it is a way of measuring the outputs of the research and innovation systems.

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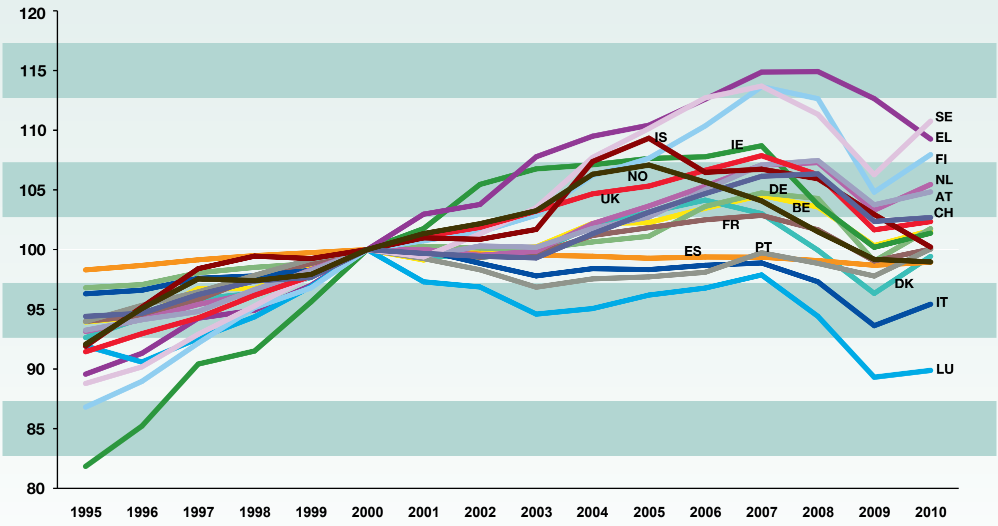
[361] Naturally, other co-evolving factors can explain this correlation, given the complexity of productivity growth.

## FIGURE III.4.7 Total factor productivity (total economy) by country, 1995-2010 (2000 = 100)



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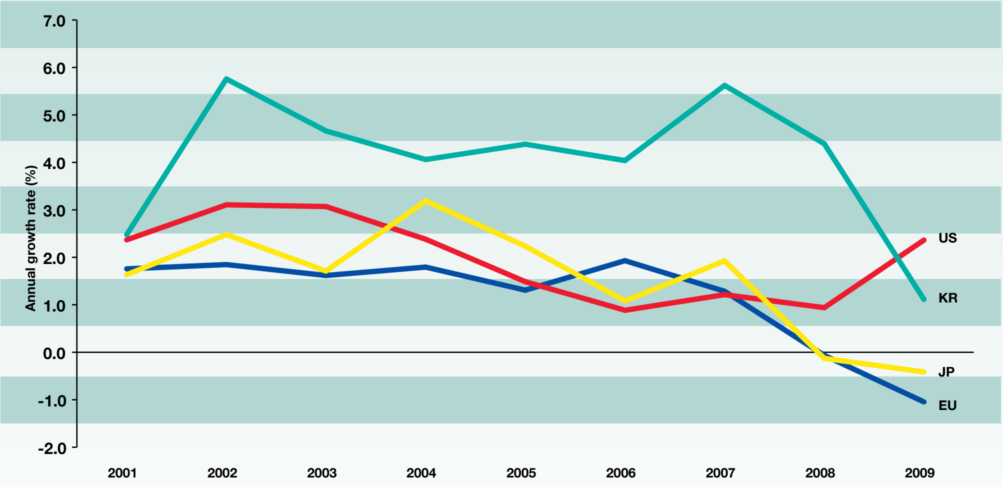
*Source:* DG Research and Innovation
*Data:* DG ECFIN

## FIGURE III.4.8 Labour Productivity – Annual real growth rate[(1)], 2000-2009



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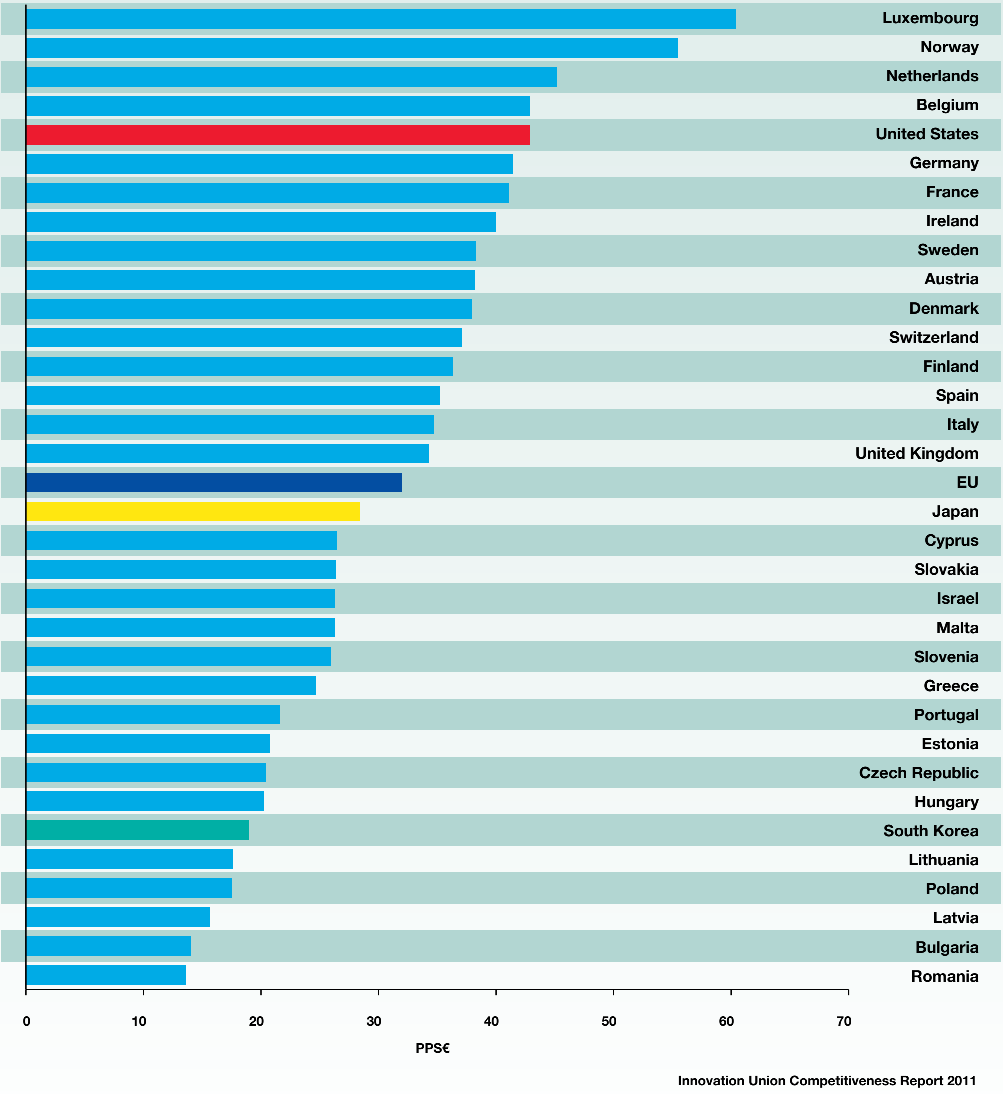
*Source:* DG Research and Innovation
*Data:* Eurostat, OECD
*Note:* (1) Derived from GDP per hour worked in PPS€ at constant prices (base year 2000).

FIGURE III.4.9 **Labour Productivity – GDP per hour worked in PPS€, 2010(1)**



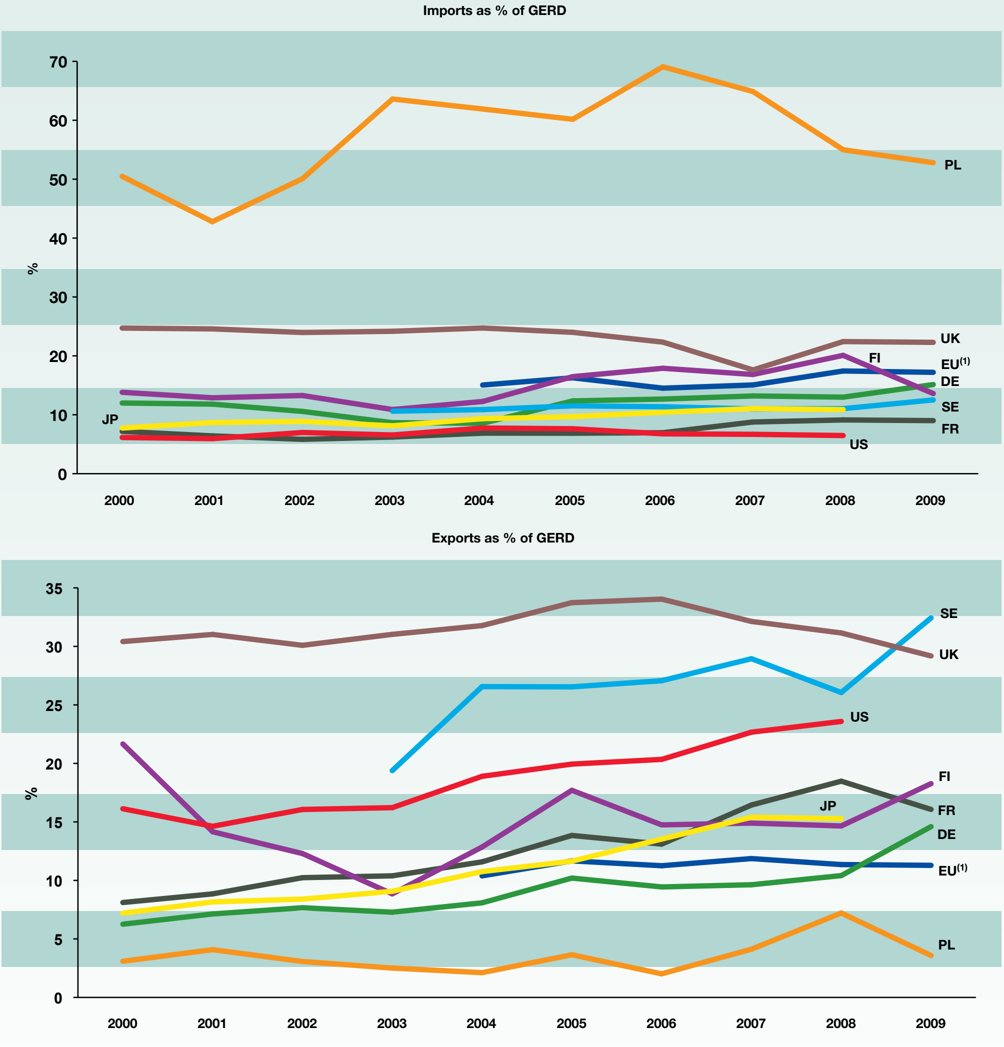
*Source:* DG Research and Innovation
*Data:* Eurostat, OECD
*Note:* (1) CH: 2008; EU, BE, CZ, ES, FR, LU, MT, SI, UK, NO, US, JP, KR, IL: 2009.

***Luxembourg is the leader in labour productivity, almost reaching the double value of EU-19 average; Norway, the Netherlands, and Belgium have equivalent levels similar to those registered by the United States***

Figure III.4.9. presents the estimated values for hourly labour productivity for 2010 for EU19 countries and the United States, Japan, South Korea: only Luxembourg, Norway, the Netherlands and Belgium surpass the US labour productivity; the EU19 average is clearly below the labour productivity of the United States but above that of Japan and South Korea.

International trade in technologies can be measured by the international transactions in royalties and licence fees as a % of GERD. A high and growing export of royalties and license fees is an indication of a competitive technology and innovation capacity. However, it could also indicate a domestic incapacity to absorb new technologies produced in the country. The import of technologies indicates, on the other hand, a domestic demand and absorptive capacity, reinforcing the knowledge intensity of the country. It could be related to an economic catching-up strategy, backed up by the absorption of knowledge produced elsewhere. However, it is also a sign of a weaker capacity of domestic knowledge production, since knowledge-intensive economies tend to have a positive trade balance of technologies.

FIGURE III.4.10 International transactions in royalties and licence fees



*Source:* DG Research and Innovation
*Data:* Eurostat
*Note:* (1) Extra-EU-27.

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### *The EU is a net importer of technology, but several Member States register a trade surplus*

Figure III.4.10 on export of patents and licences illustrates the higher degree of international competitive-technology production of the United States and Japan when compared to the EU. In 2008, the export of royalties and licence fees of the EU amounted to 10.4 % of GERD, compared to 23.0 % the United States and 15.4 % for Japan. Inside the EU, the United Kingdom and Sweden have high levels of technology exports (27.7 % and 27.2 % respectively). France, Germany and Poland experienced growing technology export since 2000.

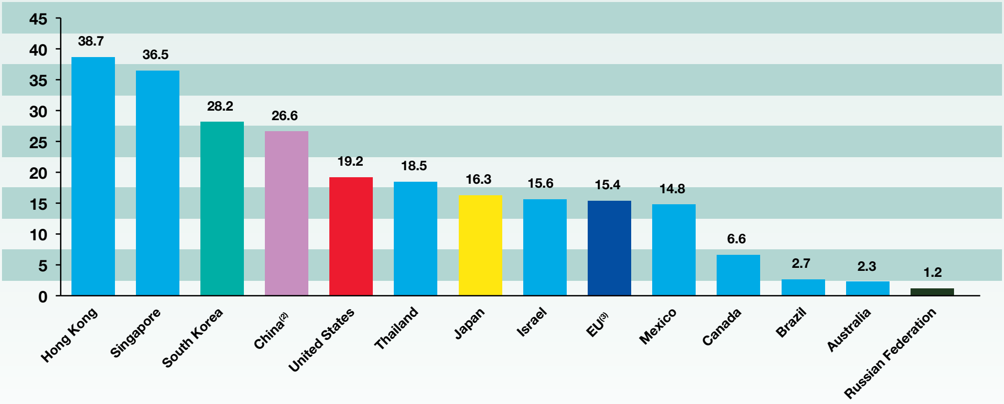
Comparing export with import, it can be seen that the EU has a trade deficit in royalties and licences, while the United States and Japan strongly expand their export while maintaining a lower and more stable level of import. The United Kingdom, Sweden and France have a trade surplus, while Finland and Poland have higher import than export.

### *The emerging Asian economies have the world's largest share of high-tech products in their exports — almost double that of the EU*

Countries commercialise the results of research and technological developments in international markets. The share of high-tech products and knowledge-intensive services exported is a way of measuring the performance and innovativeness of a country's products, technologies and processes.

The figure III.4.11 shows in what degree high-tech products are relevant to the total exports. Hong Kong, Singapore, South Korea and China have the highest shares of high-tech products in their export. This is the confirmation of a coming trend observed since 2000, when China had less than 18 % of high-tech exports in all its exports. While China has been continuously growing, there has been a marked decrease in the EU, Japan and the United States. During the same period the EU was reduced to a share of 15.4 % and Japan and the United States to 16.3 % and 19.2 % respectively. In 2006, the EU had a share around 17 % of high-tech exports in total exports.

FIGURE III.4.11 **High-Tech exports as % of total national exports, 2008[(1)]**



*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) KR: 2007.
(2) China: Hong Kong is not included.
(3) EU: Intra-EU exports are not included.

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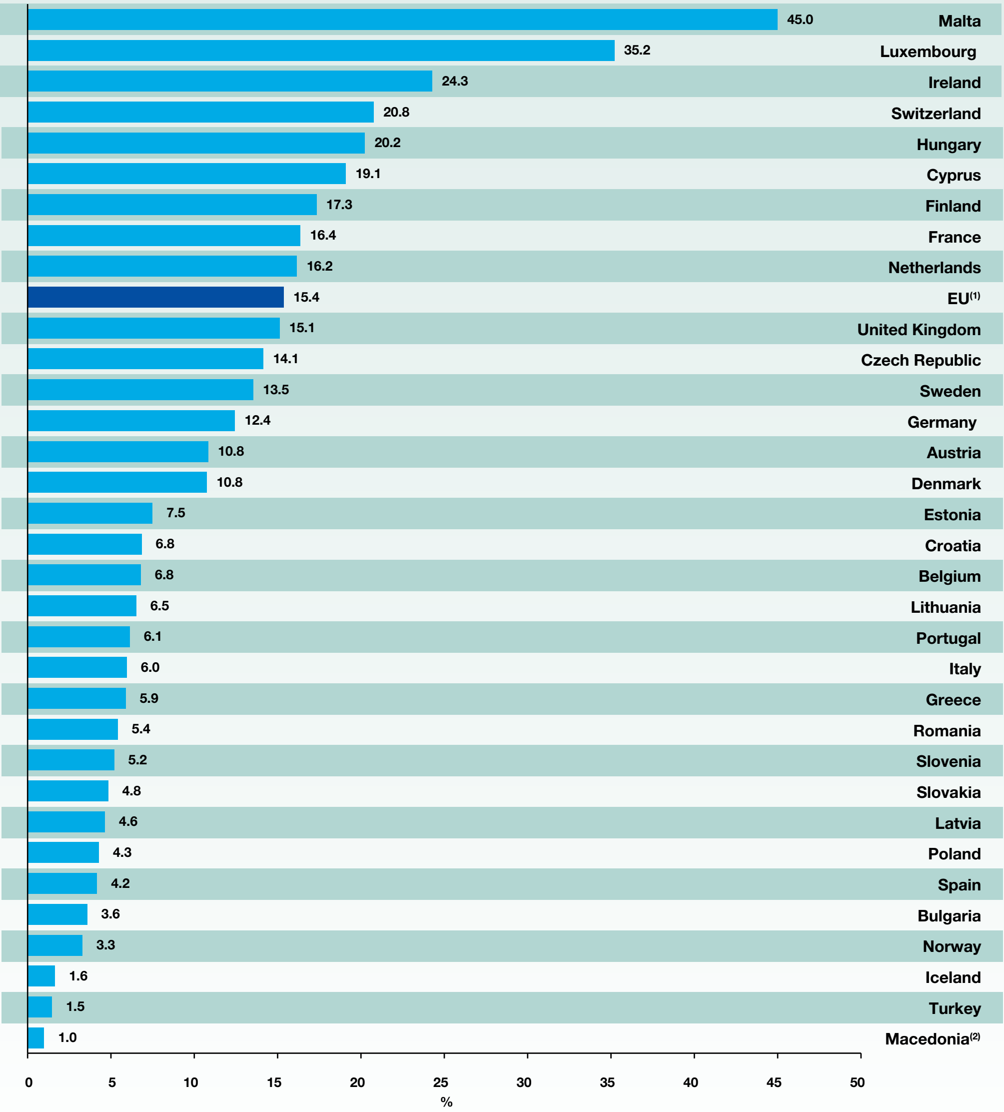
## FIGURE III.4.12 High-Tech exports as % of total national exports, 2008



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*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) EU: Intra-EU exports are not included.
(2) The former Yugoslav Republic of Macedonia.

To better interpret high-tech exports as an indicator for a knowledge-based economy, a distinction should ideally be made between different types of high-tech exports, namely in what concerns the value added and the initial origin of the product. This is particularly clear for the ICT products, where computer assembly is counted. Countries with a low-cost labour force such as China have had a competitive advantage and have consequently taken over the manufacturing part of the value chain for many such products. The consequence is that high-tech exports do not necessarily reflect the knowledge intensity of an economy. The examples of Ireland and Malta (figure III.4.12), which are specialised in ICT exports, further illustrate this analytical effect, because their R&D intensities are quite low, although their export industries are highly focused on the manufacturing of ICT products for multinational enterprises.[362]

### *Technology-driven industries increasingly dominate EU imports from China*

In 2007, the share in EU imports from China of these industries was already higher than in intra-EU imports, while high-skill industries recorded rapidly rising shares between 2000 and 2007, providing evidence for China's technological upgrade. Moreover, China (as well as India and even Russia) has been successful in price competition in high-skill industries and gained market shares in the EU. In a longer-term perspective, this 'industrial upgrading' is the most serious challenge to the EU in maintaining its competitive advantages in high-value-added products and services.

### *The bigger Member States, like France, the United Kingdom and Germany are decreasing their share of high-tech exports in total exports*

Focusing on the situation of EU-27 at country level, the tendency is to an increase of the share of high-tech exports in total exports, namely for the bigger and more advanced countries, like the United Kingdom, France and Germany, with values around the EU average or below (figure III.4.13).

### *Almost all EU Member States have increased the knowledge-intensity in their manufacturing export as share of the trade balance*

It is hard to measure the quality of these goods, or the quality of the innovation incorporated in them, using trade statistics. An indicator that can address this aspect is constructed on the contribution of innovative-related trade in manufacture goods to the balance of trade of goods, as shown in the figure III.4.13 reporting on high- and medium-high-tech manufacturing goods for the trade balance (2000 versus 2008). It is another way of expressing the degree of knowledge specialisation in international competition, of a country. It includes the aspects related to imports and re-exports of goods, after value added, that are not visible in the data. Considering this indicator, a positive evolution of the knowledge intensity of the trade balance is visible for almost all countries. In 2008, Greece continued to show a negative value. Most of the Member States showed significant increases between 2000 and 2008. Very positive change can be observed for Poland and Portugal, with a negative situation in 2000.

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[362] See also 'Made in China' tells us little about global trade, by Pascal Lamy, FT Published: January 2011.

FIGURE III.4.13 Contribution of high-tech and medium-high-tech manufactured goods to the trade balance, 2000 and 2008

Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* OECD
*Note:* (1) EU does not include BG, CY, LV, LT, MT, RO.

### *In some Member States the contribution of knowledge-intensive services to trade balance is growing*

The growing importance of services sectors in most European countries is a fact that is discussed and presented in different parts in this chapter. Unlike manufacturing goods, for which data show more consistent results, performance of services sectors are affected by various factors such as fiscal measures (for the financial services, for example) or geographical situation (peripheral countries), and the coverage does not encompass all the Member States[363]. Nevertheless, it is relevant to analyse the service sectors from the

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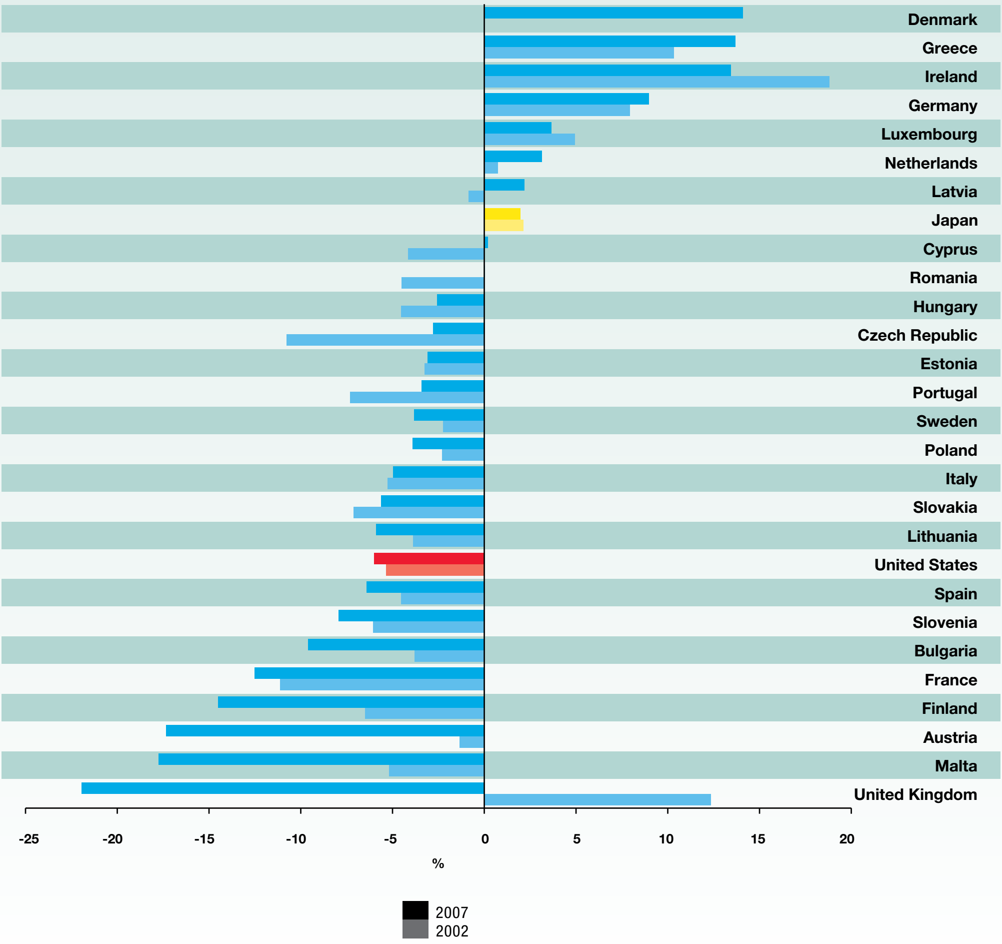
[363] To improve the quality of data available on services, at EU and Member States level, the European Commission will launch specific studies.

FIGURE III.4.14

## Contribution of Knowledge-Intensive Services (KIS) to the trade balance, 2002 and 2007



*Source:* DG Research and Innovation
*Data:* OECD

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perspective of innovation, and how they changed between 2002 and 2007. Focusing on the contribution of knowledge-intensive services in the trade balance (figure III.4.14), it is clear that countries such as Denmark and Greece experienced a strongly positive evolution. Ireland still had a very relatively high contribution of knowledge-intensive services to its trade balance, but this contribution decreased over the period 2002–2007. From a lower level, Germany, the Netherlands and Latvia had a positive evolution, while Hungary, the Czech Republic and Portugal reduced the gap. Conversely, Sweden, Poland, Bulgaria and Malta increased the knowledge-intensive service trade deficit over the same period.

### *There is a strong regional dimension of competitiveness, not captured by national level measures*

The European Commission has created a new regional competitiveness index for all NUTS2 regions.[364] This index allows the performance of a region to be assessed in relation to all the other EU regions. The set of 69 indicators used in this index are divided in three pillars: 1) the basic group, with the key drivers for all types of economies; 2) the efficiency group, with the key aspects for a developing region; 3) the innovation group, with the key drivers for the advanced economies. These three sets are assigned different weights, based in the GDP per head of a region. It is a dynamic way of assessing the progress of an individual region, as it identifies the more urgent needs at different stages of development. As an example, a less developed region might benefit more by improving institutions and education, when compared with a more advanced one, which might need to invest more in innovation to stay competitive.

The economic and financial crisis impacted differently on the indicators used to measure innovation and competitiveness. In the map (figure III.4.15), the overall competitiveness resides in the Nordic regions, the Netherlands, in Southern Germany and South-East England. Large differences in competitiveness among regions are observed in some Member States as Italy, Spain and Portugal. These results give evidence to the strong regional dimension of competitiveness, not captured by national level measures. In the less knowledge-intensive economies of the EU, the most competitive regions tend to be isolated and mainly surrounded by less competitive regions. Most of these Member States have a high concentration of factors of competitiveness around the capital city region, with still very limited spillovers to neighbouring regions. At the contrary, in the most knowledge-intensive economies of the EU, there is a more even distribution of the competitiveness factors.

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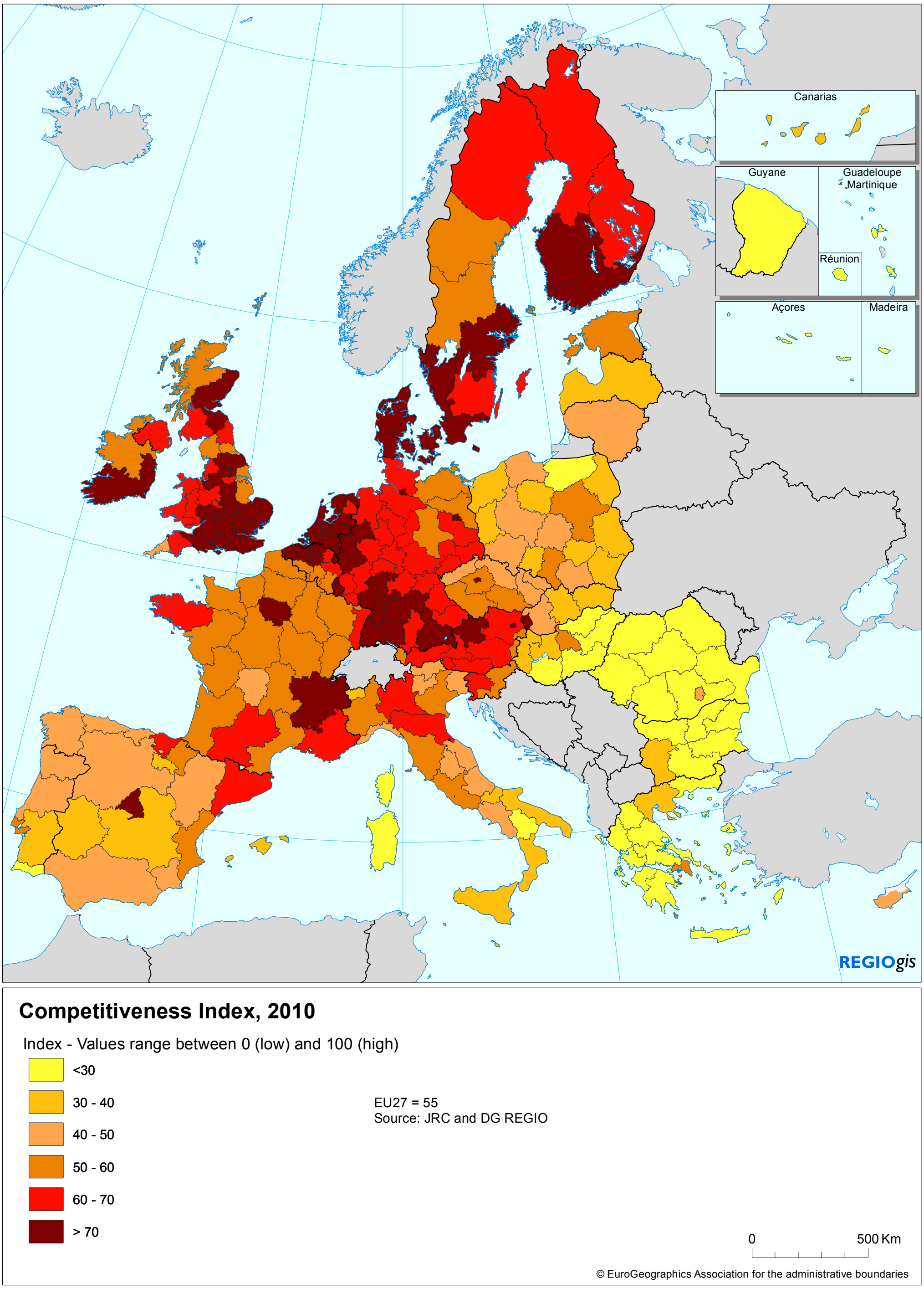
[364] See the Report "Investing in Europe's Future, Fifth Report on Economic, Social and Territorial Cohesion", DG Regional Policy, November 2010.

FIGURE III.4.15 **Competitiveness index, 2010**



*Source:* DG Research and Innovation
*Data:* DG REGIO

# CHAPTER 5

# Addressing societal challenges

## HIGHLIGHTS

Research and Innovation coupled with market development measures can help provide a solution to the societal challenges, such as climate change, a healthy aging or energy dependency that Europe faces. At the same time, these fields represent new areas for potential economic growth. As a result, many of the research programmes in Europe and elsewhere, including the economic recovery packages, have oriented towards these fields.

Overall, the EU is increasingly reinforcing its position in developing new technologies aimed at addressing societal challenges. The EU accounts for around 43 % of all the climate change mitigation related patents filed under the Patent Cooperation Treaty (PCT). The impressive record of the EU is due to a determined public investment decision that has in the past decade increased the funding of environmental sciences and technologies. Among the different technologies for climate change mitigation, the EU has made good progress in technologies for developing and deploying renewable energies. Nevertheless, more market pull measures would further improve the competitiveness of these new technologies, making them more affordable.

Health research has the potential to provide "exception returns", both in terms of reduction of direct costs of treatments or labour absenteeism, and by increasing longevity and quality of life. In this field, the United States is the world leader. It accounts for almost half of all the health related patents, either on pharmaceutical or medical technologies, and its public and private research investment is much higher than any other country.  In this field, the EU lags behind the United States, but the situation is not homogeneous across Member States. Denmark, Sweden or the Netherlands have developed strong specialisation capacities in particular health technologies and proportionally rank above the United States in terms of health technology patent applications.

Finally, since most societal challenges are global by nature, the EU research instruments in these fields, notably the Framework Programme, have opened themselves to further international cooperation. Environmental and health related research are two of the fields more prone to international cooperation, especially with other advanced economies such as the United States, Japan or increasingly other Asian economies.

***Science, technology and innovation can help provide a solution to the growing societal challenges faced by Europe. The Innovation Union initiative calls for a re-focusing on innovation to address the major societal challenges***

Science, technology and innovation are increasingly regarded as key solutions to the challenges that can affect our economic progress and quality of life. Increasingly, citizens turn to science and technology to obtain an answer for mitigating climate change, improving citizens' health or enhancing energy and resource efficiency.

The Innovation Union initiative of the European Commission has echoed these demands and has asked for a re-focus of R&D and innovation policies on the challenges our society faces. In order to provide innovative solutions, every link in the innovation chain will have to be strengthened, from 'blue sky' research to commercialisation.

This chapter will focus on a analysis of the way in which European research — including the role of the Framework Programme — is contributing to addressing these challenges in two particular areas that are the first objectives of the future European Innovation Partnerships[365]: (1) Climate-change mitigation and preserving the environment (including renewable energy technologies), and (2) Healthy ageing. These two areas are of particular interest for Europe because no single country can provide the solutions to these challenges. International cooperation is needed and there is a clear European value added in pulling research resources together to avoid the fragmentation of research investment, especially in a context of fiscal consolidation.

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[365] Please, refer to the Innovation Union Communication for a detailed description and areas of action of the European Innovation Partnerships (http://ec.europa.eu/research/innovation-union/pdf/innovation-union-communication_en.pdf#view=fit&pagemode=none).

### *Many EU Member States — as well as the United States — are orienting their research policies to embrace societal challenges in the framework of their recovery packages*

In 2008 and 2009, many EU Member States undertook large policy responses, including fiscal stimuli and structural reforms, to address the negative consequences of the worst financial and economic crisis of the last 70 years. These efforts were to a large extent coordinated on the basis of a European Economic Recovery Plan (EERP) that was endorsed by the European Council.

The overall size of public investment in the stimuli packages has been roughly estimated at around 65 billion euro, i.e. 0.32 % of EU GDP, and grouped under three main areas: investment in infrastructure, 40 billion euro, investment in energy efficiency, 20 billion euro; and investment in R&D, 5 billion euro[366].

In terms of R&D investment, the EERP encouraged Member States to research green technologies and energy efficiency. The reason for this lies on the need to focus European research on developing new environmental technologies that help mitigate climate change and pollution, and that in addition, can become important sources of economic growth.

As a result, plans to invest in green technologies can be found in several National Reform Programmes, such as those in Estonia, Spain, France, Italy, Latvia, Germany and the United Kingdom. In addition, France, Germany and the United Kingdom are also implementing research on green technologies in the automotive sector as part of their strategies, and the EERP announced two major partnerships between the public and private sectors in research on (1) a European green-cars initiative and (2) European energy-efficient buildings initiative. Both initiatives are under implementation

The United States also implemented a similar plan to fight against the economic crisis — The Recovery Act: Transforming the American Economy through Innovation. As for the EERP, the American USD-800-billion investment plan has also emphasised the need to accelerate significant advances in science and technology that not only cut costs for consumers, but that also help to improve health and develop new technologies for the exploitation of renewable energies.

### Box: The United States Recovery Act: Transform ing the American Economy through Innovation

The Recovery Act has invested nearly USD 100 billion in science, technology and innovation projects across the country, ranging from the construction of a nationwide smart-energy grid and health-information technology infrastructure to growing the emerging electric-vehicle industry, expanding broadband access and laying the groundwork for a nationwide high-speed rail system.

Thanks to the Recovery Act, the United States is now on track to achieve four major innovation breakthroughs that will keep America competitive in the 21st century economy and make new cost-saving, energy-saving and life-saving technology affordable for and accessible to consumers. These innovations are:

1. Cutting the cost of solar power in half by 2015. This will bring the cost of generating solar power down to the cost of electricity from the grid.
2. Cutting the cost of batteries for electric vehicles by 70 % between 2009 and 2015. This means that the cost of batteries for the typical all-electric vehicle will fall from USD 33 000 to USD 10 000, and the cost of typical plug-in hybrid batteries will drop from USD 13 000 to USD 4 000.
3. Doubling the United States' renewable-energy-generation and renewable-manufacturing capacities by 2012. This means that the over USD 23 billion investments in support of renewable energy will double the energy generation capacity from wind, solar and geothermal sources by 2012.
4. Bringing down the cost of a personal human-genome map to under USD 1 000 in five years. This means that it will be fifty times cheaper to obtain the DNA information that could unlock cures and give insights into some of the most debilitating diseases that exist today.

*Source: Executive Office of the President of the United States, 2010*

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[366] Source: European Commission, DG ECFIN.

## 5.1. Is European research addressing climate change and the need to preserve the environment?

***Climate change will have significant costs for the economy. New technologies can help reduce the greenhouse gas emissions and therefore mitigate these costs***

In recent years, climate change has been recognised as a global phenomenon that may cause an irreversible build-up of greenhouse gases and global warming at a potentially huge cost to the economy and society.[367] According to the Stern Report[368], the estimated costs of inaction in addressing climate change are high, and when all market and non-market impacts are taken into account, the costs can rise to 14.4 % of per capita consumption. New technologies can help reduce the emissions of greenhouse gases and therefore mitigate the negative effects of climate change. According to the Energy Technology Perspectives[369], developments in new technologies such as carbon capture and storage, nuclear energy, renewable energies and end-use efficiency gains could reduce $CO_2$ emissions by up to 50 % by 2050.

There are also new European initiatives in this field. As an illustration, two of the three Knowledge and Innovation Communities (KIC) selected in 2009 inside the European Institute of Technology (EIT), focuse on enhancing Europe's innovation capacity in the field of sustainable energy, and climate change mitigation. The KICs are set up as very focused and European-wide clusters.

### 5.1.1. Investments in science and technology for climate-change mitigation

***The EU allocates a relatively important part of its public research budgets to the development of environmental technologies, including climate-change technologies***

The public nature of climate change and other environmental technologies enhances the role that public research plays in the development of new technologies. The EU devotes more public research resources to environmental-related sciences than any other research system in the world (figure III.5.1). On average, EU governments invested in 2009 almost EUR 5 per inhabitant, while South Korea invested around EUR 4 and the United States and Japan around EUR 2.

Moreover, the EU has maintained this investment in environmental research over time and has slightly increased it since 2004.

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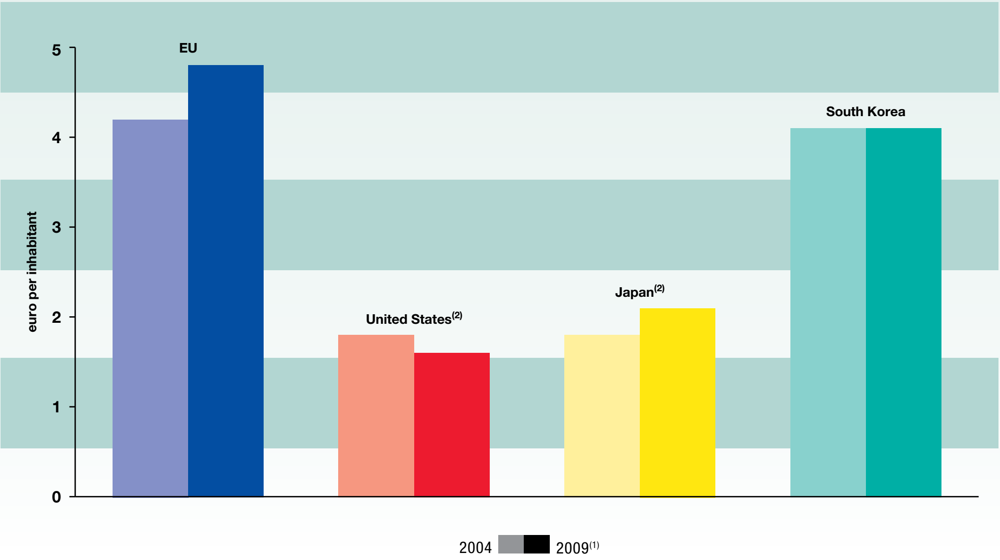
[367] OECD, 2009.

[368] Stern, N (2007) 'The Economics of Climate Change. The Stern Review', Cambridge University Press.

[369] IEA, 2008.

FIGURE III.5.1 **GBAORD for environment related R&D, 2004 and 2009**(1)



*Source:* DG Research and Innovation
*Data:* Eurostat
*Notes:* (1) US: 2008.
(2) US, JP: GBAORD refers to federal or central government only.

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## Box: European Research Collaboration to develop a nuclear fusion reactor in Europe- ITER

The energy challenge of the EU, and the World, is to assure sustainable, affordable and safe energy production with the diminishing availability and rising costs of carbon based energy, combined with the need to lower environmental impact of energy production. One of the very few candidates for large-scale carbon-free production of base-load power is fusion energy, which could potentially benefit from: (1) abundant and geographically fairly distributed fuel, (2) enhanced safety, (3) no production of $CO_2$ or atmospheric pollutants and (4) no long-lasting radioactive waste.

ITER is an international project aimed at developing the knowledge needed to have fusion available as a future energy alternative. The project counts on the membership of the EU, Japan, China, the United States, South Korea, India and Russia, who signed in 2006 an agreement to fund the construction of the world's most advanced experimental nuclear fision reactor in Europe.

The EU will contribute 45 % of the construction costs, i.e; an estimated investment of 6.6 billion euro, and the project is anticipated to last for 30 years, 10 years for the construction and 20 of the operation.

The construction of the key components, such as the buildings, vacuum vessel and magnets has already started and the EU is expected to deliver components of the machine in each key technology.

### 5.1.2. Patents for climate-change mitigation and environmental technologies[370]

To a large extent, climate-change mitigation technologies are based on the development of new sources of low-carbon emission energies, such as renewable energies. The next section analyses the recent technological evolution of this sub-section of climate-change technologies which is of particular interest for Europe, as it also reduces energy dependency.

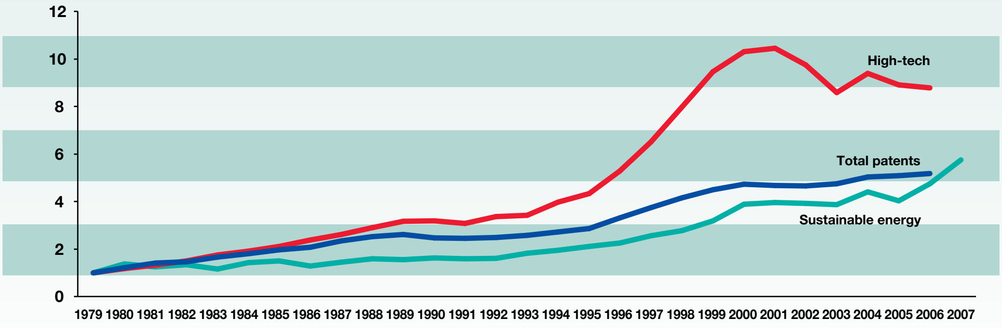
#### *Patents in sustainable energy represent a small but increasing share of overall patents*

Increasing concerns about climate change and the oil crisis of 2003–2008, which saw oil prices going up from USD 25 per barrel to a peak of more than USD 130 in 2008, have clearly intensified interest in the development of new sustainable, in particular renewable-energy technologies. Since the year 2000, the number of EPO patent applications in renewable-energy technologies has increased sharply. As shown in figure III.5.2, this growth has been overtaking the average growth of EPO patents or even of high-technology patents since 2005.

#### *The rapid growth in sustainable energy patents has occurred despite a slight stagnation of R&D investment*

Public expenditure in sustainable energies decreased from 1982 until the year 2000 (figure III.5.3). Since that year, R&D investments started to increase slowly again, with acceleration from 2006 onwards. On the other hand, despite this negative trend in research investment, patent activity continued to progress, which suggests that there has been a growing interest in the market for new technological applications in the field. In other words, the development of sustainable energies has benefited more from a market *pull*, than a technological *push*.

FIGURE III.5.2 **Long term growth of EPO patent applications in sustainable energy, high-tech and total patents, 1979 - 2007 (1979=1)**



*Source:* DG Research and Innovation
*Data:* Eurostat

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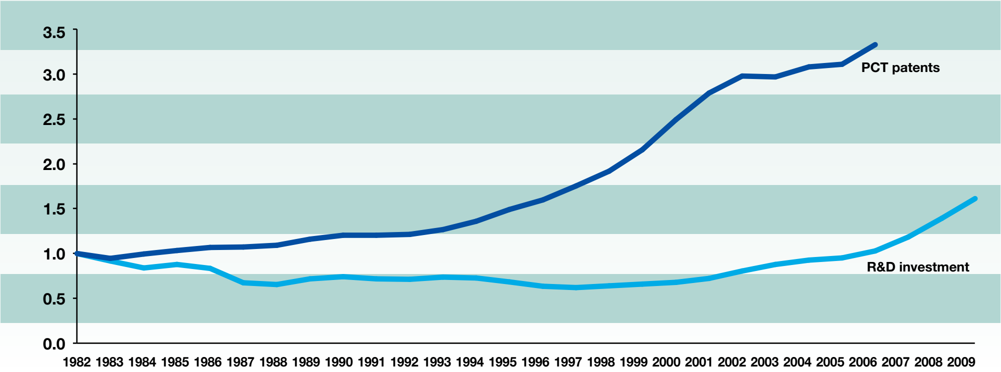
370 Climate-change mitigation technologies include renewable energy, electric and hybrid vehicles, energy efficient buildings and lighting.

## FIGURE III.5.3 R&D investment and patent evolution in renewable energy in OECD countries, 1982 =1



*Source:* DG Research and Innovation
*Data:* IEA

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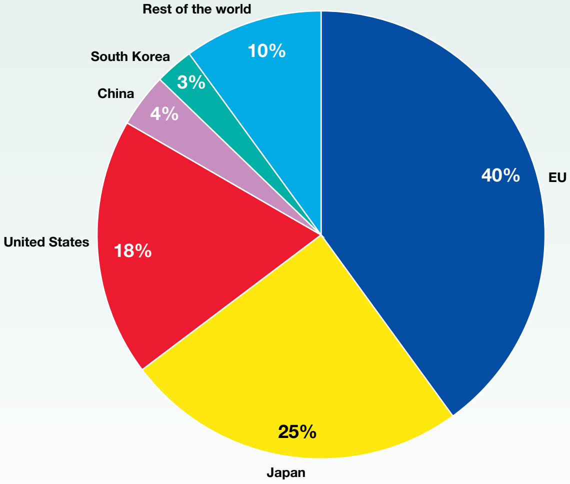
***In addition to renewable energy technologies, the EU plays a leading role in developing other new climate-change mitigation technologies. The EU accounts for 40 % of all world patent applications in this field***

While Japan presents the highest number of climate-change patents relative to the size of the economy[371], the EU is the world leader in developing new technologies to fight against climate change in absolute terms, accounting for more than 40 % of all patent applications addressing this societal challenge (figure III.5.4).

## FIGURE III.5.4 Climate change mitigation technologies – PCT patent applications – World shares, 2007



*Source:* DG Research and Innovation
*Data:* OECD

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371 Please, see part 1 of this report for details.

### *Denmark, the Netherlands, Sweden and Germany are on the technological frontier for technologies addressing climate change*

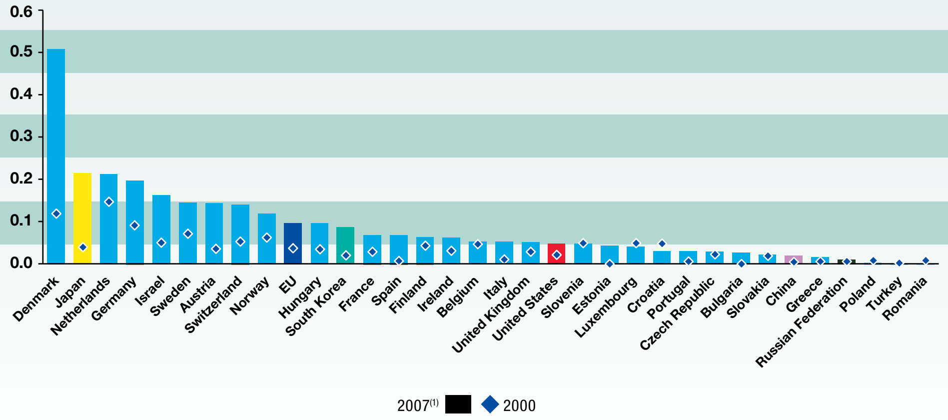
Between 2000 and 2007, innovation in climate-change mitigation technologies has been intensifying rapidly. The number of patents which address climate-change challenges has increased considerably in most countries — in Japan more so than in the EU — and represents approximately 2 % of total patent applications[372]. Denmark, the Netherlands, Germany and Japan are the countries which patent most in this area relative to their GDP[373] (figure III.5.5). In volume, Germany and Japan concentrate a large share of these patents in the world, as well as the United States, despite its lower value in relation to GDP (half of the EU). In Europe, although these data do not measure the quality nor the impact of the patents, the high intensity of patenting in Denmark, the Netherlands, Sweden and Germany both in health and climate-change mitigation tends to indicate that these countries are at the technological frontier in both domains.

### *More generally, the EU is the world leader in environmental technology patents[374], headed by Germany*

Higher public-research budgets in environmental sciences have allowed the EU to lead the race in the development of environmental technologies. As Figure III.5.6.[375] below shows, 35 % of all patents related to air- and water-pollution control, solid waste management or renewable energies have their origin in the EU. Behind the European Union, the United States and Japan account for 21 % and 20 % of all these patents respectively. In the EU, Germany is the largest R&D investor, representing 34 % of all EU's patents. The United Kingdom and France follow with 13 % and 8 %, while the rest of the EU countries account for 40.5 % of all EU's patents, i.e. 14 % of the world total.

FIGURE III.5.5

**Climate change mitigation technologies – PCT patent applications per billion GDP (PPS€), 2000 and 2007(1)**



*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) SI: 2006.
(2) CY, LV, LT, MT, IS, MK: Zero or data not available.

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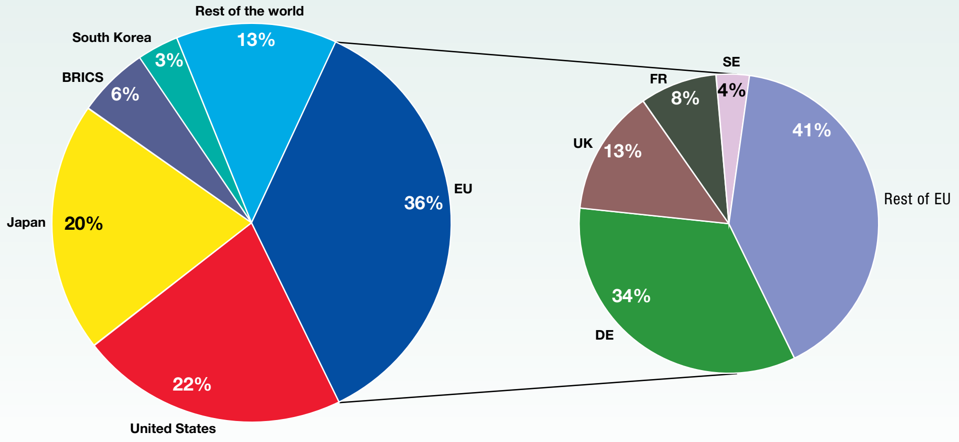
372 OECD, *Measuring innovation*, 2010, p 114.

373 In Figure III.5.5, data for patents related to climate-change mitigation are OECD data concerning PCT (Patent Cooperation Treaty) patent applications by inventor's country of residence and priority year; climate-change mitigation covers the following fields: renewable energy, electric and hybrid vehicles, energy efficiency in building and lighting.

374 Environmental technologies include air-pollution control, water-pollution control, solid waste management and renewable energy as calculated by the OECD (2009): 'Science, technology and Industry Scoreboard 2009', p.52 (http://www.oecd-ilibrary.org/content/book/sti_scoreboard-2009-en).

375 Note: Values are calculated based on an arithmetic average of the percentage of patents of each country in four environmental technology fields: (1) air-pollution control, (2) water-pollution control, (3) solid waste management and (4) renewable energies. As a result, these values assume an equal distribution of patents across four fields.

FIGURE III.5.6 **PCT patent applications in environmental technologies – World shares, 2004-2006**



*Source:* DG Research and Innovation
*Data:* OECD

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## 5.1.3. Markets demand measures to enhance technologies in climate-change mitigation and other environmental technologies

***Despite substantial technological development, the use of renewable energies or other environmental technologies still require some market 'pull' measures. Smart regulation and public procurement can accelerate the creation of a full, effective market***

Despite technological advances, renewable energies are currently still more expensive than traditional energy and, therefore, they require market 'pull' measures in order to fully deploy and further enhance technological advances and reductions in costs. The same is valid for many environmental technologies, for which a market needs to be developed in order to take into account the full costs of production, i.e. including pollution effects. Smart regulation and policy initiatives such as the Lead Market Initiative[376] on recycling or renewable energies can become important means to achieve this goal. In general, these measures to develop markets have yielded excellent results when coordinated with research efforts to bring the costs of production down. Denmark represents an excellent example where wind industry has successfully developed.

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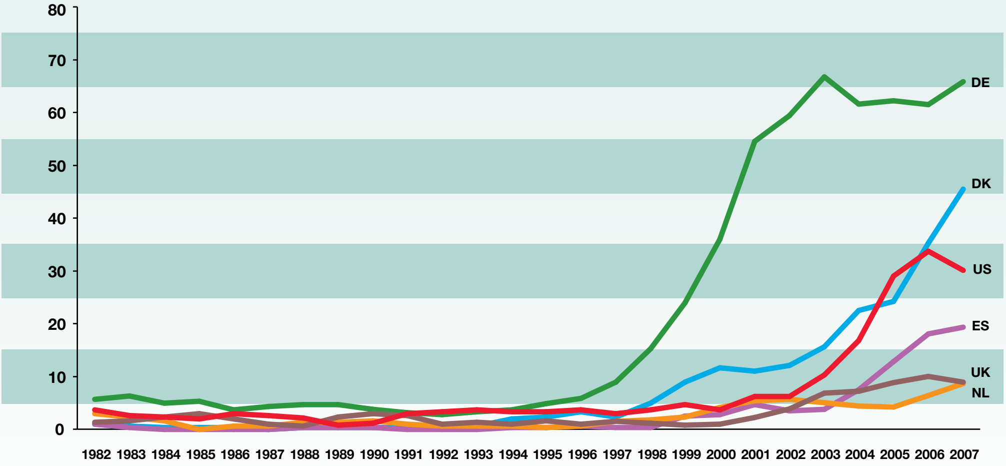
[376] Please refer to the section of Framework Condition for more ample information on the role of lead markets and innovation-friendly regulations.

## Box: The role of demand policies in Europe and the development of wind and photovoltaic industries

Germany, Denmark and Spain have been the three EU countries with the strongest market-pull policies in Europe. The emergence of Spain as an industrial player is all the more remarkable since it started from a very low base before 1995.

This has led Europe to develop a strong world presence in the wind industry. These three countries accounted for nearly half of world production in 2009. Of special interest is Denmark, which now produces 20 % of its electricity through wind power. In the same country more than 28 000 people are employed in the wind industry. Moreover, the interest of United States firms in patenting in the EU is also to be noted in the dynamic European wind-energy market have yielded excellent results when coordinated with research efforts to bring the costs of production down. Denmark represents an excellent example where wind industry has successfully developed.

FIGURE III.5.7 **EPO patent applications in wind energy – Three year moving average, 1982-2007**



*Source:* DG Research and Innovation
*Data:* OECD

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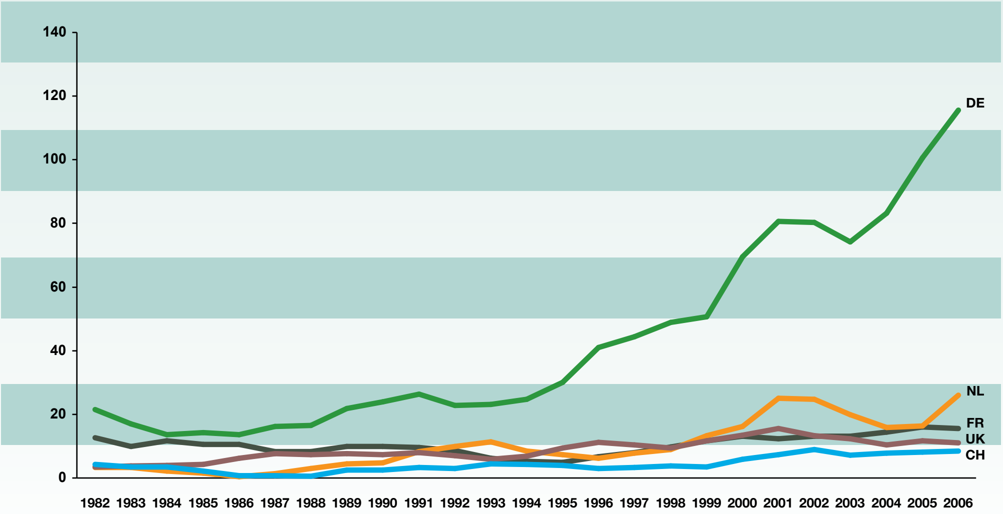
The photovoltaic (PV) industry, on the other hand, represents a source of renewable energy where Europe has been less successful as other countries play an important part in the European Market. Japanese, American and, recently, South Korean firms have been active in patent applications in Europe. This reflects the importance of Asia in the domain of PV, as 7 out of the 10 largest companies in the world come from Asia, 2 from the United States and 2 from Europe (Germany).

In Europe, thanks to Germany, the production of solar energy exploded in 1995. Demand-side policies were implemented earlier here than in any other European country, and in the most active manner. The Renewable Energy Sources Act (2004) fixed very favourable tariffs that allowed Germany to have the highest annual rate of PV installation worldwide. It is estimated that 48 000 people are employed in the PV industry alone.

FIGURE III.5.8 EPO patents in solar energy (3 year moving average), 1982-2006



*Source:* DG Research and Innovation
*Data:* IEA

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***To reap the fruits of the new technologies oriented towards mitigating climate change, lead markets need to be developed and better regulation enforcing their use is needed in order to achieve the full benefits***

While new technologies are being developed and their benefits in reducing $CO_2$ emissions or abating pollution are proven, it is still difficult to estimate the full benefits accruing from them. New innovative products and processes will have to be embedded in these upcoming 'breakthrough' technologies, so that the full benefits can be reaped.

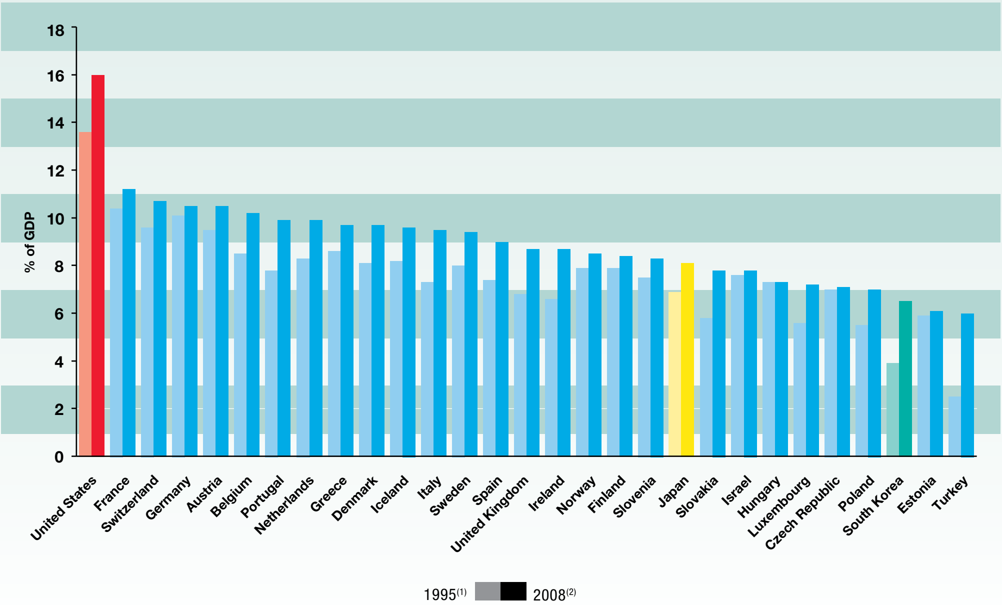
This will also require further policy developments to ensure that these new technologies are developed into new products that are then adopted into the market. Regulations, policies on the demand side and the setting of a price on carbon will also be required in addition to technological developments.

## 5.2. What contribution is science and technology making to healthy ageing?

Europe has become an aging society, and will increasingly be so. The improvements in life expectancy coupled with a fall on the fertility rates have brought about a progressive aging of European society. It is expected that in the future, this aging phenomenon will accelerate[377]. An aging population in need of more and better healthcare will pose important challenges to existing healthcare systems as public budgets come under stress. The increase in health costs coupled with the desire to improve the quality of health and long-term care for older citizens will require further investments in health. At present, many developed economies, including EU countries such as Belgium, France, and Germany, devote more than 10 % of the national wealth to these activities (figure III.5.9). Many of these countries have sharply increased the resources devoted to these activities in the last fifteen years or so, and this trend is likely to continue as the cohorts of baby boomers grow older and require more medical assistance.

In order to sustain the system, new medical technologies capable of maintaining health in old age and bringing medical costs down, are regarded as one of the main solutions — if not the only one — to sustain Europe's quality of life.

FIGURE III.5.9 **Total expenditure on health as % of GDP, 1995(1) and 2008(2)**



*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) SK: 1997; EE: 1999.
(2) LU, PT: 2006; DK, EL, TR, JP: 2007; IT, IS: 2009.
(3) BE, CZ, DK, EL, ES, LU, HU, NL, PL, PT, SI, SE, UK, IS, NO, TR: Breaks in series occur between 1995 and 2008.

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[377] See Part I, chapter 4 for a thorough description of the demographic change in Europe.

### 5.2.1. Investments in science and technology for healthy ageing

***The United States is by far the absolute and relative largest investor in health research thanks to both public and private sectors***

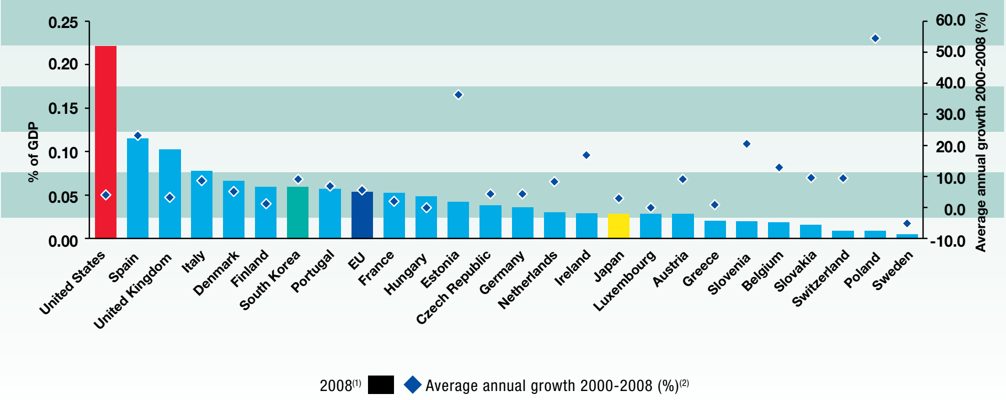
The United States presents the strongest investment patterns in the world, well ahead the EU. In terms of public budgets, the United States devoted more than 0.2 % of the national wealth to health-related R&D, while the EU and South Korea barely invested 0.05 % (figure III.5.10). At this point, it should be noted that for Europe, public R&D investment in health is likely to be higher than the values represented here. Due to the institutional complexity and diversity of centres carrying out health research, many European countries, e.g. Sweden, France, the United Kingdom and Spain, devote significant extra public R&D resources to medical research in other sections of their national budgets that do not fall directly under the 'improvement of public health' category, as defined by the Frascati Manual. Therefore, the values are not fully comparable. Unfortunately, no aggregated value is available for the EU[378].

In recent years however, European governments have increased public budgets related to health research. Since the year 2000, European public budgets grew at an average annual rate of nearly 6 %, lower than South Korea, with an average annual growth rate above 9 %, but above the United States, with average increases of nearly 4 %, and Japan at 3 %.

In terms of private R&D, pharmaceutical companies in the United States also invest more resources than EU companies (figure III.5.11). Proportionally, companies based in the United States invest almost twice as much in R&D as their European counterparts.

As a result, these high-technology enterprises can benefit both from their own higher R&D investments and the higher public R&D investments that generate a broader knowledge base from which they can capitalise and develop new innovative products and processes.

FIGURE III.5.10 **GBAORD for R&D in health as % of GDP, 2008(1) and average annual growth 2000-2008(2)**



*Source:* DG Research and Innovation

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*Data:* OECD

*Notes:* (1) HU: 2005; EU, UK, CH: 2006; BE, EL, EE, ES, LU, PL, PT, SI, 2007.
(2) EU, UK, CH: 2000-2006; BE, EL, ES, PT, SI: 2000-2007; EE: 2002-2007; PL: 2004-2007; DK: 2001-2008; CZ: 2002-2008.

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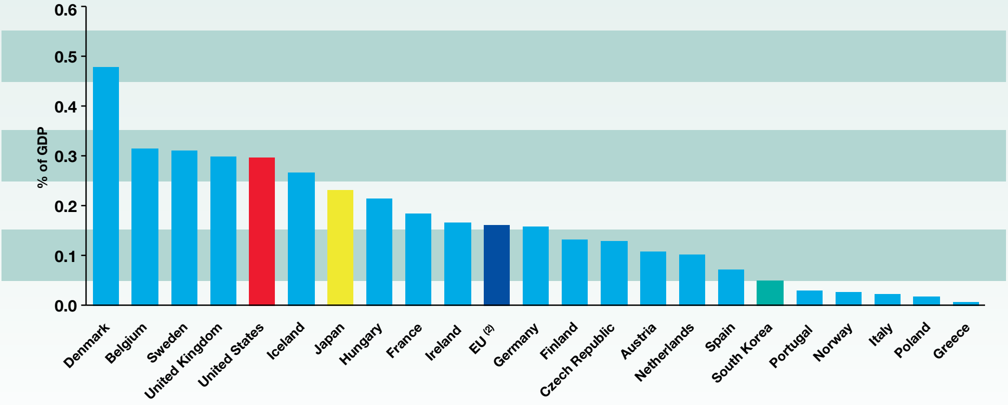
[378] For a thorough description of the methodology to calculate overall public R&D budget allocations, please consult the OECD 'Science, Technology and Industry Scoreboard, 2009'.

FIGURE III.5.11 **R&D expenditure in the pharmaceutical industry as % of GDP, 2006(1)**



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*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) IE, EL, PT, IS: 2005.
(2) EU does not include BG, EE, CY, LV, LT, LU, MT, RO, SI, SK.

## 5.2.2. Patents in healthy ageing

Health-related patents have risen in consonance with the increases in R&D investments. For our analysis, health-related technologies include both medical technologies, which are associated with high-technology, and pharmaceutical technologies that mainly refer to an area of application, not a technology *per se*[379].

### *The United States is the world leader in the development of medical-related technologies, accounting for almost half of all patents. Europe follows*

The Unites States is the world leader in developing new technologies related to human health. In terms of medical technologies, the United States accounts for almost half of all the world patents, while the EU's share is slightly above a quarter (figure III.5.12).

### *The situation in pharmaceutical patents is similar. The United States leads and the EU follows*

Pharmaceutical companies based in the United States filed 43 % of all the pharmaceutical patent applications under the PCT in the world in 2004–2006, while companies based in the EU filed 28 % of them (figure III.5.13).

In Europe, countries with strong pharmaceutical sectors such as Germany, with more than 25 % of all EU patents, or the United Kingdom, with 20 %, filed almost half of all the pharmaceutical patent applications in the EU.

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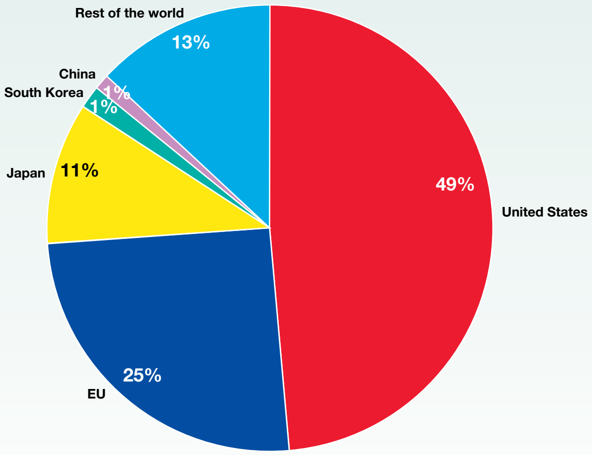
[379] For a full description of the fields covered by both medical technologies and pharmaceutical patents, please refer to the OECD (2009): 'Science, Technology and Industry Scoreboard', p. 60 (http://www.oecd-ilibrary.org/content/book/sti_scoreboard-2009-en).

FIGURE III.5.12

## PCT patent applications in medical technologies – World shares, 2004-2006



*Source:* DG Research and Innovation
*Data:* OECD

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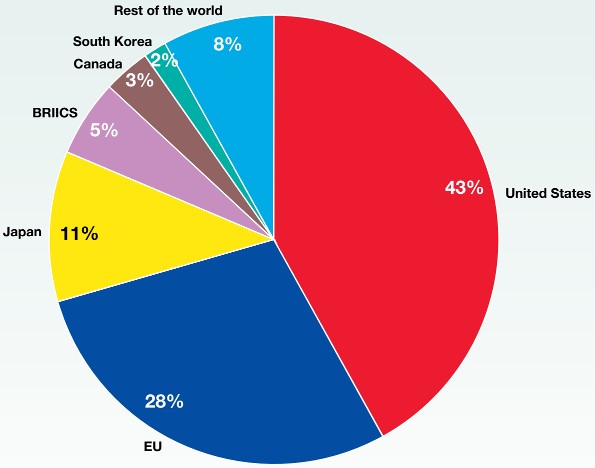
FIGURE III.5.13

## Pharmaceutical PCT patent applications – World shares, 2004-2006



*Source:* DG Research and Innovation
*Data:* OECD
*Note:* BRIICS: Brazil, Russian Federation, India, Indonesia, China, South Africa.

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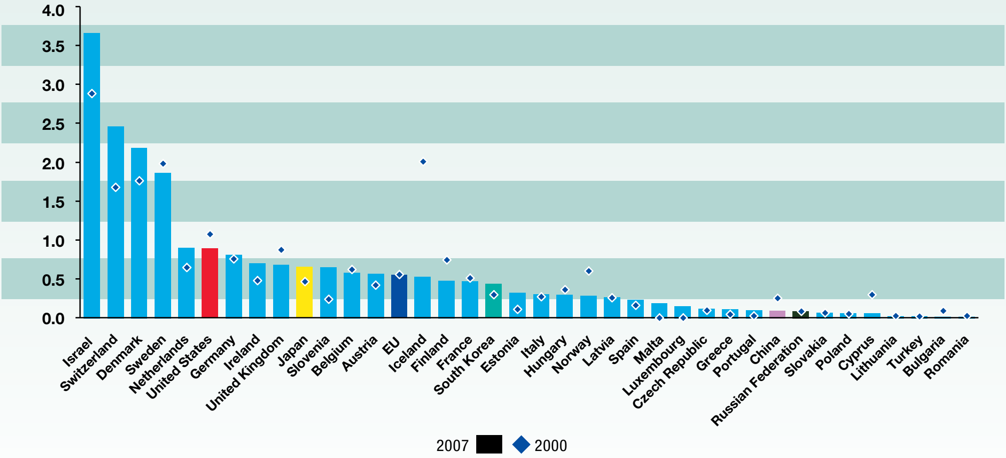
***Health-related technologies, especially those related to pharmaceutical technologies, can also provide large economic returns and represent an area for future economic growth. Health research is believed to provide 'exceptional returns'[380], both in terms of reduction of direct costs of treatments and increase of longevity and quality of life of citizens***

It is not easy to assess the economic impacts of health research in the economy and the well-being of citizens. It is difficult to measure the impacts of improved health, provide an economic value to it and link it back to the original research. However, despite these difficulties, it is broadly accepted that in Europe health research has largely contributed to the increase of life expectancy and quality of life of its citizens. In a context of aging population, health research will become even more important in the future, both from a social and economic perspective.

Citizens and governments with limited financial resources will look for an increasing number of medical and pharmaceutical innovations that will contribute to reducing the direct costs of treating illnesses, the indirect costs of employment losses associated with the mortality or morbidity of the labour force and to increasing the longevity and quality of life of the citizens. In the United States, an estimation of the reduction of direct costs in the treatment of illnesses generated by the research funded or conducted by the National Institutes of Health rose to more than USD 1.3 trillion (OECD 2008).

FIGURE III.5.14 **Health technologies – PCT patent applications per billion GDP (PPS€), 2000 and 2007**



*Source:* DG Research and Innovation
*Data:* OECD

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380 Access Economics Ltd (2003), 'Exceptional Returns: The value of Investing in Health R&D in Australia', The Australian Society for Medical Research, Canberra.

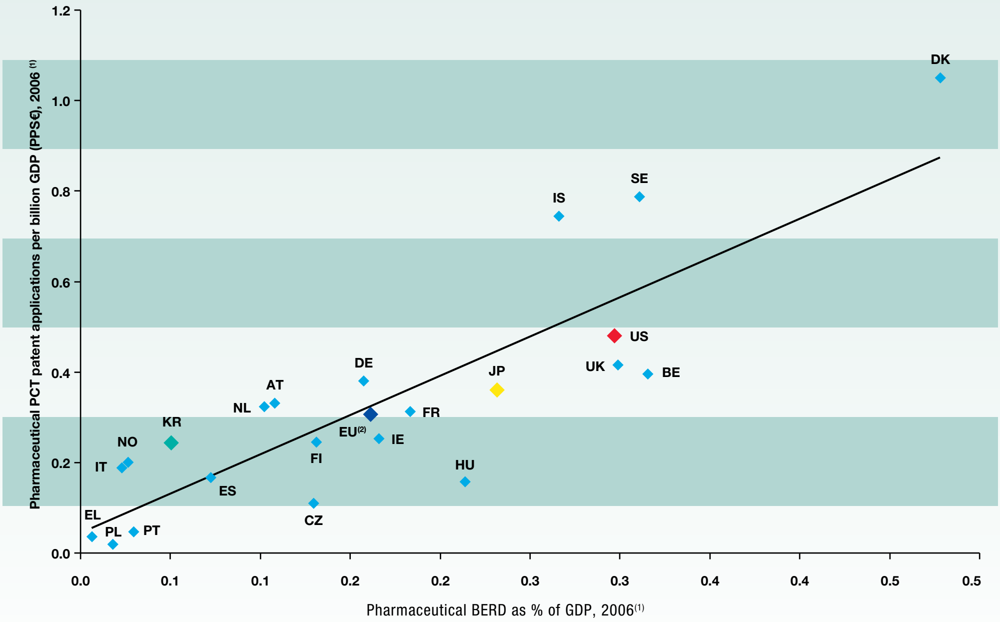
### *Israel, Switzerland, Denmark then Sweden are leading in Europe in producing technologies for health*

Israel and Switzerland are the countries in the world which produce the most health-related technology patents relative to GDP[381], well ahead of the United States and Japan in their intensity (figure III.5.14). Denmark, Sweden and the Netherlands also have a strong technological capacity in this societal field.

### *As expected, countries benefiting from strong public and private research investment also achieve ample technological returns*

The relationship and synergies between public and private research have a clear impact on the technological production. The correlation between both public and private R&D and pharmaceutical patents is very high. As figure III.5.15. below shows, and as previously explained in this chapter, the United States is by far the world leader in research investment and in patent productions, followed by the EU.

FIGURE III.5.15 **Pharmaceuticals – BERD as % of GDP and PCT patent applications per billion PPS€, 2006(1)**



*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) IE, EL, PT, IS: 2005.
(2) EU does not include BG, EE, CY, LV, LT, LU, MT, RO, SI, SK.

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[381] In Figure III.5.14, patent data for health are OECD data concerning PCT (Patent Cooperation Treaty) patent applications by inventor's country of residence and priority year. Health patents include patent in medical technologies and pharmaceuticals.

## 5.3. Does the EU Framework Programme address societal challenges?

Most key societal challenges are global in their nature. Given common interests, the internationalisation of science and the fact that over 75 % of world knowledge is produced outside the EU, how has European research tackled societal challenges through international cooperation?

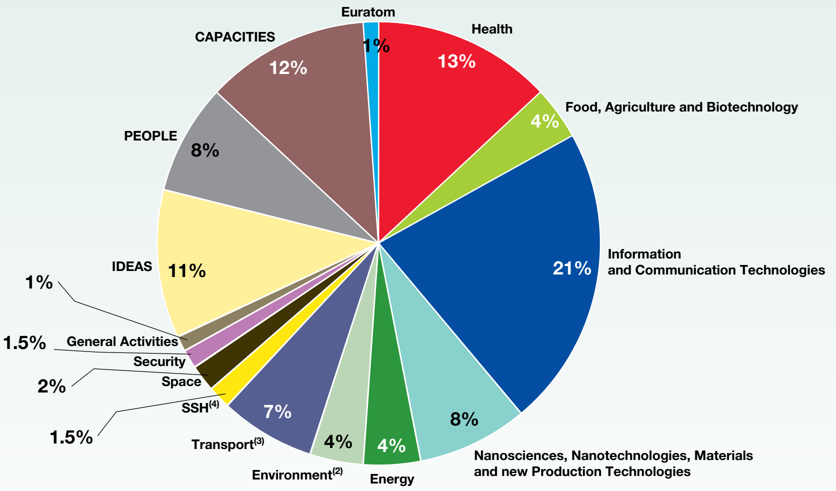
### *The funding of FP7 is largely targeted towards addressing societal challenges*

A large part of FP7 funding supports research in ICT and nanosciences, whose results can be used and exploited in many scientific and technological domains. FP7 funding is also largely funding research addressing the challenges regarding health, food, energy, environment and transport that Europe is facing.

### *A large proportion of the FP7 Cooperation programme deals with topics in different fields related to climate change or human health*[382]

A recent review of the monitoring of the Cooperation Programme of the FP reveals that around 1 032 topics (i.e. 43 % of the total number), deal with research conducive to a low-carbon society. In terms of budget, this amounts to EUR 2.7 billion, i.e. 31.5 % of the total allocated budget. In the same line, 771 topics, accounting for EUR 3.34 billion dealt with human health. These topics are not only covered in – Health –, but in many other areas.

FIGURE III.5.16 **FP7 by thematic priorities, 2007-2009 (9.2 billion euro)**(1)



*Source:* DG Research and Innovation
*Data:* DG Research and Innovation
*Notes:* (1) Selections made before 25 October, 2009.
(2) Includes Climate Change.
(3) Includes Aeronautics
(3) Socio-economic Sciences and Humanities

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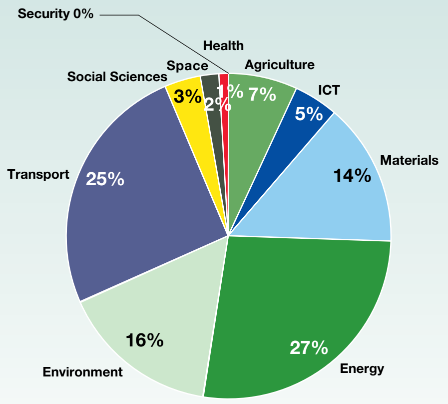
382 Preliminary data from the monitoring system of the FP7 implementation.

## Box: The Monitoring system to measure FP7's contribution to sustainable development and societal challenges

In order to assess the contribution of FP7 to sustainable development, a new monitoring system has been set up, which builds accountability for the FP7 by harnessing concrete results in the field of sustainable development. This system establishes cross-referencing between all the topics of all Work Programmes in the 'Cooperation' Programme and the 78 operational objectives included in the Sustainable Development System. For each topic, a set of 'micro-decisions' is taken at the level of each operational objective when a decision is taken, and on the impacts.

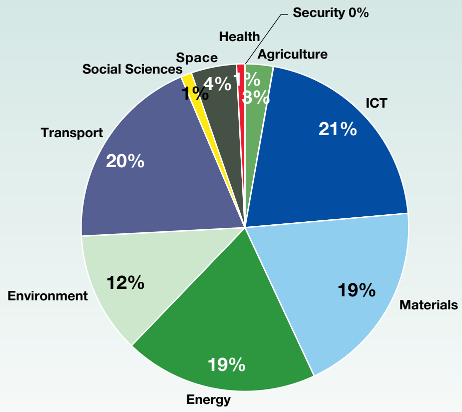
Based on this approach, a better perspective can be achieved on the real nature and impact of the different FP7 cooperation programmes in addressing different societal challenges. More precisely, regarding 'climate change[383]', 1 032 topics, i.e. 43 % of the total, call for a research conducive to a low carbon society.

FIGURE III.5.17 **1 032 topics**



*Source:* DG Research and Innovation
*Data:* DG Research and Innovation

FIGURE III.5.18 **EC contribution of € 2.70 billion euro**



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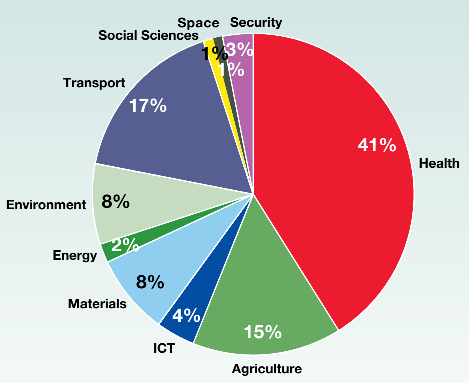
[383] This does not take into account the EU contribution of EUR 800 million invested in the Clean Sky joint Technology Initiative and the EUR 470 million invested in the Fuel Cells and Hydrogen Joint Technology Initiative.

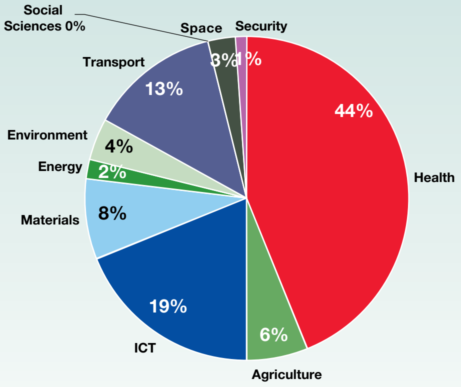
Regarding ‘health[384]’, 771 topics, leading so far to a volume of EUR 3.34 billion, are deemed to have a positive impact. As can be seen from the graphs below, this effort comes mainly, but not exclusively, from – Health – research.

FIGURE III.5.19 **771 topics**



*Source:* DG Research and Innovation
*Data:* DG Research and Innovation

FIGURE III.5.20 **EC contribution of 3.34 billion euro**



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### *European research and global initiatives are prominent in energy, climate change, biodiversity loss, health, food security, development and reduction of poverty*

Targeted actions have primarily covered research topics that have a global dimension and/or are designed to tackle global challenges. Figure III.5.21 shows the number of topics identified in the calls for proposals from thematic Cooperation programmes.

Different regions of the world have different profiles in their cooperation with the European Framework Programme (figure III.5.22). Behind these profiles there are many individual research teams, all building on their particular strengths and interests. The industrialised countries, in particular the United States and Japan, have a stronger cooperation on enabling technologies, while the Asian countries also profile themselves on cooperation in societal challenges such as environment and health. Research teams from the EU also cooperate with African research teams on societal challenges such as food, health and environment.

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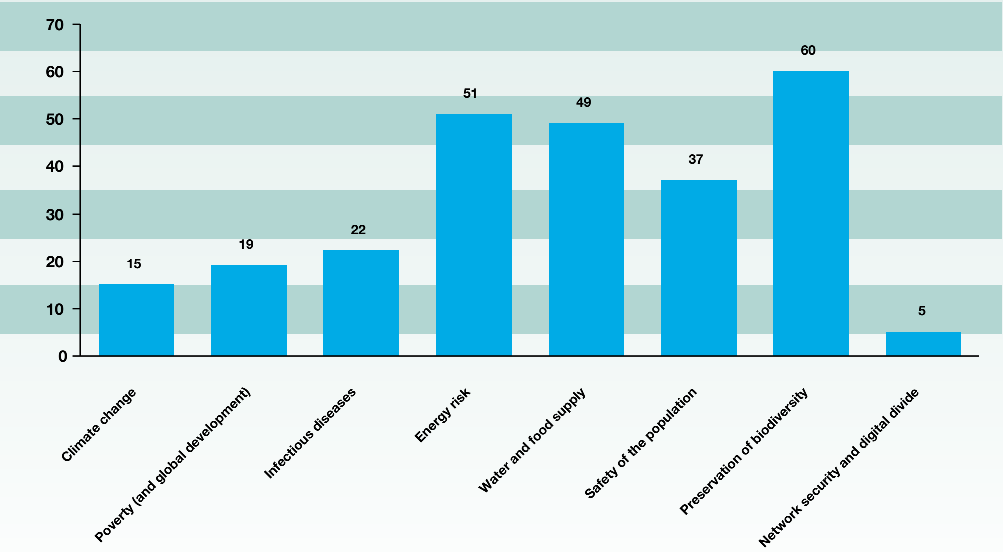
[384] This does not take into account the EC contribution of EUR 1billion invested in the Innovative Medicine Initiative.

## FIGURE III.5.21 Targeted actions and global challenges



*Source:* DG Research and Innovation
*Data:* DG Research and Innovation

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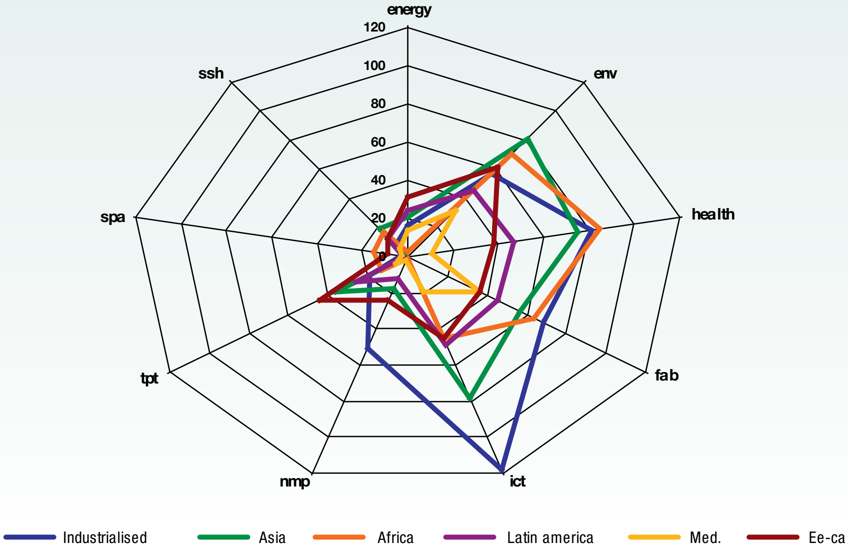
## FIGURE III.5.22 Participation of regions of the world by thematic areas



*Source:* DG Research and Innovation

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# Table of contents

# NEW PERSPECTIVES

## Smarter policy design – Building on diversity

This last section of the report is more exploratory in nature, opening up areas of future economic and statistical analysis. The underlying conceptual challenge is how to build on diversity at the European level. Unity in diversity is one of the strengths of the European construction, but further work is needed conceptually to understand what this means for the European research and innovation system. In this line, the section presents exploratory models for how to address country diversity and how to compare and learn from the comparable. It also tackles thematic and sectoral diversity, which in the context of the European Research Area is linked to concepts such as 'smart specialisation' and 'networked specialisation'. Finally, it presents established survey data on the attitudes of European citizens towards science and technology, which is an entry point to evidence on how science and technology efforts respond to citizens' needs and values, necessarily different from country to country. This also opens up a cultural dimension, given that each country has its own optimal way to reach the common objectives.

# CHAPTER 1

# Diversity of European countries

## HIGHLIGHTS

Innovation policies can not be homogeneous across countries. Research and innovation systems in Europe are diverse and face different challenges. Policy responses can be inspired by general guiding principles and knowledge, but should be tailor-made, and take into account the economic structure of a country and its capacity to generate, diffuse and use specific knowledge for its economy. A close analysis of the European Research Area (ERA) reveals the heterogeneity of research systems. Country groupings can help to design policies and facilitate peer-learning by providing a framework of reference for closer comparison and benchmarking between research systems. The analysis in this report identifies nine country groups with strong comparable characteristics.

## 1.1. Selected variables of national research and innovation systems

Research and innovation (R&I) are key for the future economic competitiveness and social progress of Europe. Thus, R&I support policies have gained importance and are now placed at the heart of public intervention, including EU policies[385].

While general guiding principles for R&I policy are widely accepted and applicable, their definition and translation into specific policy measures, instruments and programmes needs to be context-specific. R&I systems in Europe are diverse and face heterogeneous challenges. 'One-size-fits-all' strategies and policies cannot be applied across countries and tailor-made policies need to be adapted to the local conditions.

This section of the report analyses the heterogeneity of national R&I systems across Europe and identifies groups of countries with (relatively) similar features in their research conditions and innovation performance. These clusters can help improve policy learning and define better targeted policies.

It should be noted that the groupings accruing from this analysis are not meant to be prescriptive, but rather they constitute a framework for the potential use of Member States in their policy analysis, learning and benchmarking exercises.

***The European Research Area (ERA) is not a homogeneous research system, and aggregate values mask large differences between individual countries***

As table N.P.1.1 shows, there is a large variation across European countries in research intensity, the relative importance of the different research actors, their linkages, the innovation results, the economic structure, the framework conditions, and the openness of the system.

***This heterogeneity of research and innovation systems in Europe[386] demands an analysis which goes beyond a homogeneous, and unique view and policy formulation***

'One-size-fits-all strategies' are discouraged, and targeted individual analysis and policies are needed to better understand the strength and weaknesses of specific systems and identify their threats and opportunities. However, while each research and innovation system counts on the specific characteristics that distinguish them from each other, some of them also share common features that allow them to be analysed together and differentiated from the rest.

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[385] 'Europe 2020' places innovation at the heart of the next 10-year Strategy (http://ec.europa.eu/europe2020/index_en.htm)

[386] The heterogeneity of research systems in Europe can be even broader than that within European countries, specific regions count on very different sets of conditions and therefore very different research systems. This is particularly true for countries like Italy, where the inter-regional differences are very large and it is possible to talk about two different Italian research and innovation systems, the North and the South.

## TABLE N.P.1.1 Key selected variables of the national research systems in Europe

| | R&D Intensity 2009(1) | BERD Intensity 2009(2) | GOVERD Intensity 2009(3) | EPO patent applications per million population 2007 | % share of population aged 25-64 having completed tertiary education 2009 | as % of total employment | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Employment in primary sectors 2010(4) | Employment in primary sectors 2010(4) | Employment in business and financial sectors 2010(4) | Employment in high-tech and medium high-tech manufacturing 2009(5)(6) | Employment in knowledge-intensive activities 2009(5) |
| Belgium | *1.96* | *1.32* | *0.17* | *139* | 33.4 | 1.7 | 12.9 | 21.4 | *5.2* | 41.4 |
| Bulgaria | *0.53* | *0.16* | *0.29* | *4* | 23.0 | 20.3 | 20.3 | 20.5 | 3.8 | 26.0 |
| Czech Republic | 1.53 | 0.92 | 0.33 | *16* | 15.5 | *3.5* | *28.0* | *13.3* | 9.5 | 29.2 |
| Denmark | *3.02* | *2.02* | *0.09* | *194* | 34.3 | 2.7 | 12.6 | 13.3 | 5.1 | 39.2 |
| Germany | *2.82* | *1.92* | *0.41* | *291* | 26.4 | 2.1 | 18.9 | 19.4 | 10.2 | 37.3 |
| Estonia | *1.42* | *0.64* | 0.16 | *17* | 36.0 | 4.4 | 22.7 | 22.4 | 4.1 | 31.8 |
| Ireland | *1.77* | *1.17* | *0.08* | *67* | 35.9 | 4.9 | 13.0 | 13.3 | 5.0 | 41.1 |
| Greece | *0.58* | *0.16* | *0.12* | *10* | 22.8 | *12.0* | *11.1* | *11.5* | 1.5 | 31.6 |
| Spain | 1.38 | 0.72 | 0.28 | *33* | 29.7 | 4.6 | 13.8 | 14.2 | 3.7 | 30.3 |
| France | *2.21* | *1.37* | *0.36* | *132* | 28.7 | 3.2 | 13.1 | 18.8 | 5.0 | 39.5 |
| Italy | *1.27* | *0.64* | *0.17* | *86* | 14.5 | 4.0 | 19.4 | 20.0 | 6.0 | 33.0 |
| Cyprus | *0.46* | *0.10* | *0.10* | *11* | 34.1 | 4.6 | 10.2 | 10.2 | 0.7 | 33.9 |
| Latvia | 0.46 | 0.17 | 0.11 | *8* | 26.1 | 9.2 | 16.3 | 15.3 | 1.4 | 30.1 |
| Lithuania | 0.84 | 0.20 | 0.20 | *2* | 31.0 | 9.1 | 17.7 | 18.4 | 1.8 | 31.2 |
| Luxembourg | *1.68* | *1.24* | *0.29* | *230* | 34.8 | 1.4 | 10.5 | 28.9 | 0.7 | 56.2 |
| Hungary | 1.15 | 0.66 | 0.23 | *17* | 19.9 | 7.0 | 22.8 | 23.1 | 7.9 | 33.5 |
| Malta | 0.55 | *0.34* | *0.03* | *20* | 13.2 | 2.5 | 15.3 | 15.3 | 4.3 | 38.8 |
| Netherlands | *1.84* | *0.88* | *0.23* | *223* | 32.8 | 2.9 | 10.8 | 11.0 | 2.7 | 37.4 |
| Austria | *2.79* | *1.94* | *0.15* | *217* | 19.0 | 5.1 | 16.2 | 16.6 | 5.0 | 35.4 |
| Poland | 0.68 | 0.19 | 0.23 | *4* | 21.2 | 13.0 | 22.0 | 22.7 | 4.8 | 28.0 |
| Portugal | *1.66* | *0.78* | *0.12* | *11* | 14.7 | *10.8* | 17.1 | 17.2 | 3.0 | 27.9 |
| Romania | 0.48 | 0.19 | 0.17 | *1* | 13.2 | 25.7 | 23.3 | 23.2 | 4.6 | 19.8 |
| Slovenia | 1.86 | 1.20 | 0.39 | *51* | 23.3 | 8.7 | 22.8 | 23.7 | 8.5 | 31.9 |
| Slovakia | 0.48 | 0.20 | 0.16 | *8* | 15.8 | 3.0 | 23.7 | 24.3 | 8.6 | 29.1 |
| Finland | *3.93* | *2.79* | *0.37* | *251* | 37.3 | 4.7 | 16.3 | 16.9 | 5.5 | 36.5 |
| Sweden | *3.60* | *2.54* | 0.16 | *298* | 33.0 | 2.2 | 15.3 | 15.6 | 5.0 | 42.3 |
| United Kingdom | *1.87* | *1.16* | *0.17* | *89* | 33.4 | 1.8 | 10.4 | 22.8 | 3.8 | 42.8 |
| EU | 2.01 | 1.25 | 0.27 | 117 | 25.2 | 5.4 | 16.4 | 15.6 | 5.7 | 35.1 |
| Iceland | *2.65* | 1.45 | 0.47 | *91* | 32.8 | 4.0 | 10.8 | 15.4 | 1.1 | 43.1 |
| Norway | *1.80* | *0.95* | *0.29* | *110* | 35.9 | 2.8 | 13.0 | 14.1 | 3.5 | 38.7 |
| Switzerland | 3.00 | 2.20 | 0.02 | *429* | 35.2 | 3.7 | 16.8 | 17.2 | 6.3 | 42.0 |
| Croatia | 0.84 | 0.34 | 0.23 | *7* | 17.7 | 16.5 | 21.7 | 6.0 | 3.4 | 27.4 |
| Turkey(7) | 0.85 | 0.34 | 0.11 | *3* | 11.5 | *26.5* | *25.2* | *4.9* | 3.0 | 18.4 |
| Israel | *4.27* | *3.39* | *0.21* | *188* | : | 2.5 | 13.5 | 17.7 | : | : |

*Source:* DG Research and Innovation

*Data:* Eurostat, OECD

*Notes:* (1) EL: 2007; IS, CH: 2008; AT, FI: 2010
(2) EL: 2007; IS, CH: 2008; IT, FI: 2010
(3) EL: 2007; IS, CH: 2008; IE, IT, FI: 2010
(4) HR: 2004; CH: 2006; FR, IS, TR, IL: 2008; CZ, LU, UK, NO: 2009
(5) LU: 2008
(6) LT, IS: Medium-high-tech only
(7) TR: Sectoral employment is based on a sectoral definition which does not correspond exactly to the sectoral definition used for the other countries
(8) Values in italics are estimated or provisional or forecasts

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***Country grouping of research and innovation systems in Europe can address the complexity related to the heterogeneity of systems in Europe, while limiting the analysis to a manageable set of reference groups***

Any methodology aiming at reducing the complexity of a research and innovation system, and not taking into account all the specificities embedded in them, can only be a simplification and, therefore, any results should be handled with caution. Other alternative classifications taking more qualitative variables, e.g. cultural and historical elements, could also add new complementary insights into how better to classify Research and Innovation systems in Europe.

In our analysis, in order to create groups of research and innovation systems in Europe, a large number of variables featuring their main characteristics, functioning and results are selected. In total, 19 variables for which data was available were retained, and included the *total intramural expenditure in R&D* (*GERD*) as percentage of GDP, the total intramural R&D expenditure performed by the private sector (*BERD*), *the total intramural R&D expenditure performed by the public sector* (*GOVERD*), *the total intramural R&D expenditure performed by the higher education sector* (*HERD*), the *Human Resources in Science and Technology aged between 25–64, and the ratio in the top 10% of the most highly cited publications*. These six variables covered the research intensity in the system, the relative importance of each performing sector and the research performance of the system.

The *patent applications per million of population and the number of patent applications in high-tech sectors* were introduced to proxy the innovation activity of the system. The variables of the *percentage of the population working in the primary sector*, *industry*, *business and financial services*, as well as the percentage of *population working in high-tech manufacturing sectors and knowledge-intensive services* were also introduced to control for the economic structure of the country. Finally, in order to take account of the framework conditions existing in the system, the population density as a proxy for the establishment of the linkages between research actors, the *GDP* per capita as a proxy of the technological development of the country, the *natural logarithm of the GDP* as a proxy for the size of the market, and last the percentage of the *population engaged in life-long-learning activities and with tertiary education* for the availability of the skills, were also selected.

## Box 1 – Classifications of Research and Innovation Systems

The grouping of research and innovation systems has been an area of academic research and policy interest for some time already. Taxonomies based on the type of governance infrastructures (Cooke 1992), type of business innovation (Cooke 2004), learning capacity (Asheim and Isaksen 1997, 2002) or barriers to innovation (Kauffman and Tödtling, 2000) are just a few examples. In the European research and innovation policy context, the Innovation Union Scoreboard (previously known as the European Innovation Scoreboard) also presents a classification of research and innovation systems based on the combination of the current performance of the system and its evolution trend in the past years.

The grouping that is presented hereafter aims at complementing these different approaches by providing a statistics based classification that encompass a wide range of indicators that characterise the determinants and performance of research and innovation systems. While unable to encompass all important underlying cultural and behavioural features, it provides an analytical framework of reference. In this respect, it should be noted that in no manner is this classification intended to be used normatively and the European Commission does not place no any judgement on the configuration of the different groups.

## 1.2. Groups of countries based on knowledge capacity and economic structure

In order to reduce the complexity introduced by the use of such a large number of variables, a multiple multivariate econometric analysis based on a Principal Component Analysis was performed. The result of this analysis revealed that two key factors could summarise a large part of the information covered by the nineteen analysed variables. These factors were, firstly, the knowledge capacity of the system[387], and secondly, the economic structure prevailing in the system and more precisely, the importance of the manufacturing industry in the system[388].

After the Principal Component Analysis, a Cluster Analysis maximising the distance between groups and minimising this distance within groups was carried out in order to group the different research systems according to the values scored on the two key factors structuring the research and innovation systems.

### *European countries can be analysed in nine groups based on their knowledge capacity and economic structure*

As figure N.P.1.1. shows, eight different research and innovation groups could be identified:

- Group 1: Very high knowledge-intensity countries. This group would be composed of Finland, Sweden, Denmark and Switzerland.
- Group 2: High knowledge-capacity systems with a specialisation in high-tech manufacturing. Germany would stand alone in this group as its characteristics would differentiate it from all other research systems.
- Group 3: High knowledge-capacity systems with a mixed economic structure. This group would be composed of Belgium, the United Kingdom, France and Austria.
- Group 4: Medium-high knowledge-capacity systems with an economic specialisation in knowledge-intensive services. This group would be composed of Ireland, Luxembourg, the Netherlands, Norway and Iceland.
- Group 5: Medium knowledge-capacity systems with an economic specialisation in low-knowledge sectors. This group would be composed of Spain, Portugal and Estonia.
- Group 6: Medium-low knowledge capacity with a strong role of agriculture and low knowledge-intensive services. This group would be composed of Greece, Latvia, Lithuania and Malta.
- Group 7: Medium-low knowledge capacity system with a strong service-based economy Cyprus, as Germany, would be alone as its characteristics would differentiate it from all other research systems
- Group 8: Medium-low knowledge capacity with an important industrial base. This group would be composed of the Czech Republic, Slovenia, Slovakia, Hungary and Italy.
- Group 9: Low knowledge capacity systems with a specialisation in low knowledge intensive sector. This group would be composed of Bulgaria, Romania, Poland, Turkey and Croatia.

### *The results also allow for intra-group comparisons*

This group classification can help identifying how similar countries, i.e. countries belonging to a group, react in terms of research and innovation policies. In many cases, countries with similar research and innovations systems follow different paths when it comes to defining their investment strategies. As table N.P.1.3 shows, in the last decade, countries with well-developed research and innovation systems benefiting from high R&D investments and scientific and technological outputs have performed differently in terms of research and innovation.

Sweden, on the one hand, the world leader in terms of R&D investment, decreased its overall percentage and private R&D investments by 0.1 %, while Finland, a close follower, increased these investments by more than 3 %. While this analysis does not allow an accounting for the reasons of these trends, it allows the identification of

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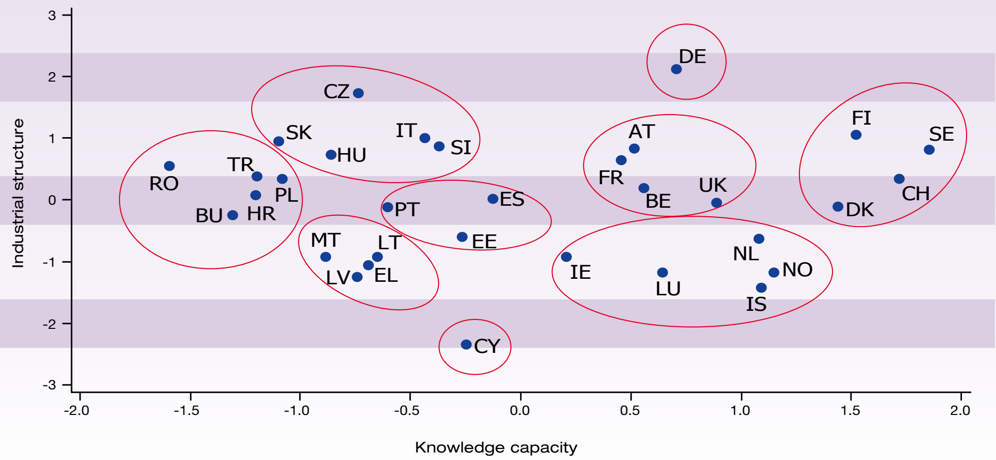
[387] This factor accounted for almost 50% of the total variance.

[388] This factor accounted for more than 12% of the total variance in the model. As a result, the Principal Component Analysis accounted for more than 62% of the variance introduced by the nineteen individual variables.

## FIGURE N.P.1.1 Groups of Research and Innovation Systems in Europe



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD

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## TABLE N.P.1.2 Key selected variables of the national research systems of the different groups

| | R&D Intensity 2009 | BERD Intensity 2009 | PCT patent applica-tions per billion GDP (PPS€) 2007 | Employment in knowl-edge- inten-sive activities as % of total employment 2009 | Scientific publica-tions within the 10% most cited scientific publica-tions worldwide as % of total scientific publica-tions of the Group 2007 | GERD average annual real growth (%) 2000-2009 | BERD average annual real growth (%) 2000-2009 |
|---|---|---|---|---|---|---|---|
| Group 1 (DK, FI, SE, CH) | 3.41 | 2.41 | 9.67 | 40.6 | 16.3 | 2.9 | 2.5 |
| Group 2 (DE) | 2.82 | 1.92 | 7.72 | 37.3 | 13.8 | 2.1 | 1.8 |
| Group 3 (BE, FR, AT, UK) | 2.09 | 1.32 | 3.78 | 40.9 | 14.1 | 1.9 | 1.6 |
| Group 4 (IE, LU, NL, IS, NO) | 1.82 | 0.96 | 4.85 | 38.5 | 16.2 | 2.8 | 1.2 |
| Group 5 (EE, ES, PT) | 1.42 | 0.72 | 1.18 | 29.9 | 11.6 | 7.8 | 8.1 |
| Group 6 (EL, LV, LT, MT) | 0.60 | 0.17 | 0.47 | 31.5 | 10.1 | 4.0 | 5.3 |
| Group 7 (CY) | 0.46 | 0.10 | 0.51 | 33.9 | 11.3 | 10.6 | 11.0 |
| Group 8 (CZ, IT, SI, SK, HU) | 1.27 | 0.67 | 1.89 | 32.2 | 10.9 | 3.1 | 3.5 |
| Group 9 (BG, PL, RO, HR, TR) | 0.72 | 0.29 | 0.38 | 25.3 | 6.2 | 7.1 | 6.7 |

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*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Note:* (1) Elements of estimation were involved in the compilation of the data

## TABLE N.P.1.3 Key selected variables of the national research systems of countries with very high knowledge intensity

| | R&D Intensity 2009[1] | BERD Intensity 2009[1] | PCT patent applications per billion GDP (PPS€) 2007 | Employment in knowledge-intensive activities as % of total employment 2009 | Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country 2007 | GERD average annual real growth (%) 2000-2009[2] | BERD average annual real growth (%) 2000-2009[2] |
|---|---|---|---|---|---|---|---|
| Denmark | *3.02* | *2.02* | 7.91 | 39.2 | 17.5 | *5.4* | *3.3* |
| Finland | *3.93* | *2.79* | 9.98 | 36.5 | 13.7 | *3.3* | *3.3* |
| Sweden | *3.60* | *2.54* | 11.01 | 42.3 | 14.7 | *0.7* | *-0.1* |
| Switzerland | 3.00 | 2.20 | 9.15 | 42.0 | 18.2 | 4.1 | 4.1 |

*Source:* DG Research and Innovation

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) CH: 2008; FI: 2010.

(2) CH: 2000-2008; FI: 2000-2010; SE: 2005-2009; DK: 2007-2009.

(3) Values in italics are estimated or provisional or forecasts.

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some interesting features of the research and innovation systems which are worth exploring further.

Perhaps more interesting is the situation of countries with weaker research and innovation systems, where the differences in performance are more remarkable, mainly due to the higher effect caused by smaller variations. For example, since the year 2000, Romania has benefited from a sharp increase in overall R&D investment, although this increase has been fuelled by the public sector, while the private sector decreased its R&D investment. On the other hand, Bulgaria decreased its R&D investment for the same period, mainly due to a decrease in the research intensity of public investment, while private R&D increased. Once again, this data does not allow an understanding of the reasons for these different behaviours, but it points to interesting areas for further research.

## TABLE N.P.1.4 Key selected variables of the national research systems of countries with low knowledge intensity and with a specialisation in low knowledge-intensive sectors

| | R&D Intensity 2009 | BERD Intensity 2009 | PCT patent applications per billion GDP (PPS€) 2007 | Employment in knowledge-intensive activities as % of total employment 2009 | Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country 2007 | GERD average annual real growth (%) 2000-2009[1] | BERD average annual real growth (%) 2000-2009[1] |
|---|---|---|---|---|---|---|---|
| Bulgaria | *0.53* | *0.16* | 0.38 | 26.0 | 5.7 | *5.0* | *9.0* |
| Poland | 0.68 | 0.19 | 0.31 | 28.0 | 5.7 | 4.4 | 1.7 |
| Romania | 0.48 | 0.19 | 0.15 | 19.8 | 6.2 | 7.9 | 1.5 |
| Croatia | 0.84 | 0.34 | 0.88 | 27.4 | *5.1* | 0.8 | 0.0 |
| Turkey | 0.85 | 0.34 | 0.46 | 18.4 | *6.9* | 10.1 | 12.3 |

*Source:* DG Research and Innovation

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Note:* (1) HR: 2002-2009

(2) Values in italics are estimated or provisional

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# CHAPTER 2

# Thematic diversity: specialisation at national and regional level

## HIGHLIGHTS

In general, European countries and regions may need to identify and define areas where they need to focus their scarce scientific and technological resources in order to achieve critical mass, obtain meaningful results and develop a competitive advantage. The process of building a competitive advantage in research and innovation is a complex strategic process that needs to build on existing strengths, create networks and be linked to broader socio-economic political goals. This process is not exempt from risks (e.g. 'picking up loser' or being driven to technological lock-in strategies), and requires a great deal of data for analysis and policy reflection. Specialisation indexes show the comparative advantage of one system and the dynamics of one country or region.

Based on these indexes, the EU, as the United States, presents overall a fairly diversified scientific and technological pattern. However, the EU, unlike the United States, depicts a negative specialisation in the most dynamic, faster-growing and technology-intensive fields, such as medical equipment, telecommunications or audio-visual electronics. Moreover, in terms of key enabling technologies, the United States presents a consistent positive specialisation in ICT, biotechnology and nanotechnology, while the EU presents a mixed picture. It still presents a lower relative specialisation in ICT and biotechnology technologies, while it has offset the lower relative specialisation in nanotechnology that it suffered at the beginning of the decade.

At a national level, Denmark and Ireland depict a positive and increasing specialisation in health technologies or environmental technologies, Finland in ICT and the Netherlands in nanotechnologies.

At a regional level, ICT technologies are concentrated around Finland, South East England, Belgium, the Netherlands and some core areas in France and Germany. For biotechnology, regions with large university centres at the core of the EU depict a positive specialisation.

However, it is important to remember that smart specialisation is a dynamic strategic process where regions and member states need to identify their long-term competitive advantages based on their local strengths, and define those actions that can lead them to maintain and/or create their competitive position.

While further work will be needed to assist regions and countries in this self-discovery process and evaluate the results and impacts, the specialisation indexes can provide an initial framework to identify existing strengths and help identify potential drivers and barriers leading to particular specialisation patterns and dynamics.

## 2.1. Evidence base for smart specialisation

Smart specialisation has recently gained political and analytical importance in Europe as a potential solution to problems of research fragmentation and imitation of research patterns, which will build critical mass, to maximise research and innovation outputs in all regions in Europe. Moreover, in the current context of fiscal consolidation, 'specialisation strategies can be conducted in ways that also enhance innovative specialisations and competitive advantages in the post-crisis period, facilitate repositioning strategies and underpin answers to severe global risks, e.g. energy shortage, climate change[389].'

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[389] Giannitsis, A and Kager M (2009): 'Technology and specialisation: Dilemmas, options and risks?', *Expert group 'Knowledge for Growth', May 2009.*

### *Smart specialisation as a dynamic and entrepreneurial process to identify and build competitive advantages in science and technology*

The concept of smart specialisation should be understood as a dynamic 'process of finding the right areas to focus on[390]'. As such, smart specialisation does not call for imposing specialisation through some form of top–down industrial policy. On the contrary, it requires an entrepreneurial process of discovery involving all stakeholders to identify and reveal what a country or region does best in terms of science and technology, and where they can expect to excel. This process of discovery needs to be attached to broader political goals and must identify governance mechanisms and criteria to guide choices.

Smart specialisation is an important policy rationale and concept for regional innovation policy. It promotes efficient, effective and synergetic use of public R&I investments and supports Member States and regions in diversifying and upgrading existing industries and in strengthening their innovation capacity. In a nutshell, smart specialisation is about placing greater emphasis on innovation and having an innovation-driven development strategy in place that focuses on each region's strength and competitive advantage. It is about specialising in a smart way, i.e. based on evidence and strategic intelligence about a region's assets and the capability to learn what specialisations can be developed in relation to those of other regions.

Many EU Member States and regions have a long-standing experience in developing and implementing innovation strategies. In many cases these strategies already include most or many of the elements that would justify them as being "smart", i.e. they were developed based on a sound assessment of a region's competitive assets and potential, including a SWOT analysis, a broad and intense stakeholder consultation, a deep understanding of business R&I needs, and they have developed a policy mix that covers the whole knowledge triangle. A few examples from regions that have embarked on such a smart specialisation exercise are included in this brochure. Yet many others have seen such exercises fail for want of strategic intelligence or political commitment or a lack of capacity or long-term political and budgetary commitment to implement such plans, properly evaluate them or sufficiently involve key stakeholders. For these there is a need to provide targeted assistance.

### *Smart specialisation requires the selection of fields to focus on resources. This process is not exempt of risks[391]*

The very concept of specialisation requires the selection of specific areas to concentrate resources around specific goals and the non selection of others. If the market is unable to identify the key areas to specialise, the cost of inaction can be high. On the other hand, if an action needs to be taken, this selection may end up 'picking up losers', which may have high associated costs.

In the field of research and innovation, it is difficult to predict the results that will accrue from investments, and increasingly, technology developments and innovation can be based on the scientific results of many different and *a priori* unrelated disciplines. As such, targeting investment decisions towards narrow scientific areas may jeopardise the potential capacity to develop new technologies and innovations.

As a result, the analysis of the scope and scale of the need to specialise requires careful consideration. The choice and development of a smart specialisation strategy is a complex process where decision makers, e.g. governments, entrepreneurs, universities, need to have a clear vision for the future, build on their strengths, be aware of developments elsewhere, create networks and communities to maximise the use of available knowledge, and finally be able to take and manage risks.

In order to render the process as efficient as possible, more information is needed. European countries and regions need data that can help them assess their comparative and competitive strengths in different scientific and technological fields. Moreover, the research agents need new data to identify other countries and regions where research in similar fields is conducted so that they can network, build on each others' findings and create synergies between researchers.

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[390] Foray D, David P A and Hall B (2009): 'Smart Specialisation: the concept', *Expert group 'Knowledge for Growth', May 2009.*

[391] A more in-depth review of the pros and cons of 'Smart specialisation' can be found in Pontikakis D, Kyriakou D and van Bavel R (eds) 2009: 'The Question of R&D specialisation: perspectives and policy implications', JRC Scientific and Technical Reports EUR 23834. For an analysis of the networking and regional innovation capacity, see also Varga, A. and Pontikakis, D., 2009. "Is networking a substitute or a complement to regional innovation capacity? Evidence from the EU's 5th Framework Programme". *JRC Scientific and Technical Reports, EUR 23836 EN.*

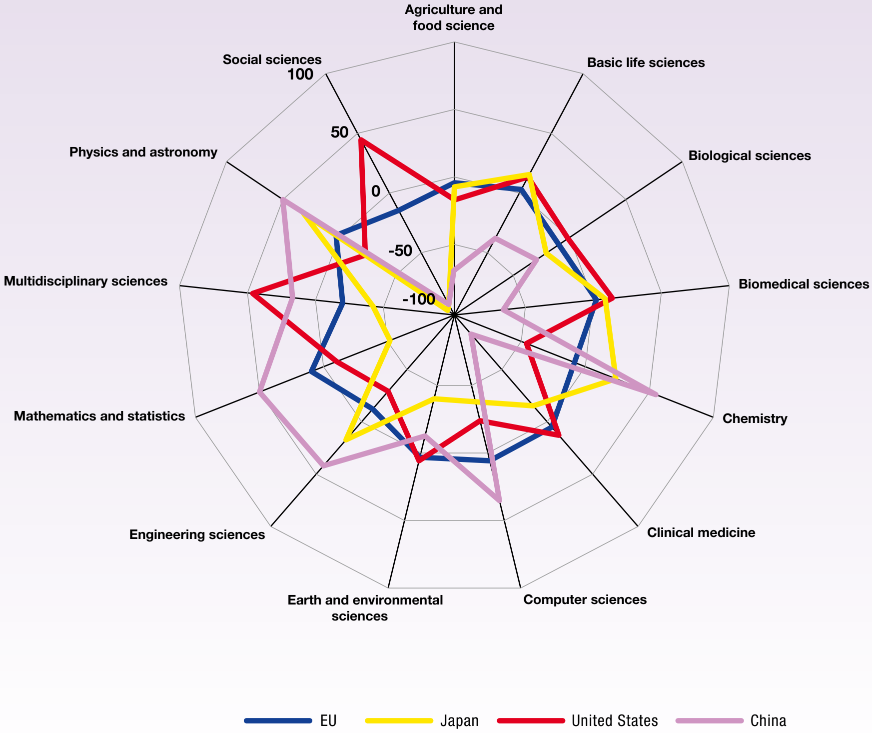
***Much data is needed to inform the smart specialisation process. The specialisation indexes reveal the comparative advantage of one research and innovation system in one field and can help partially inform the process***

A large battery of indicators can contribute to an understanding and explanation of the process of selecting and building scientific and technological competitive advantages in particular fields.

The scientific and technological specialisation indexes[392] rank high in this list. They indicate the areas where a country or region exhibits a stronger position than other countries or regions, and conversely the areas of relative weakness. In other words, they represent the different weight that scientific or technological fields carry in the overall research and innovation system in comparison with the rest of the world. As such, they do not reflect the absolute, but the comparative conditions for one area in one country, and their interpretation needs to be carefully done. The terminology 'positive' and 'negative' specialisation does not imply any normative value; they represent standard terminology in statistical analysis of specialisation indexes.

It should be noted that the specialisation indexes do not reflect the potential use of these technologies, but

FIGURE N.P.2.1 **Scientific specialisation in the EU, the United States, Japan and China, 2004-2006**



*Source:* DG Research and Innovation
*Data:* Web of Science (Thomson scientific) / CWTS, University of Leiden

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[392] The mathematical definition of the specialisation indexes are calculated according to the following formula: RCAki = 100 x tanh ln {(Aki/ΣiAk)/(ΣkAki/ΣkiAki)}, with Aki indicating the number of publications (patents) of country k in the field i, whereby field is defined by scientific fields (patent classes). LN centres the data around zero and the hyperbolic tangent multiplied by 100 limits the RCA values to a range of +100 to -100.

the production; positive- and negative-specialisation indexes do not always correspond to the existence of favourable or unfavourable conditions for these scientific or technological fields in a given country, as they cannot measure other important variables, such as the existence of clusters of complementary activities or critical mass which are crucial to construct scientific, technological or economic competitive advantages.

## 2.2. Scientific and technological specialisation of the EU

The following sections present a series of scientific and technological specialisation profiles for the EU, the United States and Japan, and analyse in more detail the specialisation indexes for Member States and their regions, in a number of particularly interesting technological fields.

### *The EU's scientific system is highly diversified with little relative specialisation in any particular field*

The EU has developed a diversified scientific base where most fields are represented at the average world level (Figure N.P.2.1). To some extent, this pattern responds to the vast importance of the EU scientific production that largely influences the world patterns of scientific production. Nevertheless, the United States, which also has very large scientific production, presents a less diversified system, as it depicts a stronger specialisation in social sciences, multidisciplinary science and to a lesser extent, clinical medicine. Japan and China present less diversified scientific systems, with Japan showing a positive specialisation in physics, engineering and chemistry, and China on maths, engineering and computer science.

### *The EU-27, like most other large economies, counts on a highly diversified technological system, with a comparatively slight negative specialisation in high-technology sectors, such as telecommunication, electronics or medical equipment*

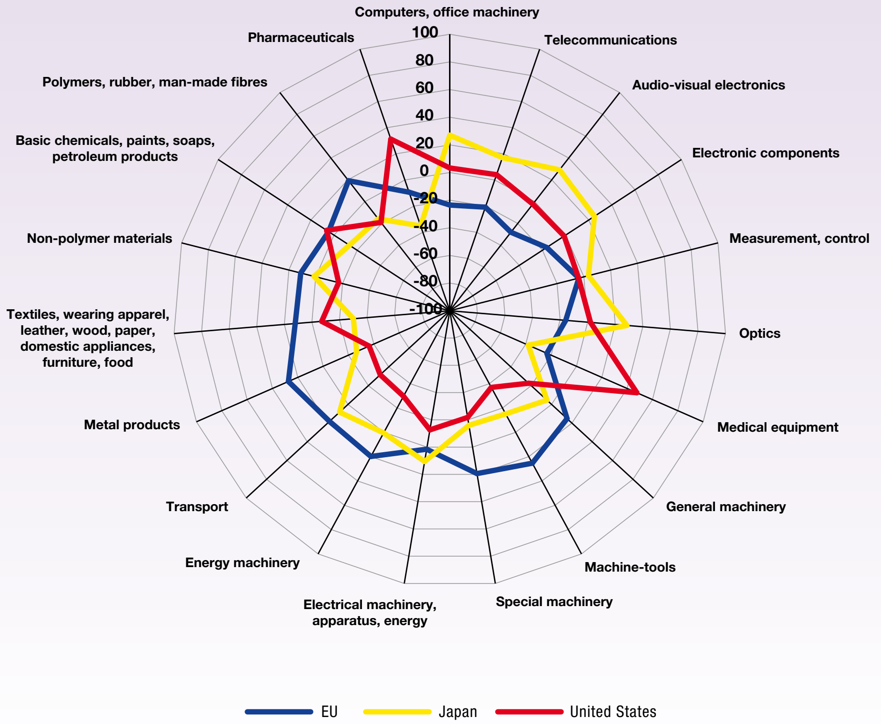
EU-27, like the United States and Japan, has maintained a relatively stable technological specialisation pattern in recent years. On average, large economies have diversified technological systems where few specific fields stand out. However, it is important to point out that in comparison, Japan has a relative specialisation in highly research-intensive electronic fields such as computers, office and machinery, telecommunications, audio-visual electronics, electronic components or optics. The United States specialises more on high-tech and high added-value technological fields related to medical equipment and pharmaceuticals, while the European Union seems to have a stronger specialisation in lower research-intensity sectors such as metal production or machinery-related technologies and a negative specialisation in ICT-related sectors such a telecommunications, audio-visual electronics or electronic components.

### *As for science, European technology tends to be highly diversified with a relative specialisation in machine-related and metal-product technologies*

The European Union's technological pattern presents a fairly diversified picture with a certain specialisation in medium technology-intensive areas such as metal-product-, transport- or machinery-related technologies (Figure N.P.2.2). This pattern contrasts with that of the United States or Japan, which present a less uniform distribution of technological development. More precisely, the United States counts on strong specialisation on high technology fields such as medical equipment or pharmaceuticals, while Japan presents a higher specialisation in other high technological fields such as telecommunications, and electronics-related technologies.

These patterns have been stable over time and somehow reflect the differences in the economic structure of Europe vis-à-vis its main trading competitors. Although it is difficult to identify whether the scientific and technological patterns are the cause or the consequence of a given productive specialisation, this data shows that Europe has a lower relative specialisation in the production of high-technology knowledge. The continuation of this pattern can cast some doubts on the competitiveness of its industry to produce and export high technology and added-value products.

FIGURE N.P.2.2 **Technological specialisation in the EU, the United States and Japan, 2005-2006**



*Source:* DG Research and Innovation
*Data:* JRC-IPTS , EPO, WIPO
*Note:* Patent applications by region of residence of the inventor(s).

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***While it is difficult to establish close relationships between scientific and technological specialisation profiles, some patterns can be identified***

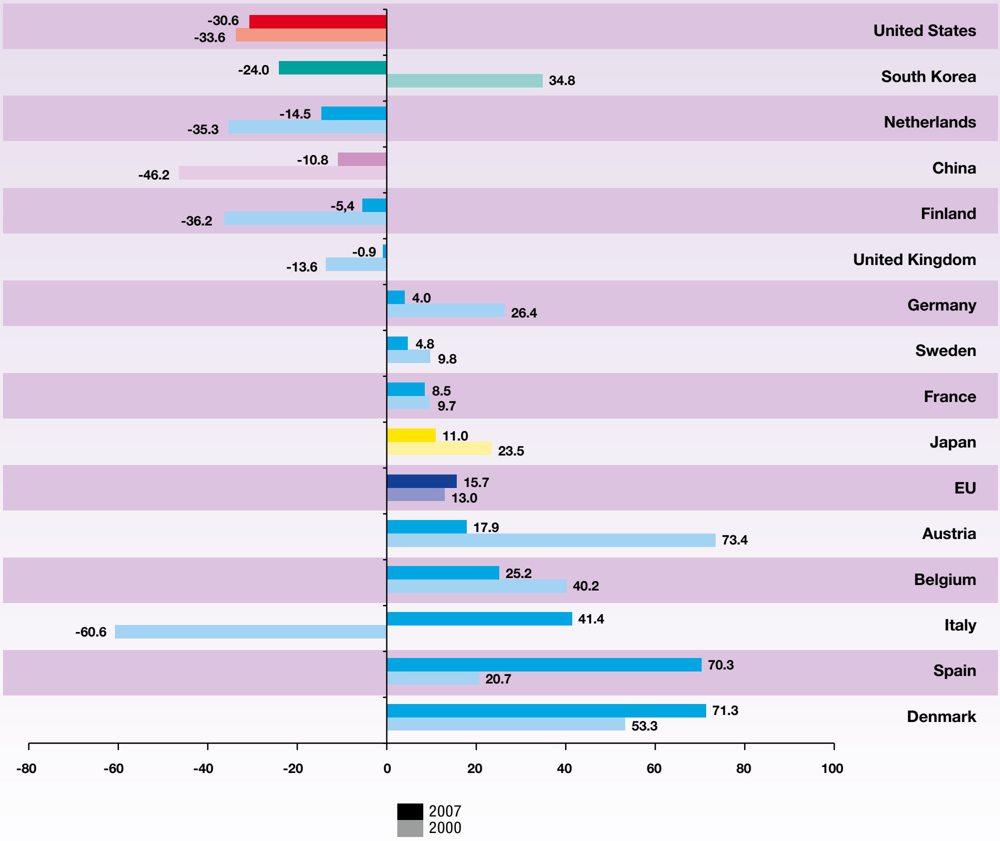
The United States depicts a positive scientific specialisation in life science and biomedical sciences and a technological specialisation in pharmaceuticals and medical equipment. Japan shows a positive specialisation in physics and engineering and a positive specialisation in ICT-related technologies.

## 2.3. Specialisation in environmental and health technologies

***The European Union is increasingly improving its relative strengths in developing new technologies aimed at improving the environment, including climate change***

In terms of relative specialisation in environmental technological fields, the EU depicts a positive specialisation pattern, in contrast to the United States, with a negative specialisation index (Figure N.P.2.3). Member States such as Spain, Denmark, Hungary and the Czech Republic lead the list of countries where environmental technologies play a comparatively stronger role in the national technological production. It is important to highlight the case of Italy,

FIGURE N.P.2.3 **Environmental technologies - specialisation index by country, 2000 and 2007**



*Source:* DG Research and Innovation
*Data:* PCT JRC-IPTS, OECD
*Note:* Patent applications by region of residence of the inventor(s).

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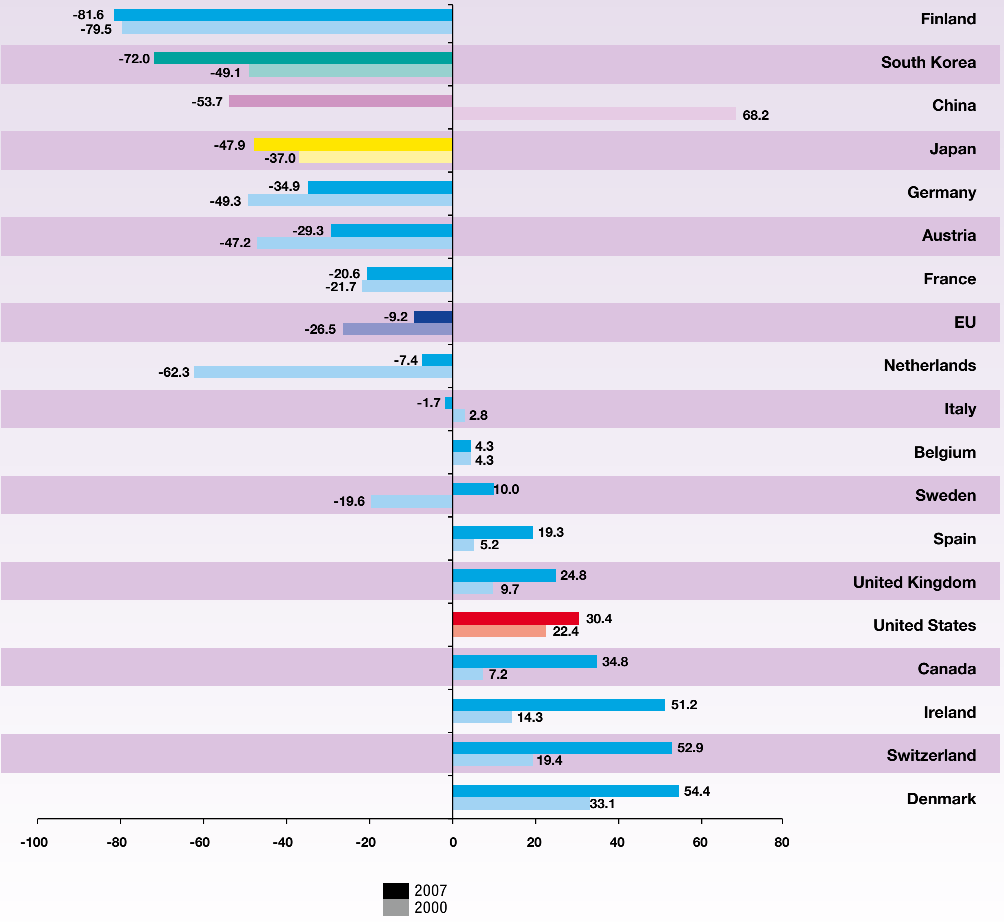
which in the last decade reversed an important negative specialisation index and now has moved to become one of the most promising technological fields.

### *The EU suffers a negative specialisation in health technologies, where the United States has an absolute and relative advantage*

The United States, overall, has both an absolute and comparative advantage in the development of health-related technologies. While the EU-27 has been catching up in the last decade, it still suffers from a negative specialisation in this field, as other technological fields are comparatively better positioned (Figure N.P.2.4). However, within Europe, there are some countries that have developed very strong positions in health-related technologies such as Denmark, Ireland or the United Kingdom. This specialisation has been more marked over time, which suggests a process of increasing specialisation in these technologies in these countries, which most likely count on the right factors (both in terms of resources like institutions and policies) allowing to them to concentrate their research and scientific efforts towards these fields.

It should be noted that both highly research-intensive systems such as South Korea and Japan also count on a high negative specialisation in these technologies, which suggest a high specialisation in other technological fields, and likely, a lack of the right conditions to develop these types of technologies.

## FIGURE N.P.2.4 Health technologies - specialisation index by country, 2000 and 2007



*Source:* DG Research and Innovation
*Data:* JRC-IPTS, OECD
*Note:* Patent applications by region of residence of the inventor(s).

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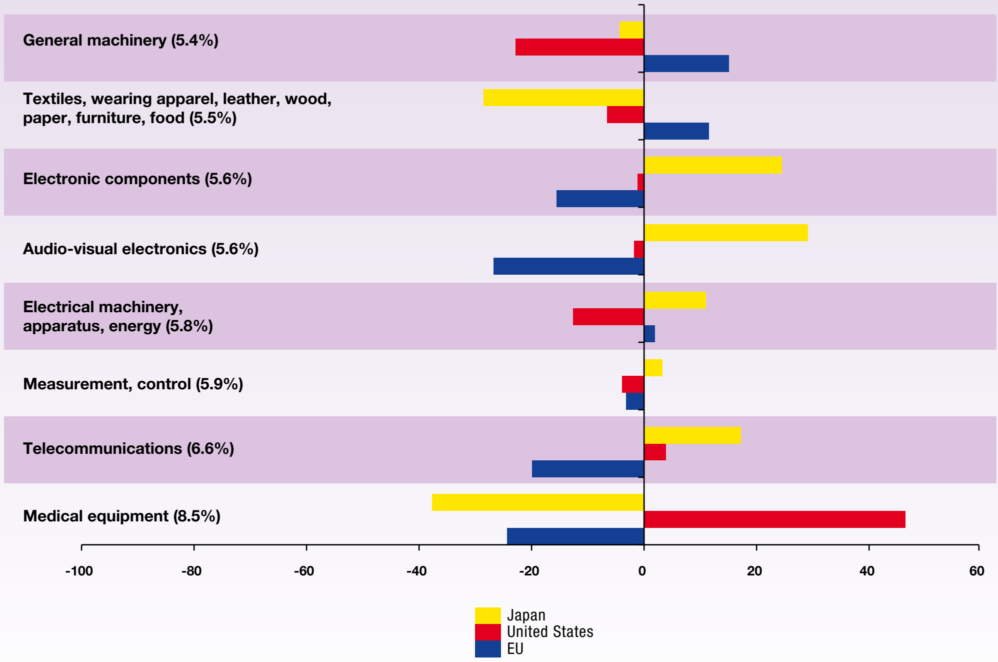
## 2.4. Specialisation in new growth areas and general-purpose technologies

Technological fields evolve according to their own idiosyncratic characteristics, which may include historical factors, knowledge developments or changes in economic and societal demands. As a result, comparisons across fields are difficult. However, some technological fields seem to be more dynamic over time, presenting higher growth rates in patenting activity. As figure N.P.2.5. shows, fields such as medical equipment, telecommunications or measurement and control technologies have been growing faster than other fields in the recent past.

## FIGURE N.P.2.5 Fast growing technology fields(1) - specialisation index, 2004-2006



*Source:* DG Research and Innovation

*Data:* JRC-IPTS, OECD

*Notes:* (1) Fast growing technology fields over the periods 2003-2004 and 2004-2005. Growth of patent applications between the two periods is given in brackets.
(2) Patent applications by region of residence of the inventor(s).

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### *The European Union presents a negative specialisation in the most dynamic, faster-growing and technology-intensive fields*

The EU seems to lag behind in these technology-intensive sectors, as the specialisation indexes are negative for these technologies, indicating that there are fewer EU patents in these areas than there would be if patent numbers corresponded to the EU's overall technological activity.

Moreover, general-purpose technologies, such as ICT, biotechnology or nanotechnology, have been at the basis of recent important technological developments and they are expected to be crucial for future economic growth.

### *The EU has a negative specialisation in ICT, although some Member States and especially, some regions within them, show a positive technological specialisation in these fields*

The EU still shows a lower specialisation in the development of ICT technologies. Evidence at the level of firms in the IT sector suggests that the EU's R&D deficit may be due to constraints on the rapid growth of new-technology entrants in the EU compared to that of the United States[393]. With the exception of Finland, Sweden and to a lesser extent Ireland, the role of ICT in the EU has been shrinking over time. In contrast, in addition to the United States, countries in Asia, e.g. China, South Korea or Japan, have become increasingly specialised in this field internationally,

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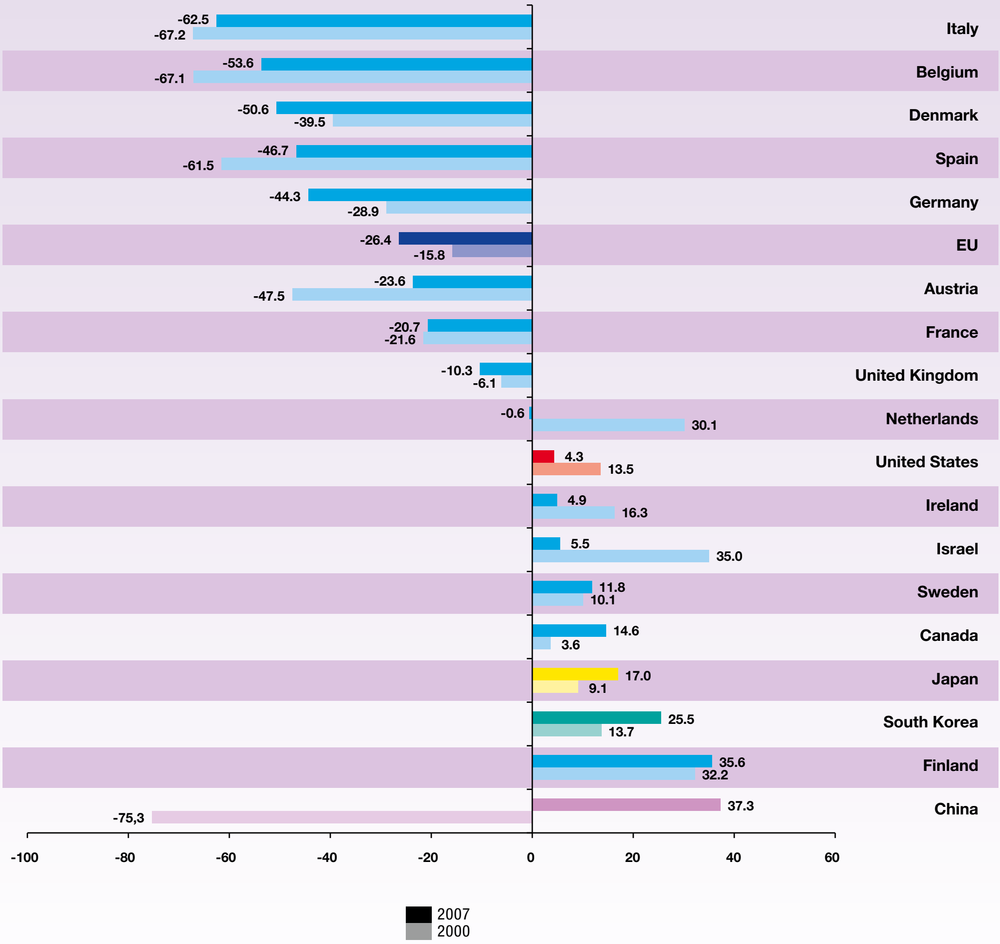
[393] Source: DG Enterprise: 'European Innovation Scoreboard, 2010' (p.49).

FIGURE N.P.2.6 **ICT technologies - specialisation index by country, 2000 and 2007**



*Source:* *DG Research and Innovation*
*Data:* JRC-IPTS, OECD, Eurostat
*Note:* Patent applications by region of residence of the inventor(s).

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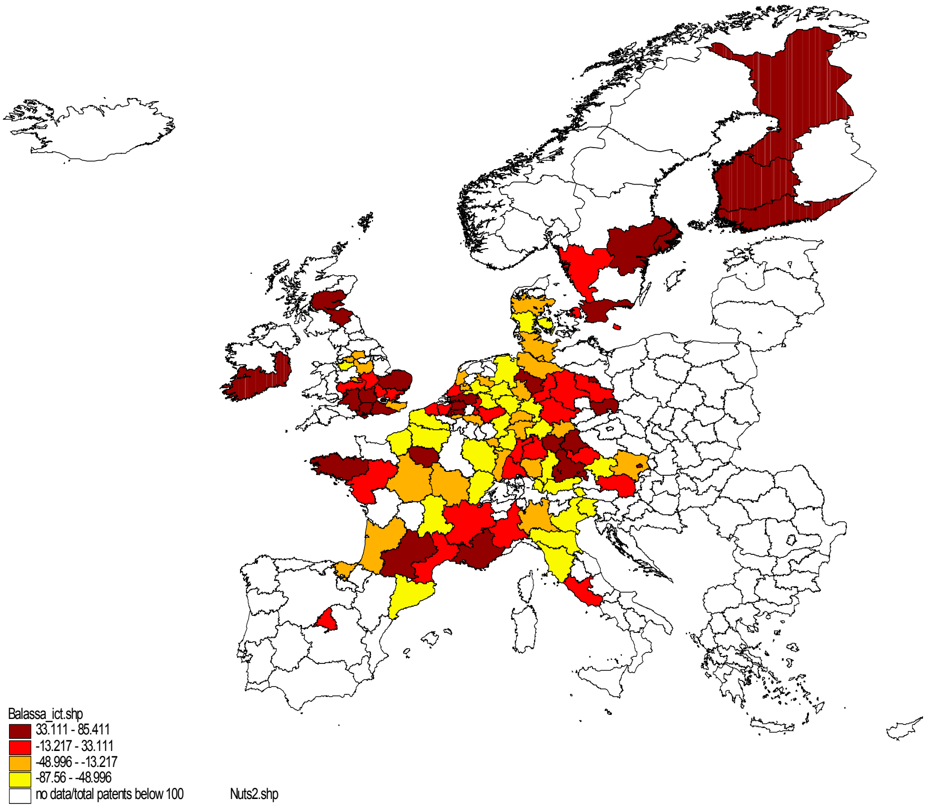
which makes them an important global hub for ICT-related technological development (Figure N.P.2.6).

It is important to note that in dynamic terms, most countries have maintained their specialisation patterns over time – China being a notable exception – passing from a large negative specialisation in 2000 to a significant positive specialisation in 2007.

In recent years, many regional governments have expressed their interest in entering the biotechnology and ICT fields. The potential high returns of these technologies, either on their own or in interaction with

FIGURE N.P.2.7 **EU technological specialisation in ICT technologies at NUTS 2 regional level: 2004–2006**(1)(2)



*Source:* DG Research and Innovation, JRC-IPTS
*Data:* OECD, Eurostat
*Notes:* (1) Patent applications by region of residence of the inventor(s).
(2) The regional analysis only takes into account regions that produce more than 100 patents in order to avoid misleading interpretation of specialisation patterns in very low technology production intensive regions. The regions are distributed in four groups, each of which contains 25% of the analysed regions.

other fields, have attracted increasing interest and investment from local and regional governments.

At the regional level[394], ICT technologies are highly concentrated around Finland, the South East of England and some core regions in Belgium, the Netherlands, some core regions in Germany and France, and finally in some capital regions of Île-de-France and Madrid (Figure N.P.2.7).

***The emerging biotechnology and nanotechnology fields seem to be concentrated around core countries of the EU, such as the United Kingdom, Belgium and the Netherlands***

In terms of biotechnology, the field seems to be less mature and stable than that of ICT, and many countries have experienced significant changes in their specialisation patterns over the last decade. The United States shows a positive specialisation in this field, while the EU has relatively advanced in the last decade, although still depicts a slight relative negative specialisation (Figure N.P.2.8).

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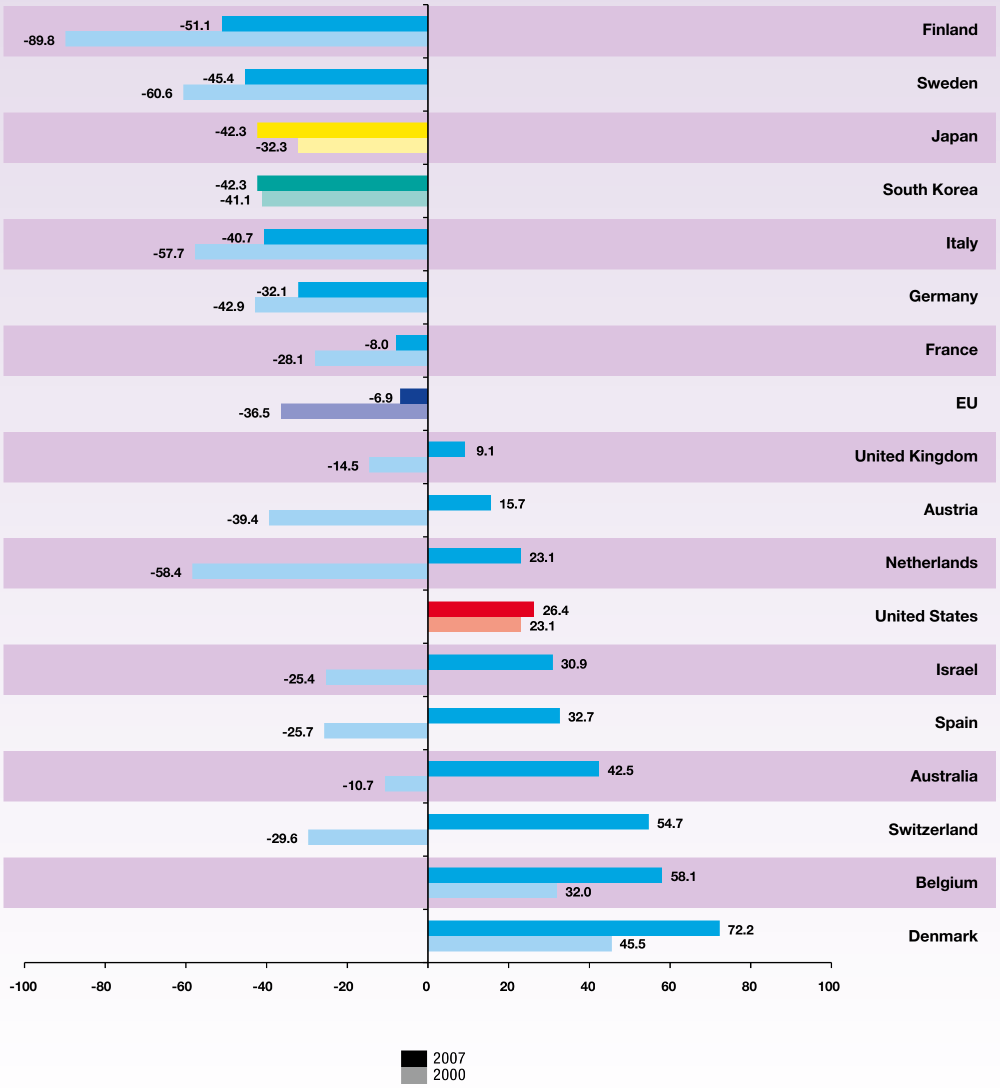
[394] As it happened for Member States, the statistical construction of the indicator requires the analysis to be focused on those regions counting a statistical significant number of patents. Only regions with 100 or more patents in any of the analysed years are taken into account in the study. 108 regions comply with this requirement.

FIGURE N.P.2.8 **Biotechnology - specialisation index by country, 2000 and 2007**



*Source:* DG Research and Innovation
*Data:* JRC-IPTS, Fraunhofer ISI, Eurostat
*Note:* Patent applications by region of residence of the inventor(s).

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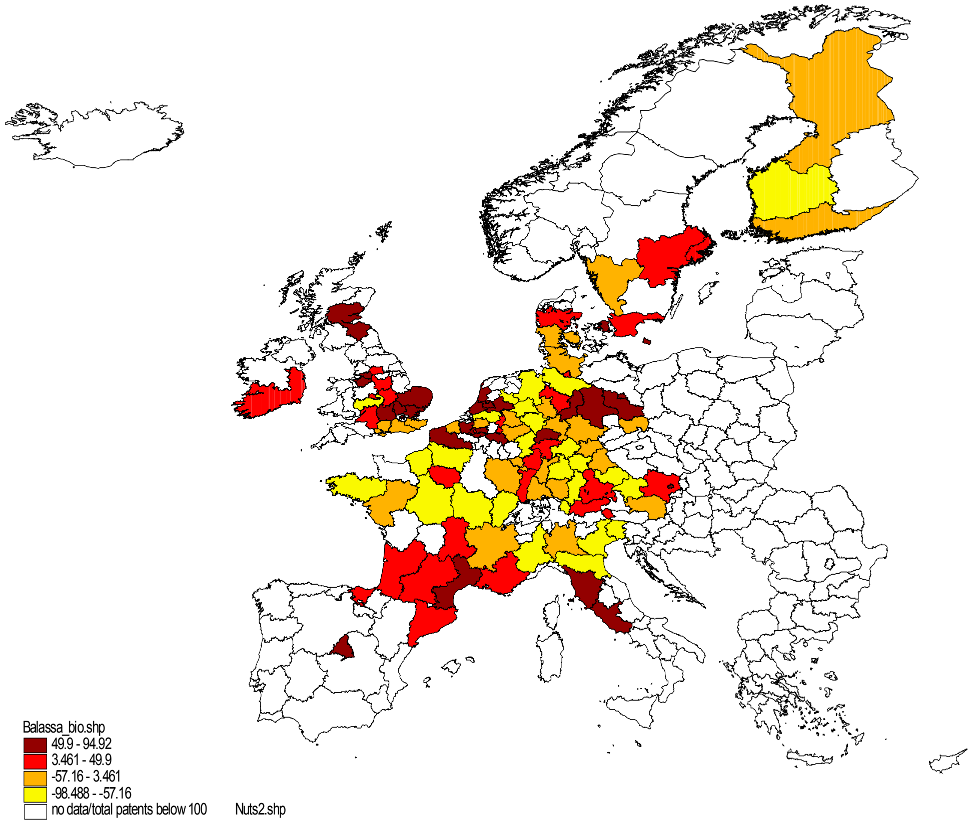
Countries like the United Kingdom or the Netherlands have reverted negative specialisation patterns from 2000 into a positive relative specialisation, which suggest a relative improvement of the conditions in these countries for biotechnology. Belgium and Denmark have increased their specialisation

FIGURE N.P.2.9 **EU technological specialisation in biotechnology at NUTS 2 regional level: 2004–2006(1)(2)**



*Source:* DG Research and Innovation, JRC-IPTS
*Data:* Fraunhofer ISI, Eurostat
*Notes:* (1) Patent applications by region of residence of the inventor(s).
(2) The regional analysis only takes into account regions that produce more than 100 patents in order to avoid misleading interpretation of specialisation patterns in very low technology production intensive regions. The regions are distributed in four groups, each of which contains 25% of the analysed regions.

pattern. This data confirms the high importance of biotechnology for health technologies, as the countries with higher specialisation patterns in medical technologies also present a high specialisation pattern in biotechnologies.

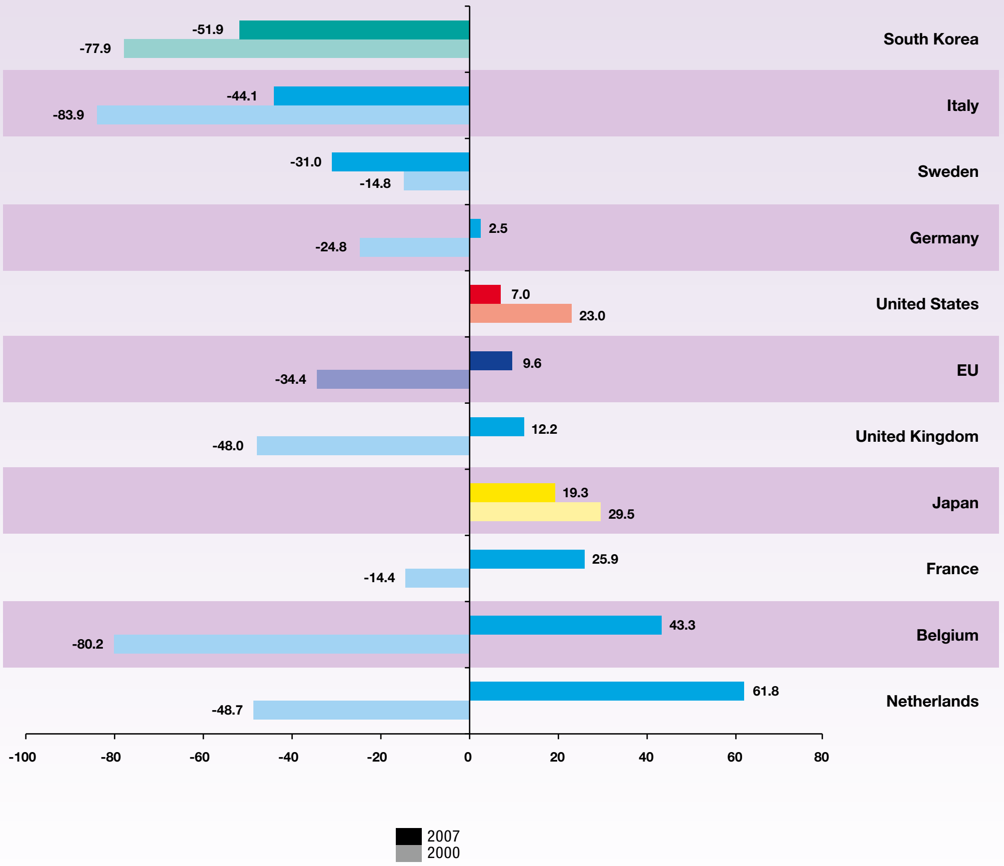
### *Biotechnology is highly concentrated in a few regions in Europe*

Regions with large university centres in the south East of England, Scotland, the south of France, Belgium, the Netherlands, Denmark, Germany, Madrid in Spain and Lazio in Italy are more highly specialised in science-dependent biotechnology (Figure N.P.2.9).

### *In nanotechnologies, the EU is catching up with Japan and the Unites States. Within the EU, the Netherlands, Belgium and France are developing an important specialisation*

The field of nanotechnology, like biotechnology, is more novel than that of ICT, and in the last decade, many countries have managed to develop an important specialisation in this field. While still emerging and not consolidated, the dynamic analysis of the specialisation indexes reveals that some countries seem to be becoming better positioned, suggesting the existence of significant comparative advantages for the development of these fields, e.g. Belgium and the Netherlands (Figure N.P.2.10).

FIGURE N.P.2.10 **Nanotechnology - specialisation index by country, 2000 and 2007**



*Source:* DG Research and Innovation
*Data:* JRC-IPTS, OECD
*Note:* Patent applications by region of residence of the inventor(s).

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Overall, the EU shows a small positive specialisation in these fields comparable to that of the United States. This value masks high internal differences, as a few countries in Europe, the Netherlands, Belgium, the United Kingdom, France and Germany, seem to concentrate the large majority of patents. This geographical concentration of the nanotechnology patents at the European core seems to suggest that the field requires large investments and benefits from large concentration and spillover effects.

# CHAPTER 3

# Trust and dialogue between science and society

## HIGHLIGHTS

Among European citizens there is a widespread agreement that science and technology make our lives healthier, easier and more comfortable. However, since 2005 the share of Europeans experiencing a general trust in science has declined from 78% to 66%. This being said, Europeans trust science more or less at the same extent as citizens of the United States and Canada, with the exception of science for nuclear power, about which Europeans are more sceptical.

The majority of European citizens consider that science and technology are important to solve environmental problems, but there are differences inside Europe between the Northern Europeans (most supportive) and citizens in East European countries (less supportive). Data for EU-15 suggest that trust in the biotechnology industry is in decline, with some exceptions such as France and Greece where there has been an increase of trust. Levels of optimism about computers and information technology and solar energy have been high and stable over the period. A majority of the Europeans express trust in nanotechnology with differences across countries.

European citizens feel that decisions about science and technology should be made in dialogue with them by scientists, engineers and politicians, and the public should be informed about these decisions.

The large majority of European research-active universities surveyed have strategies of public engagement with society although there is a diversity of aims. In European countries there is a wide array of tools, ranging from a more informative to a more participatory approach. The main actors behind public engagement activities are the ministries of science and technology, the institutes for science and technology or, less frequently, institutions or organisations specifically dedicated to this.

The relationship between science and society in contemporary societies has been characterised by an evolution (Bauer et al., 2007)[395] from an initial stage based on diffusion of scientific literacy to the last stage of confidence and trust crises. Within this context, it is important to ask questions such as: do European citizens trust science? What are the differences in public support for some of the main technologies? What are the differences among European countries? Is there any difference between the US and Europe? Are scientists trusted as a source of information by European citizens? What are the policy tools needed to engage in dialogue with society in Europe?

At the European level, data on public opinion on science and technology has now been collected for more than twenty years, and is increasingly more systematic and complete. On the other hand, data on the policy dimension responds to a more recent demand, which is why this kind of information is less consolidated. The enlargement of the EU and the rise of new needs and approaches in the dialogue between science and society requires a systematic collection of data. This is a task for future editions of this chapter: bringing together experiences and information by different evaluation exercises done within European countries and at EU level, such as evaluation studies, foresight exercises and related research.

## 3.1. Do European citizens trust science and technology?

The collection of information on public trust in science at European level has been at the centre of a substantial body of research in the past decades but data tends to be fragmented in several initiatives without much continuity or longitudinal comparison. The exception are several initiatives of the Eurobarometer with their special surveys at the European level.

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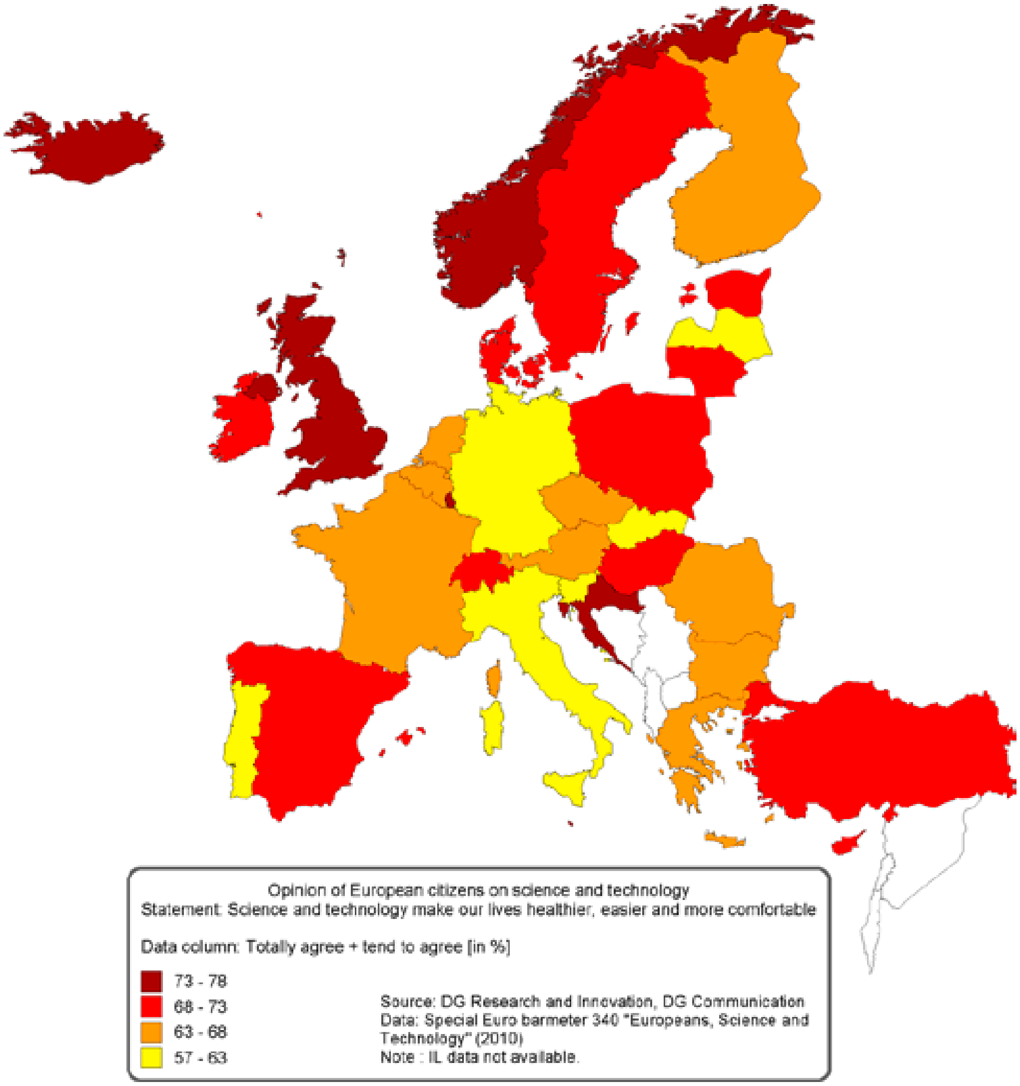
[395] Bauer, M., Allum, N. and Miller, S.(2007a) What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda. *Public Understanding of Science* 16: 79-95.

**FIGURE N.P.3.1** Share of European citizens considering that science and technology makes our lives healthier, easier and more comfortable



*Source:* DG Research and Innovation
*Data:* Special Euro barometer 340 'Europeans, Science and Technology', 2010

### *Two thirds of the European citizens trust science and technology to make their lives healthier, easier and more comfortable – a clear decline in trust since 2005*

Support and trust in science depend on the social and economic context of a country. Therefore it is necessary to analyse trust at country level, to map the differences within the EU. Figure N.P.3.1. presents an indicator on optimism about science and technology. When asked whether science and technology make our lives healthier, easier and more comfortable, 66% of Europeans on average agreed in 2010, compared to 78% in 2005.

### *The highest trust in science and technology can be found in Malta, Iceland, the United Kingdom, Luxembourg and Norway*

Table N.P.3.1. shows that there is widespread agreement among individual European countries that science and technology makes our lives healthier, easier and more comfortable. In five countries, three quarters or more of respondents agree with the statement: Malta at 78%, Iceland at 77%, the United Kingdom at 76% and Luxembourg and Norway at 75%. Finland saw 20% of respondents disagreeing that science is making our lives healthier, easier and more comfortable, and this is well above the EU-27 average of 12% of respondents.

The largest decline in trust has taken place in Germany, Italy and Poland. In all countries, except Norway, Hungary and Luxembourg, citizens have lost part of their trust in science. The survey also showed that in a knowledge-intensive country as Finland, 20% of the respondents disagreed with the statement of optimism towards science and technology.

### *Overall, EU citizens have become sensitive and sceptical to specific dimensions of science and technology*

Figure N.P.3.2. presents the average responses for the 27 EU Member States to a series of questions concerning attitudes towards science and technology. It shows that EU citizens feel strongly that science could be used by terrorists in the future, with 78% in agreement and only 7% in disagreement. However, EU citizens are positive about science providing more opportunities, with 75% in agreement with this. The majority also feel that science is making our lives healthier, easier and more comfortable (66%). It should be noted that only half of the respondents were presented with this statement whereas the other half were only asked whether science and technology is making our lives healthier. It is interesting that this latter statement obtains a lower level of agreement, (52%) which indicates that there is more doubt about the effect of science on health alone, but when considered in the context of making life easier and more comfortable, people are much more positive about the effect of science. Finally, a large majority of respondents (61%) agree that the application of science and new technologies will make people's work more interesting.

The results also indicate some reservations about science. Two out of three (66%) Europeans feel that experimentation using mice is acceptable only if this leads to improvement in health and well-being. However, when asked if scientists should be allowed to experiment on animals like dogs and monkeys if this can help sort out human health problems, only 44% of respondents at EU-27 level agree while 37% disagree. There is also a tendency to feel that science can sometimes damage people's moral sense, as 62% of Europeans agree. Close to 6 out of 10 Europeans (58%) feel that science makes our daily life change too quickly and 53% feel that scientists can be too powerful and potentially dangerous.

Europeans on the whole believe that science will help, but cannot solve every problem. A slim majority of 54% believe that science can sort all environmental problems, but very few, 22%, agree that science can solve any problem and only 21% believe that science will lead to the world's natural resources being inexhaustible.

## TABLE N.P.3.1 Trust in science and technology in European countries 2005-2010

QC6.1 I would like to read out some statements that people have made about science, technology or the environment. For each statement, please tell me how much you agree or disagree. Science and technology make our lives healthier. easier and more comfortable

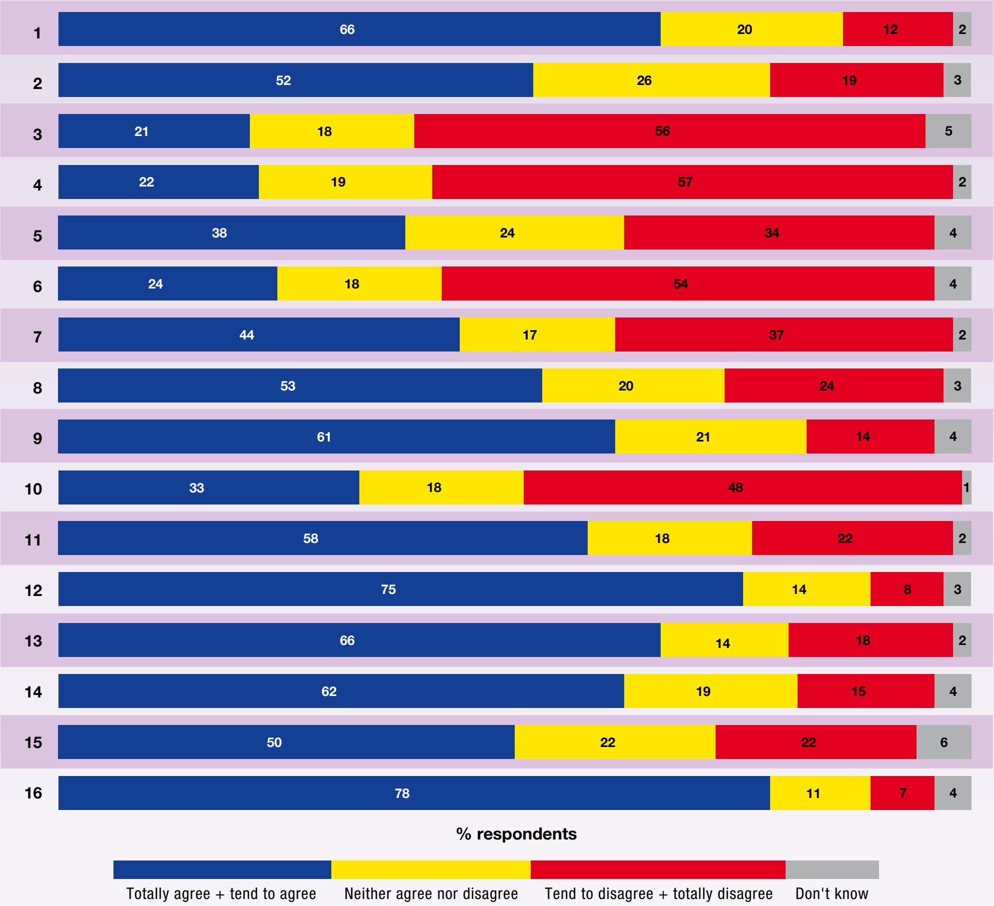
% Totally agree + Tend to agree

| | 2010(1) | 2005(2) | Difference |
|---|---|---|---|
| EU | 66% | 78% | -12 |
| Luxembourg | 75% | 73% | 2 |
| Spain | 72% | 73% | -1 |
| Denmark | 70% | 73% | -3 |
| United Kingdom | 76% | 79% | -3 |
| Greece | 63% | 67% | -4 |
| Slovenia | 62% | 66% | -4 |
| Netherlands | 65% | 70% | -5 |
| Bulgaria | 63% | 68% | -5 |
| Czech Republic | 63% | 69% | -6 |
| France | 66% | 73% | -7 |
| Ireland | 70% | 77% | -7 |
| Austria | 64% | 71% | -7 |
| Latvia | 62% | 71% | -9 |
| Malta | 78% | 87% | -9 |
| Belgium | 67% | 77% | -10 |
| Finland | 67% | 77% | -10 |
| Hungary | 69% | 79% | -10 |
| Sweden | 69% | 81% | -12 |
| Cyprus | 69% | 81% | -12 |
| Estonia | 72% | 86% | -14 |
| Poland | 69% | 83% | -14 |
| Romania | 64% | 78% | -14 |
| Lithuania | 68% | 83% | -15 |
| Slovakia | 59% | 74% | -15 |
| Portugal | 61% | 77% | -16 |
| Italy | 59% | 76% | -17 |
| Germany | 57% | 86% | -29 |
| Croatia | 74% | 71% | 3 |
| Turkey | 71% | 74% | -3 |
| Iceland | 77% | 81% | -4 |
| Norway | 75% | 73% | 2 |
| Switzerland | 70% | 82% | -12 |

*Source:* DG Research and Innovation
*Data:* Special Eurobarometer 340 "European, Science and Technology" (2010)
*Notes:* (1) Eurobarometer 73.1
(2) Eurobarometer 63.1

## FIGURE N.P.3.2 Optimisms and attitudes towards science and technology

**QC6. I would like to read out some statements that people have made about science, technology or the environment. For each statement, please tell me how much you agree or disagree.**



1) Science and technology are making our lives healthier, easier and more comfortable
2) Science and technology are making our lives healthier
3) Thanks to scientific and technological advances, the Earth’s natural resources will be inexhaustible
4) Science and technology can sort out any problem
5) We depend too much on science and not enough on faith
6) Science and technology cannot really play a role in improving the environment
7) Scientists should be allowed to experiment on animals like dogs and monkeys if this can help sort out human health problems
8) Because of their knowledge, scientists have a power that makes them dangerous
9) The application of science and new technolgies will make people's work more interesting
10) In my daily life, it is not important to know about science
11) Science makes our ways of life change too fast
12) Thanks to science and technology, there will be more opportunities for future generations
13) Scientists should be allowed to do research on animals like mice if it produces new information about human health problems
14) Science and technology can sometimes damage people's moral sense
15) The applications of science and technology can threaten human rights
16) Science and technology could be used by terrorists in the future

*Source:* DG Research and Innovation
*Data:* Special Eurobarometer 340 (2010)

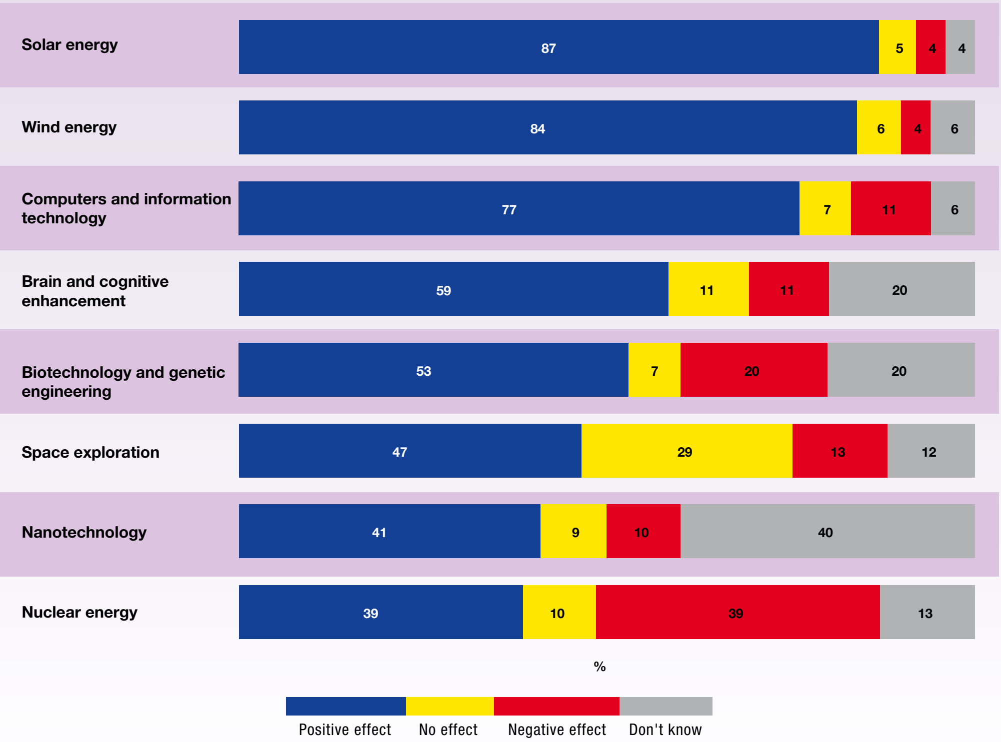
## 3.2. What is the attitude of Europeans towards individual technologies?

***EU citizens have high trust in ICT, solar and wind energy, brain and cognitive enhancements, while expressing more reservations on biotechnology and technologies for nuclear energy***

When analysing public opinion in science and technology, it is important to differentiate between different technologies, because attitudes can vary considerably according to the technology or scientific issue in question. Figure N.P.3.3. reports optimism for a number of technologies: ICT, solar and wind energy, mobile phones, biotechnology and genetic engineering, space exploration, nanotechnology and nuclear energy.

Data from the recent Special Eurobarometer 341 (2010) tells us that a majority of Europeans are optimistic about biotechnology and genetic engineering. In comparison, they are more optimistic about brain and cognitive enhancement, computers and information technology, wind energy and solar energy, but are less optimistic about space exploration, nanotechnology and nuclear energy.

FIGURE N.P.3.3 **EU citizens' trust in individual technologies**



*Source:* DG Research and Innovation
*Data:* Special Eurobarometer 341 "Biotechnology" (2010)

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In the case of biotechnology, 53% are optimistic and 20% are pessimistic and the comparable figures for nuclear power are 39% optimistic and 39% pessimistic. Remarkably, biotechnology still elicits a rather high percentage of 'don't know' response, similarly to 2005[396]. For information technology, 77% are optimistic and 11% are pessimistic.

Nanotechnology is viewed rather optimistically (41%) although there's a small minority of pessimists (10%). However, on account of its novelty, the percentage of 'don't know' responses for nanotechnology is above 40% – very similar to the data obtained in 2005[397].

Brain and cognitive enhancement is still relatively unfamiliar to many of the public (20% give a 'don't know' response). However those who had an opinion were largely optimistic, with optimists outnumbering pessimists by a ratio of 5 to 1.

As shown by previous data collections, nuclear power is the most controversial in the opinions of respondents. However, compared to the data of 2005[398], optimists and pessimists have both increased, reaching the same percentage, 39%, and with a decrease in 'no effect' responses.

***Levels of optimism about computers and information technology and solar energy have been high and stable over the period. By contrast, optimism in biotechnology, which declined steadily over the period 1991–99, rose considerably between 1999 and 2002 but from 2005 onwards, is in decline***

The trends in the index of optimism (see Figure N.P.3.4.) show some interesting trajectories. The first result is that, for all of the energy technologies – wind and solar energy and nuclear power – an upward trend is seen. Supporters of solar energy tend to be also supporters of wind energy while they are divided between optimists (46%) and pessimists on nuclear power (42%).

Secondly, a recent noticeable trend is that of declining optimism in biotechnology, nanotechnology and computer and information technology. While computer and information technology has been consistently at around 80% on the index, there was a small decline in the period 2005–2010. While both biotechnology and nanotechnology had been on an upward trend since 1999 and 2002 respectively, in 2010 there was a similar decline in optimism. For both nanotechnology and biotechnology, supporters remained the same, but pessimists made a slight increase, gained from those who previously opted for the 'no difference' option.

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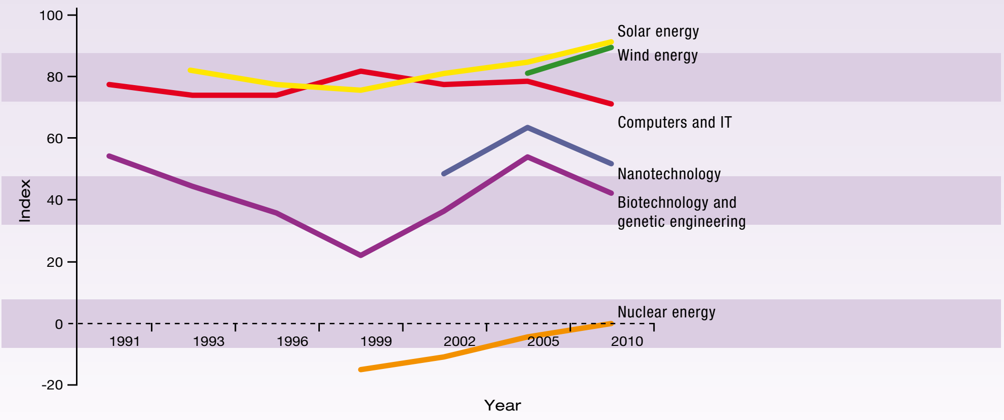
[396] Special Eurobarometer 244b 'Europeans and Biotechnology' (2005).

[397] Ibidem above.

[398] Ibidem above.

FIGURE N.P.3.4 **Optimism in individual technologies - evolution**



*Source:* DG Research and Innovation
*Data:* Special Euro barometer 341 'Biotechnology' (2010)

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***Overall, from the data available, there are no large differences between Europe, United States and Canada, with the exception of nuclear technology, which is more acceptable in United States than in Europe and Canada, and a slightly higher optimism on genetically modified Food in the United States than in Europe***

Europe and the United States are different in many social and economic dimensions and, therefore, it is valuable to explore what might be the differences in terms of public support and optimism in science and new technologies. Data on such comparisons is scarce and has not been updated. Nevertheless, in the past ten years some data is available from different cross-national surveys.

For example, results from the Special Eurobarometer 244b summarised in Table N.P.3.2. show that, apart from nuclear energy, Europeans are more or less as optimistic about computers and IT, biotechnology and nanotechnology as citizens of United States and Canada (on average). Europe does not appear to be particularly hostile. However, nuclear energy is an interesting case. On the one hand, it attracts the least optimism of any of the four technologies considered. And on the other hand, Europeans are somewhat less optimistic, on average (37%), than Canadians, and considerably less optimistic (46%) than citizens of the United States (59%). This is in line with previous findings from the relevant scientific literature[399].

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[399] For example, Gaskell, G., T Ten Eyck, J Jackson, G. Veltri. (2005). Imagining nanotechnology: cultural support for technological innovation in Europe and the United States. *Public Understanding of Science*, 14(1), 81-90.

## TABLE N.P.3.2 Optimism in new technologies in US, Europe and Canada

| Do you think each of the following technologies will improve our way of life in the next 20 years | % Europe | % United States | % Canada |
|---|---|---|---|
| Computers and IT | 82 | 86 | 83 |
| Biotechnology | 75 | 78 | 75 |
| Nanotechnology | 70 | 71 | 68 |
| Nuclear Energy | 37 | 59 | 46 |

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*Source:* DG Research and Innovation
*Data:* Special Eurobarometer 244 "Europeans and Biotechnology" (2006)

On genetically modified (GM) food, Europeans and Canadians have rather similar views on average. The only difference to note is that the Canadians see GM food as slightly more morally acceptable as do Europeans. People in United States see GM food as being more useful for society, less risky, more morally acceptable, and have somewhat more confidence in its regulation.

## TABLE N.P.3.3 Perception of GM Food and Nanotechnology

| GM Food | Europe | United States | Canada |
|---|---|---|---|
| Useful for society | 4.55 | 5.15 | 4.42 |
| Risky | 6.11 | 5.3 | 6.08 |
| Morally acceptable | 4.59 | 6.22 | 5.44 |
| Confidence in current regulatory arrangements | 3.85 | 4.25 | 3.85 |
| **Nanotechnology** | | | |
| Useful for society | 7.19 | 6.8 | 6.73 |
| Risky | 4.23 | 4.28 | 4.66 |
| Morally acceptable | 7.07 | 7.08 | 6.59 |
| Confidence in current regulatory arrangements | 5.29 | 4.83 | 4.69 |

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*Source:* DG Research and Innovation
*Data:* Special Eurobarometer 244b "Europeans and Biotechnology" (2006)

From the scientific literature, Scheufele, Corley et al. (2009) also found differences between the United States and Europe which focus on the impact of religious beliefs on attitudes to nanotechnology. They found that American citizens were significantly less likely to consider nanotechnology as morally acceptable as were Europeans. Another recent study by Vandermoere and Blanchemanche et al. (2010) reaffirms the diversity between the United States and Europe, studying the impact of religious and moral beliefs on the acceptance of nanotechnology food applications. Their study shows that religiosity has no or only a marginally significant effect on people's attitudes toward nanotechnology in Germany, contrary to Scheufele, Corley et al. (2009). Instead, for German respondents, moral covariants other than religion were negatively correlated to acceptance of nanotechnology's food applications.

### *In 2010, 54% of respondents at the EU level consider that science and technology play a real role in improving the environment – a slight increase compared to 2005*

Climate change is at the centre of political, societal and economic debate in Europe, and confidence in technology related to this issue is a key factor for consideration. A majority of Europeans are of the view that science and technology can play a role in improving the environment. The survey shows that 54% of respondents disagree with the statement that science and technology cannot play a role in improving the environment. Only 24% at the EU-27 level agree that science cannot play a role. Figure N.P.3.5. shows large differences between countries, with Northern Europeans most inclined to find that science and technology can play a role in improving the environment. In both Sweden and Norway around 8 in 10 respondents (79%) disagree with the statement that science cannot play a role in improving the environment. Five further countries showed more than two thirds of respondents who disagree: Denmark at 78%, Iceland at 76%, the Netherlands at 73%, Finland at 72% and the United Kingdom at 68%. At the other end of the scale, Romanians express the lowest level of belief that science can help in environmental improvements: only 28% of respondents disagree with the statement and 34% of respondents agree.

Results for a similar statement in 1992 show that this rate of disagreement was higher at the time (60%). Those who believe most in the positive role of science in the environment are found in Denmark and Norway, where respectively 71% and 70% of citizens disagree with this statement. Citizens in Sweden (66%), Finland (65%), Belgium (65%), the United Kingdom (63%), the Netherlands (63%) and the Czech Republic (61%) also have disagreement rates above the 60% mark. Men, younger populations and the most educated have the highest rates of agreement (i.e. a low level of trust).

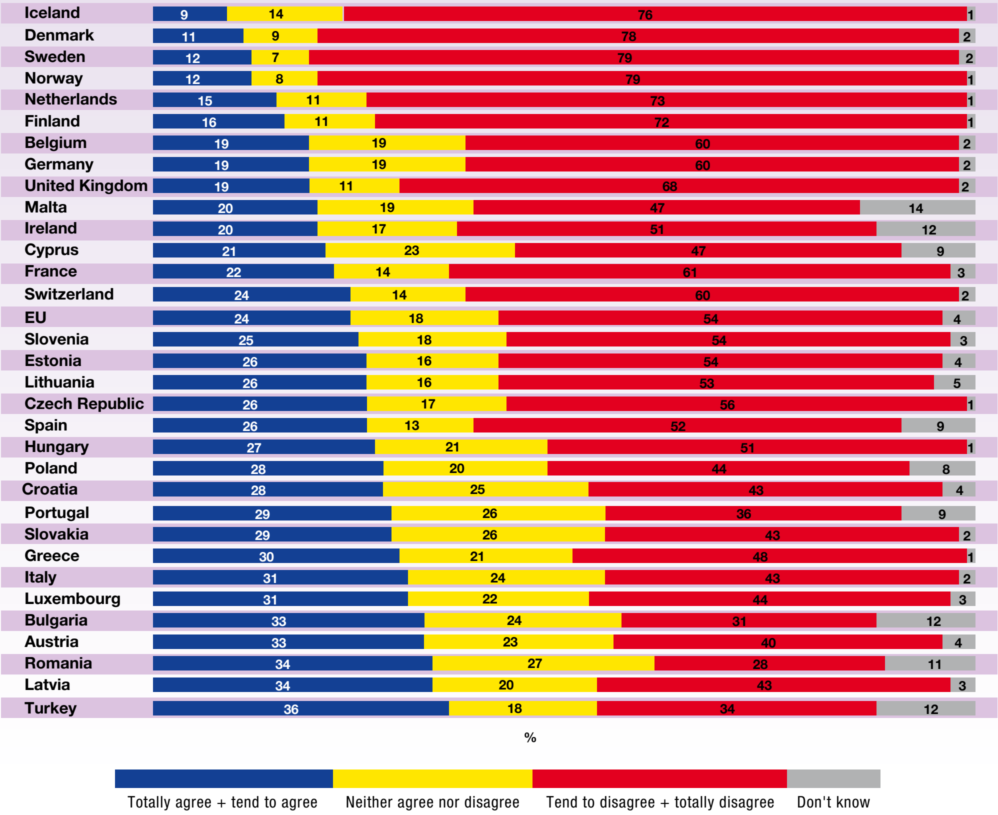
The same question was present in the 2005 Eurobarometer 224 survey on Science and Technology, where 50% of the EU respondents expressed trust that science and technologies would improve the environment. There is a slight shift towards disagreement with the statement, suggesting a more positive overall view of the role science and technology in environmental issues.

Seven countries show the opposite trend. In Belgium the 65% of respondents who disagreed in 2005 has now fallen to 60% (-5), Ireland (-8), Malta (-7), the Czech Republic (-5), Portugal (-4) Poland (-3) and Slovenia (-2). This effect is counteracted by some countries that show a major shift towards disagreement: respondents in Iceland rose from 49% of respondents in 2005 to 76% of respondents in 2010 (+27) and Spain from 32% of respondents in 2005 to 52% of respondents in 2010 (+20) who disagree.

FIGURE N.P.3.5 **Trust in science and technologies for improving the environment**

**QC6.6 I would like to read out a statement that people have made about science, technology or the environment. Please tell me how much you agree or disagree.**

**Science and technology cannot really play a role in improving the environment**



*Source:* DG Research and Innovation
*Data:* Special Eurobarometer 340 "Europeans, science and Technology" (2010)

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## *Public trust in biotechnology is in decline*

Citizens' attitude towards biotechnology has been the object of much research, particularly in Europe because of the debates and public controversies raised by this technology in the past[400]. Hence, as in the previous section, we consider the level of trust in specific technologies, this time biotechnology and nanotechnology.

Analysing the situation in Europe with country level data[401], Table N.P.3.4. presents trends of the index of optimism for biotechnology over the period 1991–2010. In all countries, with the exception of Austria, the index has positive values, indicating more optimists than pessimists. But in only three countries (Finland, Greece and Cyprus) do we see an increase in the index from 2005 to 2010. The table also shows little change in

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[400] Bauer, M. W., & Gaskell, G. (2002). *Biotechnology: The making of a global controversy.* Cambridge: Cambridge University Press.

[401] The EU-15 countries are ordered from the most to the least optimistic in 2010, followed by the 10 new Member States of 2004, then Romania and Bulgaria and finally Iceland, Norway, Turkey, Switzerland and Croatia (also ordered from most to least optimistic).

## TABLE N.P.3.4 Change in biotechnology's trust surplus deficit, 1999–2010

| Country | 1991 | 1993 | 1996 | 1999 | 2002 | 2005 | 2010 |
|---|---|---|---|---|---|---|---|
| Spain | 82 | 78 | 67 | 61 | 71 | 75 | 74 |
| Sweden | | | 42 | | 61 | 73 | 63 |
| Finland | | | 24 | 13 | 31 | 36 | 59 |
| Portugal | 50 | 77 | 67 | 50 | 57 | 71 | 54 |
| Ireland | 68 | 54 | 40 | 16 | 26 | 53 | 51 |
| United Kingdom | 53 | 47 | 26 | 5 | 17 | 50 | 50 |
| Italy | 65 | 65 | 54 | 21 | 43 | 65 | 48 |
| France | 56 | 45 | 46 | 25 | *39* | 49 | 46 |
| Denmark | 26 | 28 | 17 | -1 | 23 | 56 | 45 |
| Greece | 70 | 47 | 22 | -33 | 12 | 19 | 35 |
| Belgium | 53 | 42 | 44 | 29 | 40 | 46 | 32 |
| Luxembourg | 47 | 37 | 30 | 25 | 29 | 55 | 32 |
| Netherlands | 38 | 20 | 29 | 39 | 39 | 47 | 31 |
| Germany | 42 | 17 | 17 | 23 | 24 | 33 | 12 |
| Austria | | | -11 | 2 | 25 | 22 | -7 |
| Cyprus | | | | | | 74 | 78 |
| Estonia | | | | | | 79 | 76 |
| Malta | | | | | | 81 | 64 |
| Hungary | | | | | | 62 | 58 |
| Czech Republic | | | | | | 71 | 53 |
| Slovakia | | | | | | 55 | 48 |
| Latvia | | | | | | 60 | 43 |
| Poland | | | | | | 59 | 41 |
| Slovenia | | | | | | 47 | 33 |
| Lithuania | | | | | | 66 | 28 |
| Romania | | | | | | | 36 |
| Bulgaria | | | | | | | 24 |
| Iceland | | | | | | | 79 |
| Norway | | | | | | | 70 |
| Turkey | | | | | | | 49 |
| Switzerland | | | | | | | 32 |
| Croatia | | | | | | | 25 |

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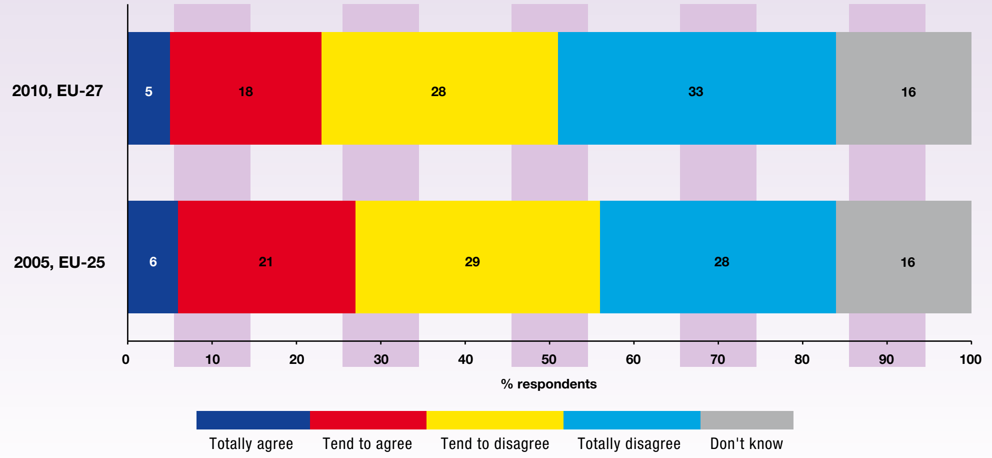
*Source:* DG Research and Innovation
*Data:* Special Eurobarometer 341 "Biotechnology" (2010)

optimism over the last five years in Spain, Ireland, the United Kingdom, France and Estonia, and that the non-EU countries Iceland and Norway stand amongst the most optimistic countries. However, in the rest of Europe there is a consistent decline in optimism about biotechnology.

### *EU citizens express a low level of support for GM food, relative to other applications of biotechnology*

Figure N.P.3.6. presents the levels of support for GM food for both EU-27 in 2010 and for comparative purposes EU-25 in 2005. In 2010, combining 'totally agree' and 'tend to agree', we find 27% in support. By the same token, 57% are not willing to support GM food. The comparison between 2010 and 2005 shows no substantial changes in the public's perception of GM food.

FIGURE N.P.3.6 **Support for GM Food (EU)**



*Source:* DG Research and Innovation
*Data:* Special Eurobarometer 341 "Biotechnology" (2010)

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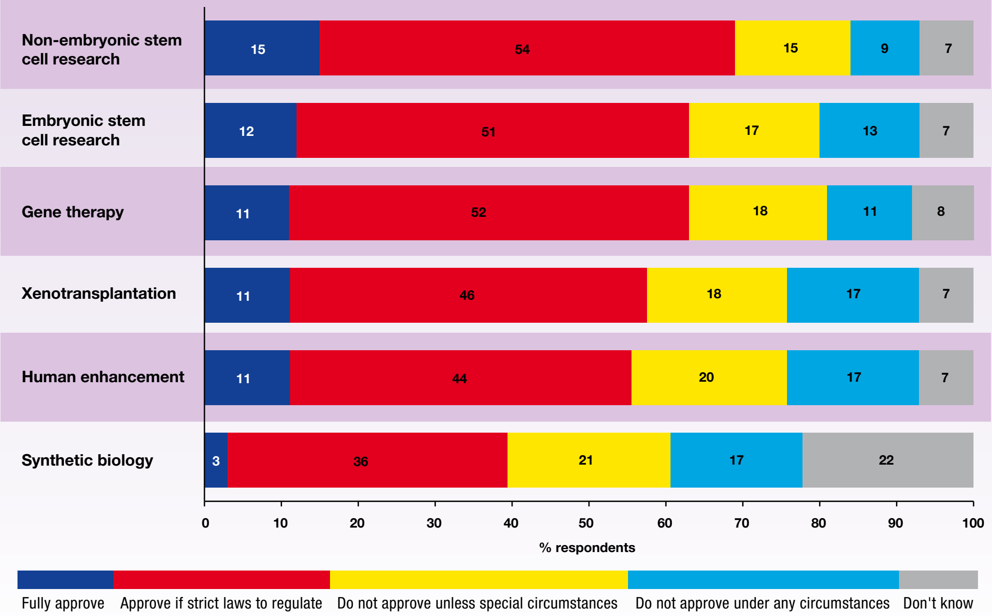
The figure below focuses on biomedical research and presents the overall results for the EU-27 countries as a whole. Some of the applications of this kind of biotechnology are very novel.

In general, levels of approval are rather high. If we combine the two positive statements, some 68% approve of stem cell research and 63% approve of embryonic stem-cell research. Levels of approval for gene therapy are similar, at 64%. In addition, the greater majority of the European public expressed an opinion on regenerative medicine (less than 10% gave 'don't know' answers). Also, xenotransplantation is now approved by 58% of respondents. Synthetic biology remains puzzling for European respondents with one quarter of them choosing the 'don't know' option.

Consistently with optimism on brain and cognitive enhancements shown in Figure N.P.3.7. there is a clear support for medical applications of biotechnology and those aimed at human improvement (56% approval).

FIGURE N.P.3.7 **Levels of approval of biomedical research and synthetic biology (EU)**



*Source:* DG Research and Innovation
*Data:* Special Eurobarometer 341 "Biotechnology" (2010)

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## 3.3. Which are the key actors and policies for a dialogue between science and society?

***The majority of European citizens – 63% of respondents at the EU-27 average – agree that scientists working at a university or government laboratories are best qualified to explain scientific and technological developments***

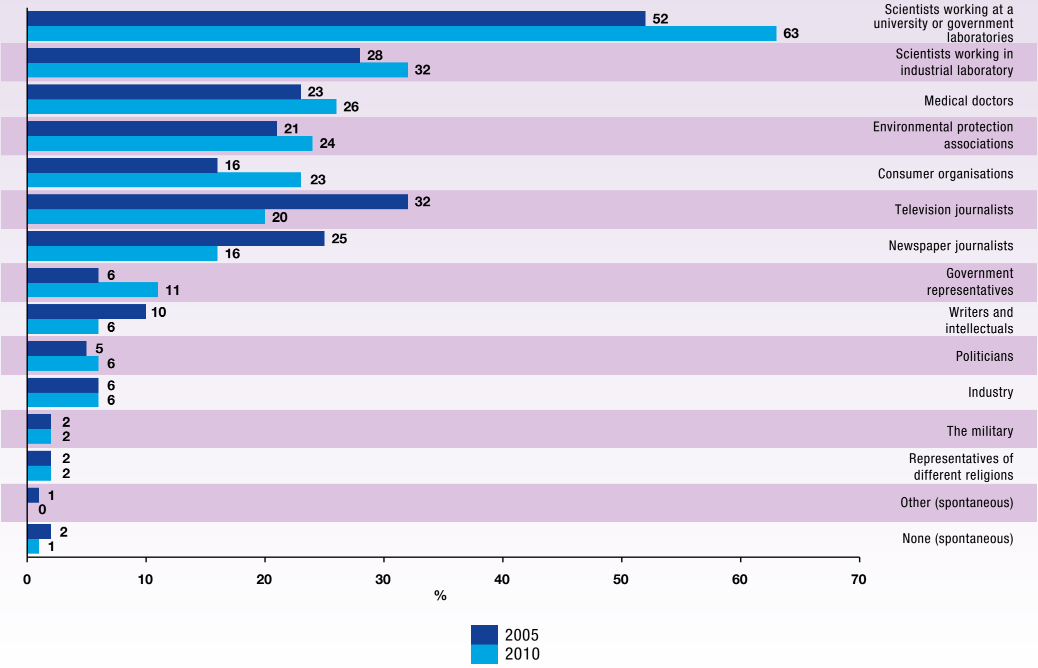
The figure below (figure N.P.3.8.) shows that the given importance of scientists working in universities or government laboratories has increased from 52% of respondents in 2005 at the EU-25 level to 63% of respondents at the EU-27 level in 2010. The trust in newspaper journalists has diminished from 25% in 2005 to 16% in 2010, and television journalists likewise are seen as less trustworthy, declining from 32% in 2005 to 20% 2010, while the perceived quality of information from consumer organisations has increased from 16% in 2005 to 23% in 2010.

***Europeans feel most strongly that decisions about science and technology should be made by scientists, engineers and politicians, and the public should be informed about these decisions***

The way policy decisions about science and technology are taken is also very important in determining the general attitudes of citizens towards these issues. Figure N.P.3.9. presents some evidence on public opinion in Europe. Respondents are asked to indicate their level of agreement to five statements

**FIGURE N.P.3.8** **Most trustworthy actors in science and technology**

**QC5. Among the following categories of people and organisations working in your country, wich are the best qualified to explain the impact of scientific and technologial developments on society?**



*Source:* DG Research and Innovation
*Data:* Special Eurobarometer 340 "Europeans and Science and Technology" (2010)

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about public involvement[402]. The relative majority of European citizens (38%) consider it appropriate that decisions should be made by experts and politicians and the public informed. However, an important minority (29%) wants a more participatory approach in which the public is consulted and taken into account when decisions are needed. The third minority of citizens by size (14%) consider public opinion's approval as a necessary condition for any decisions on science and technology.

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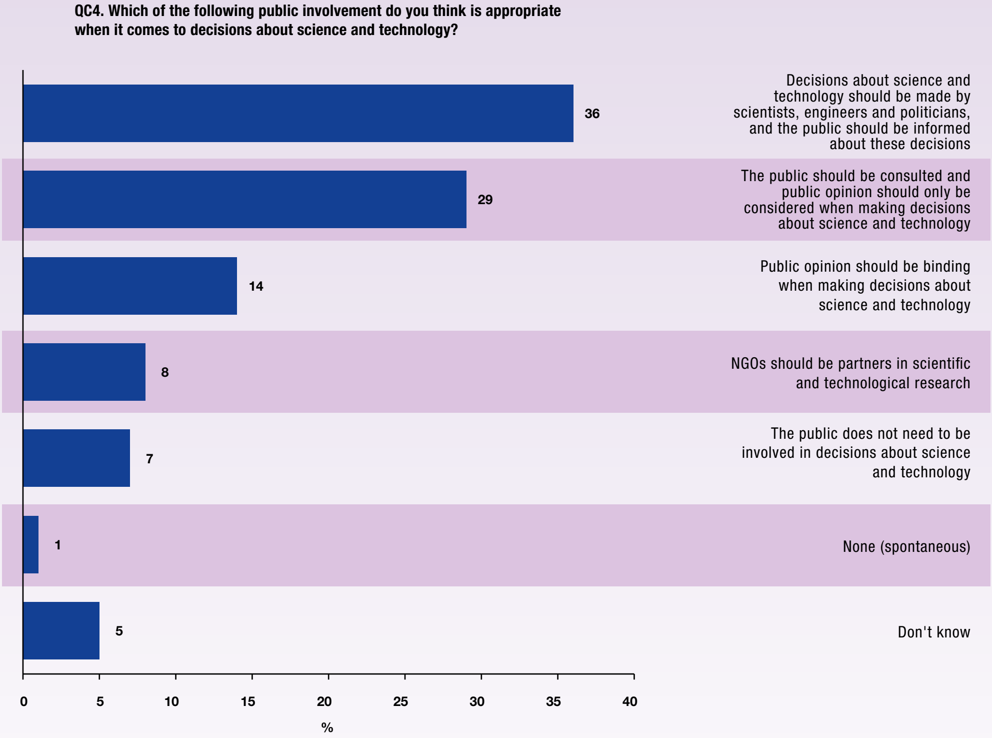
[402] The public does not need to be involved in decisions about science and technology; decisions about science and technology should be made by scientists, engineers and politicians, and the public should be informed about these decisions; the public should be consulted and public opinion should only be considered when making decisions about science and technology; public opinion should be binding when making decisions about science and technology; NGOs should be partners in scientific and technological research.

FIGURE N.P.3.9 **Europeans' opinions on decision-making in science and technology**



*Source:* DG Research and Innovation
*Data:* Special Eurobarometer 340 "Europeans and Science and Technology" (2010)

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***Citizens in Finland, Denmark and Germany are relatively more in favour of increased use of public consultation on science and technology decisions***

The table N.P.3.5. shows that in some European countries respondents are more in favour of the second statement: in Finland at 47%, Denmark at 45% and Germany at 43% respondents are more in favour of more consultations with the public about science issues. There are four countries where half or more of respondents agree that decisions about science and technology should be made by scientists, engineers and politicians, and the public should be informed about these decisions, with Cyprus at 57% of respondents, Norway at 54% of respondents, Greece at 53% of respondents and Slovakia at 50% of respondents.

## TABLE N.P.3.5 Opinion in European countries on decision-making in S&T

QC4. Which of the following public involvement do you think is appropriate when it comes to decisions about science and technology?

| | Decisions about science and technology should be made by scientists. engineers and politicians. and the public should be informed about these decisions | The public should be consulted and public opinion should only be considered when making decisions about science and technology | Public opinion should be binding when making decisions about science and technology | NGOs should be partners in scientific and technological research | The public does not need to be involved in decisions about science and technology | None (spontaneous) | Don't know |
|---|---|---|---|---|---|---|---|
| EU | 36% | 29% | 14% | 8% | 7% | 1% | 5% |
| Belgium | **35%** | 31% | 11% | *7%* | 11% | 4% | 1% |
| Bulgaria | **44%** | 23% | 16% | *3%* | *7%* | | 7% |
| Czech Republic | **47%** | 19% | 14% | 9% | *8%* | 1% | 2% |
| Denmark | 36% | **45%** | 7% | 6% | *4%* | | 2% |
| Germany | 29% | **43%** | 10% | 9% | *5%* | 1% | 3% |
| Estonia | **43%** | 20% | 16% | 8% | *7%* | 1% | 5% |
| Ireland | **43%** | 29% | 9% | *2%* | *7%* | 1% | 9% |
| Greece | **53%** | 23% | 16% | *3%* | 4% | | 1% |
| Spain | **40%** | 19% | 17% | 9% | *6%* | 2% | 7% |
| France | 27% | **36%** | 16% | 9% | *6%* | 1% | 5% |
| Italy | **41%** | 19% | 17% | 8% | *7%* | 3% | 5% |
| Cyprus | **57%** | 23% | 10% | 2% | 3% | | 5% |
| Latvia | **45%** | 25% | 12% | 4% | 8% | 2% | 4% |
| Lithuania | **39%** | 20% | 21% | 5% | 7% | 2% | 6% |
| Luxembourg | **37%** | 36% | 12% | 5% | 7% | 1% | 2% |
| Hungary | **43%** | 25% | 18% | 4% | 7% | 1% | 29% |
| Malta | **42%** | 32% | 8% | 4% | 6% | | 8% |
| Netherlands | **47%** | 35% | 5% | 6% | *4%* | 1% | 2% |
| Austria | 31% | **34%** | 13% | 12% | *6%* | 1% | 3% |
| Poland | **29%** | 24% | 15% | *9%* | 11% | 1% | 11% |
| Portugal | **33%** | 20% | 14% | *9%* | 12% | 2% | 10% |
| Romania | **43%** | 19% | 9% | *3%* | 9% | 2% | 15% |
| Slovenia | **39%** | 24% | 15% | 9% | *8%* | 2% | 3% |
| Slovakia | **50%** | 14% | 14% | 11% | *8%* | | 3% |
| Finland | 32% | **47%** | *6%* | 8% | 6% | | 1% |
| Sweden | **48%** | 31% | *3%* | 10% | 4% | 1% | 3% |
| United Kingdom | **32%** | **32%** | 15% | 7% | *6%* | 1% | 7% |
| Croatia | **46%** | 23% | 13% | *5%* | 6% | 1% | 6% |
| Turkey | **42%** | 23% | 8% | *4%* | 11% | 2% | 10% |
| Iceland | **43%** | 27% | *3%* | 15% | 7% | 3% | 2% |
| Norway | **54%** | 26% | 5% | 7% | *4%* | 1% | 3% |
| Switzerland | 28% | **39%** | 13% | 8% | 6% | 3% | 3% |

*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* Special Eurobarometer 340 "Europeans and Science and Technology" (2010)

*Note:* In bold, the highest results per country, in italics the lowest results per country; the grey rectangle shows the highest results per value; the rectangle with black borders shows the lowest results per value

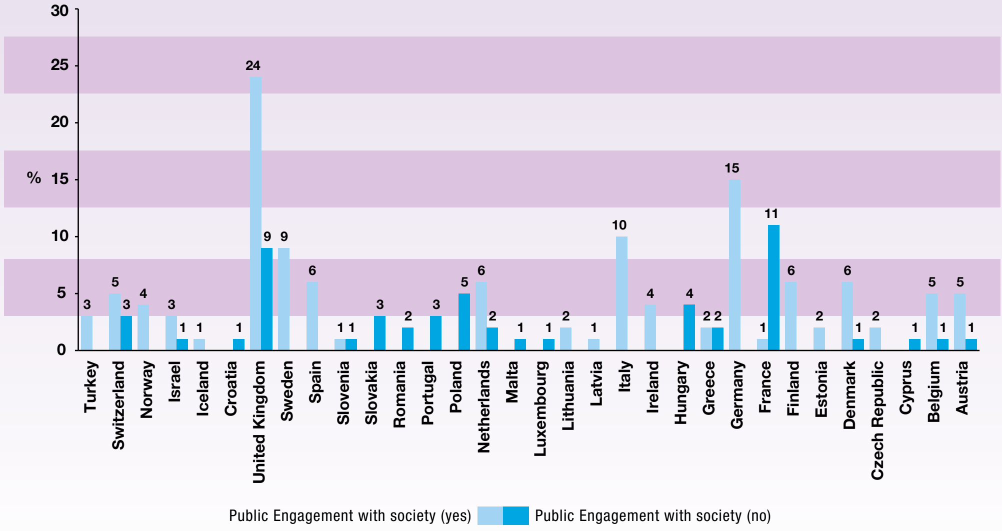
***The large majority of European research-active universities surveyed have strategies of public engagement with society, although there is a diversity of aims: from increasing youth involvement, to scientific disciplines to help evaluate socio-economic impacts***

It is important to assess the role of universities in diffusing science to the public at large, considering that they are among the most trusted scientific actors according to the European public opinion (a majority of European citizens – 52% – trust scientists working at a university or a governmental laboratory). The recent collection of data about research universities of the 'European Observatory of Research-Active Universities and National Public Research Funding Agencies' by JRC IPTS provides some insights.

The observatory sample shows that a solid majority, 64% of the research-active universities do have a strategy of public engagement with the public (35% do not have one). It is necessary to clarify that the absence of a strategy does not mean that a university is not involved in public engagement activities organised by third parties (for example a regional government).

The figure below summarises this data, disaggregated per country, from which we can notice that many Eastern European countries (Slovakia, Romania, Poland and Croatia) and Portugal, Malta and Luxembourg have no PES strategy. In all other countries the majority of the universities sampled had a strategy of public engagement, with the exceptions of Slovenia and Greece. Considering the relative novelty of such policy, it is quite remarkable that two thirds of the universities in the sample did have an explicit strategy and, therefore, commitment on public engagement with society.

FIGURE N.P.3.10 **Public engagements with society strategy in sample of European research intensive universities**



*Source:* DG Research and Innovation
*Data:* JRC-IPTS, 2010

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### *National policies for public engagement in science focus on mobilising funds, human resources and public trust building*

The analysis of the rationales of recent national policies of public engagement helped to identify three main recurrent orientations. The first theme is the need to justify the allocation of public resources through a showcase of the benefits of investing in science and technology. Examples are the recent policies adopted by Italy, Greece, Slovakia, Germany, Latvia and Spain.

The second theme is the aim of increasing the appeal of science and technology disciplines to youngsters in order to increase the ranks. Examples are the policy initiatives in Austria, the Czech Republic, Slovakia, Poland and Estonia. Public engagement is directed to a specific target group – youths – with the aim of increasing science and technology disciplines. The third rationale is to increase public trust in science by evaluating the social impact of science and technology and involving the public at large in dialogue. This is well-developed in the United Kingdom, Denmark and partially France.

Public events where scientists and the general public can meet are to be a prominent tool in most Member States. The role of the scientists is to explain scientific and technological issues and to show the utility and future applications of their current research. The public has an opportunity to clear their minds, to clarify doubts and, in general, to gain knowledge on scientific and technological topics. Such events might go under different names such as 'Science Fairs', 'Open Science Week' or 'Science Days'. Such events of direct communication are now widely adopted across Europe, with an explicit policy strategy in Italy, Latvia, Germany, United Kingdom, Slovakia, Poland and Spain.

In addition, there are events specially targeting youngsters with the aim of increasing the appeal of studying scientific disciplines. This is the case for Italy, the Czech Republic, Austria, Germany, Poland, the United Kingdom, Turkey and Estonia, where there is a special interest in motivating youngsters to enrol in studying scientific disciplines.

**Austria**

The three ministries in charge of R&D are the main financers of such activities. The main concern of R&D policy addressing the public is to enhance the general public understanding of science and technology (S&T) and thus to gain acceptance for the allocation of (more) public funds to R&D. Another important aim is the motivation of more young people to decide on a research career, especially in natural sciences and engineering. Indeed, it is expected that the gap in engineering and R&D skills may even widen in the coming years.

**Spain**

The Spanish Foundation for Science and Technology (FECYT) is a non-profit organisation (created by the government in 2001) that works as a multidisciplinary and inter-sectoral platform bringing together stakeholders from the scientific, technological and business fields, including the Conference of Spanish Universities' Chancellors (CRUE), the CSIC, entrepreneurial associations and the main innovating companies. They meet because one of the strategic objectives of FECYT is to promote the dissemination of scientific knowledge so as to inform society of the results of R&D and create public awareness of the role of science. It also sets out to promote activities which producers of science and technology may carry out to make their achievements known to society through Science Fairs and Science Weeks held annually (for example the Madrid Science Fair).

With respect to the third rationale of enhancing the trust of a country in science, specific tools are mobilised, such as science museums, which are designed to have a pedagogical role, to reassure the public of the utility and goodness of science and to provide correct factual knowledge to avoid misunderstanding that might lead to hostility. Another approach specifically aims at public consultation and public dialogue events, and it consists of a wider array of instruments. In this case, there is a clear mandate of investigating the social impact of scientific and technological issues, and, therefore, a large collection of 'tools' are used such as public hearings, foresight studies, public consultations and assessments, surveys, sponsoring social sciences studies and public consultations and events of public dialogues.

**United Kingdom**
In the United Kingdom there are specific and dedicated institutional actors such as 'The Sciencewise Expert Resource Centre for Public Dialogue In Science and Innovation' (ERC), which is funded by the Department for Business Innovation & Skills (BIS). In 2004, the Sciencewise programme was established to help policymakers find out the public's views before major policy decisions are made, a process known as 'upstream' engagement. In 2006, following a number of successful projects supported by Sciencewise, the high-level Council for Science and Technology recommended that public dialogue should be firmly embedded into Government policy-making processes. In 2007, the current Sciencewise-ERC was established

Within the domain of the participatory approach, an example is the well-studied case of GM Nation in a 2003 national debate on agricultural biotechnology that included preliminary discussion workshops with demographically selected members of the public to determine the stimulus material later used in open meetings. These meetings included expert presence and debates around a motion.

**Denmark**
The Danish Board of Technology has, over a number of years, harvested experiences at a series of 'conferences', making it possible to include the public and their experiences in the technology assessment. This is the 'Consensus Conference', which gives citizens – lay people – the opportunity to assess a given technological development and make up their minds about its possibilities and consequences.

The conference is open to the public and is conducted as a dialogue between experts and lay people over three days. The final document is passed on to the members of Parliament. Bridging the gap between the public, experts and politicians is thus an important aim of the Consensus Conferences held by the Board.

The role of the experts is to inform a panel of citizens about the technology and its implications. On several occasions the Consensus Conferences have caused political debate and the initiation of new regulation.

# Table of contents

# Overall review of EU Member States and Associated countries

As a final section of the report, a series of individual country notes are presented for all 27 Member States and 6 Associated Countries to the European cooperation[1]. Each note analyses the strengths and weaknesses of the national research and innovation system, its dynamics in the last decade and contribution to enhancing economic competitiveness and addressing societal challenges.

All country notes follow the same structure. The first (line) graph depicts the R&D intensity evolution in the last decade in both the analysed country and the EU, and projects this evolution up to 2020. In addition, the graph compares this past evolution to the progress that will be required to meet the 2020 target. The second (bars) graph presents the current performance of the research system and the third (radar) graph depicts its dynamic evolution. This analysis is based on a series of key indicators and compares the individual country to the EU, the United States and the average of a group of countries that share similar research and innovation characteristics[2]. In order to analyse the participation of the country in the European Research Area, the note introduces two maps that present the degree of scientific co-publications and co-invented patents of the country with other European countries. In those cases where data is available, the note finishes with a brief study of the structural change towards a more research-intensive economy in the last 12 years. Finally, an overview is given of the country's participation in the 7th Framework Programme with key facts and figures. In a few countries, some information is given on the EU Structural Funds for research and innovation. A comprehensive overview of European Union cohesion policy and regional aid is given by DG Regional policy.

In order to enrich the analysis, in addition to the quantitative data gathered in these graphs, each country analysis benefits from further information and qualitative analysis covered in different sections of the IUC Report, as well as from other crucial information sources, such as ERAWATCH country profiles, the Innovation Trendchart or the OECD Science, Technology and Industry Outlook.

**Information on individual countries can also be found in the online version of the IUC report: ec.europa.eu/iuc2011**

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[1] An increasing number of international reports analysing research, innovation and competitiveness include country specific quantitative and qualitative assessment in the form of country profiles : e.g. Innovation Union Scoreboard 2010, OECD Outlook report 2010, European Commission report by DG Enterprise *Member States competitiveness performance and policies*, JRC-IPTS ERAWATCH country profiles, European Commission DG Information Society *Europe's Digital Competitiveness Report 2010*, European Commission DG Employment Employment in Europe 2010.

[2] For more ample information on the construction of the reference groups, please see the chapter ‘Diversity of European countries’ of the IUC Report (Part New Perspectives, Chapter 1).

# COUNTRY PROFILE

# AT – Austria

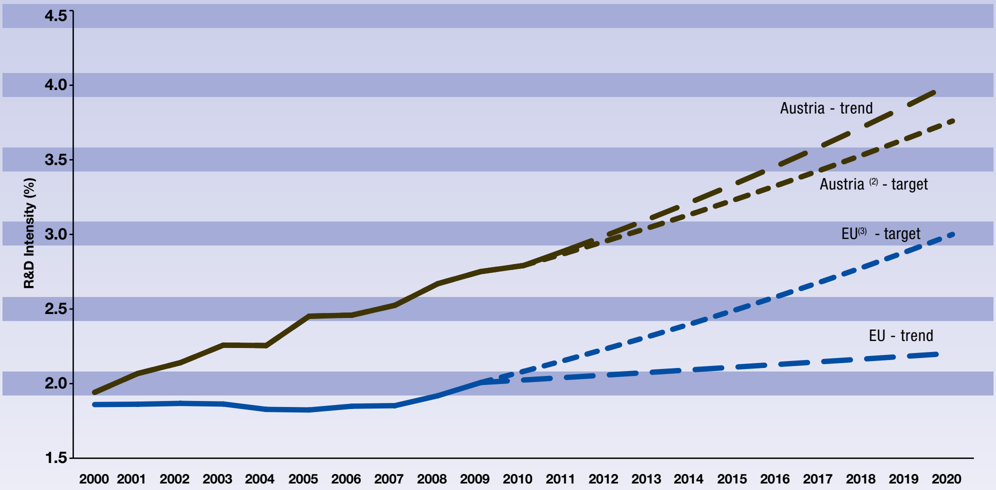
## Progress towards meeting the Europe 2020 R&D intensity target

R&D intensity increased during the past decade, from 1.94% in 2000 to 2.79% of GDP in 2009. This trend is significantly higher than the EU average and has allowed Austria to approach the 3% R&D target set for 2010.

If the trend from the last decade continued, Austria would approach an R&D intensity of 4%, positioning the country at the world forefront, with values similar to countries like Sweden, Finland, South Korea or Japan.

Both public and private R&D increased in the last decade, and in the last years, public R&D increased anti-cyclically, compensating the decrease in the share of business R&D due to the economic crisis. The federal government sector increased its share in overall R&D expenditures from 28% in 2007 to 35% in 2010, while the percentage of gross R&D financed by industry decreased to 43%, in comparison to 49% in 2007.

AUSTRIA **R&D Intensity projections, 2000-2020**(1)



*Source:* DG Research and Innovation

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*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009 in the case of the EU and for 2000-2010 in the case of Austria.
(2) AT: This projection is based on a tentative R&D Intensity target of 3.76% for 2020.
(3) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.

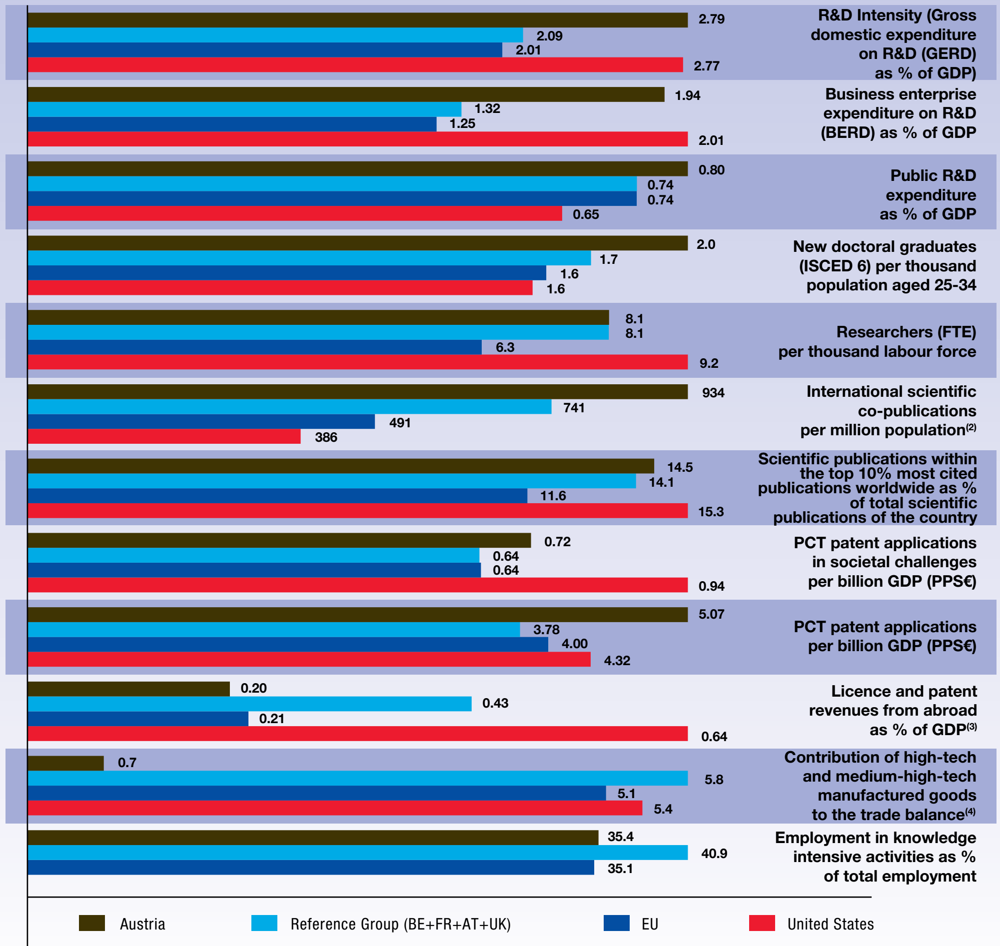
## Research and Innovation Performance

The Austrian research and innovation system depicts a strong performance. The high R&D investments, especially in the private sector, are translated both into a high quality scientific production and a strong technological inventiveness capacity. In this respect, Austria outperforms the EU on average and approaches the United States in key indicators such as the share of high-impact publications or PCT patents. Strikingly enough, the translation of these efforts into purely economic terms does not appear clearly. In particular the contribution of high-tech and medium-tech manufactured goods to the trade balance outside of EU-27 is much lower than average. This situation has been recognised by the Austrian authorities, who have launched (March 2011) a Research, Technology and Innovation Strategy with a 2020 perspective to upgrade the innovativeness level of the economy as a whole and become a country at the "technological frontier" leading to higher productivity gains.

From a dynamic perspective, in the last decade, Austria has significantly improved its scientific and technological competitiveness in virtually all dimensions, largely outperforming the EU or other similar research systems.

**AUSTRIA**

**R&D profile, 2009[(1)]**



*Source:* DG Research and Innovation

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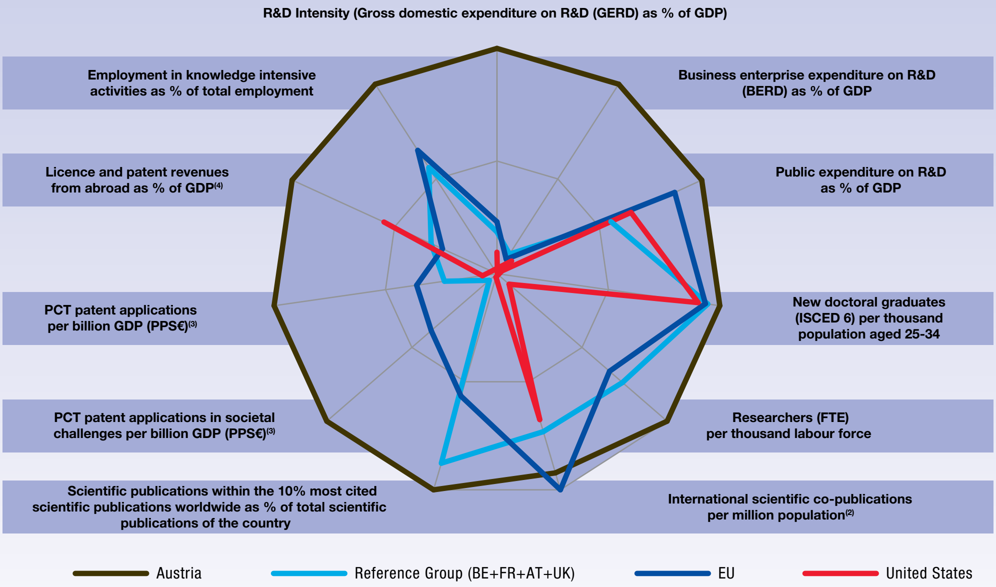
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## AUSTRIA

## Average annual growth (%), 2000-2009(1)

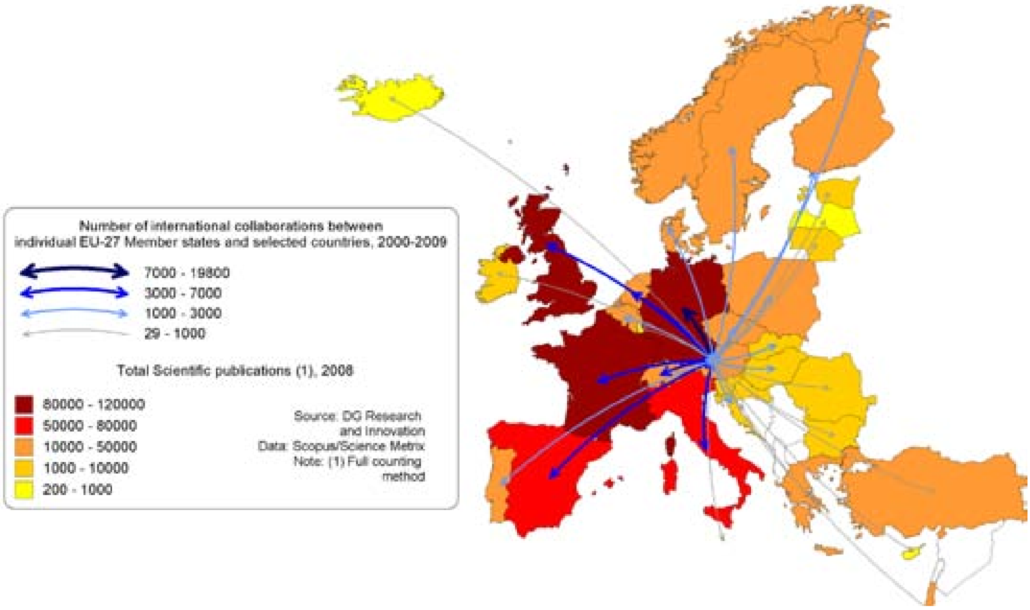


**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average.
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## AUSTRIA

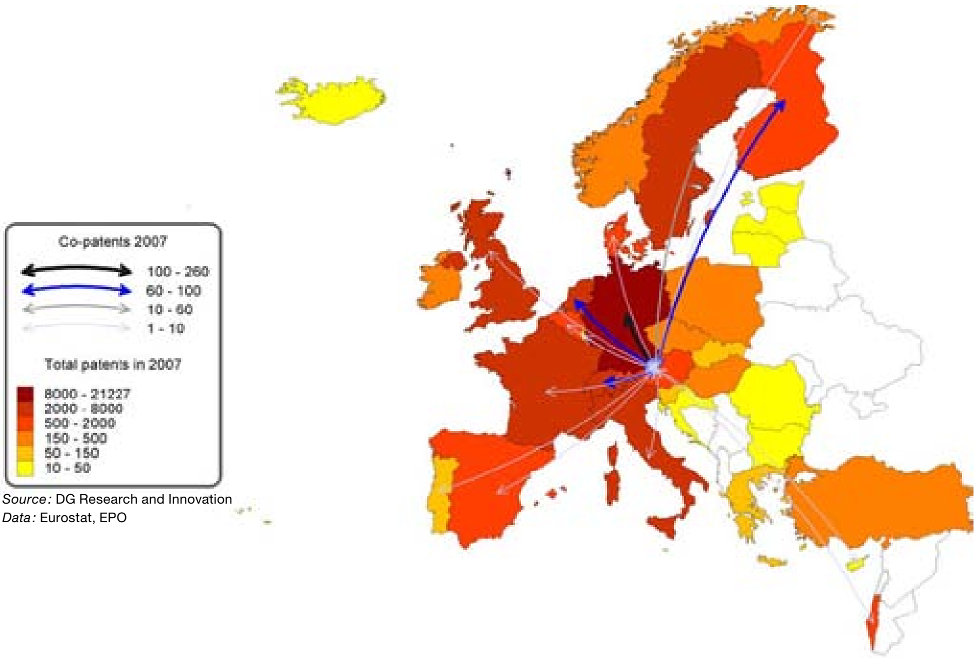
## Co-publications between Austria and European Countries in 2000-2009



Source: DG Research and Innovation
Data: Scopus/Science Metrix
Note: (1) Full counting method

## AUSTRIA

### Co-invented patent applications between Austria and European Countries, 2007



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

## Participation in the European Research Area: Scientific and Technological collaborations

Austria is a rather small but open research and innovation system which can benefit from strong knowledge spillovers, as evidenced by the large number of increasing international scientific co-publications. If the main scientific partner is Germany, due to its size and the linguistic and historical ties between the two countries, Austria has significant collaborations with a number European country.

In terms of co-invented patents, the main technological partner is once again Germany, but Switzerland, the Netherlands and Finland also rank high in the list. In case of higher Industry –University cooperation, progress in co-patenting activity with countries such as France, Spain, the United Kingdom and Italy would allow Austria to take better benefit from scientific cooperation existing with these latter countries.

The geographical, historical and cultural factors that reflect in the industrial ties influence the technological cooperation pattern.

## Structural change towards a more knowledge-intensive economy

As mentioned earlier, private R&D intensity grew in Austria in the last decade in almost all sectors. To a large extent, this increase can be traced back to two main sources: (1) an increase of the importance of some medium-high and high tech sectors such as motor vehicles and chemicals and chemical products, in the overall Austrian economy, and (2) an increase in the research intensity, i.e. R&D investment as a percentage of total value added, of some key medium-high tech and high tech sectors such as electric machinery and apparatus, medical precision and optical instruments or machinery equipment. Despite this progress, the average R&D intensity of most Austrian manufacturing sectors remains similar to Germany, but slightly below leading countries such as Sweden or France[3].

As a result, the Austrian manufacturing sector may find new opportunities to move even further towards higher research-intensive, more value added products in the global added value chain of some specific sectors.

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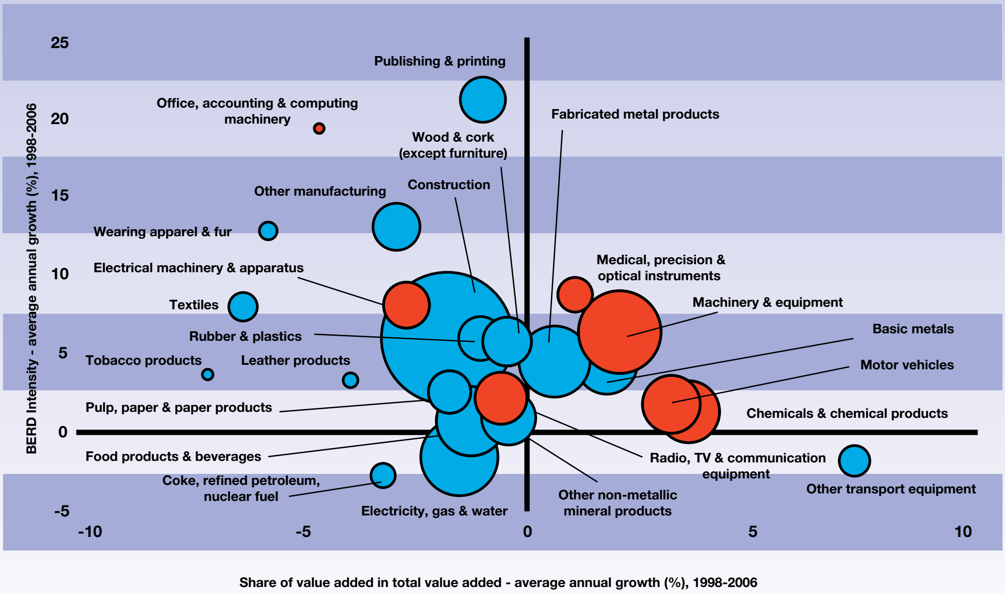
[3] Private R&D intensity, i.e; R&D investment over total value added, in manufacturing in 2006 was of 6.83% in Austria, 7.54% in Germany, 10.05% in France and 13.23% in Sweden. (source: DG Research and Innovation)

## AUSTRIA

### Share of value added versus BERD Intensity - Average annual growth, 1998-2006



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.
(2) 'Recycling' is not included on the graph.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 5 918 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 8 080 applicants from Austria (3.03% of EU-27*) and
- requesting EUR 2 613.05m of EC contribution (2.96% of EU-27*)

Among the EU-27* Austria (AT) ranks:

- 10th in terms of number of applicants and
- 10th in terms of requested EC contribution

### Success rates

- The AT applicant success rate of 21.4% is similar to the EU-27* applicant success rate of 21.6%.
- The AT EC financial contribution success rate of 20.4% is similar to the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 1 286 proposals were retained for funding (21.7%)
- involving 1 733 (21.4%) successful applicants from Austria and
- requesting EUR 532.27m (20.4%) of EC financial contribution

Among the EU-27*, Austria (AT) ranks:

- 12th in terms of applicants success rate and
- 9th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Austria (AT) participates in

- 1 087 signed grant agreements
- involving 13 517 participants of which 1 477 (10.93%) are from Austria
- benefiting from a total of EUR 3920.46m of EC financial contribution of which EUR 477.66m (12.18%) is dedicated to participants from Austria.

Among the EU-27* in all FP7 signed grant agreements, Austria (AT) ranks:

- 10th in number of participations and
- 10th in budget share

### SME performance and participation

- The AT SME applicant success rate of 18.48%

is similar to the EU-27* SME applicant success rate of 19.33%.

- The AT SME EC financial contribution success rate of 17.74% is similar to the corresponding EU-27* rate of 18.26%.

Specifically,

- 2673 AT SME applicants requesting EUR 742.45m
- 494 (18.48%) successful SMEs requesting EUR 131.70m (17.74%)

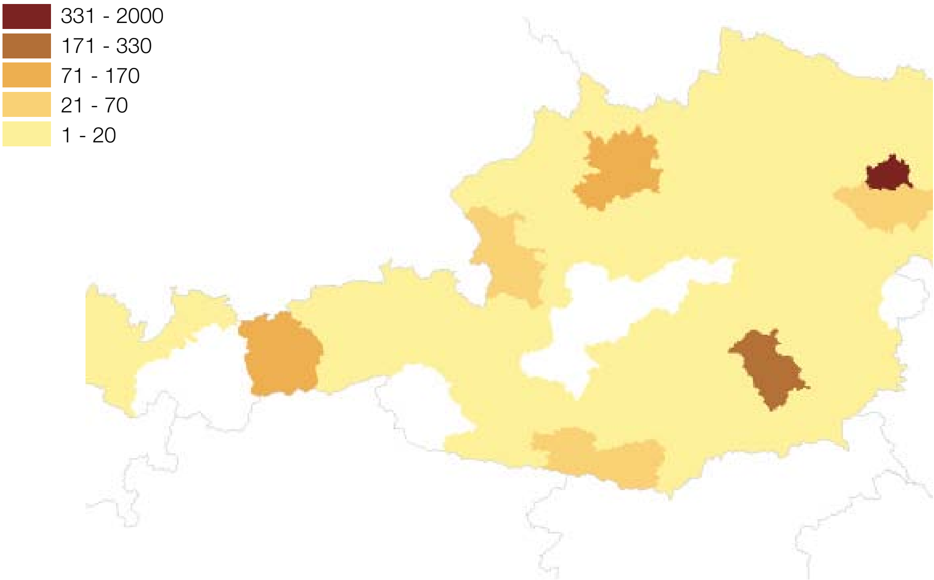
In signed grant agreements, as of 2011/03/16,

- 318 AT SME grant holders, i.e., 21.53% of total AT participation
- EUR 89.66m, i.e., 18.77% of total AT budget share

**Top 3 collaborative links with**

- DE - Germany (2 067)
- UK - United Kingdom (1 205)
- FR - France (1 109)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 6th | |
| - Above EU-27 average | | |
| - Innovation Follower | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 8 080 | |
| (3.03%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 2 613.05 | |
| (2.96%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 1 733 | |
| (2.93%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 532.27 | |
| (2.91%) | 18 262.02 | |
| Success rate FP7 applicants | 21.4% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 20.4% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 1 477 | |
| (2.88%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 477.66 | |
| (2.88%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 291 | |
| (19.70%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| % of grant holders) | 318 | |
| (21.53%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 89.66 | |
| (18.77%) | 2 207.73 | |
| (13.32%) | | |



## TABLE 1

## AT - Austria - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 2069 | 799.51 | 370 | 17.88% | 152.14 | 19.03% |
| Marie-Curie Actions | 950 | n/a | 226 | 23.79% | n/a | n/a |
| Health | 671 | 289.71 | 148 | 22.06% | 66.98 | 23.12% |
| Environment (including Climate Change) | 651 | 189.50 | 135 | 20.74% | 32.58 | 17.19% |
| Research for the benefit of SMEs | 641 | 88.75 | 105 | 16.38% | 14.61 | 16.46% |
| Transport (including Aeronautics) | 524 | 150.76 | 140 | 26.72% | 41.16 | 27.30% |

## TABLE 2

## AT - Austria - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all AT grant holders | EC contribution (EUR million) | % of total EC contribution to AT |
|---|---|---|---|---|
| Information and Communication Technologies | 375 | 25.39% | 141.26 | 29.57% |
| ERC | 45 | 3.05% | 63.38 | 13.27% |
| Health | 136 | 9.21% | 59.77 | 12.51% |
| Marie-Curie Actions | 184 | 12.46% | 42.94 | 8.99% |
| Transport (including Aeronautics) | 116 | 7.85% | 33.23 | 6.96% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 88 | 5.96% | 28.44 | 5.95% |

Notes: Report generated on: 2011/03/25.02:14 PM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## AT - Austria - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 3 274 | 901.54 | 662 | 20.22% | 172.33 | 19.12% | 582 | 217.19 | 45.47% |
| PRC | 2 167 | 635.72 | 465 | 21.46% | 142.68 | 22.44% | 441 | 137.86 | 28.86% |
| REC | 1 534 | 493.23 | 340 | 22.16% | 106.00 | 21.49% | 324 | 101.83 | 21.32% |
| OTH | 522 | 117.38 | 94 | 18.01% | 21.99 | 18.74% | 40 | 5.22 | 1.09% |
| PUB | 342 | 73.32 | 132 | 38.60% | 18.67 | 25.46% | 90 | 15.56 | 3.26% |
| | | | | | | | | | |
| SME | 2 673 | 742.45 | 494 | 18.48% | 131.70 | 17.74% | 318 | 89.66 | 18.77% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education)

## TABLE 4

## AT - Austria - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| AT - Austria region | Number of grant holders | % of all AT - Austria grant holders | EC contribution (M euro) | % of total EC contribution to AT |
|---|---|---|---|---|
| Wien (AT130) | 768 | 52.00% | 239.35 | 50.11% |
| Graz (AT221) | 206 | 13.95% | 81.44 | 17.05% |
| Innsbruck (AT332) | 97 | 6.57% | 42.52 | 8.90% |
| Linz-Wels (AT312) | 74 | 5.01% | 17.84 | 3.73% |
| Wiener Umland/SoΩ½oΩ½dteil (AT127) | 49 | 3.32% | 14.36 | 3.01% |

## TABLE 5

## AT - Austria - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all AT grant holders | EC contribution (M euro) | % of total EC contribution to AT grant holders |
|---|---|---|---|---|
| Technische Universitaet Wien (TU WIEN) | 100 | 6.77% | 34.95 | 7.32% |
| Universitaet Wien (Univie) | 81 | 5.48% | 31.79 | 6.66% |
| Universitaet Innsbruck (UIBK) | 50 | 3.39% | 25.46 | 5.33% |
| Technische Universitaet Graz (TU GRAZ) | 64 | 4.33% | 25.43 | 5.32% |
| Medizinische universitaet wien | 52 | 3.52% | 23.46 | 4.91% |

# COUNTRY PROFILE

# BE - Belgium

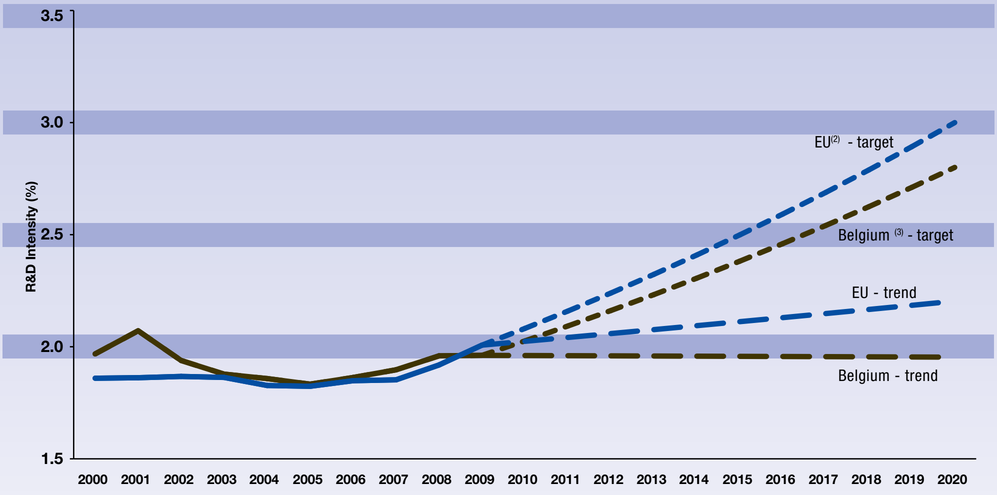
## Progress towards meeting the Europe 2020 R&D intensity target

The R&D intensity in Belgium remained close to 2% during the period 2000-2009, passing from 1.97% of GDP in 2000 to 1.96% of GDP in 2009 as the result of two opposite trends. While the R&D intensity of the private sector decreased from 1.45% to 1.32%, the public R&D intensity increased from 0.52% to 0.62%.

Belgium set an R&D intensity target to be achieved by 2020 between 2.6% and 3% of GDP. This target is ambitious with regard to recent trends but is within reach given the current structure of the Belgium economy. Compared to other countries, Belgium has the potential to increase the R&D intensity in existing sectors, both in the high-tech and medium high-tech sectors.

BELGIUM

**R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation

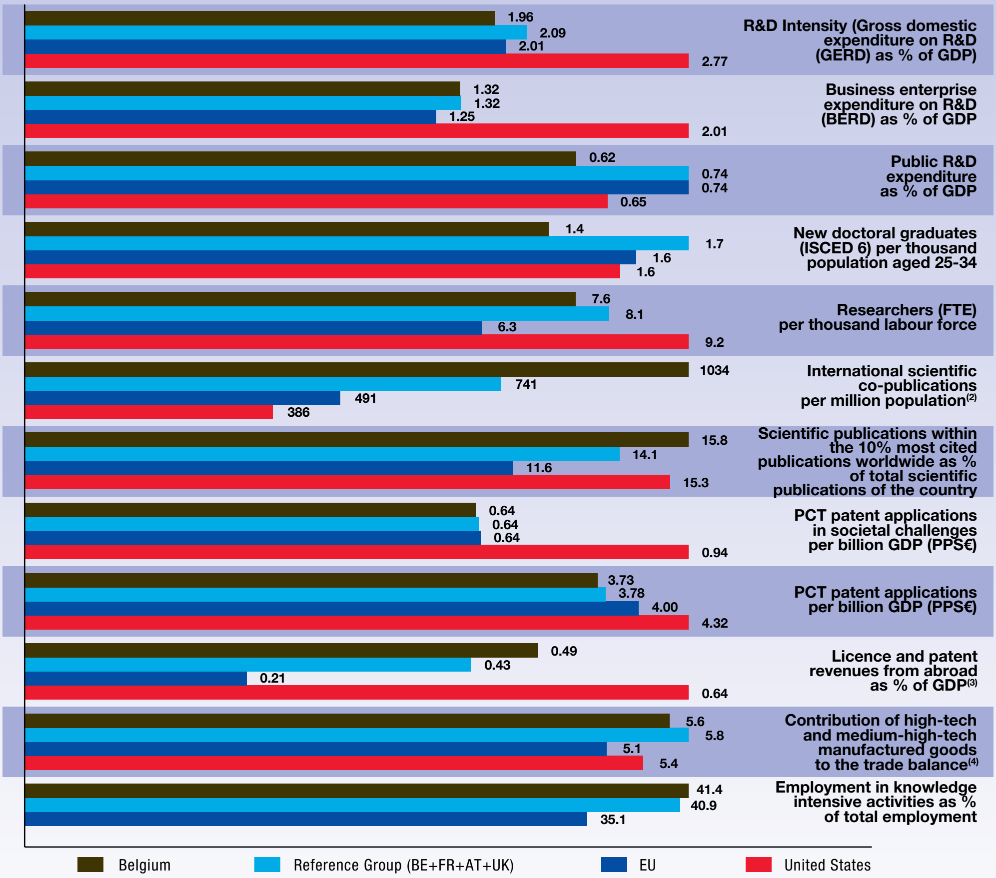
**Innovation Union Competitiveness Report 2011**

*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) BE: This projection is based on a tentative R&D Intensity target of 2.8% for 2020.

## BELGIUM

**R&D profile, 2009(1)**



*Source:* DG Research and Innovation

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

**Innovation Union Competitiveness Report 2011**

## Research and Innovation Performance

As set out in the 2010 Innovation Union Scoreboard, Belgium is an innovation follower, with a performance above the EU average[4]. Relative strengths are in Human resources, Open, excellent and attractive research systems and Linkages & entrepreneurship. Relative weaknesses are in Firm investments, Intellectual assets and Outputs.

Overall, the research and innovation system of Belgium displays a set of very strong indicators. The number of researchers per thousand labour force is 7.6, well above the EU average of 6.3 researchers. The international scientific co-publications per million population is more than double that of the EU average of the United States, giving evidence of the degree of openness of the Belgian research and innovation system. Moreover, the quality of the scientific production is evidenced by the number of scientific publications within the top 10% most cited publications worldwide, as% of the total publications of Belgium (15.8%, well above EU average and also higher than the 15.3% of the United States). For these two indicators as well as for the proportion of its work force employed in knowledge intensive activities, Belgium leads the basket of countries of reference indicated in the R&D profile below. Finally, 38.3% of all innovative SMEs in Belgium introduced a new or a significantly improved product new to the market[5], a figure only surpassed in Sweden.

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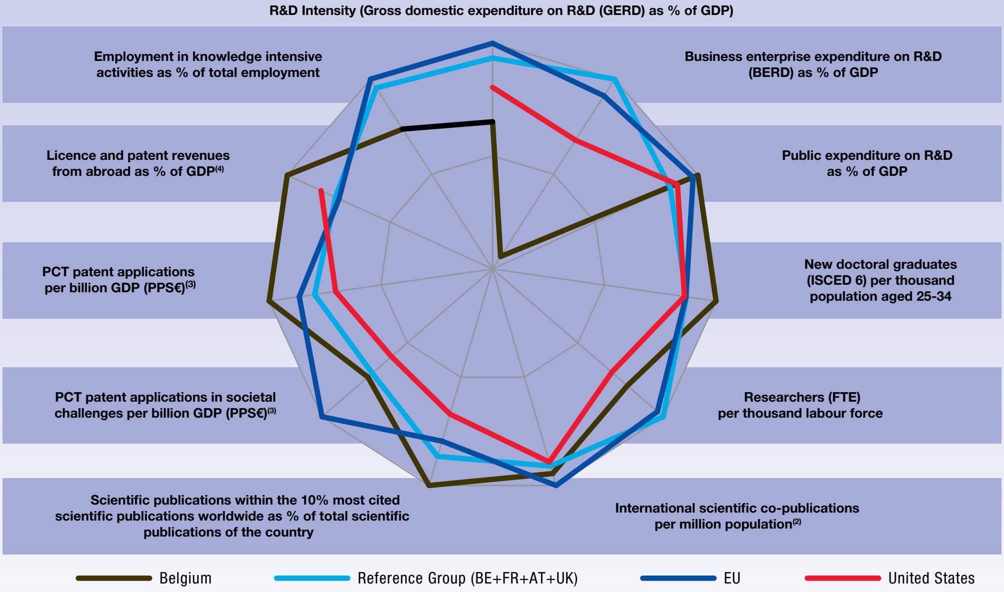
[4] IUS 2010

[5] CIS 2008

## BELGIUM

## Average annual growth (%), 2000-2009[1]

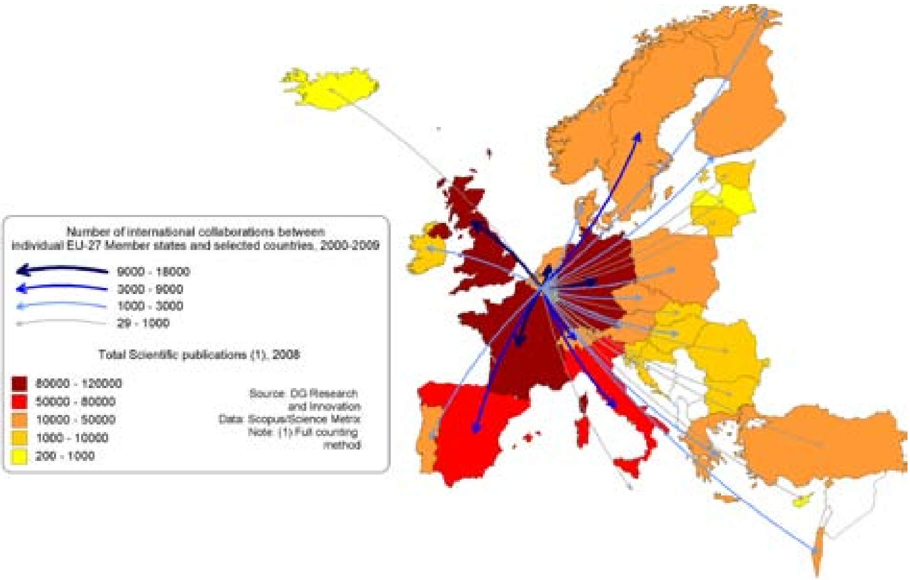


**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average.
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## BELGIUM

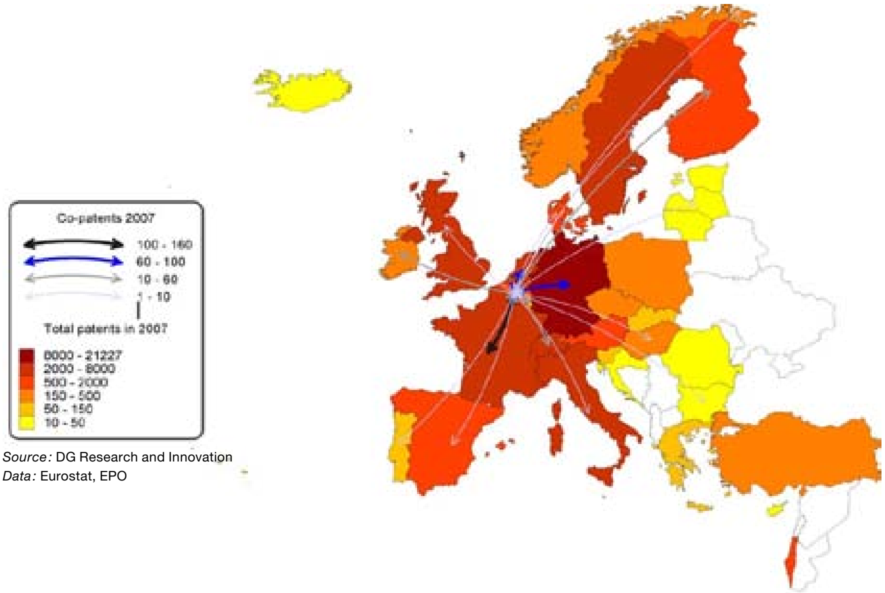
## Co-publications between Belgium and European Countries in 2000-2009



Source: DG Research and Innovation
Data: Scopus/Science Metrix
Note: (1) Full counting method

## BELGIUM

### Co-invented patent applications between Belgium and European Countries, 2007



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

But the Belgian research and innovation system also has some weaknesses: business expenditure on R&D has been decreasing (as a% of GDP, not in absolute terms, as mentioned before) and PCT patent applications per billion GDP are below the EU average[6]. Equally important, the public expenditure of R&D as a% of GDP remains below the EU average.

## Participation in the European Research Area: Scientific and Technological collaborations

Belgium has a very open research and innovation system well connected with the major European research and innovation networks. As measured in terms of co-publications, Belgium researchers have an active collaboration with researchers from the Netherlands, where the geographical proximity plays an important role, but also with France, the United Kingdom, Germany and Italy.

20% of all EPO patent applications filed by Belgian residents are co-patents including a third country. The transnational knowledge flows involving Belgium partners are mostly with Germany, France and the Netherlands.

This degree of internationalisation reflects the very high quality and interconnection of the Belgium scientific and technological base. This strong position is reflected in the context of the EU R&D Framework Programmes, where Belgium is one of the most successful countries in FP6 and FP7 (see Part II 4.3.3 of this report).

## Structural change towards a more knowledge-intensive economy

The manufacturing sector in Belgium accounts for 80% of the BERD, which is highly concentrated with only 3 sectors responsible for 50% (Chemicals, Pharmaceuticals, and Radio, TV and telecommunication equipment). The contraction of the Chemicals sector and of the Radio, TV and telecommunication sector over the period 1995-2006 has been very important, this in spite of the expansion of pharmaceuticals (counted as NACE2 category "Chemicals and chemical products"). This concentration is reflected in the number of large companies and (foreign owned) multinationals in the Chemicals, Pharmaceuticals and Biotech sectors. In general terms one can say that research in the Belgian private sector is now more than ever dominated by life sciences.

During the period 1995-2006, R&D intensity increased in most sectors, with the following exceptions: publishing and printing, coke, refined petrol products and nuclear fuel. During the same period, the economic structure has become less research oriented as some research-intensive economic activities declined in absolute terms. BERD intensity slightly increased during the same period, thus compensating the impact of the trend of the economy towards less research intensive activities.

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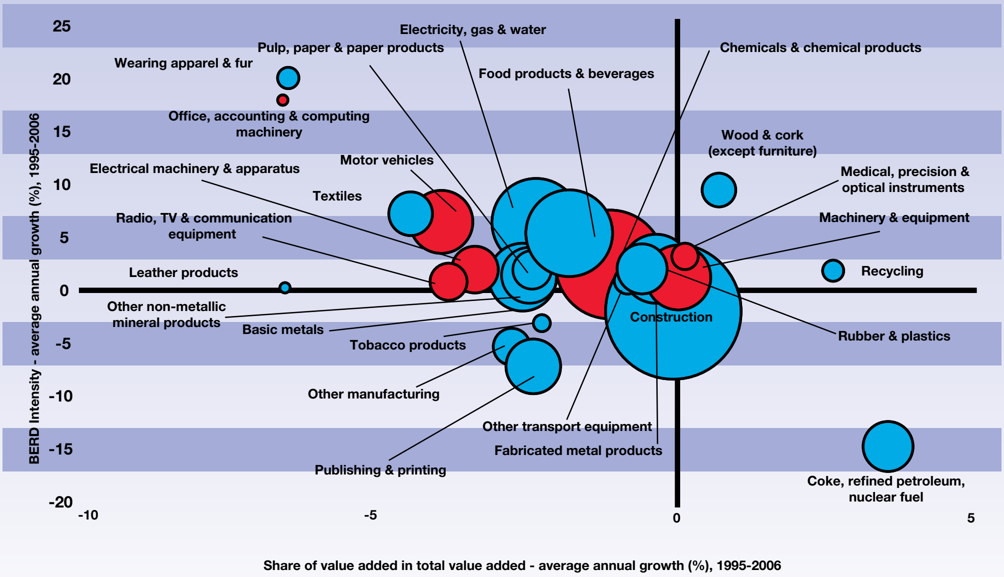
[6] The total Belgium triadic patent families is also low with a share of 0.8% - OECD STI Outlook report 2010.

## BELGIUM

## Share of value added versus BERD Intensity - Average annual growth, 1995-2006



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* OECD
*Note:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 8 147 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 11 134 applicants from Belgium (4.18% of EU-27*) and
- requesting EUR 3 602.93m of EC contribution (4.08% of EU-27*)

Among the EU-27* Belgium (BE) ranks:

- 8th in terms of number of applicants and
- 9th in terms of requested EC contribution

### Success rates

- The BE applicant success rate of 26.9% is higher than the EU-27* applicant success rate of 21.6%.
- The BE EC financial contribution success rate of 24.4% is higher than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 2 025 proposals were retained for funding (24.9%)
- involving 2 995 (26.9%) successful applicants from Belgium and
- requesting EUR 880.81m (24.4%) of EC financial contribution

Among the EU-27*, Belgium (BE) ranks:

- 1st in terms of applicants success rate and
- 2nd in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Belgium (BE) participates in

- 1 624 signed grant agreements
- involving 19 850 participants of which 2 391 (12.05%) are from Belgium
- benefiting from a total of EUR 5 613.01m of EC financial contribution of which EUR 707.89m (12.61%) is dedicated to participants from Belgium.

Among the EU-27* in all FP7 signed grant agreements, Belgium (BE) ranks:

- 7th in number of participations and
- 8th in budget share

### SME performance and participation

- The BE SME applicant success rate of 25.39% is higher than the EU-27* SME applicant success rate of 19.33%.
- The BE SME EC financial contribution success rate of 23.05% is higher than the corresponding EU-27* rate of 18.26%.

Specifically,

- 3 237 BE SME applicants requesting EUR 872.43m
- 822 (25.39%) successful SMEs requesting EUR 201.08m (23.05%)

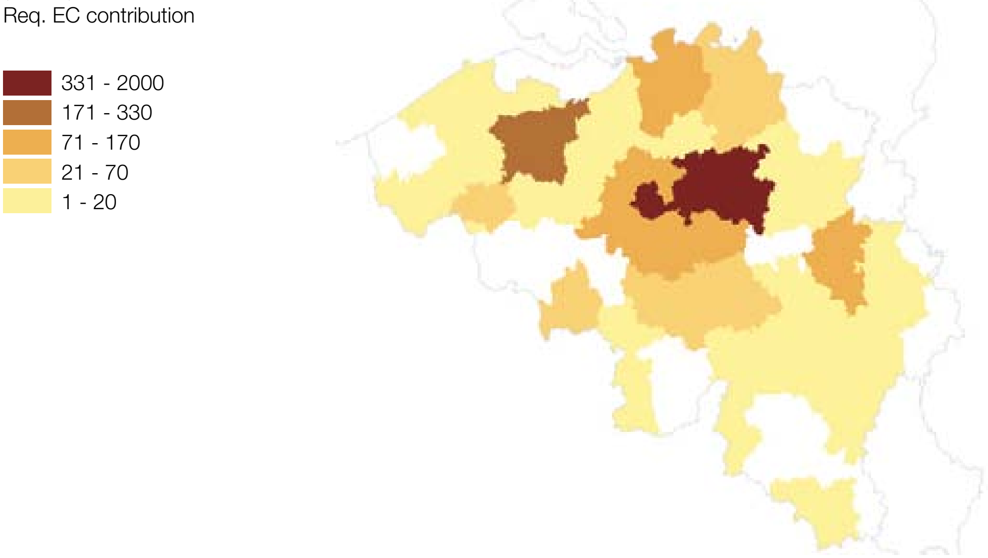
In signed grant agreements, as of 2011/03/16,

- 502 BE SME grant holders, i.e., 21.00% of total BE participation
- EUR 122.11m, i.e., 17.25% of total BE budget share

### Top 3 collaborative links with

- DE - Germany (2 659)
- UK - United Kingdom (1 964)
- FR - France (1 944)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 8th | |
| - Above EU-27 average | | |
| - Innovation Follower | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 11 134 | |
| (4.18%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 3 602.93 | |
| (4.08%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 2 995 | |
| (5.06%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 880.81 | |
| (4.82%) | 18 262.02 | |
| Success rate FP7 applicants | 26.9% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 24.4% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 2 391 | |
| (4.66%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 707.89 | |
| (4.27%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 406 | |
| (16.98%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 502 | |
| (21.00%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 122.11 | |
| (17.25%) | 2 207.73 | |
| (13.32%) | | |



## TABLE 1

## BE - Belgium - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 2288 | 932.28 | 478 | 20.89% | 192.53 | 20.65% |
| Marie-Curie Actions | 1371 | n/a | 311 | 22.68% | n/a | n/a |
| Transport (including Aeronautics) | 1156 | 279.45 | 374 | 32.35% | 85.74 | 30.68% |
| Health | 1077 | 458.02 | 271 | 25.16% | 103.25 | 22.54% |
| Environment (including Climate Change) | 760 | 203.57 | 191 | 25.13% | 45.53 | 22.37% |
| Research for the benefit of SMEs | 681 | 125.37 | 178 | 26.14% | 33.70 | 26.88% |

## TABLE 2

## BE - Belgium - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all BE grant holders | EC contribution (EUR million) | % of total EC contribution to BE |
|---|---|---|---|---|
| Information and Communication Technologies | 449 | 18.78% | 167.43 | 23.65% |
| Health | 251 | 10.50% | 91.93 | 12.99% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 201 | 8.41% | 66.48 | 9.39% |
| ERC | 53 | 2.22% | 63.14 | 8.92% |
| Transport (including Aeronautics) | 274 | 11.46% | 59.28 | 8.37% |
| Marie-Curie Actions | 244 | 10.20% | 55.95 | 7.90% |

*Notes:* Report generated on: 2011/03/25.02:14 PM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## BE - Belgium - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 3688 | 1043.64 | 835 | 22.64% | 237.08 | 22.72% | 805 | 294.76 | 41.64% |
| PRC | 2787 | 759.78 | 724 | 25.98% | 184.98 | 24.35% | 638 | 161.62 | 22.83% |
| REC | 2341 | 783.19 | 732 | 31.27% | 246.38 | 31.46% | 533 | 178.15 | 25.17% |
| OTH | 1461 | 324.10 | 462 | 31.62% | 105.26 | 32.48% | 312 | 54.65 | 7.72% |
| PUB | 450 | 79.97 | 186 | 41.33% | 27.36 | 34.22% | 103 | 18.71 | 2.64% |
| SME | 3237 | 872.43 | 822 | 25.39% | 201.08 | 23.05% | 502 | 122.11 | 17.25% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education)

## TABLE 4

## BE - Belgium - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| BE - Belgium region | Number of grant holders | % of all BE - Belgium grant holders | EC contribution (M euro) | % of total EC contribution to BE |
|---|---|---|---|---|
| Arr. de Bruxelles-Capitale / Arr. van Brussel-Hoofdstad (BE100) | 904 | 37.81% | 203.41 | 28.73% |
| Arr. Leuven (BE242) | 479 | 20.03% | 196.81 | 27.80% |
| Arr. Gent (BE234) | 262 | 10.96% | 99.78 | 14.10% |
| Arr. Antwerpen (BE211) | 140 | 5.86% | 45.53 | 6.43% |
| Arr. Nivelles (BE310) | 120 | 5.02% | 33.81 | 4.78% |

## TABLE 5

## BE - Belgium - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all BE grant holders | EC contribution (M euro) | % of total EC contribution to BE grant holders |
|---|---|---|---|---|
| Katholieke Universiteit Leuven (K.U.Leuven) | 259 | 10.83% | 108.38 | 15.31% |
| Interuniversitair Micro-Electronica Centrum Vzw | 114 | 4.77% | 61.79 | 8.73% |
| Universiteit Gent (UGENT) | 127 | 5.31% | 52.25 | 7.38% |
| Université Libre De Bruxelles (ULB) | 85 | 3.55% | 30.65 | 4.33% |
| Université Catholique De Louvain (UCL) | 92 | 3.85% | 26.29 | 3.71% |

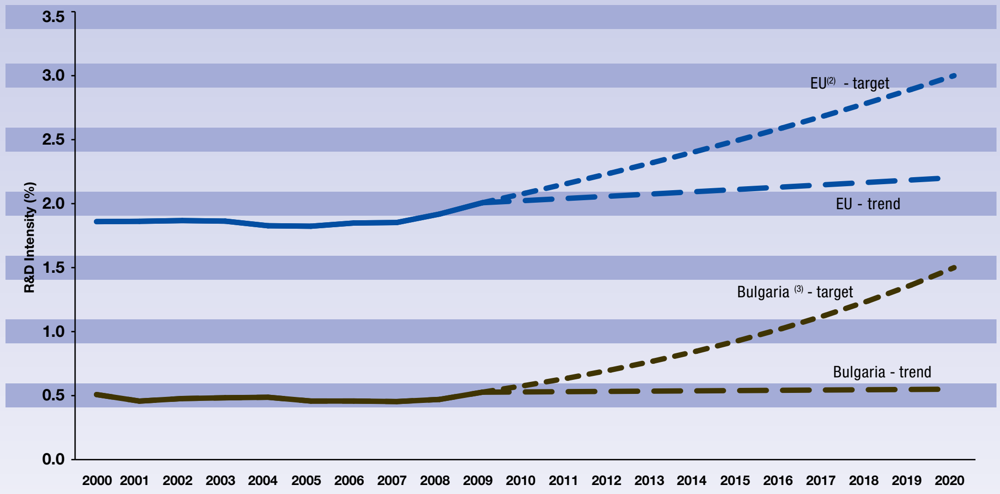
# COUNTRY PROFILE

# BG - Bulgaria

## Progress towards meeting the Europe 2020 R&D intensity target

Bulgaria is one of the countries with the lowest R&D intensity in the EU. Bulgaria's R&D intensity has been decreasing over time, from 0.57% in 1999 to 0.53% of GDP in 2009; i.e. around four times less than the EU-27 average. The very low level of private R&D investment in the economy is particularly worrying. At 0.16% of the GDP in 2009, having increased however from 0.10% of GDP in 2002, Bulgaria ranks the lowest in the EU. The sectoral specialisation in low technology sectors and the current scarcity of medium and high technology firms in the economy is responsible for this low level of private R&D. A substantial increase of the R&D spending, both in absolute and relative terms, will be instrumental for Bulgaria in order to raise the economic competitiveness and secure high-quality jobs. Aware of the need to raise R&D investment, the Bulgarian government approved a national target for R&D intensity for 2020 of 1.5% of GDP. This target is rather ambitious and will be reached only if strong efforts and reforms based on a long-term strategy is put in place and implemented in a sustained manner.

BULGARIA R&D Intensity projections, 2000-2020(1)



*Source:* DG Research and Innovation

*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) BG: This projection is based on a tentative R&D Intensity target of 1.5% for 2020.

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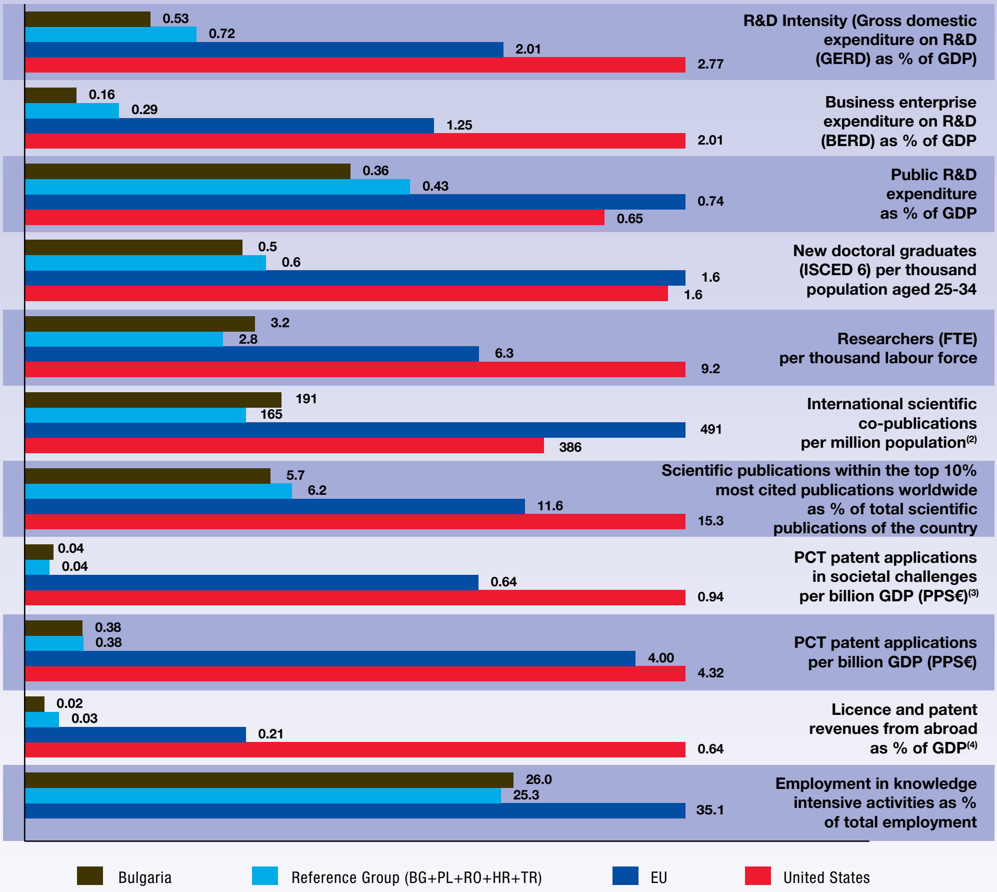
## BULGARIA

### R&D profile, 2009(1)



Innovation Union Competitiveness Report 2011

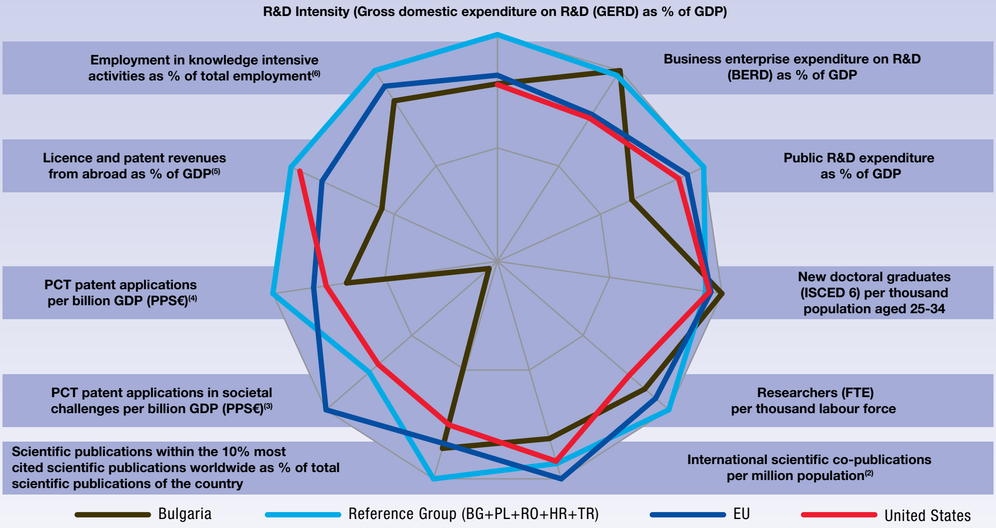
*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) (i) HR and TR are not included in the Reference Group; (ii) The EU value refers to the median rather than to the average.
(3) HR is not included in the Reference Group.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## Research and Innovation Performance

In addition to the overall low R&D investment, an important challenge of the Research and Innovation system is its overall fragmentation, as reflected by the large number of research performers, e.g. universities, research institutes and institutes of the Bulgarian Academy of Science, which leads to a lack of critical mass and deficiencies in the quality of research results. Overall, Bulgaria scores low in terms of high-quality scientific publications or patents, especially in new technologies aimed at addressing societal challenges, such as the ageing of the population or climate change, and that can constitute important new sources of economic growth. As a result, the weak scientific and technological performance hinders Bulgaria's capacity to move towards more knowledge intensive, higher value added, activities. The much needed structural change will increasingly require important and efficient investments in research and innovation, as well as in education. In comparison to other similar European countries in terms of economic structure and R&D characteristics, Bulgaria appears particularly weak as regards public R&D expenditures and high-quality technological inventiveness. On the other hand, the number of researchers employed in the system, while still low compared to the EU average, is slightly higher than in the comparison countries, and, therefore, there can be potential to raise the quality of the scientific production, should the necessary reforms be adopted.

## BULGARIA

## Average annual growth (%), 2000-2009(1)

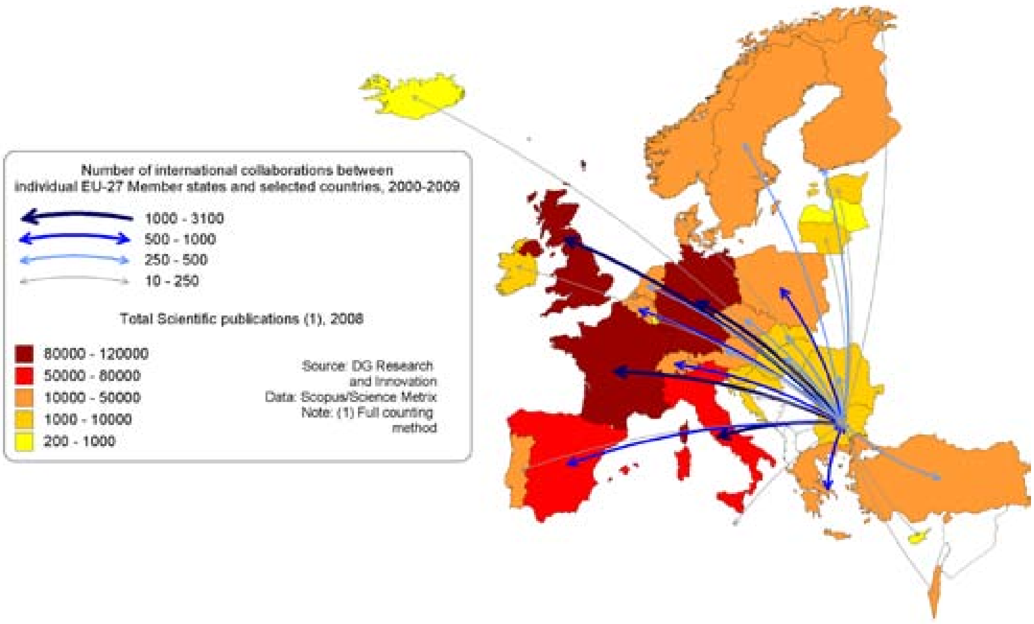


**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) (i) HR and TR are not included in the Reference Group; (ii) EU refers to the median rather than to the average.
(3) HR is not included in the Reference Group; Average annual growth refers to real growth.
(4) Average annual growth refers to real growth.
(5) EU refers to extra-EU.
(6) TR is not included in the Reference Group.
(7) Elements of estimation were involved in the compilation of the data.

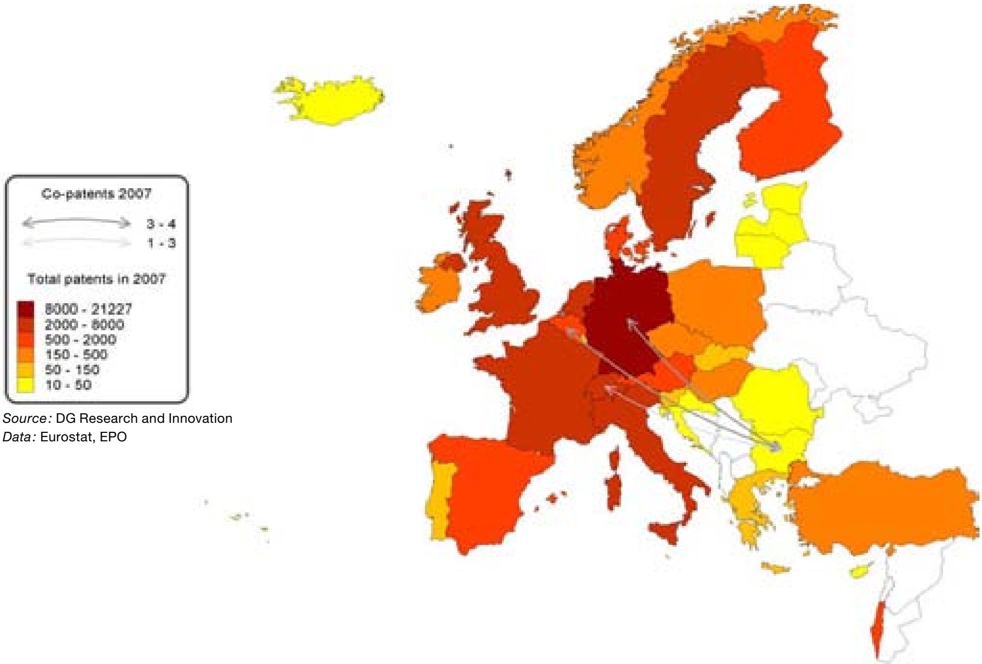
## BULGARIA

## Co-publications between Bulgaria and European Countries in 2000-2009



BULGARIA

## Co-invented patent applications between Bulgaria and European Countries, 2007



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

In dynamic terms, the progress of the Bulgarian research and innovation system presents a mixed picture. On the one hand, private R&D intensity and the number of new doctoral graduates increased, albeit from low initial values, above the EU average, and at a similar rate as the reference group of similar countries. On the other hand, the scientific and technological production underperformed, which was translated in a lower progress of the economy towards more knowledge intensive activities. This relatively poor progress in scientific and technological performance suggests the existence of structural deficiencies in the research and innovation system and the need for further reform measures, targeting the development of an appropriate legislative framework for R&I activities, an increased efficiency of public R&D spending, an innovation policy more demand-driven and a targeted support for young innovative companies, as well as long-term strategic plans of the research institutions.

The adoption of the National Research Strategy currently under preparation will be instrumental in defining key milestones for the further development of the Bulgarian R&I system, by establishing a limited number of research priorities in those areas in which Bulgaria has strengths identified by international benchmarking and in those which contribute to address societal challenges and can attract business R&D activities, as well as by increasing the share of competitive funding and by enlarging the scope for better framework conditions for private R&I. Bulgaria has also other relevant legislative measures in place or in preparation, such as the Law on Academic Staff Development, the Law on Bulgarian Academy of Science and the Law on Innovation.

### Participation in the European Research Area: Scientific and Technological collaborations

The overall number of co-publications between Bulgarian researchers and researchers from other ERA countries is one of the lowest in Europe. This suggests that the country does not sufficiently benefit from the international knowledge flows favoured by the European Research Area architecture. Main partners in terms of co-publications are the big European countries: Germany, France, Italy, the United Kingdom, and Spain.

As regards co-patenting, Germany, Switzerland and Belgium appear to be among the main partners of Bulgarian technological actors.

## FP7 Key facts and figures

**Applications:**

As of 2011/03/16, a total of

- 2.014 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 2.600 applicants from Bulgaria (0,98% of EU-27*) and
- requesting EUR 494,62m of EC contribution (0,56% of EU-27*)

Among the EU-27* Bulgaria (BG) ranks:

- 20th in terms of number of applicants and
- 20th in terms of requested EC contribution

**Success rates:**

- The BG applicant success rate of 16,8% is lower than the EU-27* applicant success rate of 21,6%.
- The BG EC financial contribution success rate of 10,9% is lower than the EU-27* rate of 20,7%.

Specifically, following evaluation and selection, a total of

- 337 proposals were retained for funding (16,7%)
- involving 438 (16,8%) successful applicants from Bulgaria and
- requesting EUR 53,95m (10,9%) of EC financial contribution

Among the EU-27*, Bulgaria (BG) ranks:

- 24th in terms of applicants success rate and
- 26th in terms of EC financial contribution success rate

**Signed grant agreements**

As of 2011/03/16, Bulgaria (BG) participates in

- 292 signed grant agreements
- involving 4.344 participants of which 385 (8,86%) are from Bulgaria
- benefiting from a total of EUR 1.003,70m of EC financial contribution of which EUR 47,09m (4,69%) is dedicated to participants from Bulgaria.

Among the EU-27* in all FP7 signed grant agreements, Bulgaria (BG) ranks:

- 20th in number of participations and
- 21st in budget share

**SME performance and participation**

- The BG SME applicant success rate of 14,15% is lower than the EU-27* SME applicant success rate of 19,33%.
- The BG SME EC financial contribution success rate of 12,80% is lower than the corresponding EU-27* rate of 18,26%.

**Specifically,**

- 926 BG SME applicants requesting EUR 151,81m
- 131 (14,15%) successful SMEs requesting EUR 19,43m (12,80%)

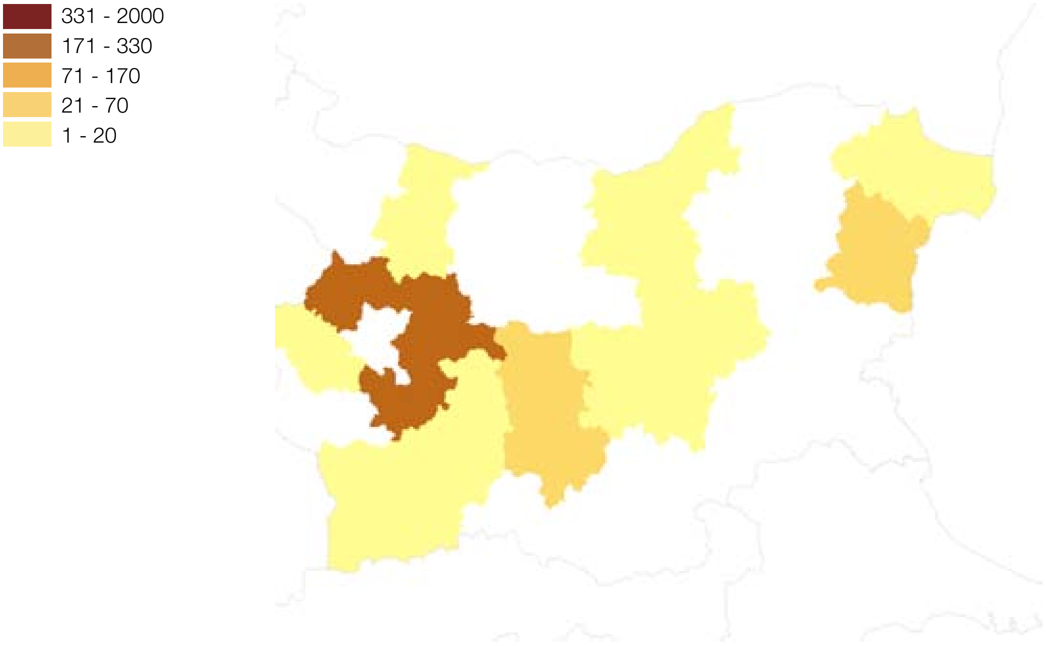
In signed grant agreements, as of 2011/03/16,

- 76 BG SME grant holders, i.e., 19,74% of total BG participation
- EUR 13,10m, i.e., 27,82% of total BG budget share
- Top 3 collaborative links with:
- UK - United Kingdom (371)
- DE - Germany (371)
- IT - Italy (291)

| | | |
|---|---|---|
| **GERD as % of GDP | 0,48% | 1,83% |

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as % of population | N/A | 0,40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 27th | |
| - Below EU-27 average | | |
| - Catching-up Country | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 2.600 | |
| (0,98%) | 266.507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 494,62 | |
| (0,56%) | 88.295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 438 | |
| (0,74%) | 59.199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 53,95 | |
| (0,30%) | 18.262,02 | |
| Success rate FP7 applicants | 16,8% | 21,6% |
| Success rate | | |
| FP7 EC contribution | 10,9% | 20,7% |

| | |
|---|---|
| Nr. of FP7 grant holders | |
| (% EU-27*) | 385 |
| (0,75%) | 51.279 |
| EC contribution | |
| to FP7 grant holders | |
| in EUR million | |
| (% EU-27*) | 47,09 |
| (0,28%) | 16.578,15 |
| Nr. of FP7 coordinators | |
| (% of grant holders) | 29 |
| (7,53%) | 9.383 |
| (18,30%) | |
| Nr. of FP7 SME grant holders | |
| (% grant holders) | 76 |
| (19,74%) | 8.845 |
| (17,25%) | |
| EC contribution to FP7 SME | |
| grant holders in EUR million | |
| (% of grant holders) | 13,10 |
| (27,82%) | 2.207,73 |
| (13,32%) | |



## TABLE 1

## BG - Bulgaria - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 429 | 89.92 | 41 | 9.56 % | 8.62 | 9.58 % |
| Research for the benefit of SMEs | 273 | 36.15 | 43 | 15.75 % | 6.21 | 17.17 % |
| Socio-economic sciences and Humanities | 242 | 29.38 | 19 | 7.85 % | 1.43 | 4.86 % |
| Environment (including Climate Change) | 239 | 34.73 | 40 | 16.74 % | 4.07 | 11.72 % |
| Marie-Curie Actions | 224 | n/a | 75 | 33.48 % | n/a | n/a |
| Food, Agriculture and Fisheries, and Biotechnology | 147 | 22.70 | 21 | 14.29 % | 1.86 | 8.20 % |

## TABLE 2

## BG - Bulgaria - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all BG grant holders | EC contribution (EUR million) | % of total EC contribution to BG |
|---|---|---|---|---|
| Information and Communication Technologies | 47 | 12.21% | 7.41 | 15.73 % |
| Research Potential | 12 | 3.12% | 7.16 | 15.20 % |
| Research for the benefit of SMEs | 44 | 11.43% | 6.03 | 12.81 % |
| Research Infrastructures | 45 | 11.69% | 4.68 | 9.93 % |
| Health | 18 | 4.68% | 2.87 | 6.10 % |
| Environment (including Climate Change) | 33 | 8.57% | 2.81 | 5.97 % |

*Notes:* Report generated on: 2011/03/25.02:14 PM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## BG - Bulgaria - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 829 | 160.98 | 144 | 17.37% | 15.79 | 9.81% | 120 | 15.30 | 32.50% |
| REC | 633 | 122.87 | 114 | 18.01% | 12.29 | 10.00% | 111 | 12.96 | 27.53% |
| PRC | 567 | 94.20 | 91 | 16.05% | 14.24 | 15.11% | 91 | 13.11 | 27.83% |
| OTH | 280 | 39.72 | 41 | 14.64% | 4.81 | 12.12% | 29 | 3.06 | 6.49% |
| PUB | 203 | 24.14 | 45 | 22.17% | 3.46 | 14.31% | 34 | 2.66 | 5.65% |
| | | | | | | | | | |
| SME | 926 | 151.81 | 131 | 14.15% | 19.43 | 12.80% | 76 | 13.10 | 27.82% |

PRC - Private for profit (excl. education), HES - Higher or secondary education, OTH - Others, REC - Research organisations, PUB - Public body (excl. research and education)

## TABLE 4

## BG - Bulgaria - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| BG - Bulgaria region | Number of grant holders | % of all BG - Bulgaria grant holders | EC contribution (M euro) | % of total EC contribution to BG |
|---|---|---|---|---|
| Sofia (BG412) | 287 | 74,55% | 34,12 | 72,46% |
| Varna (BG331) | 29 | 7,53% | 3,13 | 6,65% |
| Plovdiv (BG421) | 25 | 6,49% | 5,36 | 11,39% |
| Ruse (BG323) | 12 | 3,12% | 0,94 | 1,99% |
| Stara Zagora (BG344) | 4 | 1,04% | 0,22 | 0,47% |

## TABLE 5

## BG - Bulgaria - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all CY grant holders | EC contribution (M euro) | % of total EC contribution to BG grant holders |
|---|---|---|---|---|
| University Of Cyprus (UCY) | 55 | 25.58% | 13.87 | 35.24% |
| The Cyprus Research And Educational Foundation (CREF CYI) | 13 | 6.05% | 5.36 | 13.62% |
| Cyprus University Of Technology (CUT) | 12 | 5.58% | 1.48 | 3.75% |
| Primetel Plc (Primetel) | 7 | 3.26% | 1.44 | 3.65% |
| Sigint Solutions Ltd (Sigint) | 5 | 2.33% | 1.42 | 3.60% |

# COUNTRY PROFILE

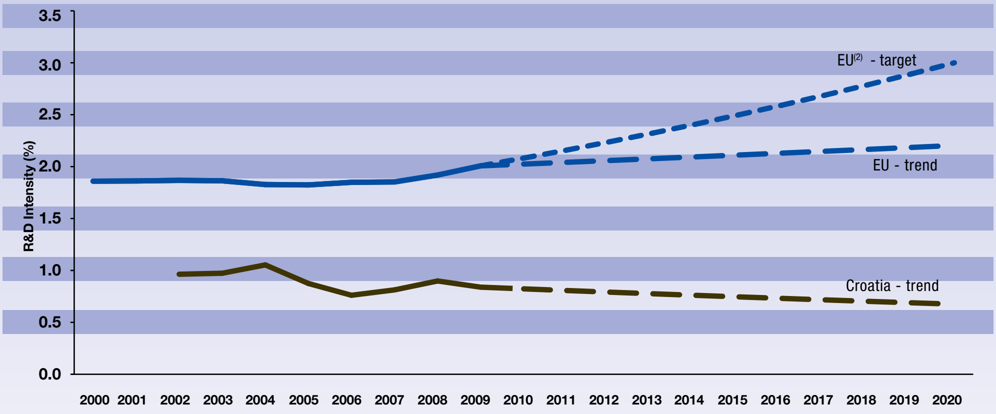
# HR - Croatia

## Progress towards increasing the R&D intensity

Croatia had an R&D intensity of 0.84% in 2009, a value which is considerably lower than the EU average of 2.01%. R&D intensity in Croatia has fluctuated over the last decade. More precisely, it decreased from 1.05% in 2004 to 0.76% in 2006, slightly increased to 0.9% in 2008, before decreasing in 2009 to 0.84%. These fluctuations are mirrored by fluctuations in the R&D intensity of both private and public sector (Government plus Higher Education) over the same period. In 2009 the business enterprise expenditure on R&D as a% of GDP was 0.34% and the public sector expenditure (Government plus Higher Education) was 0.50%, these values being above the Reference Group countries' average. Given the trend scenario presented below, Croatia would still be below the EU average in 2020, at an R&D intensity level of 0.68%. Even if the Associated countries to the European research cooperation does not form part of the Europe 2020 strategy of the European Union, certain countries do envisage fixing an objective for research investment and initiatives for fast growing innovative enterprises. This strategy could be justified if based on a consultation with the stakeholders in the country.

**CROATIA**

**R&D Intensity projections, 2000-2020(1)**



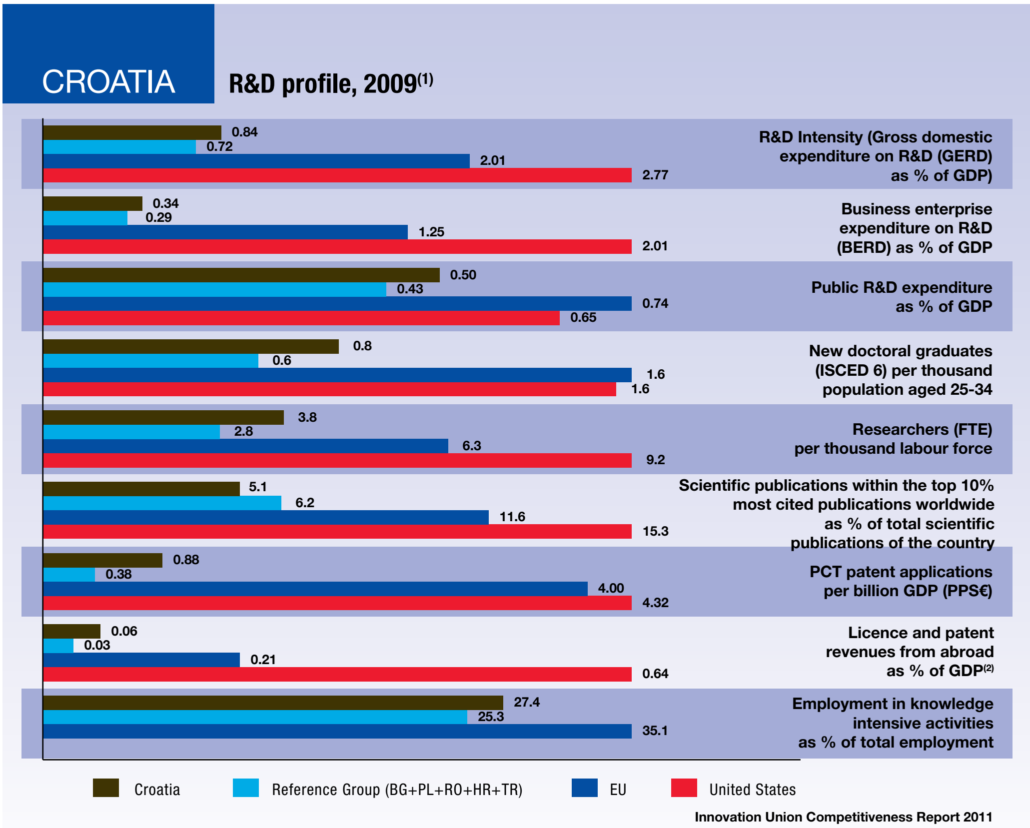
*Source:* DG Research and Innovation.
*Data:* DG Research and Innovation, Eurostat.
*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009 in the the case of the EU and for 2002-2009 in the case of Croatia.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.

**Innovation Union Competitiveness Report 2011**

## Research and Innovation Performance

Based on its average innovation performance, Croatia is one of the moderate innovators with a below average performance[7]. Croatia scores higher than the Reference Group countries average in the share of new doctoral graduates per thousand population aged 25-34, PCT patent applications per billion GDP, licence and patent revenues from abroad as percentage of GDP and employment in knowledge intensive activities. Compared to the EU, the main weaknesses are the business enterprise expenditure on R&D and the licence and patent revenues.

In dynamic terms, relative strengths and increases in the Croatian science and innovation system, comparative to Reference Group countries average, are in employment in knowledge intensive activities, new doctoral graduates and high-impact scientific publications. Relative weaknesses are in patenting intensity and licence and patents revenues from abroad.



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) EU refers to extra-EU.
(3) Elements of estimation were involved in the compilation of the data.

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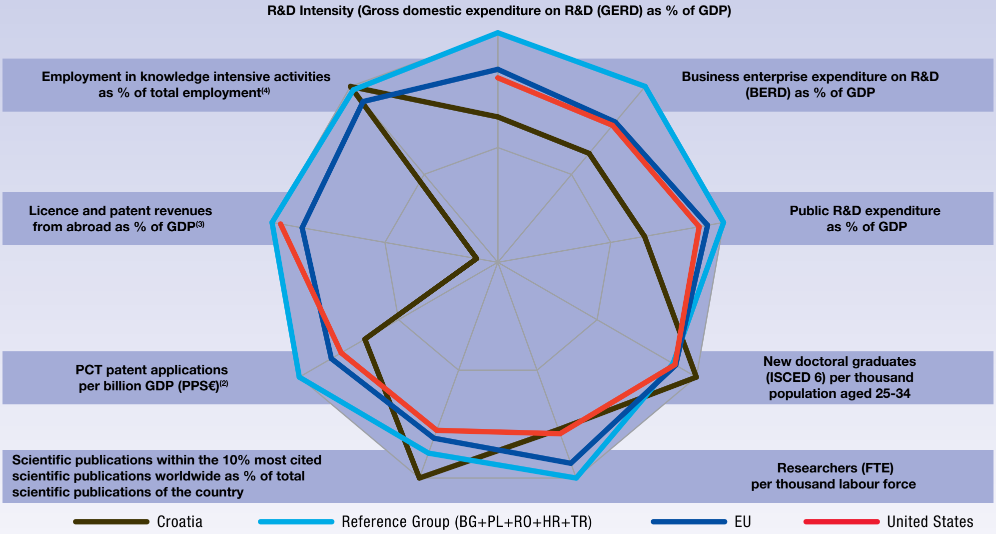
[7] Innovation Union Scoreboard 2010, The Innovation Union's performance scoreboard for Research and Innovation (RIUS), http://www.proinno-europe.eu/inno-metrics/page/innovation-union-scoreboard-2010

## CROATIA

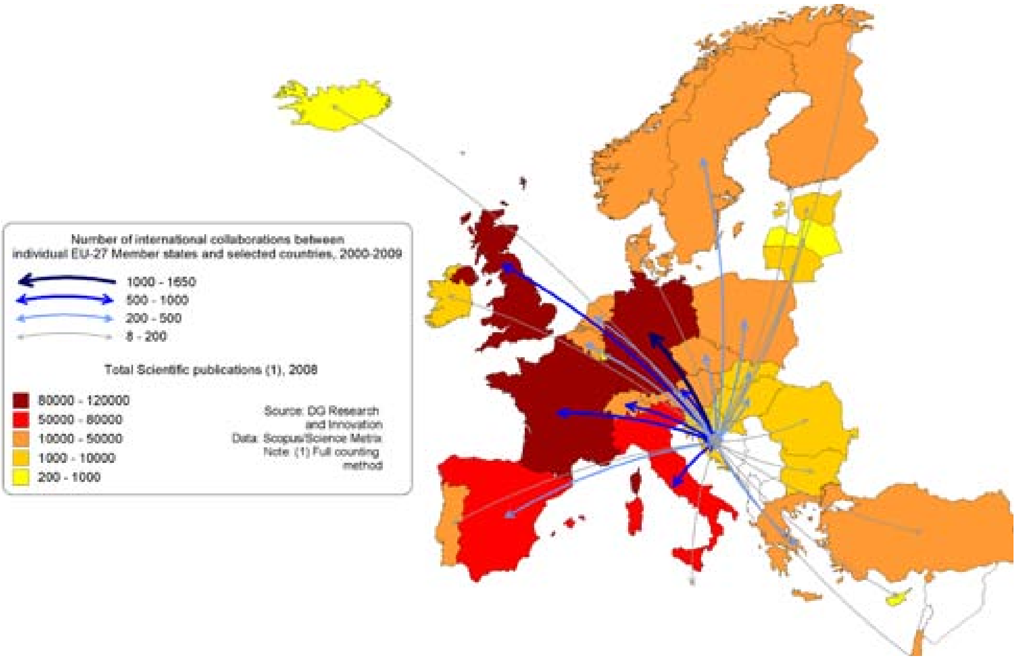
## Average annual growth (%), 2000-2009[1]



*Source:* DG Research and Innovation **Innovation Union Competitiveness Report 2011**
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) Average annual growth refers to real growth.
(3) EU refers to extra-EU.
(4) TR is not included in the Reference Group.
(5) Elements of estimation were involved in the compilation of the data.

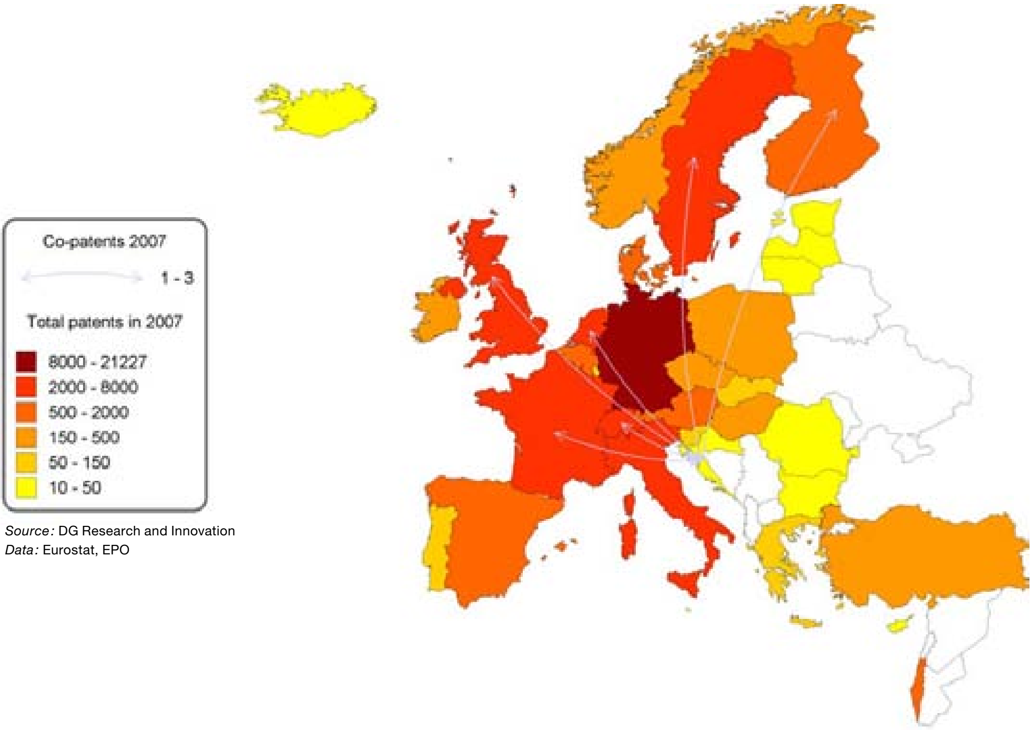
## CROATIA

## Co-publications between Croatia and European Countries in 2000-2009



# CROATIA

## Co-invented patent applications between Croatia and European Countries, 2007



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

### Participation in the European Research Area: Scientific and Technological collaborations

Croatia's scientific cooperation (measured by co-publications) with other European countries is broader and more intense than its technological cooperation (measured by co-patents), providing potential for growing internationalisation of the technology cooperation. The main scientific partner country is Germany, followed by countries such as the United Kingdom, France and Italy. As a difference from the technological cooperation, co-publications are intensive with Sweden, Finland, the United Kingdom, France, Switzerland and the Netherlands.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 998 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 1 238 applicants from Croatia (20.09% of Candidate Countries) and
- requesting EUR 312.63m of EC contribution (15.03% of Candidate Countries)

Among the Candidate Countries Croatia (HR) ranks:

- 2nd in terms of number of applicants and
- 2nd in terms of requested EC contribution

### Success rates

- The HR applicant success rate of 17.7% is similar to the Candidate Countries applicant success rate of 17.9%.
- The HR EC financial contribution success rate of 10.7% is higher than the Candidate Countries rate of 7.3%.

Specifically, following evaluation and selection, a total of

- 168 proposals were retained for funding (16.8%)
- involving 219 (17.7%) successful applicants from Croatia and
- requesting EUR 33.57m (10.7%) of EC financial contribution

Among the Candidate Countries, Croatia (HR) ranks:

- 4th in terms of applicants success rate and
- 3rd in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Croatia (HR) participates in

- 132 signed grant agreements
- involving 2 113 participants of which 164 (7.76%) are from Croatia
- benefiting from a total of EUR 511.80m of EC financial contribution of which EUR 27.47m (5.37%) is dedicated to participants from Croatia.

Among the Candidate Countries in all FP7 signed grant agreements, Croatia (HR) ranks:

- 2nd in number of participations and
- 2nd in budget share

### SME performance and participation

- The HR SME applicant success rate of 17.95% is higher than the Candidate Countries SME applicant success rate of 15.12%.
- The HR SME EC financial contribution success rate of 15.45% is higher than the corresponding Candidate Countries rate of 10.71%.

Specifically,

- 440 HR SME applicants requesting EUR 80.05m
- 79 (17.95%) successful SMEs requesting EUR 12.36m (15.45%)

In signed grant agreements, as of 2011/03/16,

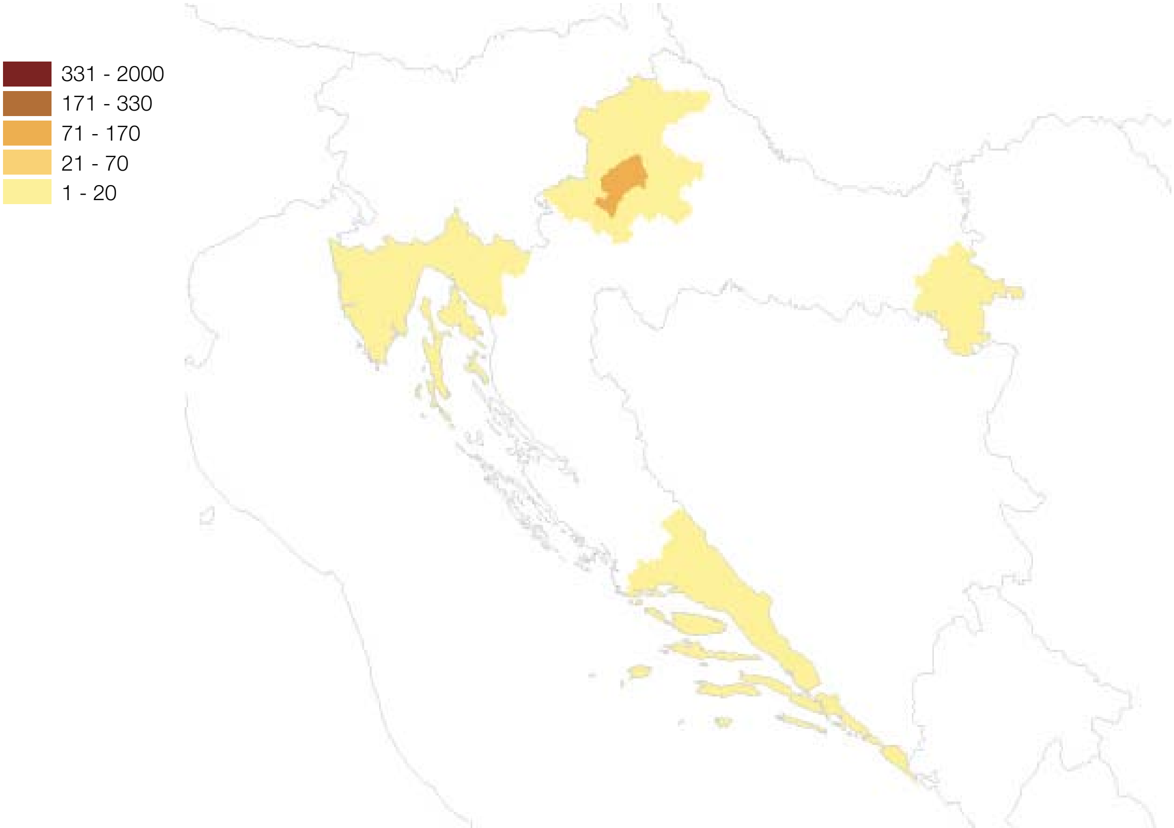
- 26 HR SME grant holders, i.e., 15.85% of total HR participation
- EUR 4.73m, i.e., 17.22% of total HR budget share

### Top 3 collaborative links with

- DE - Germany (174)
- UK - United Kingdom (134)
- IT - Italy (115)

| | | |
|---|---|---|
| Nr. of FP7 applicants | | |
| (% Candidate Countries) | 1 238 | |
| (20.09%) | 6 161 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% Candidate Countries) | 312.63 | |
| (15.03%) | 2 079 | |
| Nr. of successful FP7 applicants | | |
| (% Candidate Countries) | 219 | |
| (20.43%) | 1 072 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% Candidate Countries) | 33.57 | |
| (22.00%) | 152.58 | |
| Success rate FP7 applicants | 17.7% | 17.9% |
| Success rate | | |
| FP7 EC contribution | 10.7% | 7.3% |
| Nr. of FP7 grant holders | | |
| (% Candidate Countries) | 164 | |

| | |
|---|---|
| (18.79%) | 873 |
| EC contribution | |
| to FP7 grant holders | |
| in EUR million | |
| (% Candidate Countries) | 27.47 |
| (20.31%) | 135.27 |
| Nr. of FP7 coordinators | |
| (% of grant holders) | 14 |
| (8.54%) | 195 |
| (22.34%) | |
| Nr. of FP7 SME grant holders | |
| (% of grant holders) | 26 |
| (15.85%) | 131 |
| (15.01%) | |
| EC contribution to FP7 SME | |
| grant holders in EUR million | |
| (% of grant holders) | 4.73 |
| (17.22%) | 30.20 |
| (22.32%) | |



## TABLE 1

## HR - Croatia - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Research for the benefit of SMEs | 174 | 19.05 | 46 | 26.44% | 4.41 | 23.14% |
| Information and Communication Technologies | 136 | 30.77 | 12 | 8.82% | 1.50 | 4.88% |
| Research Potential | 107 | 118.36 | 11 | 10.28% | 7.44 | 6.29% |
| Marie-Curie Actions | 106 | n/a | 24 | 22.64% | n/a | n/a |
| Food, Agriculture and Fisheries, and Biotechnology | 95 | 15.31 | 14 | 14.74% | 1.41 | 9.22% |
| Environment (including Climate Change) | 93 | 16.40 | 18 | 19.35% | 2.29 | 13.96% |

## TABLE 2

## HR - Croatia - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all HR grant holders | EC contribution (EUR million) | % of total EC contribution to HR |
|---|---|---|---|---|
| Research Potential | 11 | 6.71% | 7.44 | 27.10% |
| Transport (including Aeronautics) | 18 | 10.98% | 4.49 | 16.34% |
| Research for the benefit of SMEs | 26 | 15.85% | 2.19 | 7.99% |
| Energy | 13 | 7.93% | 2.03 | 7.39% |
| Environment (including Climate Change) | 14 | 8.54% | 1.65 | 6.01% |
| Health | 6 | 3.66% | 1.45 | 5.26% |

*Notes:* Report generated on: 2011/03/28.11:22 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## HR - Croatia - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 530 | 143.43 | 69 | 13.02% | 12.33 | 8.59% | 52 | 11.26 | 40.99% |
| PRC | 267 | 49.58 | 64 | 23.97% | 9.98 | 20.14% | 59 | 8.20 | 29.86% |
| REC | 182 | 58.64 | 36 | 19.78% | 5.01 | 8.54% | 27 | 4.85 | 17.64% |
| OTH | 122 | 19.17 | 17 | 13.93% | 2.01 | 10.47% | 7 | 0.49 | 1.80% |
| PUB | 110 | 13.23 | 33 | 30.00% | 4.24 | 32.05% | 19 | 2.67 | 9.72% |
| | | | | | | | | | |
| SME | 440 | 80.05 | 79 | 17.95% | 12.36 | 15.45% | 26 | 4.73 | 17.22% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education)

## TABLE 4

## HR - Croatia - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| HR - Croatia region | Number of grant holders | % of all BE - Belgium grant holders | EC contribution (M euro) | % of total EC contribution to BE |
|---|---|---|---|---|
| Grad Zagreb (HR011) | 128 | 78.05% | 18.62 | 67.77% |
| Primorsko-goranska zupanija (HR031) | 12 | 7.32% | 3.87 | 14.08% |
| Splitsko-dalmatinska zupanija (HR035) | 8 | 4.88% | 1.78 | 6.49% |
| Vukovarsko-srijemska zupanija (HR026) | 3 | 1.83% | 0.12 | 0.45% |
| Osjecko-baranjska zupanija (HR025) | 3 | 1.83% | 0.63 | 2.30% |

## TABLE 5

## HR - Croatia - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all HR grant holders | EC contribution (M euro) | % of total EC contribution to HR grant holders |
|---|---|---|---|---|
| Ruder Boskovic Institute (RBI) | 11 | 6.71% | 2.99 | 10.90% |
| Sveuciliste U Rijeci, Medicinski Fakultet | 3 | 1.83% | 2.94 | 10.70% |
| Sveuciliste U Zagrebu Fakultet Elektrotehnike I Racunarstva (FER) | 7 | 4.27% | 1.53 | 5.58% |
| Zagrebacki Holding Doo*Zagreb Cityholding Ltd (Cistoca) | 2 | 1.22% | 1.09 | 3.97% |
| Sveuciliste U Zagrebu Tekstilno-Tehnoloski Fakultet (TTF-UZ) | 2 | 1.22% | 0.96 | 3.49% |

# COUNTRY PROFILE

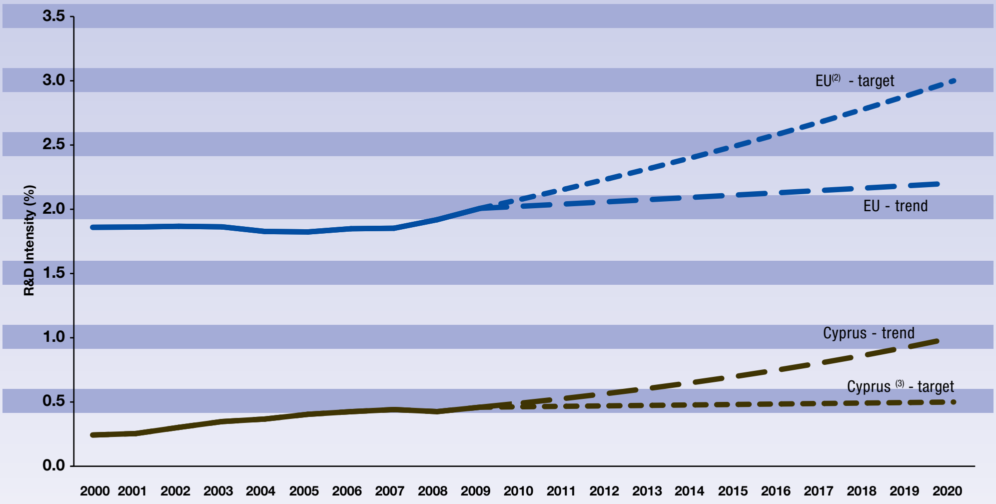
# CY - Cyprus

## Progress towards meeting the Europe 2020 R&D intensity target

Despite a very low level of R&D intensity, 0.46% of GDP in 2009, a positive trend is observed over the past decade. The research system, practically developed in the last twenty years, is, however, much less developed than the rest of economy and is predominantly financed by the public sector. Cypriot authorities consider that the R&D system has reached a point of saturation and they set a target for R&D intensity of 0.5% of GDP in 2020. A more ambitious target would be nevertheless possible to achieve according to the overall development of economy of Cyprus in the last decade and the current positive trend of the R&D intensity. One key feature is currently a high contrast between a high level of investment in education and a low level of investment in research, which may create a potential risk for brain drain.

CYPRUS

**R&D Intensity projections, 2000-2020**(1)



*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* DG Research and Innovation, Eurostat

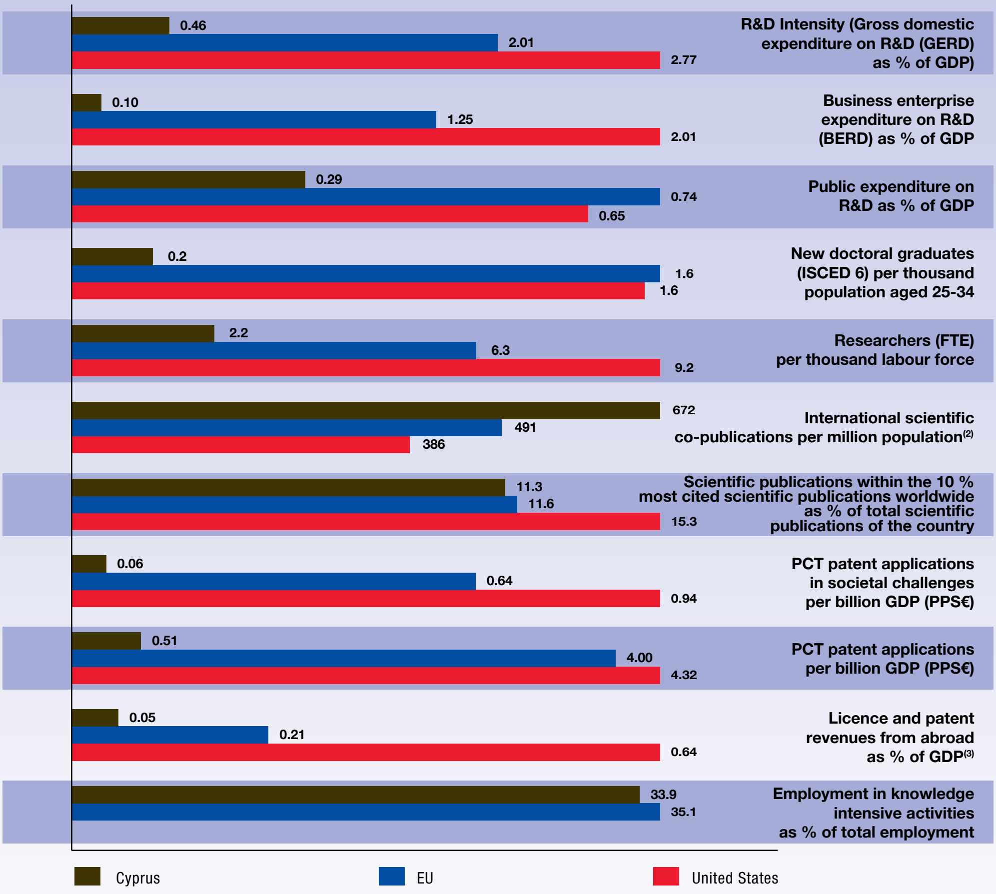
*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) CY: This projection is based on a tentative R&D Intensity target of 0.5% for 2020.

## Research and Innovation Performance

The Innovation Union Scoreboard 2010 classifies Cyprus among the 'Innovation Followers', which is a significant progress in comparison with the previous years. The government has introduced a set of measures to encourage stronger industry participation in research and innovation. However, the research and innovation system of Cyprus is characterised by the need of reform. There are two main bottlenecks: on one hand, limited human resources available due to a small demand from business and industry, and on the other hand, limited engagement of business to research activities in the absence of big companies and high-tech industry.

Over the last decade, Cyprus has been progressing at a pace similar to the EU average annual growth in terms of percentage of public expenditure in R&D, the relative share of new doctoral graduates of population aged 25-34 or the relative share of international scientific co-publication.

**CYPRUS** **R&D profile, 2009(1)**

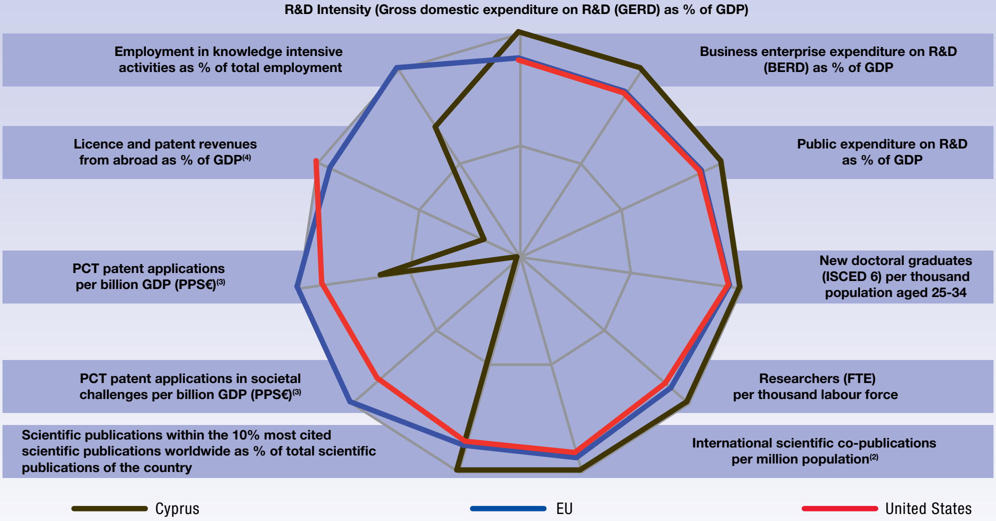


Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) Elements of estimation were involved in the compilation of the data.

## CYPRUS

### Average annual growth (%), 2000-2009[1]

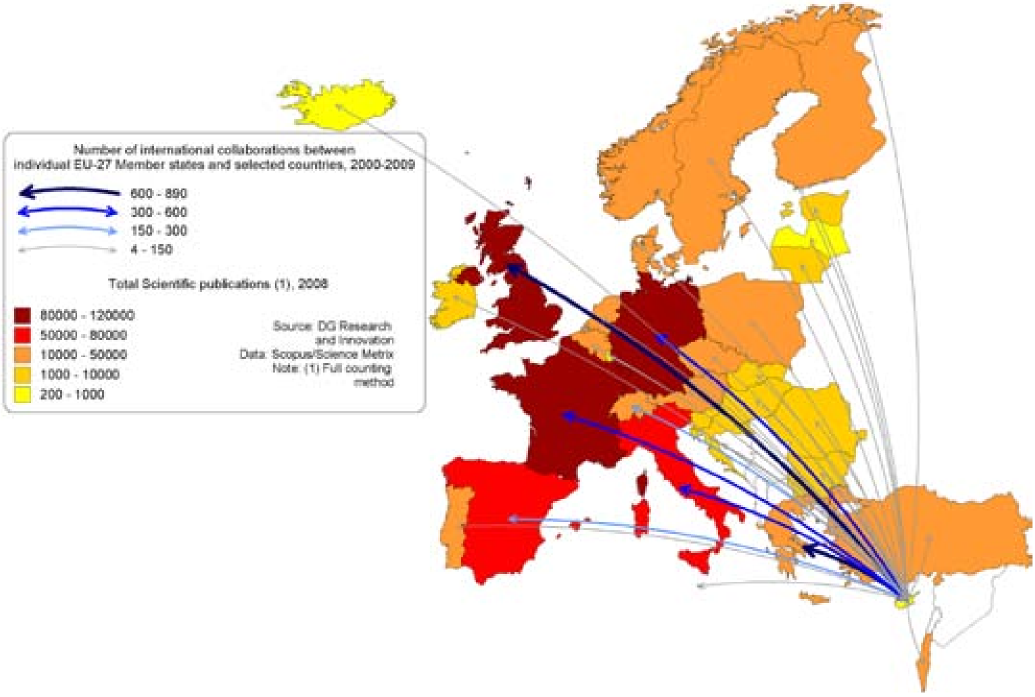


**Innovation Union Competitiveness Report 2011**

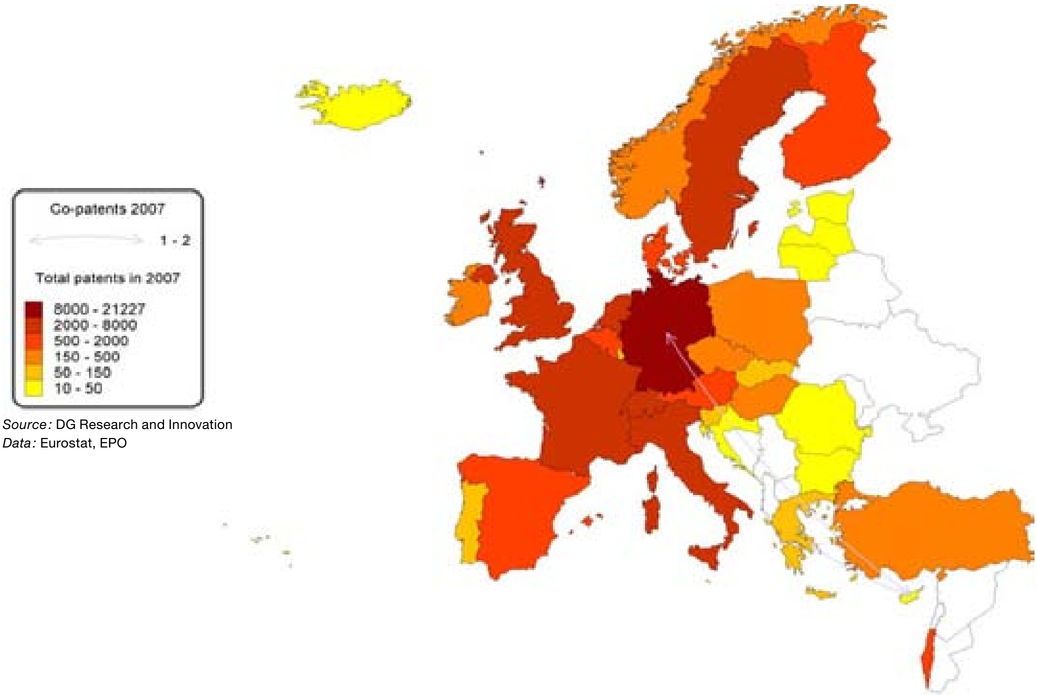
*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average.
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## CYPRUS

### Co-publications between Cyprus and European Countries in 2000-2009



## Co-invented patent applications between Cyprus and European Countries, 2007



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

Nevertheless, Cyprus has scored low levels of average annual growth in PCT patent applications, mainly in societal challenges and in licence and patent revenues rates from abroad. The overall trend between 2000 and 2009 of annual growth of GERD is over the average on the European Union but the rate of BERD remains low.

### Participation in the European Research Area: Scientific and Technological collaborations

As indicated in the figure below, between 2000 and 2009, the greatest number of co-publications of Cyprus were with Switzerland and Spain. As for co-patenting, in 2007 Germany was the biggest partner of Cypriot technological actors for co-invented patent applications, but with a low figure.

However, the results in terms of co-publications are relative positive, especially the rate of international scientific co-publications per million population which is over the EU average.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 1 213 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 1 474 applicants from Cyprus (0.55% of EU-27*) and
- requesting EUR 333.59m of EC contribution (0.38% of EU-27*)

Among the EU-27* Cyprus (CY) ranks:

- 22nd in terms of number of applicants and
- 21st in terms of requested EC contribution

### Success rates

- The CY applicant success rate of 17.3% is lower than the EU-27* applicant success rate of 21.6%.
- The CY EC financial contribution success rate of 11.6% is lower than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 220 proposals were retained for funding (18.1%)
- involving 255 (17.3%) successful applicants from Cyprus and
- requesting EUR 38.86m (11.6%) of EC financial contribution

Among the EU-27*, Cyprus (CY) ranks:

- 23rd in terms of applicants success rate and
- 21st in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Cyprus (CY) participates in

- 184 signed grant agreements
- involving 2 589 participants of which 215 (8.30%) are from Cyprus
- benefiting from a total of EUR 653.84m of EC financial contribution of which EUR 39.37m (6.02%) is dedicated to participants from Cyprus.

Among the EU-27* in all FP7 signed grant agreements, Cyprus (CY) ranks:

- 23rd in number of participations and
- 23rd in budget share

### SME performance and participation

- The CY SME applicant success rate of 14.36% is lower than the EU-27* SME applicant success rate of 19.33%.
- The CY SME EC financial contribution success rate of 10.65% is lower than the corresponding EU-27* rate of 18.26%.

Specifically,

- 759 CY SME applicants requesting EUR 155.18m
- 109 (14.36%) successful SMEs requesting EUR 16.52m (10.65%)

In signed grant agreements, as of 2011/03/16,

- 62 CY SME grant holders, i.e., 28.84% of total CY participation
- EUR 11.60m, i.e., 29.47% of total CY budget share

### Top 3 collaborative links with

- UK - United Kingdom (200)
- DE - Germany (199)
- FR - France (165)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 13th | |
| - Above EU-27 average | | |
| - Innovation Follower | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 1 474 | |
| (0.55%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 333.59 | |
| (0.38%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 255 | |
| (0.43%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 38.86 | |
| (0.21%) | 18 262.02 | |
| Success rate FP7 applicants | 17.3% | 21.6% |

| | | |
|---|---|---|
| Success rate | | |
| FP7 EC contribution | 11.6% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 215 | |
| (0.42%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 39.37 | |
| (0.24%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 36 | |
| (16.74%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 62 | |
| (28.84%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 11.60 | |
| (29.47%) | 2 207.73 | |
| (13.32%) | | |

## TABLE 1

## CY - Cyprus - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 379 | 106.46 | 45 | 11.87% | 12.65 | 11.89% |
| Research for the benefit of SMEs | 280 | 46.61 | 54 | 19.29% | 6.84 | 14.67% |
| Marie-Curie Actions | 143 | n/a | 51 | 35.66% | n/a | n/a |
| Environment (including Climate Change) | 103 | 19.13 | 9 | 8.74% | 1.13 | 5.91% |
| Socio-economic sciences and Humanities | 99 | 16.66 | 10 | 10.10% | 0.96 | 5.76% |
| Health | 76 | 23.19 | 7 | 9.21% | 1.15 | 4.97% |

## TABLE 2

## CY - Cyprus - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all CY grant holders | EC contribution (EUR million) | % of total EC contribution to CY |
|---|---|---|---|---|
| Information and Communication Technologies | 49 | 22.79% | 12.81 | 32.54% |
| Marie-Curie Actions | 40 | 18.60% | 5.60 | 14.23% |
| ERC | 4 | 1.86% | 4.71 | 11.97% |
| Research for the benefit of SMEs | 32 | 14.88% | 3.55 | 9.01% |
| Research Infrastructures | 16 | 7.44% | 3.29 | 8.36% |
| Transport (including Aeronautics) | 9 | 4.19% | 1.57 | 3.98% |

*Notes:* Report generated on: 2011/03/25.02:56 PM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## CY - Cyprus - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| PRC | 585 | 121.20 | 83 | 14.19% | 14.75 | 12.17% | 71 | 14.14 | 35.90% |
| HES | 502 | 99.86 | 94 | 18.73% | 13.50 | 13.52% | 89 | 21.44 | 54.47% |
| OTH | 130 | 22.72 | 34 | 26.15% | 2.69 | 11.82% | 28 | 1.24 | 3.14% |
| REC | 119 | 23.04 | 26 | 21.85% | 2.45 | 10.65% | 12 | 1.45 | 3.67% |
| PUB | 101 | 14.70 | 15 | 14.85% | 1.15 | 7.81% | 15 | 1.11 | 2.82% |
| | | | | | | | | | |
| SME | 759 | 155.18 | 109 | 14.36% | 16.52 | 10.65% | 62 | 11.60 | 29.47% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education)

## TABLE 4

## CY - Cyprus - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| CY - Cyprus region | Number of grant holders | % of all CY - Cyprus grant holders | EC contribution (M euro) | % of total EC contribution to CY |
|---|---|---|---|---|
| Kypros / Kibris (CY000) | 215 | 100.00% | 39.37 | 100.00% |

## TABLE 5

## CY - Cyprus - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all CY grant holders | EC contribution (M euro) | % of total EC contribution to CY grant holders |
|---|---|---|---|---|
| University Of Cyprus (UCY) | 55 | 25.58% | 13.87 | 35.24% |
| The Cyprus Research And Educational Foundation (CREF CYI) | 13 | 6.05% | 5.36 | 13.62% |
| Cyprus University Of Technology (CUT) | 12 | 5.58% | 1.48 | 3.75% |
| Primetel Plc (Primetel) | 7 | 3.26% | 1.44 | 3.65% |
| Sigint Solutions Ltd (Sigint) | 5 | 2.33% | 1.42 | 3.60% |

# COUNTRY PROFILE

# CZ - Czech Republic

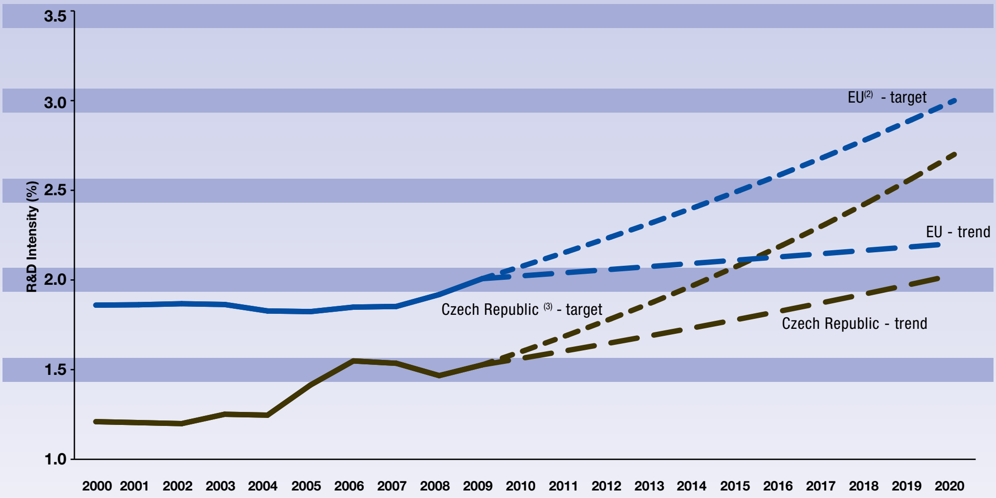
## Progress towards meeting the Europe 2020 R&D intensity target

The Czech Research and Innovation system went under a radical transformation alongside the post-Communist economic and social changes that characterised the early 1990s. During this period, the system suffered from significant public R&D cuts as well as from short-sighted decreases in private R&D, which put at stake the long-term technological and innovative capacity of the country. In the last decade, however, this trend reverted and R&D intensity rose from 1.21% in the year 2000 to 1.55% in 2006, i.e. at an average growth rate of 4.2%. However, while the reform of the Czech R&I system seemed well on track until 2006, the situation deteriorated again during the period 2006–2008, with a fall of R&D intensity to 1.47% in 2008, rising again to 1.53% in 2009 due to a drop in GDP.

Despite this increase, R&D intensity still falls short the EU average by around 33%. In order to ensure the scientific and technological convergence and not jeopardise the recently initiated economic and social convergence, R&D investments should accelerate. The Czech authorities have recognised this need and have established an ambitious R&D target for 2020 at 2.7 % - very close to the 3% EU target.

CZECH REPUBLIC

**R&D Intensity projections, 2000-2020(1)**

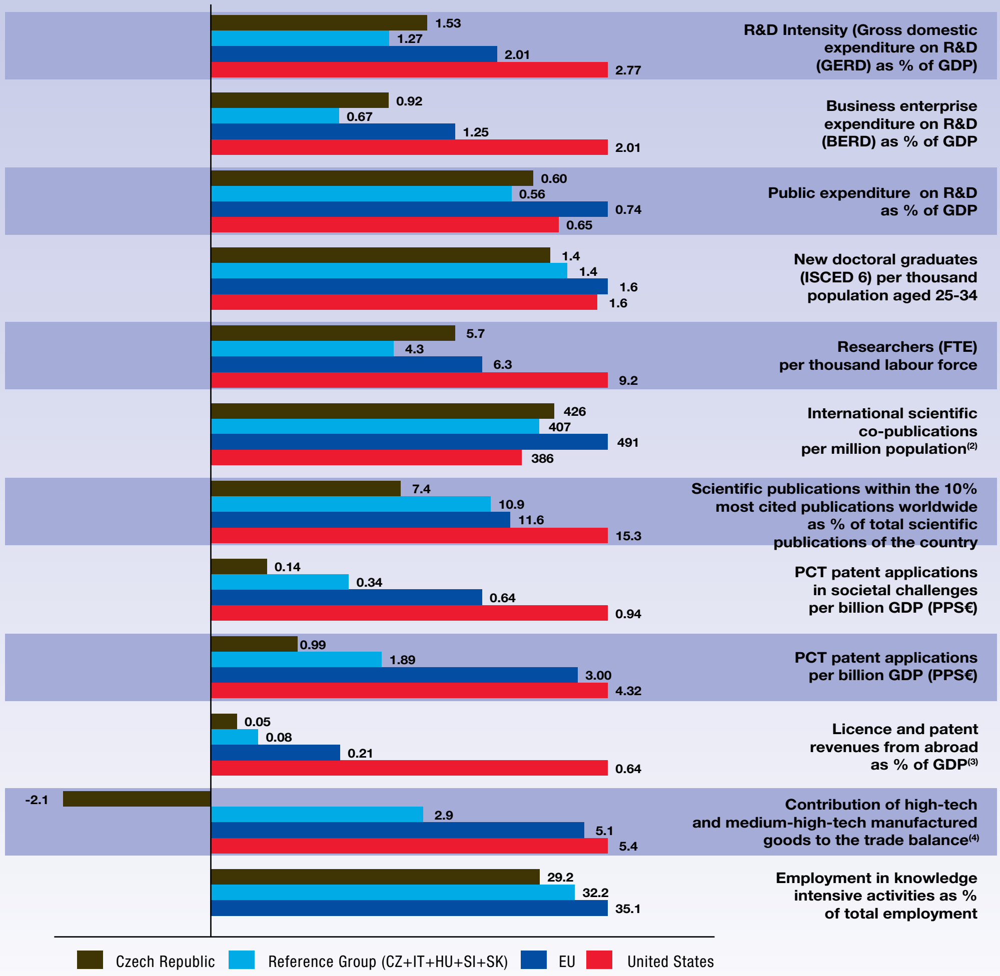


*Source:* DG Research and Innovation
*Data:* DG Research and Innovation, Eurostat
*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) CZ: This projection is based on a tentative R&D Intensity target of 2.7% for 2020.

**Innovation Union Competitiveness Report 2011**

# CZECH REPUBLIC

## R&D profile, 2009(1)



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

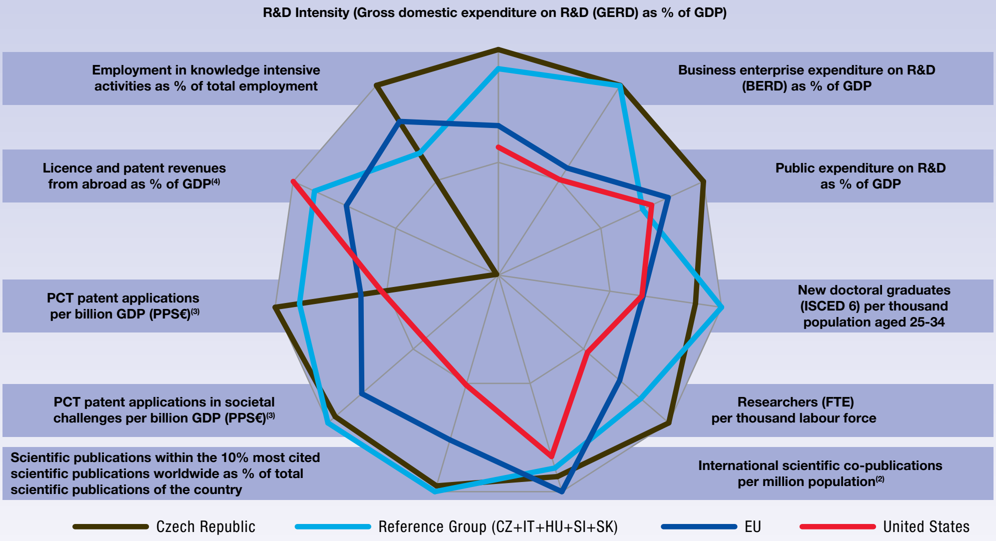
## Research and Innovation Performance

Czech research and innovation is characterised by a need to increase the efficiency and excellence of the system. While both research investments and human resources with capacity to carry out research activities are below the EU average, they score above a group of countries with similar research structure characteristics. However, the system systematically shows poorer scientific and technological outputs, in terms of high impact scientific publications, PCT patents or licence and patent revenues from abroad, than both the EU and the reference group.

These findings highlight the relevance of the recently adopted reforms in terms of (1) simplification of the research funding system, (2) support of R&D excellence, (3) more flexible organisational structure of public R&D or (4) international cooperation in R&D, in order to boost the efficiency of the system. A lack of improvement in the efficiency of the system could jeopardise a smooth transition towards a knowledge-based economy and endanger the good economic performance of the last decade and convergence with the EU.

## CZECH REPUBLIC

## Average annual growth (%), 2000-2009[1]

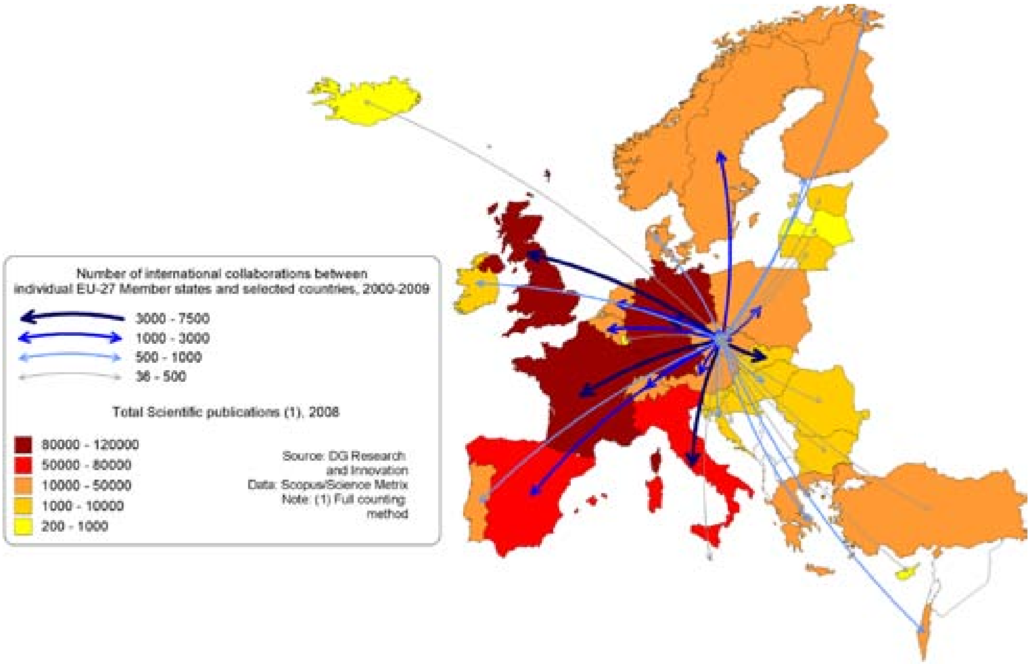


**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average.
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

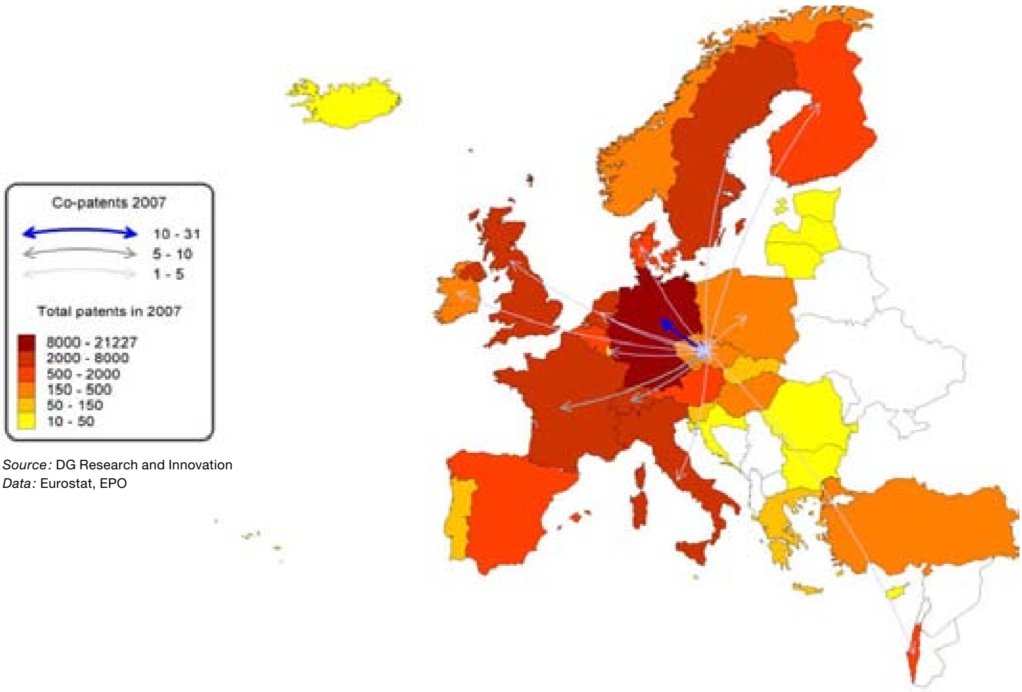
## CZECH REPUBLIC

## Co-publications between the Czech Republic and European Countries in 2000-2009



## CZECH REPUBLIC

## Co-invented patent applications between the Czech Republic and European Countries, 2007



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

In dynamic terms, the Czech Republic has achieved good progress in the last decade. The progressive consolidation of the transformation of the research and innovation system allowed a steady increase of public and private R&D investments and an increase in the number of researchers in the labour force. As a result, the scientific and technological performance and the shift towards more knowledge-intensive activities both advanced at a good pace.

### Participation in the European Research Area: Scientific and Technological collaborations

The Czech Republic is a relatively small country that needs to open up in order to tap into international knowledge and benefit from the potential spillovers generated by the ERA. In the last decade, the national research system has significantly opened as evidenced by the increase in the number of international scientific co-publications. The Czech Republic's main partners in science are Germany, the United Kingdom, France, Italy and the Slovak Republic. This reflects to a large extent the size of the research systems of these countries, but also geographical and cultural ties, especially in the case of the Slovak Republic.

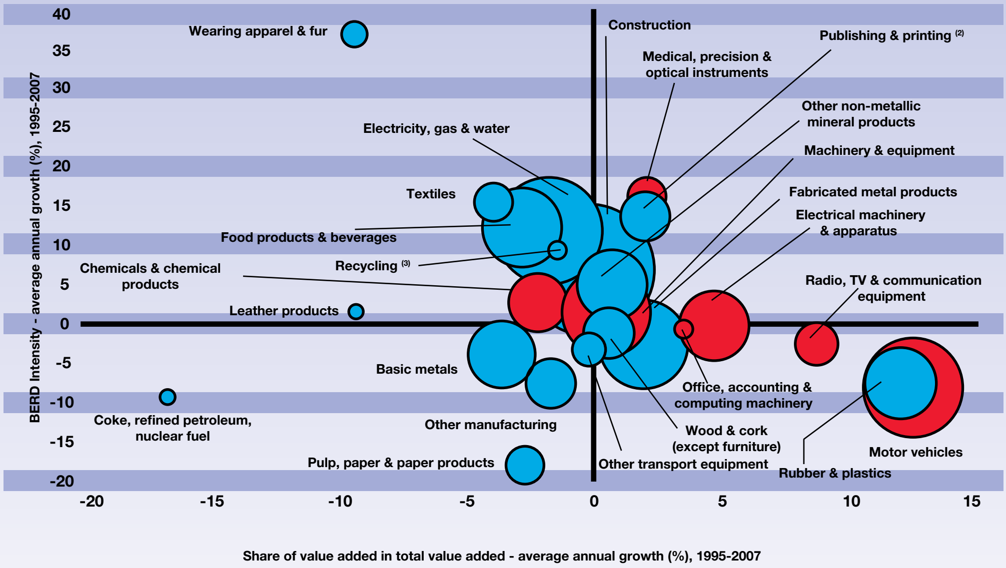
In terms of co-inventions of patents, these are not very numerous, which may hint to potential weaknesses in the capacity to engage in international technological networks. The main technological partner is Germany, largely due to its large technological capacity and the close industrial links between Czech and German companies, especially in the automotive sector.

### Structural change towards more knowledge-intensive economy

In order to accelerate the shift towards a knowledge-based, research-intensive economy, existing sectors, especially medium-high and high technology sectors such as motor vehicles, electric machinery and apparatus or machinery and equipment, should become more research-intensive and move up towards higher-value-added segments of the international value-added chain.

# CZECH REPUBLIC

## Share of value added versus BERD Intensity - Average annual growth, 1995-2007



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.
(2) 'Publishing and printing': average annual growth refers to 1996-2007.
(3) 'Recycling': average annual growth refers to 2000-2007.
(4) 'Tobacco products' is not included on the graph.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 3 054 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 3 793 applicants from Czech Republic (1.42% of EU-27*) and
- requesting EUR 834.06m of EC contribution (0.94% of EU-27*)

Among the EU-27* Czech Republic (CZ) ranks:

- 18th in terms of number of applicants and
- 18th in terms of requested EC contribution

### Success rates

- The CZ applicant success rate of 20.2% is lower than the EU-27* applicant success rate of 21.6%.
- The CZ EC financial contribution success rate of 15.9% is lower than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 635 proposals were retained for funding (20.8%)
- involving 767 (20.2%) successful applicants from Czech Republic and
- requesting EUR 132.59m (15.9%) of EC financial contribution

Among the EU-27*, Czech Republic (CZ) ranks:

- 16th in terms of applicants success rate and
- 16th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Czech Republic (CZ) participates in

- 572 signed grant agreements
- involving 8 151 participants of which 697 (8.55%) are from Czech Republic
- benefiting from a total of EUR 2 195.85m of EC financial contribution of which EUR 122.99m (5.60%) is dedicated to participants from Czech Republic.

Among the EU-27* in all FP7 signed grant agreements, Czech Republic (CZ) ranks:

- 17th in number of participations and
- 17th in budget share

**SME performance and participation**

- The CZ SME applicant success rate of 17.83% is lower than the EU-27* SME applicant success rate of 19.33%.
- The CZ SME EC financial contribution success rate of 16.36% is lower than the corresponding EU-27* rate of 18.26%.

Specifically,

- 1 223 CZ SME applicants requesting EUR 228.75m
- 218 (17.83%) successful SMEs requesting EUR 37.43m (16.36%)

In signed grant agreements, as of 2011/03/16,

- 131 CZ SME grant holders, i.e., 18.79% of total CZ participation
- EUR 23.50m, i.e., 19.11% of total CZ budget share

**Top 3 collaborative links with**

- DE - Germany (1 074)
- UK - United Kingdom (734)
- FR - France (716)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | 0.41% | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 15th | |
| - Below EU-27 average | | |
| - Moderate Innovator | | |

| | | |
|---|---|---|
| Nr. of FP7 applicants | | |
| (% EU-27*) | 3 793 | |
| (1.42%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 834.06 | |
| (0.94%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 767 | |
| (1.30%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 132.59 | |
| (0.73%) | 18 262.02 | |
| Success rate FP7 applicants | 20.2% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 15.9% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 697 | |
| (1.36%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 122.99 | |
| (0.74%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 59 | |
| (8.46%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 131 | |
| (18.79%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 23.50 | |
| (19.11%) | 2 207.73 | |
| (13.32%) | | |

| | |
|---|---|
| 🟥 | 331 - 2000 |
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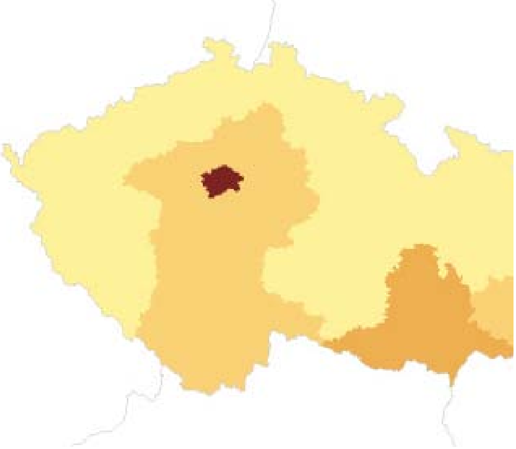


## TABLE 1

## CZ - Czech Republic - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 585 | 169.74 | 87 | 14.87% | 24.82 | 14.62% |
| Marie-Curie Actions | 421 | n/a | 105 | 24.94% | n/a | n/a |
| Research for the benefit of SMEs | 406 | 49.11 | 71 | 17.49% | 10.78 | 21.96% |
| Transport (including Aeronautics) | 361 | 71.50 | 68 | 18.84% | 12.90 | 18.04% |
| Environment (including Climate Change) | 292 | 56.25 | 52 | 17.81% | 6.60 | 11.73% |
| Health | 272 | 83.44 | 37 | 13.60% | 8.01 | 9.60% |

## TABLE 2

## CZ - Czech Republic - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all CZ grant holders | EC contribution (EUR million) | % of total EC contribution to CZ |
|---|---|---|---|---|
| Information and Communication Technologies | 89 | 12.77% | 21.34 | 17.35% |
| Marie-Curie Actions | 88 | 12.63% | 13.18 | 10.71% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 74 | 10.62% | 12.80 | 10.41% |
| Transport (including Aeronautics) | 55 | 7.89% | 10.09 | 8.21% |
| Health | 44 | 6.31% | 8.79 | 7.15% |
| Research for the benefit of SMEs | 57 | 8.18% | 8.36 | 6.79% |

*Notes:* Report generated on: 2011/03/25.04:34 PM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## CZ - Czech Republic - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 1 470 | 300.34 | 269 | 18.30% | 42.69 | 14.21% | 236 | 45.44 | 36.95% |
| PRC | 1 080 | 213.68 | 219 | 20.28% | 43.95 | 20.57% | 215 | 35.62 | 28.97% |
| REC | 669 | 127.64 | 170 | 25.41% | 27.19 | 21.30% | 200 | 35.41 | 28.79% |
| OTH | 290 | 38.98 | 65 | 22.41% | 6.43 | 16.49% | 19 | 2.06 | 1.67% |
| PUB | 165 | 24.51 | 39 | 23.64% | 3.90 | 15.90% | 27 | 4.45 | 3.62% |
| | | | | | | | | | |
| SME | 1 223 | 228.75 | 218 | 17.83% | 37.43 | 16.36% | 131 | 23.50 | 19.11% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education)

## TABLE 4

## CZ - Czech Republic - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| CZ - Czech Republic region | Number of grant holders | % of all CZ - Czech Republic grant holders | EC contribution (M euro) | % of total EC contribution to CZ |
|---|---|---|---|---|
| Hlavni mesto Praha (CZ010) | 383 | 54.95% | 71.48 | 58.12% |
| Jihomoravsky kraj (CZ064) | 112 | 16.07% | 25.20 | 20.49% |
| Stredocesky kraj (CZ020) | 58 | 8.32% | 6.70 | 5.45% |
| Jihocesky kraj (CZ031) | 23 | 3.30% | 3.81 | 3.10% |
| Zlinsky kraj (CZ072) | 21 | 3.01% | 2.36 | 1.92% |

## TABLE 5

## CZ - Czech Republic - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all CZ grant holders | EC contribution (M euro) | % of total EC contribution to CZ grant holders |
|---|---|---|---|---|
| Univerzita Karlova V Praze (Univerzita Karlova V) | 68 | 9.76% | 13.42 | 10.91% |
| Ceske Vysoke Uceni Technicke V Praze (CVUT) | 46 | 6.60% | 8.39 | 6.82% |
| Ustav Organicke Chemie A Biochemie, Av Cr, V.V.I. (UOCHB AVCR) | 8 | 1.15% | 6.04 | 4.91% |
| Vysoke uceni technicke v Brne (BUT) | 19 | 2.73% | 5.84 | 4.75% |
| Masarykova univerzita (MU) | 28 | 4.02% | 4.88 | 3.97% |

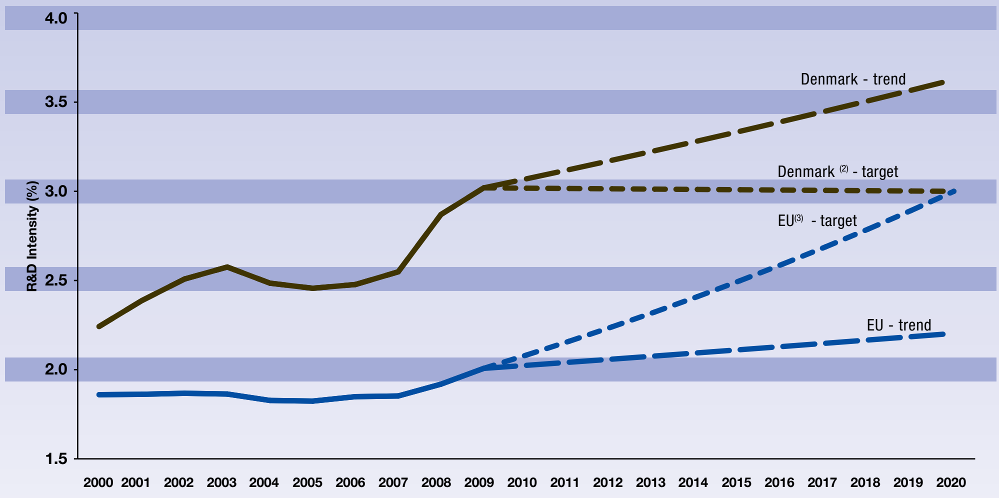
# DK - Denmark

## Progress towards meeting the Europe 2020 R&D intensity target

Denmark reached its R&D intensity target for 2010 already in 2009 with a proportion of public-private R&D intensity well in line with the Barcelona objectives of one third - two thirds. The most recent figures for Denmark on R&D intensity are 3.02% for 2009 (0.99% public + 2.02% private). Over the period 2000-2009, Denmark's R&D intensity has increased clearly, with an average annual growth rate of 8.84% over the period 2006-2009, one of the highest growth rates among the EU Member States. In view of 2020, Denmark has set a preliminary national R&D target of 3% of GDP, which is in fact already achieved. Therefore, Denmark has scope of being more ambitious in its R&D intensity target for 2020, in particular if the country has the ambition to keep its position among the world's research and innovation leaders. Given the trend scenario presented below, Denmark has the potential to reach a level even above 3.5% by 2020. In 2009 and 2010, new innovation policy measures were introduced in Denmark targeting private R&D investment, including increased public procurement of eco-innovations, support for large demonstration facilities, the launch of the Renewal Fund and a risk capital fund.

### DENMARK

### R&D Intensity projections, 2000-2020(1)

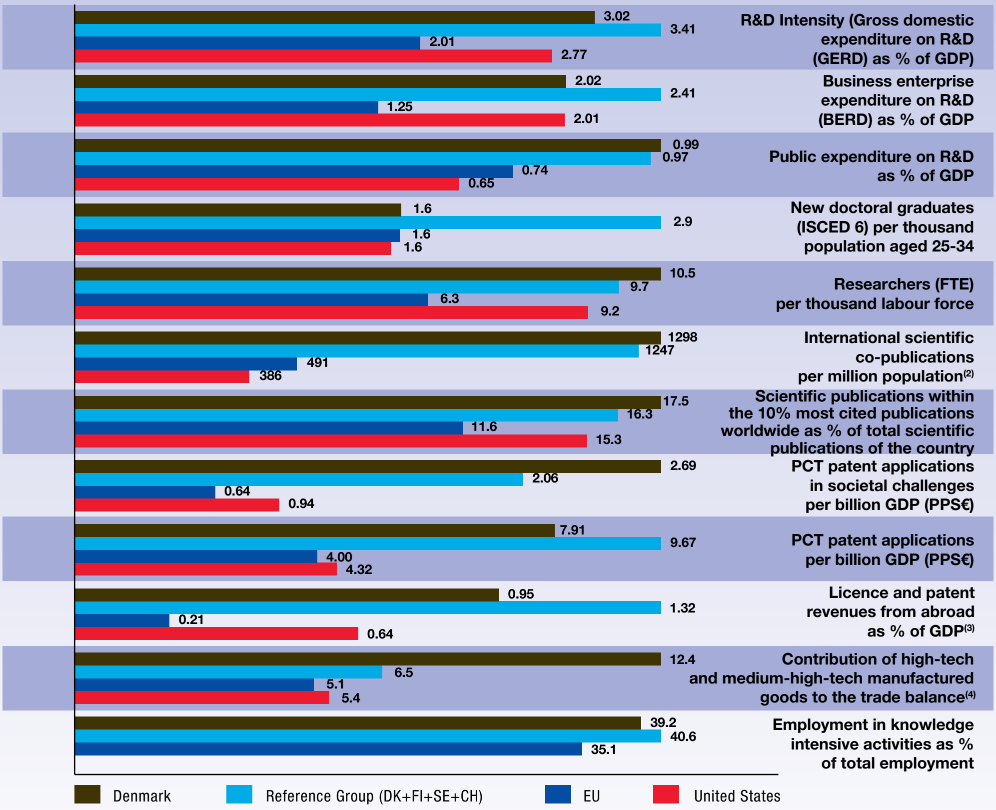


*Source:* DG Research and Innovation
*Data:* DG Research and Innovation, Eurostat
*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009 in the case of the EU and for 2000-2006 in the case of Denmark.
(2) DK: This projection is based on a tentative R&D Intensity target of 3.0% for 2020.
(3) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(4) DK: There is a break in series between 2007 and the previous years.

**Innovation Union Competitiveness Report 2011**

# DENMARK

## R&D profile, 2009(1)



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) (i) The EU value refers to the median rather than to the average; (ii) CH is not included in the Reference Group.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU; (iii) CH is not included in the Reference Group.
(5) Elements of estimation were involved in the compilation of the data.

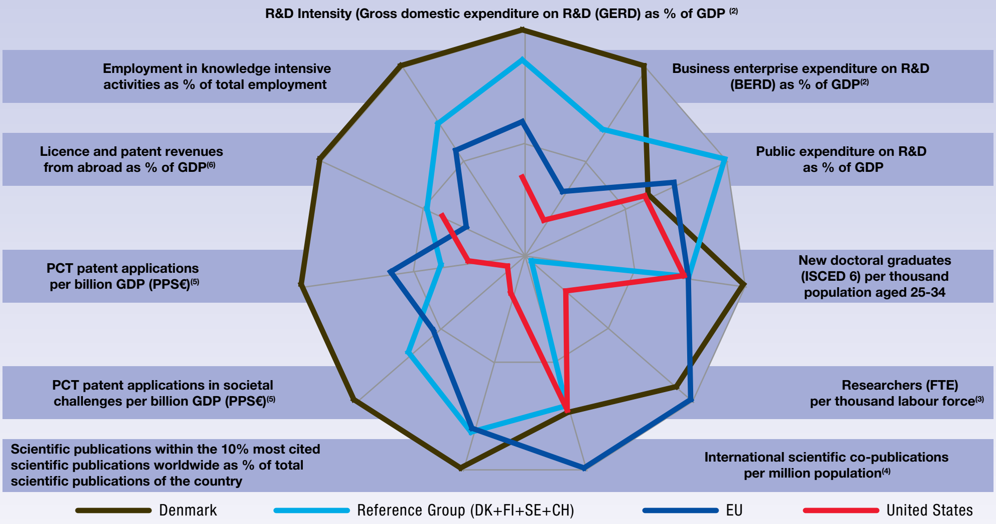
## Research and Innovation Performance

Denmark's research and innovation system benefits from a strong scientific production, building on a high level of funding, human resources and international scientific cooperation. Over the period 2000-2009, the Danish government has increased the share of total government expenditures allocated to R&D (GBAORD), leading to an increase by 30% in R&D expenditures financed by government as% of GDP. This funding is reflected in one of the world's highest levels of scientific excellence (a ratio of 17.5% of national publications to the 10% most highly-cited in the world). The Danish innovation system also builds on large researcher intensity in the labour force and a focus on technologies for societal challenges and future growth areas, well adapted to the Danish industry profile. The weaker points in the Danish innovation system in relative terms are the patent intensity and share of new doctoral graduates, which are at a lower level than in similar knowledge-intensive countries such as Sweden, Finland and Switzerland.

Over the period 2000-2009, Denmark has increased its performance in all areas where it is lagging behind the other world innovation leaders, in particular in technology production. Denmark has also enhanced the knowledge-intensity of its economy, with a growing share of activities based on highly-skilled employees. Only in public R&D expenditure and international scientific cooperation has Denmark lost ground compared to both the EU average and to the other world innovation leaders.

## DENMARK

## Average annual growth (%), 2000-2009[1]

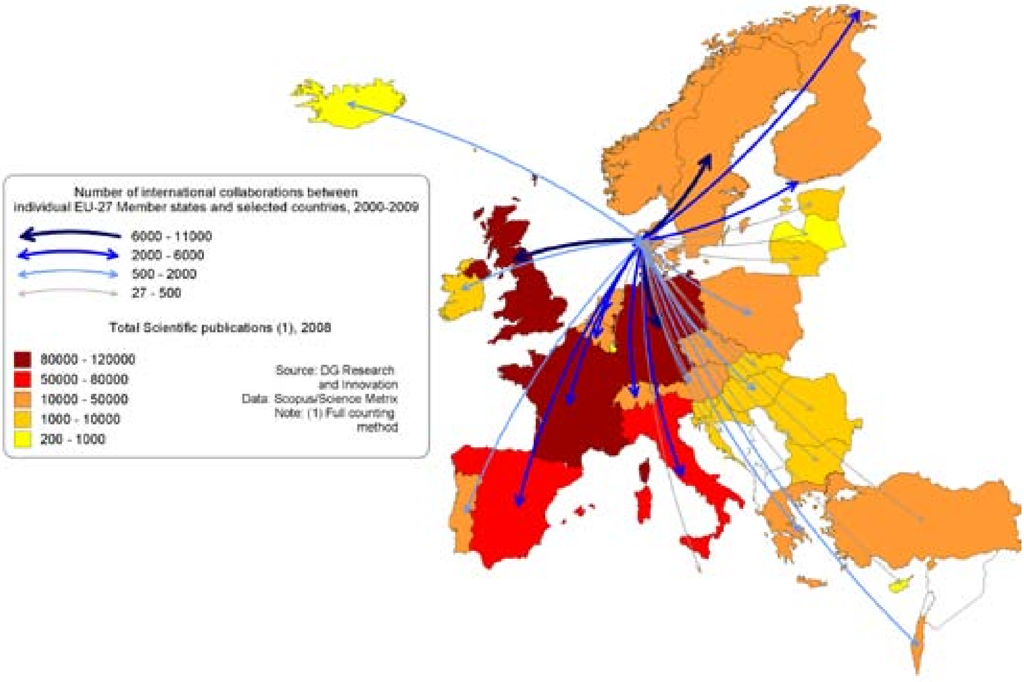


**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) Average annual growth for Denmark refers to 2000-2006 - there is a break in series between 2007 and the previous years.
(3) Average annual growth for Denmark refers to 2002-2006 - there are breaks in series between 2002 and the previous years and 2007 and the previous years.
(4) (i) The EU value refers to the median rather than to the average; (ii) CH is not included in the Reference Group.
(5) Average annual growth refers to real growth.
(6) EU refers to extra-EU.
(7) Elements of estimation were involved in the compilation of the data.

## DENMARK

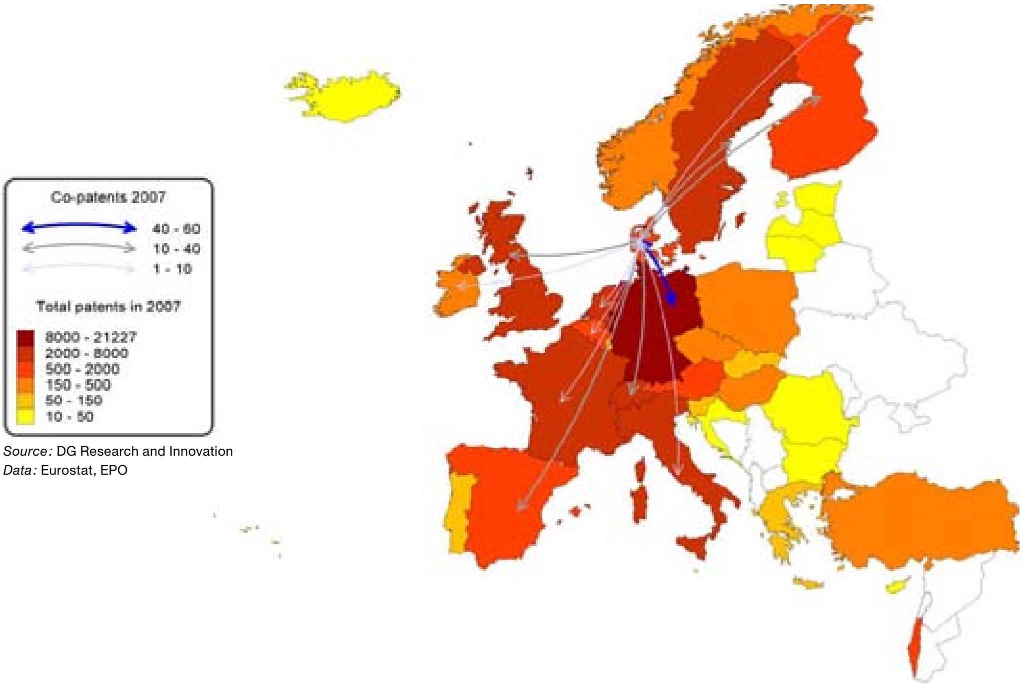
## Co-publications between Denmark and European Countries in 2000-2009



Source: DG Research and Innovation
Data: Scopus/Science Metrix
Note: (1) Full counting method

DENMARK

## Co-invented patent applications between Denmark and European Countries, 2007



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

### Participation in the European Research Area: Scientific and Technological collaborations

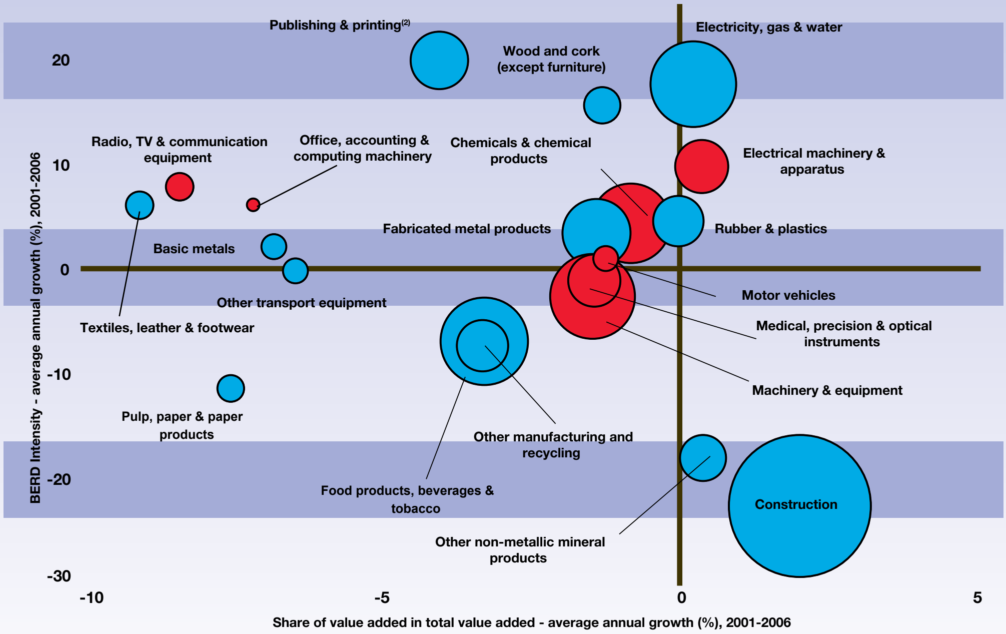
Denmark is a small and open country, which is reflected in both scientific and technological cooperation. However, its scientific cooperation with other European countries, benefiting from the emerging European Research Area, is more intensive and broader in scope than its technological cooperation in Europe. Denmark's main scientific cooperation partners are the United Kingdom, Germany, Sweden and the Netherlands, but Danish scientists also have extensive cooperation with researchers in Southern European countries. The report shows the overall scientific and cooperation networks across Europe, where Denmark is well integrated also in the technological cooperation, even if the technological cooperation does not fully match the extent of the scientific cooperation, thus very probably signalling an untapped potential.

### Structural change towards more knowledge-intensive economy

Since 2001, R&D intensity growth has to a large extent been due to an increase of the private R&D investment. For most of the relevant sectors of the Danish economy, private R&D intensity increased in the last decade (exceptions were the medical instruments and machinery & equipment sectors that decreased their BERD intensity). Denmark increased the knowledge-intensity in both high-tech/medium high-tech and medium and low-tech sectors. Overall, Denmark shows changes in its economic structure with an increasing weight of the high-tech sector electrical machinery. However, a decreasing knowledge-intensity in more traditional sectors of the Danish economy, such as food products or machinery & equipment, should be noticed as well as the decreasing weight of many of the high and medium-high tech sectors in the overall Danish economy (particularly noticeable for the Radio, TV and communication equipment sector). As in many other European economies, the construction sector increased its economic weight in the pre-crisis period, but contrary to some other European countries the construction sector in Denmark substantially decreased its knowledge-intensity.

## DENMARK

### Share of value added versus BERD Intensity - Average annual growth 2001-2006



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.
(2) 'Publishing and printing': average annual growth refers to 2002-2006.
(3) 'Coke, refined petroleum, nuclear fuel' is not included on the graph.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 4 177 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 5 468 applicants from Denmark (2.05% of EU-27*) and
- requesting EUR 1 991.35m of EC contribution (2.26% of EU-27*)

Among the EU-27* Denmark (DK) ranks:

- 14th in terms of number of applicants and
- 12th in terms of requested EC contribution

### Success rates

- The DK applicant success rate of 24.8% is higher than the EU-27* applicant success rate of 21.6%.
- The DK EC financial contribution success rate of 23.8% is higher than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 1 032 proposals were retained for funding (24.7%)
- involving 1 356 (24.8%) successful applicants from Denmark and
- requesting EUR 473.22m (23.8%) of EC financial contribution

Among the EU-27*, Denmark (DK) ranks:

- 5th in terms of applicants success rate and
- 5th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Denmark (DK) participates in

- 886 signed grant agreements
- involving 11 115 participants of which 1 150 (10.35%) are from Denmark
- benefiting from a total of EUR 3 296.56m of EC financial contribution of which EUR 414.52m (12.57%) is dedicated to participants from Denmark.

Among the EU-27* in all FP7 signed grant agreements, Denmark (DK) ranks:

- 12th in number of participations and
- 12th in budget share

## SME performance and participation

- The DK SME applicant success rate of 22.85% is higher than the EU-27* SME applicant success rate of 19.33%.
- The DK SME EC financial contribution success rate of 24.30% is higher than the corresponding EU-27* rate of 18.26%.

Specifically,

- 1 313 DK SME applicants requesting EUR 399.87m
- 300 (22.85%) successful SMEs requesting EUR 97.15m (24.30%)

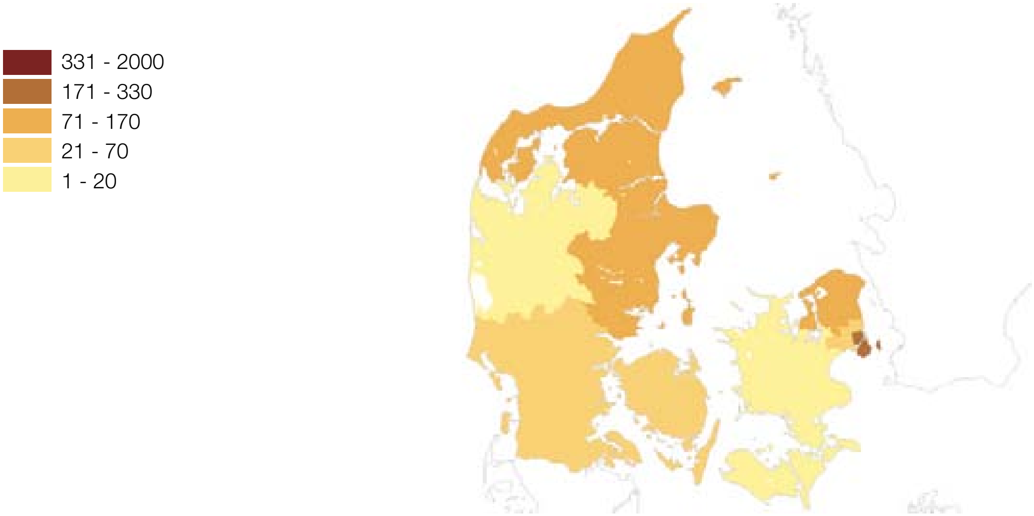
In signed grant agreements, as of 2011/03/16,

- 189 DK SME grant holders, i.e., 16.43% of total DK participation
- EUR 64.88m, i.e., 15.65% of total DK budget share

## Top 3 collaborative links with

- DE - Germany (1 352)
- UK - United Kingdom (1 245)
- FR - France (904)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 5th | |
| - Above EU-27 average | | |
| - Innovation Leader | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 5 468 | |
| (2.05%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 1 991.35 | |
| (2.26%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 1 356 | |
| (2.29%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 473.22 | |
| (2.59%) | 18 262.02 | |
| Success rate FP7 applicants | 24.8% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 23.8% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 1 150 | |
| (2.24%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 414.52 | |
| (2.50%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 175 | |
| (15.22%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 189 | |
| (16.43%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 64.88 | |
| (15.65%) | 2 207.73 | |
| (13.32%) | | |



## TABLE 1

## DK - Denmark - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Marie-Curie Actions | 872 | n/a | 186 | 21.33% | n/a | n/a |
| Information and Communication Technologies | 768 | 341.70 | 145 | 18.88% | 53.27 | 15.59% |
| Health | 593 | 296.61 | 157 | 26.48% | 73.94 | 24.93% |
| Research for the benefit of SMEs | 577 | 98.27 | 129 | 22.36% | 20.31 | 20.67% |
| Food, Agriculture and Fisheries, and Biotechnology | 492 | 168.62 | 113 | 22.97% | 32.86 | 19.49% |
| Environment (including Climate Change) | 427 | 146.19 | 122 | 28.57% | 39.39 | 26.94% |

## TABLE 2

## DK - Denmark - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all DK grant holders | EC contribution (EUR million) | % of total EC contribution to DK |
|---|---|---|---|---|
| Health | 143 | 12.43% | 61.98 | 14.95% |
| Energy | 97 | 8.43% | 55.63 | 13.42% |
| Information and Communication Technologies | 133 | 11.57% | 50.91 | 12.28% |
| Marie-Curie Actions | 143 | 12.43% | 41.42 | 9.99% |
| ERC | 26 | 2.26% | 36.06 | 8.70% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 93 | 8.09% | 34.56 | 8.34% |

*Notes:* Report generated on: 2011/03/25.04:35 PM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## DK - Denmark - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 2770 | 884.81 | 672 | 24.26% | 203.41 | 22.99% | 588 | 229.52 | 55.37% |
| PRC | 1350 | 405.73 | 332 | 24.59% | 116.90 | 28.81% | 298 | 101.26 | 24.43% |
| REC | 567 | 161.67 | 158 | 27.87% | 44.59 | 27.58% | 131 | 35.26 | 8.51% |
| OTH | 298 | 79.75 | 71 | 23.83% | 21.48 | 26.93% | 29 | 10.04 | 2.42% |
| PUB | 260 | 75.77 | 97 | 37.31% | 33.39 | 44.07% | 104 | 38.44 | 9.27% |
| | | | | | | | | | |
| SME | 1313 | 399.87 | 300 | 22.85% | 97.15 | 24.30% | 189 | 64.88 | 15.65% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education)

## TABLE 4

## DK - Denmark - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| DK - Denmark region | Number of grant holders | % of all DK - Denmark grant holders | EC contribution (M euro) | % of total EC contribution to DK |
|---|---|---|---|---|
| Byen Kobenhavn (DK011) | 351 | 30.52% | 119.69 | 28.87% |
| Ostjylland (DK042) | 171 | 14.87% | 61.80 | 14.91% |
| Nordjylland (DK050) | 94 | 8.17% | 34.06 | 8.22% |
| Nordsjolland (DK013) | 91 | 7.91% | 34.82 | 8.40% |
| Fyn (DK031) | 58 | 5.04% | 20.99 | 5.06% |

## TABLE 5

## DK - Denmark - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all DK grant holders | EC contribution (M euro) | % of total EC contribution to DK grant holders |
|---|---|---|---|---|
| Kobenhavns Universitet (UCPH) | 156 | 13.57% | 68.17 | 16.45% |
| Danmarks Tekniske Universitet (DTU) | 180 | 15.65% | 65.72 | 15.85% |
| Aarhus Universitet | 116 | 10.09% | 46.05 | 11.11% |
| Aalborg Universitet (AAU) | 62 | 5.39% | 22.71 | 5.48% |
| Syddansk Universitet (SDU) | 37 | 3.22% | 14.19 | 3.42% |

# COUNTRY PROFILE

# EE - Estonia

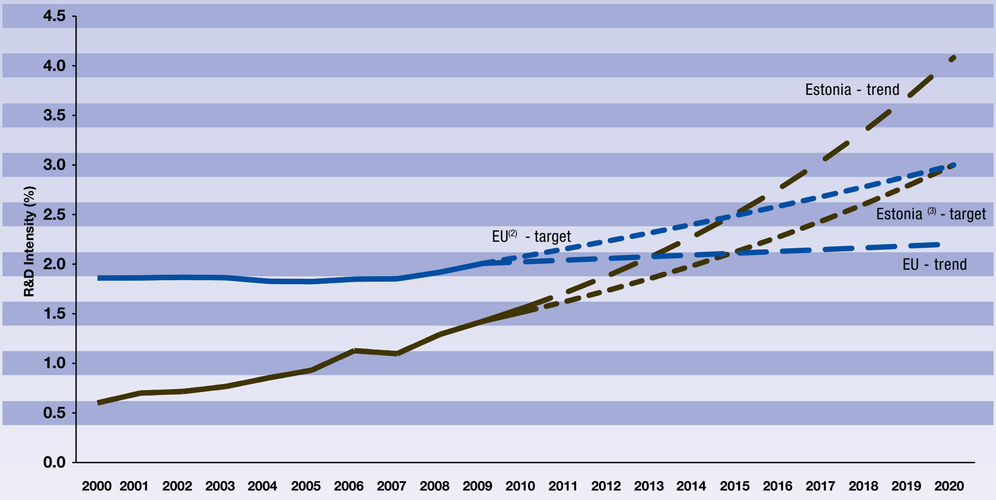
## Progress towards meeting the Europe 2020 R&D intensity target

In the last decade, R&D intensity in Estonia increased from 0.60% of GDP in 2000 to 1.42% in 2009, i.e. an impressive annual average growth rate above 10%. It is to be noted that the latest increase in R&D intensity from 2008 to 2009 is mainly due to a crises-related drop in GDP whereas nominal R&D expenditure increased only slightly.

The R&D target for 2020 has been set to 3%. This is ambitious, but realistic in the case business R&D grows significantly. The target is supported e.g. by a political commitment to R&I, relatively sound public finances and temporary support provided by frontloaded (R&I focused) Structural funds and by continuous efforts to create competitive framework conditions for businesses.

**ESTONIA**

**R&D Intensity projections, 2000-2020**(1)



*Source:* DG Research and Innovation

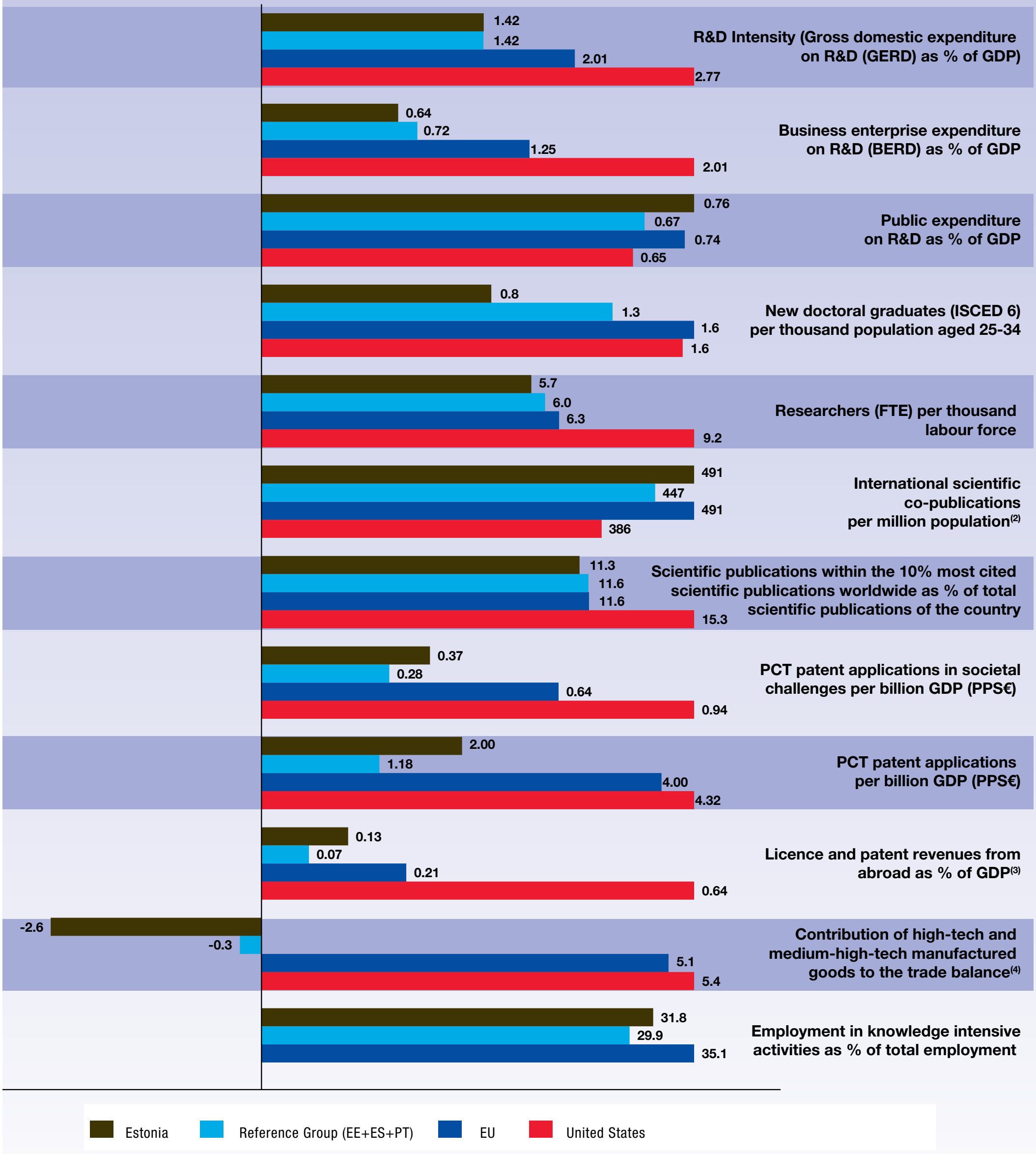
*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) EE: This projection is based on a tentative R&D Intensity target of 3.0% for 2020.

**Innovation Union Competitiveness Report 2011**

# ESTONIA

## R&D profile, 2009[1]

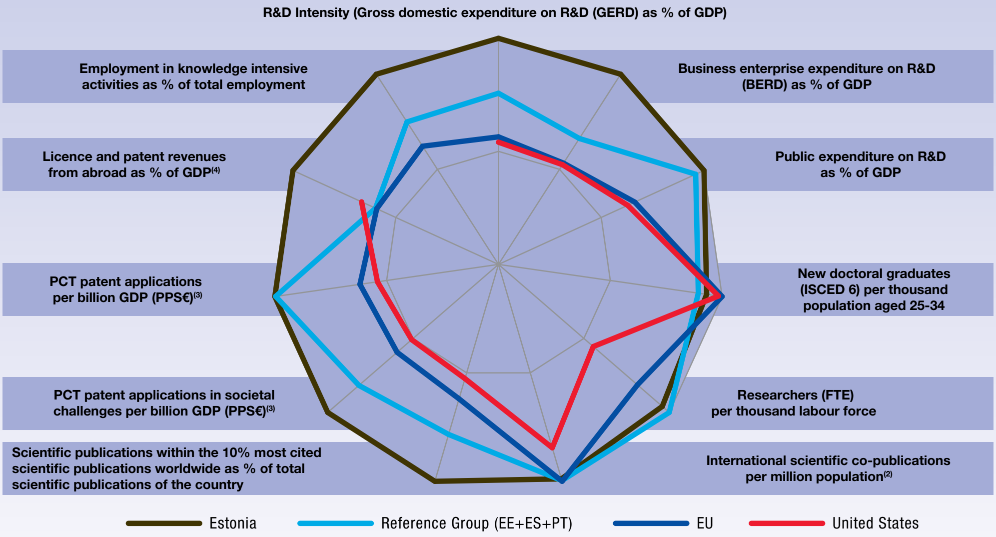


Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## ESTONIA

## Average annual growth (%), 2000-2009(1)

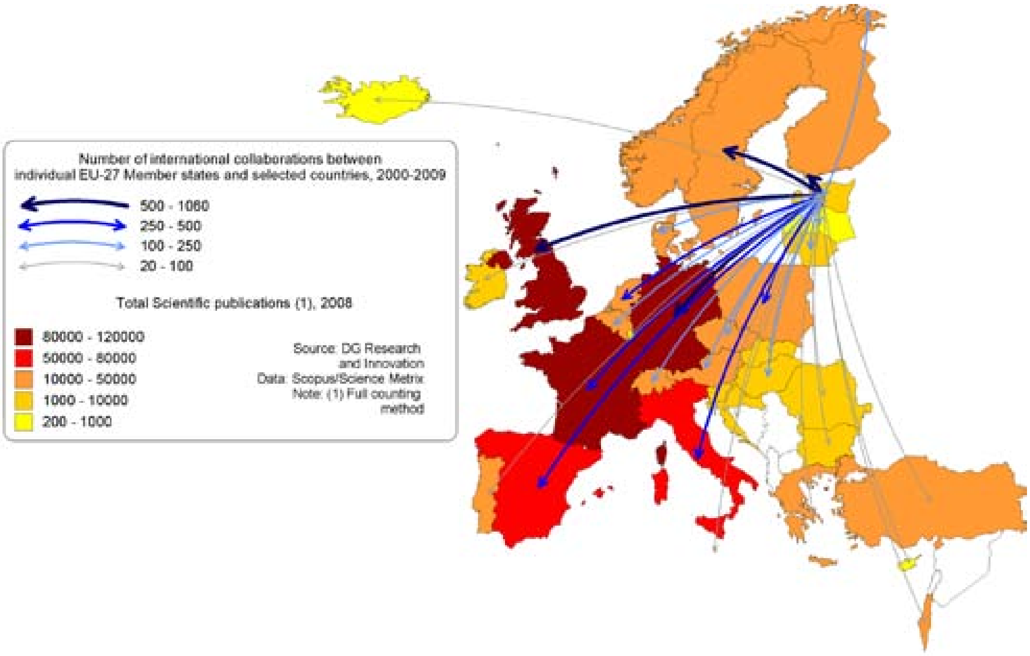


**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average.
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

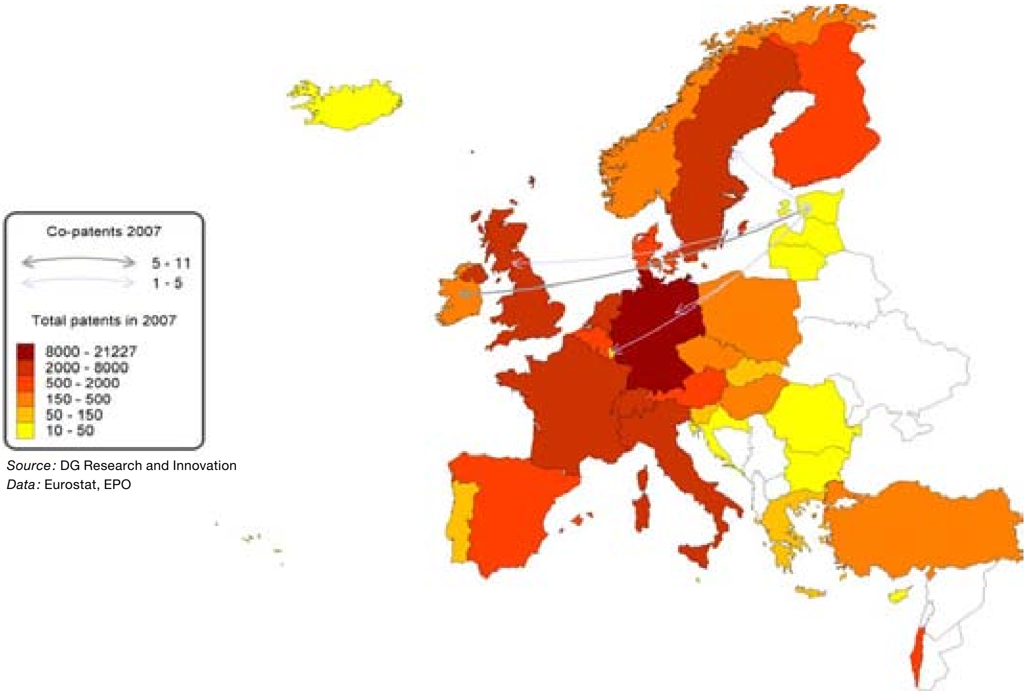
## ESTONIA

## Co-publications between Estonia and European Countries in 2000-2009



## ESTONIA

## Co-invented patent applications between Estonia and European Countries, 2007



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

### Research and Innovation Performance

The Estonian research and innovation system is characterised by government sector dominated funding (about 50% of GERD, compared to the EU average of 33.5% in 2008) and an important role of higher education institutions (especially universities) in performing research and innovation. Consequently, Estonia scores already at EU-average in scientific output measured by international scientific co-publications and is equal to its reference group in top cited publications.

The business sector has made constant progress, but the output measured in patents remains relatively modest in an EU comparison. Nevertheless, in dynamic terms Estonia has improved faster than its reference group during the last decade. The trade balance indicator, however, underlines that the Estonian manufacturing sector is not yet able to compete in high-tech goods. Improvement in the business-academia links may help improve the performance in patenting and in medium-high and high-tech production. A smart specialisation strategy might also help gaining a critical mass in some of these (sub)sectors.

### Participation in the European Research Area: Scientific and Technological collaborations

Estonia is a small and open economy with very limited resources and markets and dependent of external trade and internationalisation of R&I. Consequently, it has actively integrated to the European research system. The Innovation Union Competitiveness report illustrates several aspects of Estonian scientific and technological cooperation. European-wide maps illustrate that Estonia is already connected to the main nodes of European networks. The strongest links of the Estonian science and technology cooperation are with Germany, Sweden, Finland and the United Kingdom.

Internationalisation being such an important priority for Estonian R&I efforts, much of the future development will depend on how it succeeds to attract human resources and R&I intensive investments and firms from abroad. The R&D cooperation in the framework of Baltic sea strategy is, in this regard, an interesting opportunity for the country, which is currently making efforts to improve the level of R&D infrastructure closely linked to ESFRI plans and with the help of structural funds.

## FP7 Key facts and figures

### Applications

As of 26/10/2010, a total of

- 1 027 eligible proposals were submitted in response to 219 FP7 calls for proposals
- involving 1 216 applicants from Estonia (0.51% of EU-27*) and
- requesting EUR 251.44m of EC contribution (0.32% of EU-27*)

Among the EU-27* Estonia (EE) ranks:

- 23rd in terms of number of applicants and
- 23rd in terms of requested EC contribution

### Success rates

- The EE applicant success rate of 23.7% is higher than the EU-27* applicant success rate of 21.9%.
- The EE EC financial contribution success rate of 18.5% is lower than the EU-27* rate of 20.9%.

Specifically, following evaluation and selection, a total of

- 252 proposals were retained for funding (24.5%)
- involving 288 (23.7%) successful applicants from Estonia and
- requesting EUR 46.61m (18.5%) of EC financial contribution

Among the EU-27*, Estonia (EE) ranks:

- 10th in terms of applicants success rate and
- 11th in terms of EC financial contribution success rate

### Signed grant agreements

As of 26/10/2010, Estonia (EE) participates in

- 199 signed grant agreements
- involving 2 744 participants of which 229 (8.35%) are from Estonia
- benefiting from a total of EUR 634.74m of EC financial contribution of which EUR 39.81m (6.27%) is dedicated to participants from Estonia.

Among the EU-27* in all FP7 signed grant agreements, Estonia (EE) ranks:

- 21st in number of participations and
- 22nd in budget share

### SME performance and participation

- The EE SME applicant success rate of 18.99% is similar to the EU-27* SME applicant success rate of 19.42%.
- The EE SME EC financial contribution success rate of 14.54% is lower than the corresponding EU-27* rate of 18.28%.

Specifically,

- 495 EE SME applicants requesting EUR 100.54m
- 94 (18.99%) successful SMEs requesting EUR 14.62m (14.54%)

In signed grant agreements, as of 26/10/2010,

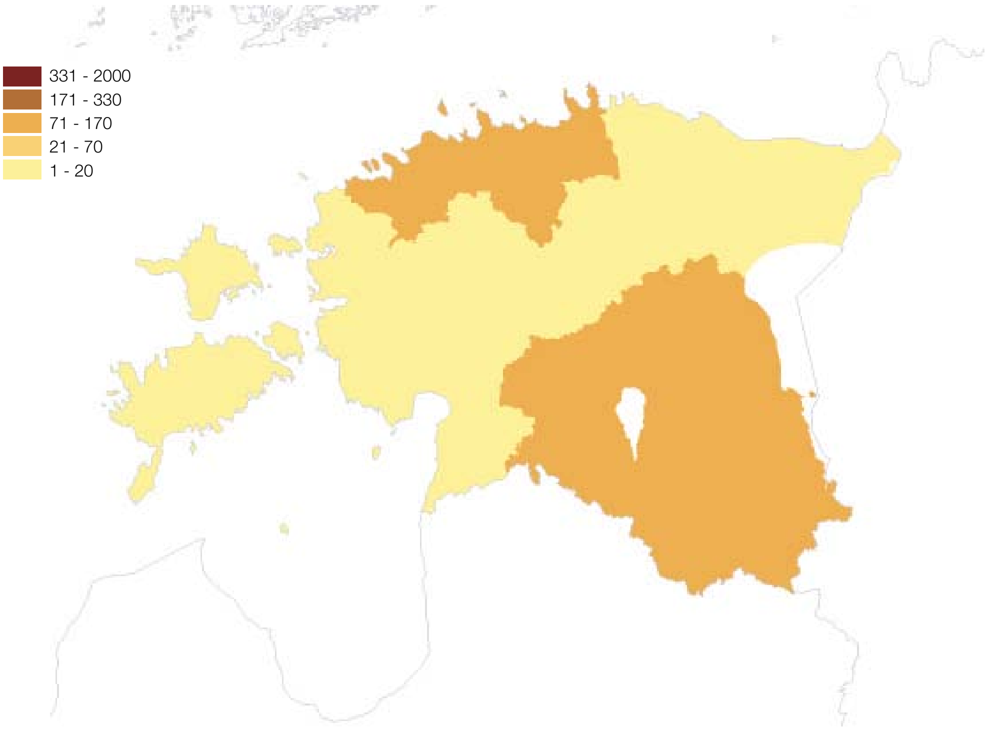
- 69 EE SME grant holders, i.e., 30.13% of total EE participation
- EUR 9.93m, i.e., 24.96% of total EE budget share

### Top 3 collaborative links with

- UK - United Kingdom (243)
- DE - Germany (228)
- IT - Italy (180)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | 0.50% | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 12th | |
| - Above EU-27 average | | |
| - Innovation Follower | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 1 216 | |
| (0.51%) | 237 592 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 251.44 | |
| (0.32%) | 78 321 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 288 | |
| (0.54%) | 53 276 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 46.61 | |
| (0.29%) | 16 349.48 | |
| Success rate FP7 applicants | 23.7% | 21.9% |

| | | |
|---|---|---|
| Success rate | | |
| FP7 EC contribution | 18.5% | 20.9% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 229 | |
| (0.52%) | 43 650 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 39.81 | |
| (0.28%) | 14 130.79 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 28 | |
| (12.23%) | 8 052 | |
| (18.45%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 69 | |
| (30.13%) | 7 914 | |
| (18.13%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 9.93 | |
| (24.96%) | 2 060.08 | |
| (14.58%) | | |



## TABLE 1

## EE - Estonia - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Research for the benefit of SMEs | 213 | 31.03 | 53 | 24.88% | 6.30 | 20.30% |
| Health | 159 | 47.00 | 32 | 20.13% | 6.84 | 14.55% |
| Socio-economic sciences and Humanities | 143 | 19.98 | 23 | 16.08% | 2.71 | 13.56% |
| Information and Communication Technologies | 139 | 34.92 | 20 | 14.39% | 4.41 | 12.64% |
| Marie-Curie Actions | 92 | n/a | 27 | 29.35% | n/a | n/a |
| Science in Society | 80 | 8.33 | 30 | 37.50% | 2.56 | 30.68% |

## TABLE 2

## EE - Estonia - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all EE grant holders | EC contribution (EUR million) | % of total EC contribution to EE |
|---|---|---|---|---|
| Research Potential | 7 | 3.06% | 7.27 | 18.27% |
| Health | 32 | 13.97% | 6.11 | 15.35% |
| Marie-Curie Actions | 22 | 9.61% | 4.71 | 11.84% |
| Research for the benefit of SMEs | 41 | 17.90% | 4.61 | 11.58% |
| Information and Communication Technologies | 19 | 8.30% | 4.12 | 10.35% |
| Transport (including Aeronautics) | 9 | 3.93% | 3.00 | 7.53% |

*Notes:* Report generated on: 2011/02/03.08:31 AM
FP7 proposal and application figures are valid as of 26/10/2010
FP7 grant agreements and participation figures are valida as of 26/10/2010
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## EE - Estonia - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 507 | 105.51 | 106 | 20.91% | 20.34 | 19.27% | 77 | 18.64 | 46.82% |
| PRC | 357 | 71.69 | 68 | 19.05% | 10.37 | 14.46% | 67 | 9.32 | 23.42% |
| REC | 133 | 20.40 | 37 | 27.82% | 5.44 | 26.68% | 34 | 5.14 | 12.90% |
| OTH | 116 | 17.32 | 40 | 34.48% | 4.35 | 25.11% | 35 | 5.52 | 13.86% |
| PUB | 89 | 15.71 | 35 | 39.33% | 5.53 | 35.22% | 16 | 1.19 | 3.00% |
| | | | | | | | | | |
| SME | 495 | 100.54 | 94 | 18.99% | 14.62 | 14.54% | 69 | 9.93 | 24.96% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education)

## TABLE 4

## EE - Estonia - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| EE - Estonia region | Number of grant holders | % of all EE - Estonia grant holders | EC contribution (M euro) | % of total EC contribution to EE |
|---|---|---|---|---|
| PГµhja-Eesti (EE001) | 132 | 57.64% | 21.09 | 52.97% |
| LГµuna-Eesti (EE008) | 90 | 39.30% | 18.05 | 45.34% |
| Kesk-Eesti (EE006) | 3 | 1.31% | 0.33 | 0.84% |
| LГ¤Г¤ne-Eesti (EE004) | 1 | 0.44% | 0.06 | 0.16% |
| Kirde-Eesti (EE007) | 1 | 0.44% | 0.15 | 0.38% |

## TABLE 5

## EE - Estonia - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all DK grant holders | EC contribution (M euro) | % of total EC contribution to EE grant holders |
|---|---|---|---|---|
| Tartu ulikool (UT) | 45 | 19.65% | 9.87 | 24.78% |
| Tallinna Tehnikaulikool | 16 | 6.99% | 4.43 | 11.13% |
| Sihtasutus Archimedes (Archimedes) | 17 | 7.42% | 2.35 | 5.89% |
| Tallinn University | 5 | 2.18% | 2.14 | 5.38% |
| Sihtasutus Eesti Teadusfond (ETF) | 5 | 2.18% | 1.98 | 4.96% |

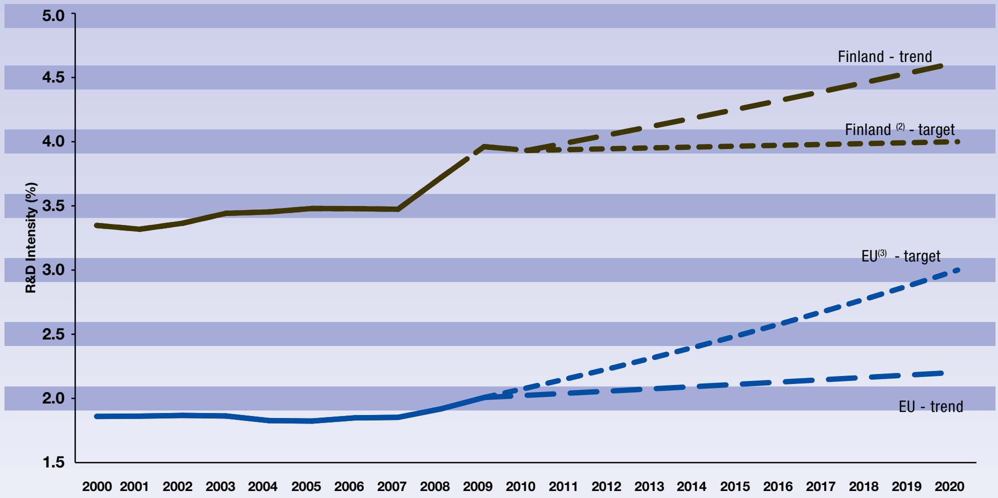
# COUNTRY PROFILE

# FI - Finland

## Progress towards meeting the Europe 2020 R&D intensity target

R&D intensity in 2009 rose to 3.93%, very close to the 4% target, and confirmed once again the front leading position of Finland in terms of R&D investments. Public R&D in 2009 increased up to 1.11% and somehow compensated for the slight decrease of private R&D that resulted after the financial and economic downturn of the last couple of years. Nevertheless, private R&D still remains strong in the country at 2.79%. The R&D target for 2020 has been set at 4%, a value very close to the existing R&D intensity. While the continuation of the recent R&D growth trend would suggest the possibility of a more ambitious target, it should be noted that Finland faces a structural and acute challenge to raise further R&D investment, as a great part of private sector investment is concentrated in one sector, i.e. ICT, and around one company, Nokia. A widely shared view in Finland is that investing in R&I is necessary for competitiveness and productivity growth, and consequently a general commitment to moderately increase public R&D funding is expected in the future. This could be combined with efforts to further improve framework conditions for fast growing innovative firms, also beyond ICT, in emerging user driven sectors including in services, in order to help the diversification of the economy building on the strong knowledge base assets of Finland. The recent review for 2011-2015 Research and Innovation policy guidelines of the Prime Minister led Research and Innovation Council raised the public funding, while ensuring the effectiveness of the public investments and a simplification of the R&I system.

**FINLAND** **R&D Intensity projections, 2000-2020**(1)



*Source:* DG Research and Innovation

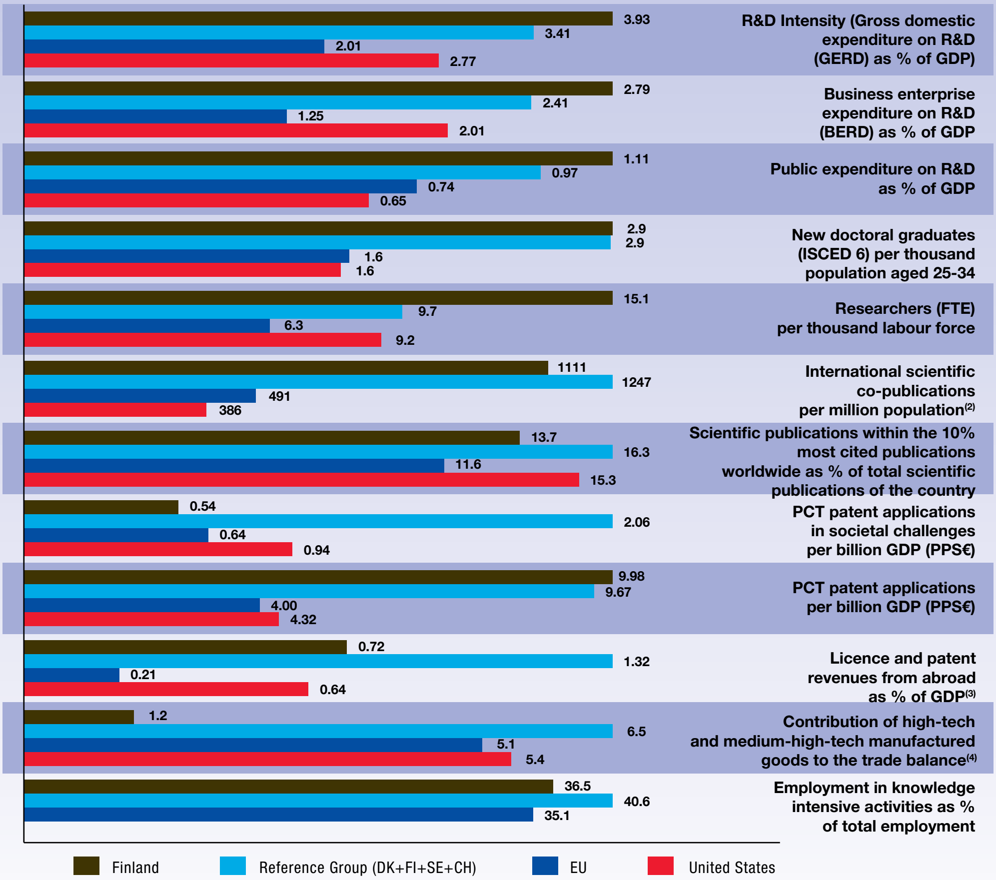
**Innovation Union Competitiveness Report 2011**

*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009 in the case of the EU and for 2000-2010 in the case of Finland.
(2) FI: This projection is based on a tentative R&D Intensity target of 4.0% for 2020.
(3) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.

# FINLAND

## R&D profile, 2009[1]



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) (i) The EU value refers to the median rather than to the average; (ii) CH is not included in the Reference Group.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU; (iii) CH is not included in the Reference Group.
(5) Elements of estimation were involved in the compilation of the data.

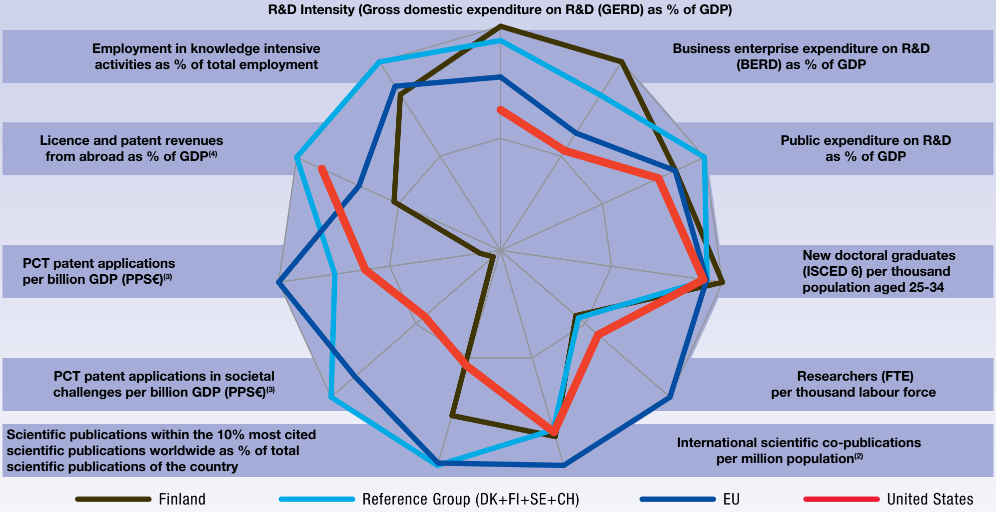
## Research and Innovation Performance

The Finnish research and innovation (R&I) system is characterised by a strong commitment both from the public and private sectors to increase R&I and education investments. Finland is leading in terms of R&D intensity and human resources. A distinctive characteristic is the high dependency of the system on one company, Nokia, which accounts for nearly 50% of the total business sector R&D investments, which in turn accounts for 71% of the total R&D investment. The large R&D investments and favourable framework condition in terms of macroeconomic stability and relatively high access to venture capital result in important scientific and technological outputs. Finland scores well above the EU average in terms of high quality scientific publications, patents and their contribution to a knowledge-base economy.

In dynamic terms, in the last decade Finland has outperformed the EU, the United States and other highly knowledge-intensive countries in Europe in terms of private and public R&D investments and the share of new doctoral graduates. However, this rosy picture in terms of increasing input does not find its immediate translation in terms of growth in scientific and technological output, especially in terms of patents, where the country seems to lose ground vis-à-vis these reference countries.

## FINLAND

## Average annual growth (%), 2000-2009(1)

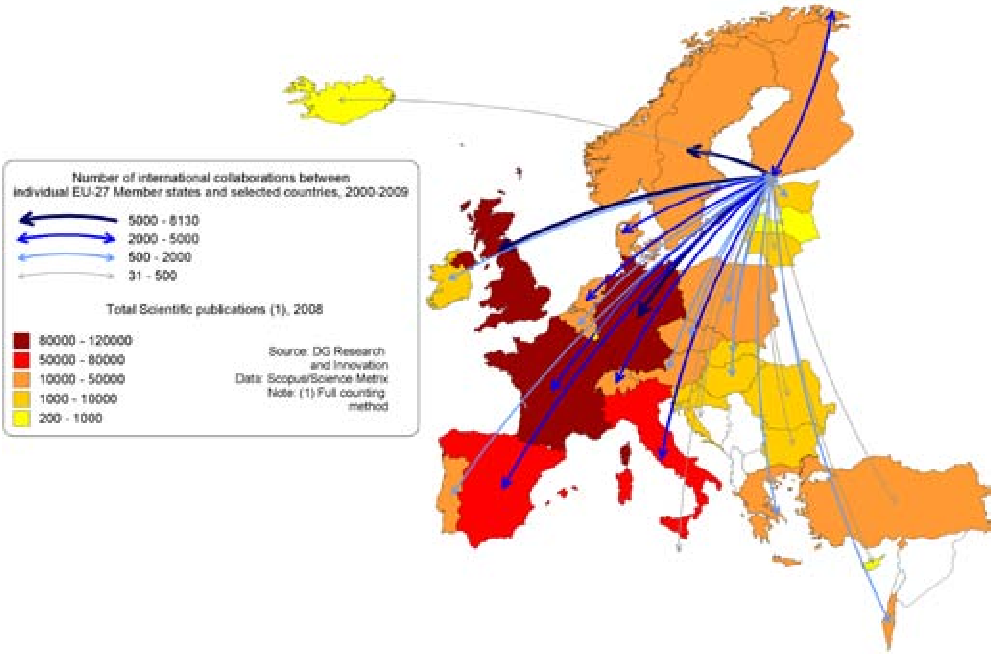


**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) (i) The EU value refers to the median rather than to the average; (ii) CH is not included in the Reference Group.
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

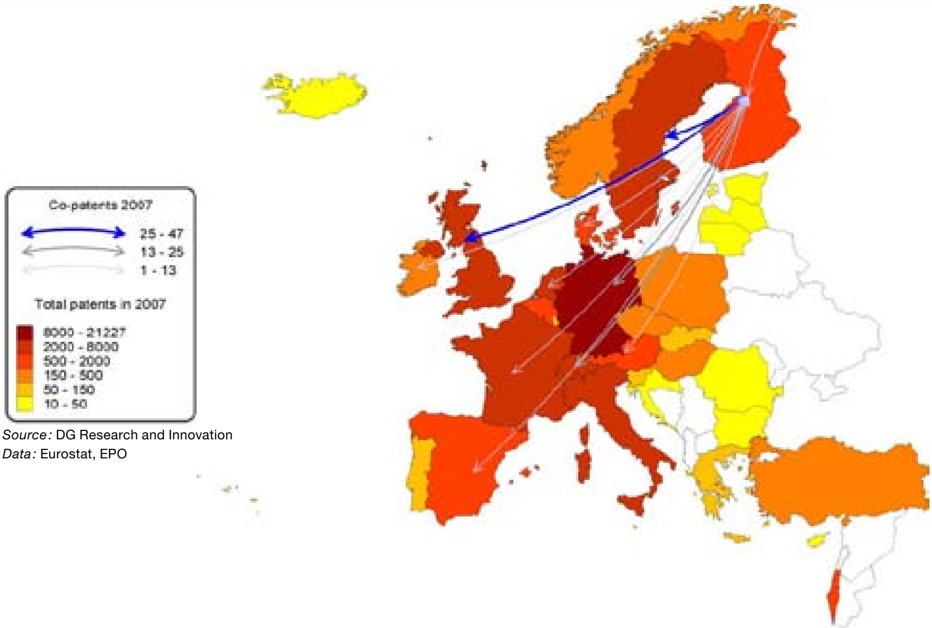
## FINLAND

## Co-publications between Finland and European Countries in 2000-2009



Source: DG Research and Innovation
Data: Scopus/Science Metrix
Note: (1) Full counting method

**Co-invented patent applications between Finland and European Countries, 2007**



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

This relative weaker growth performance may evidence some areas where the efficiency of the system to translate high R&D investments into high quality scientific and technological output and economic activity could be improved. In this sense, the recent review of the 2011-2015 Research and Innovation policy guidelines of the Prime Minister draw the attention to the need for boosting the effectiveness of public investments.

## Participation in the European Research Area: Scientific and Technological collaborations

Finland is a small economy with limited resources and markets, dependent of external trade and internationalisation of R&I. Alongside internal reforms, the efficiency of the research system is being strengthened by an opening up and integration into the European research system. The integration towards other R&I relevant European organisations and scientific networks is improving.

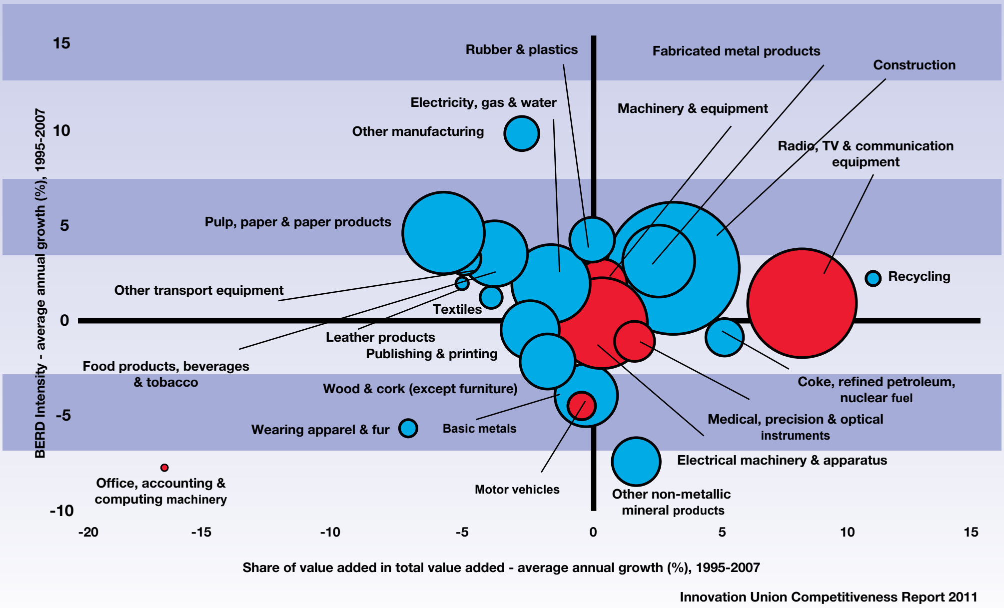
The Innovation Union Competitiveness report illustrates several aspects of scientific and technological cooperation. European-wide maps illustrate that Finland is connected to the main nodes of the networks, which are located in major research-intensive countries of Western and Central Europe. The strongest links of the Finnish science and technology cooperation are with the main EU trade partners especially Germany, Sweden and the United Kingdom, but some cooperation is also visible with Southern and Eastern European countries. More generally, Finnish researchers are integrating in the international scientific knowledge flows as evidenced by the international co-publications including cooperation with the United States and Asia. However, despite being among the scientific and technological leaders in Europe, Finland's internationalisation in science and technology still remains behind the reference group including Sweden, Denmark and Switzerland, notably in terms of technological cooperation. This may signal an untapped potential for progress that could benefit future competitiveness and growth of the country.

## Structural change towards more knowledge-intensive economy

In the last fifteen year, Finland has become a research intensive economy, with an important increase in terms of private R&D investments. The development of Nokia has led the High-tech ICT cluster to dominate the Finnish economy. ICT related growth has, to some extent, overshadowed the development of prior traditional sectors, such as Machinery and Equipment, which have however managed to increase their R&D intensity, measured as the share of R&D investment over total value added. Large sectors such as Construction and Fabricated metal products have demonstrated their capacity to raise their R&D intensity and to translate this in additional growth. The Pulp and Paper sector might get similar benefits over the years to come. However, it

## FINLAND

### Share of value added versus BERD Intensity - Average annual growth, 1995-2007



*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.
(2) 'Chemicals and chemical products' is not visible on the graph.

is widely acknowledged in Finland that the emergence of new R&I intensive sectors and growth companies are crucial for the future well-being of the country. In this regard, Finland expects also service innovations and design to play a significant role. Conversations on how to foster this structural change are currently ongoing among major national stakeholders.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 4 425 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 6 117 applicants from Finland (2.30% of EU-27*) and
- requesting EUR 2 364.28m of EC contribution (2.68% of EU-27*)

Among the EU-27* Finland (FI) ranks:

- 12th in terms of number of applicants and
- 11th in terms of requested EC contribution

### Success rates

- The FI applicant success rate of 23.1% is higher than the EU-27* applicant success rate of 21.6%.
- The FI EC financial contribution success rate of 21.3% is similar to the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 986 proposals were retained for funding (22.3%)
- involving 1 415 (23.1%) successful applicants from Finland and
- requesting EUR 503.47m (21.3%) of EC financial contribution

Among the EU-27*, Finland (FI) ranks:

- 9th in terms of applicants success rate and
- 8th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Finland (FI) participates in

- 851 signed grant agreements
- involving 11 429 participants of which 1 271 (11.12%) are from Finland
- benefiting from a total of EUR 3 264.07m of EC financial contribution of which EUR 432.01m (13.24%) is dedicated to participants from Finland.

Among the EU-27* in all FP7 signed grant agreements, Finland (FI) ranks:

- 11th in number of participations and
- 11th in budget share

### SME performance and participation

- The FI SME applicant success rate of 21.88% is higher than the EU-27* SME applicant success rate of 19.33%.
- The FI SME EC financial contribution success rate of 22.78% is higher than the corresponding EU-27* rate of 18.26%.

Specifically,

- 1 161 FI SME applicants requesting EUR 299.99m
- 254 (21.88%) successful SMEs requesting EUR 68.33m (22.78%)

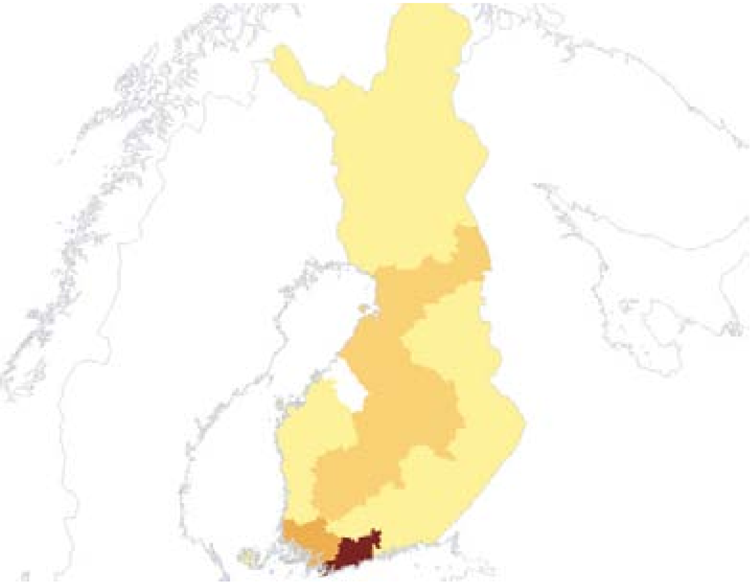
In signed grant agreements, as of 2011/03/16,

- 163 FI SME grant holders, i.e., 12.82% of total FI participation
- EUR 39.15m, i.e., 9.06% of total FI budget share

### Top 3 collaborative links with

- DE - Germany (1 550)
- UK - United Kingdom (1 091)
- FR - France (985)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 2nd | |
| - Above EU-27 average | | |
| - Innovation Leader | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 6 117 | |
| (2.30%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 2 364.28 | |
| (2.68%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 1 415 | |
| (2.39%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 503.47 | |
| (2.76%) | 18 262.02 | |
| Success rate FP7 applicants | 23.1% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 21.3% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 1 271 | |
| (2.48%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 432.01 | |
| (2.61%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 185 | |
| (14.56%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 163 | |
| (12.82%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 39.15 | |
| (9.06%) | 2 207.73 | |
| (13.32%) | | |



## TABLE 1

## FI - Finland - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 1 527 | 635.58 | 263 | 17.22% | 104.19 | 16.39% |
| Marie-Curie Actions | 607 | n/a | 142 | 23.39% | n/a | n/a |
| Health | 531 | 260.91 | 130 | 24.48% | 58.26 | 22.33% |
| Socio-economic sciences and Humanities | 375 | 95.88 | 38 | 10.13% | 14.80 | 15.44% |
| Research for the benefit of SMEs | 365 | 45.99 | 79 | 21.64% | 9.71 | 21.11% |
| Food, Agriculture and Fisheries, and Biotechnology | 362 | 125.91 | 80 | 22.10% | 26.10 | 20.73% |

## TABLE 2

## FI - Finland - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all FI grant holders | EC contribution (EUR million) | % of total EC contribution to FI |
|---|---|---|---|---|
| Information and Communication Technologies | 278 | 21.87% | 90.11 | 20.86% |
| Health | 125 | 9.83% | 55.23 | 12.79% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 124 | 9.76% | 47.56 | 11.01% |
| ERC | 32 | 2.52% | 46.53 | 10.77% |
| Energy | 53 | 4.17% | 28.17 | 6.52% |
| Food, Agriculture and Fisheries, and Biotechnology | 68 | 5.35% | 24.27 | 5.62% |

*Notes:* Report generated on: 2011/03/25.04:38 PM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## FI - Finland - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 2464 | 746.08 | 475 | 19.28% | 131.77 | 17.66% | 461 | 168.94 | 39.11% |
| REC | 1589 | 656.30 | 440 | 27.69% | 178.45 | 27.19% | 421 | 169.26 | 39.18% |
| PRC | 1291 | 340.07 | 321 | 24.86% | 93.47 | 27.49% | 294 | 78.28 | 18.12% |
| PUB | 253 | 44.57 | 90 | 35.57% | 16.24 | 36.43% | 50 | 6.06 | 1.40% |
| OTH | 228 | 62.23 | 57 | 25.00% | 25.36 | 40.74% | 45 | 9.47 | 2.19% |
| | | | | | | | | | |
| SME | 1161 | 299.99 | 254 | 21.88% | 68.33 | 22.78% | 163 | 39.15 | 9.06% |

HES - Higher or secondary education, REC - Research organisations, PRC - Private for profit (excl. education), PUB - Public body (excl. research and education), OTH - Others

## TABLE 4

## FI - Finland - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| FI - Finland region | Number of grant holders | % of all FI - Finland grant holders | EC contribution (M euro) | % of total EC contribution to FI |
|---|---|---|---|---|
| Uusimaa (FI181) | 848 | 66.72% | 316.12 | 73.17% |
| Varsinais-Suomi (FI183) | 96 | 7.55% | 29.19 | 6.76% |
| Pirkanmaa (FI197) | 80 | 6.29% | 27.15 | 6.29% |
| Pohjois-Pohjanmaa (FI1A2) | 61 | 4.80% | 17.71 | 4.10% |
| Pohjois-Savo (FI132) | 42 | 3.30% | 11.69 | 2.71% |

## TABLE 5

## FI - Finland - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all DK grant holders | EC contribution (M euro) | % of total EC contribution to DK grant holders |
|---|---|---|---|---|
| Teknologian Tutkimuskeskus VTT (VTT) | 215 | 16.92% | 100.40 | 23.24% |
| Helsingin Yliopisto | 125 | 9.83% | 59.79 | 13.84% |
| Aalto-Korkeakoulusaatio | 99 | 7.79% | 33.17 | 7.68% |
| Turun Yliopisto | 50 | 3.93% | 17.76 | 4.11% |
| Oulun Yliopisto | 39 | 3.07% | 14.05 | 3.25% |

# COUNTRY PROFILE

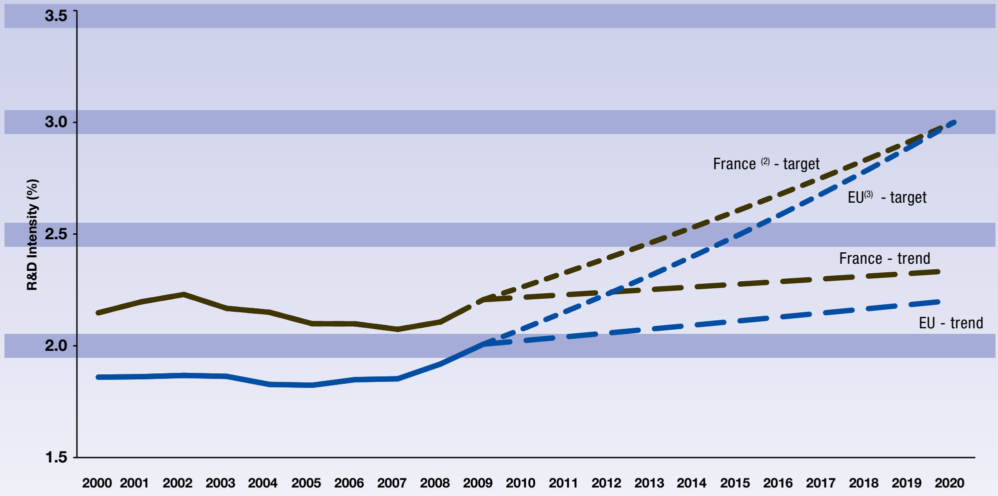
# FR - France

## Progress towards meeting the 2020 R&D target

In the last decade, R&D intensity in France remained in the range of 2.07-2.21% of GDP, about 16% above the EU-27 average. If France's and the EU-27's current trends continue, France's R&D intensity will hardly be above EU-27 average in 2020. In order to maintain and increase its economic competitiveness and secure high-quality jobs, France will have to increase its investments in research and innovation.

French authorities have recognised this and have set an ambitious, albeit realistic national R&D target for 2020: R&D intensity in France should account for 3% of the national GDP in 2020.

**FRANCE** **R&D Intensity projections, 2000-2020(1)**



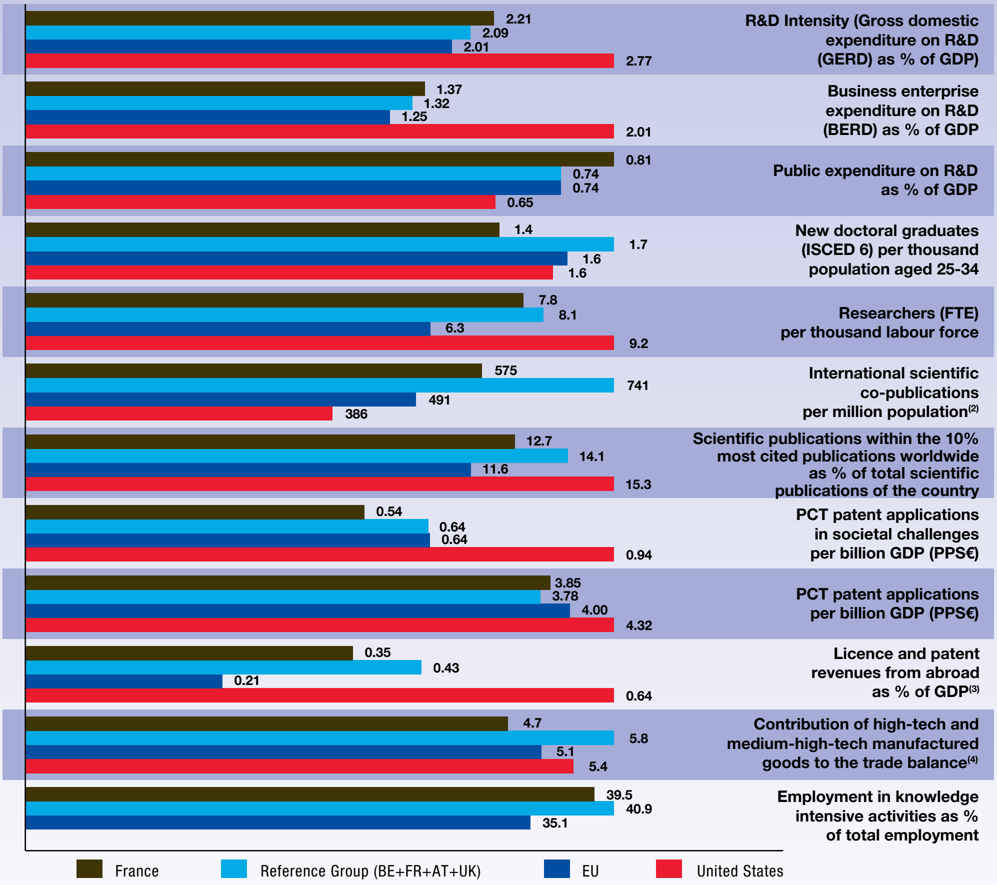
*Source:* DG Research and Innovation
**Innovation Union Competitiveness Report 2011**
*Data:* DG Research and Innovation, Eurostat
*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009 in the case of the EU and for 2004-2009 in the case of France.
(2) FR: This projection is based on a tentative R&D Intensity target of 3.0% for 2020.
(3) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(4) FR: There is a break in series between 2004 and the previous years.

## Research and Innovation Performance

The R&D intensity gap in France lies primarily in the business sector. The insufficient level of business expenditure on R&D in France is to a large extent a reflection of the economic structure of the country moderately oriented towards high-tech manufacturing sectors. High-tech and medium-high-tech manufactured goods contribute less than the EU average to the trade balance. France also scores moderately in terms of patented inventions, in particular patents in technologies related to health and climate change mitigation. In addition, the country benefits only moderately from

## FRANCE

### R&D profile, 2009[1]



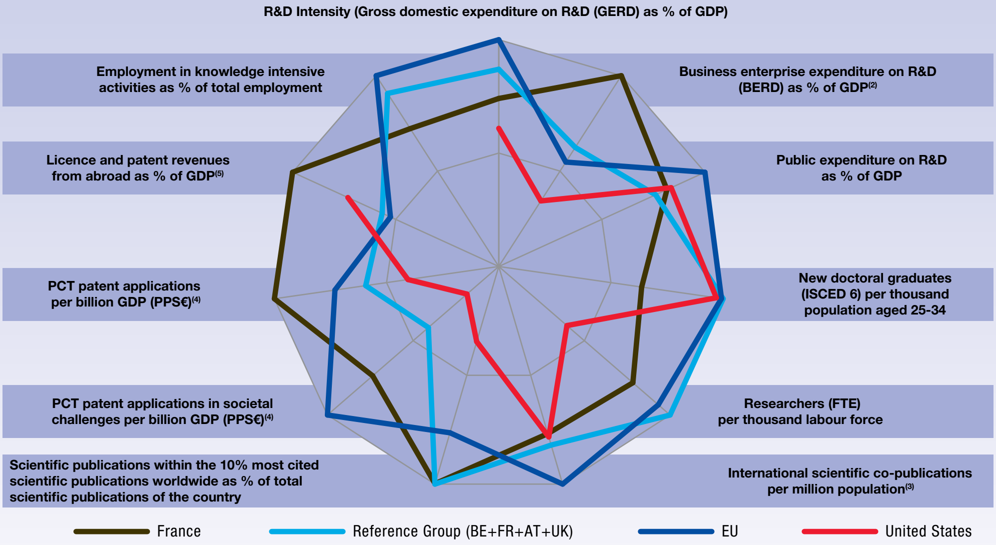
Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

licence and patent revenues from abroad compared to the US, and also to countries of comparable research intensity in the EU. This demonstrates that part of the research is not related to the fast growing domains at world scale, or that the ability to protect and market technologies is still limited, calling for the development of a more intense knowledge-intensity in France. Finally, France produces fewer doctoral graduates relative to its population aged 25-34 than the average in EU-27 and 20% fewer than in comparable EU countries. This may be related to the dual higher education system in France, which undermines the attractiveness of the doctorate diploma. Surprisingly, this low rate of doctoral graduates every year does not affect the number of researchers in the labour force, suggesting that a higher proportion of doctoral graduates in France engage in research careers than in other countries where doctoral graduates might engage more often in other professional activities.

In dynamic terms, in general France has made good progress in outputs: high-impact publications, but also patents and licence and patent revenues from abroad which have been weaknesses of the French system. Progress on the input side — public and business expenditure, new doctoral graduates and researchers — has been more moderate and less rapid than the EU average. A more rapid progress in outputs than in inputs points to an increased efficiency of the overall system.

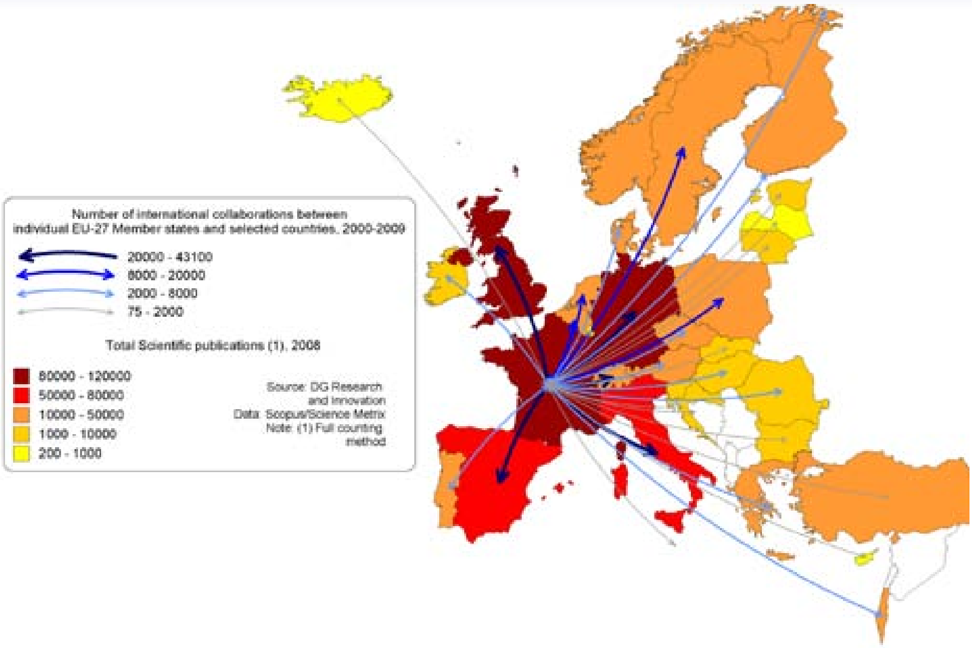
## FRANCE Average annual growth (%), 2000-2009[1]



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) Average annual growth for France refers to 2006-2009 - there is a break in series between 2006 and the previous years.
(3) The EU value refers to the median rather than to the average.
(4) Average annual growth refers to real growth.
(5) EU refers to extra-EU.
(6) Elements of estimation were involved in the compilation of the data.

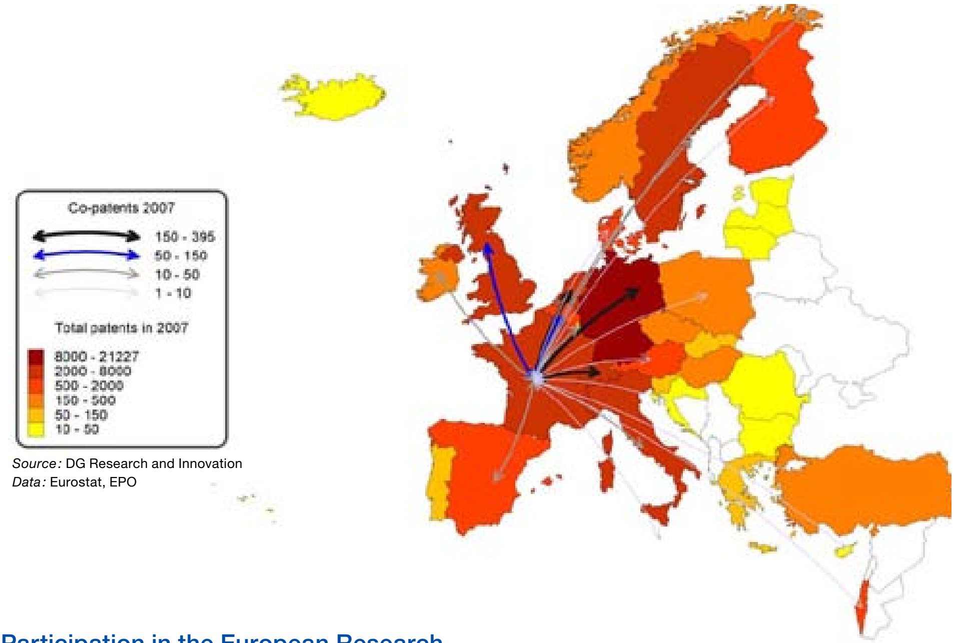
## FRANCE Co-publications between France and European Countries in 2000-2009



Source: DG Research and Innovation
Data: Scopus/Science Metrix
Note: (1) Full counting method

FRANCE

**Co-invented EPO patent applications between France and European Countries, 2007**



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

## Participation in the European Research Area: Scientific and Technological collaborations

France has a good level of international scientific co-publications (R&D profile above). Its main EU partners in science are Germany, the United Kingdom, Italy, Spain and Switzerland, followed by the Netherlands, Belgium and Poland. This reflects, to a large extent, the size of the research systems of these countries, but also geographical and cultural ties. This cooperation appears balanced and highly diversified, which constitutes an asset for the country.

There are always much fewer co-patents than co-publications in science. But France has strong ties with foreign co-inventors based in the most active European countries in patenting, namely Germany, Switzerland and the Netherlands, followed by the United Kingdom and Belgium. The connections with other European countries are relatively limited or non-existant. The lack of co-inventions with southern partners such as Spain and Italy contrasts with the number of co-publications with these countries, highlighting possible room for improvement.

## Structural change towards more knowledge-intensive economy

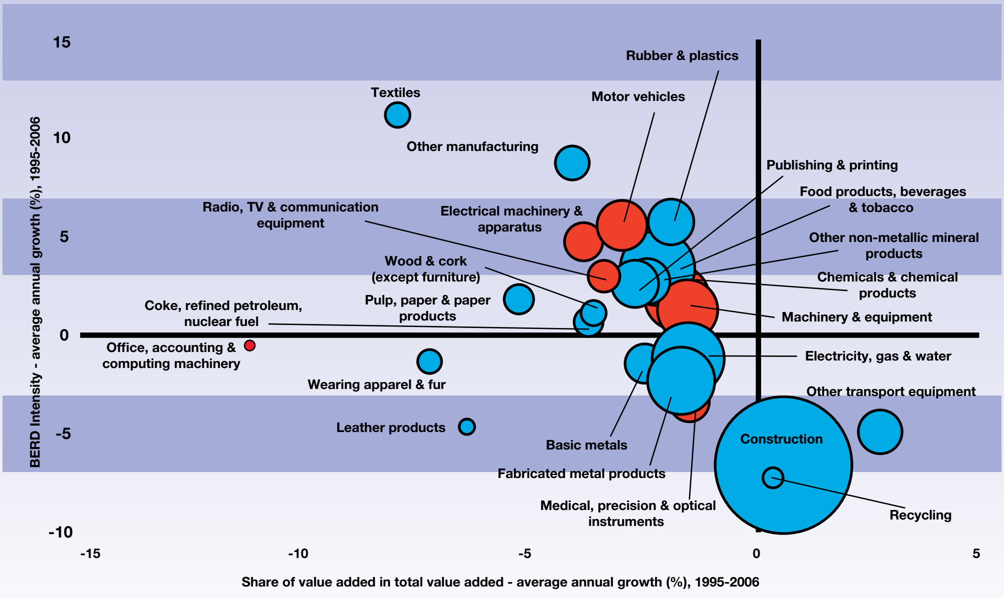
High-tech and medium-high-tech manufacturing sectors (in red in the figure below) are by far the most research intensive sectors in advanced economies. Their respective sizes relative to the whole economy and their respective individual research intensities (R&D expenditure/value added) determine, to a large extent, the overall level of business R&D intensity in a country.

In most of these sectors, France is at, or close to, the technological frontier: the research intensities of these sectors in France are among the highest in international comparisons and they have progressed continuously over 1995–2006 to the noticeable exception of Medical, precision & optical instruments. In contrast, the weight of these sectors in the French economy is smaller than in countries with higher R&D intensities and has been decreasing over the same period. This decrease in the weight of high-tech and medium-high-tech manufacturing sectors in the French economy has compensated for the increase in their individual research intensities, resulting in a stagnation of business R&D intensity in France.

A significant increase in business R&D intensity in France cannot occur without a shift of the economy towards the more research-intensive sectors. The capability of France to effectively encourage the development of fast growing innovative firms that would position themselves in new emerging domains might be decisive in making such a structural change happen.

## FRANCE

**Share of value added versus BERD Intensity - Average annual growth, 1995-2006**



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* OECD
*Note:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 15 850 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 25 170 applicants from France (9.44% of EU-27*) and
- requesting EUR 8 884.21m of EC contribution (10.06% of EU-27*)

Among the EU-27* France (FR) ranks:

- 5th in terms of number of applicants and
- 4th in terms of requested EC contribution

### Success rates

- The FR applicant success rate of 25.9% is higher than the EU-27* applicant success rate of 21.6%.
- The FR EC financial contribution success rate of 26.5% is higher than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 3 836 proposals were retained for funding (24.2%)
- involving 6 529 (25.9%) successful applicants from France and
- requesting EUR 2 357.51m (26.5%) of EC financial contribution

Among the EU-27*, France (FR) ranks:

- 3rd in terms of applicants success rate and
- 1st in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, France (FR) participates in

- 3 311 signed grant agreements
- involving 34 181 participants of which 5 803 (16.98%) are from France
- benefiting from a total of EUR 10 295.60m of EC financial contribution of which EUR 2 247.34m (21.83%) is dedicated to participants from France.

Among the EU-27* in all FP7 signed grant agreements, France (FR) ranks:

- 3rd in number of participations and
- 3rd in budget share

### SME performance and participation

- The FR SME applicant success rate of 22.83% is higher than the EU-27* SME applicant success rate of 19.33%.
- The FR SME EC financial contribution success

rate of 21.58% is higher than the corresponding EU-27* rate of 18.26%.

Specifically,

- 5 816 FR SME applicants requesting EUR 1 602.71m
- 1 328 (22.83%) successful SMEs requesting EUR 345.91m (21.58%)

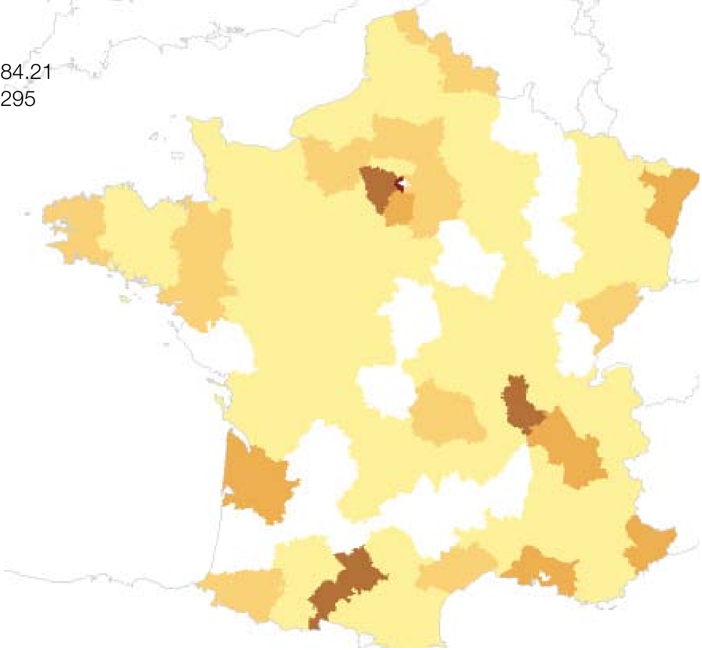
In signed grant agreements, as of 2011/03/16,

- 902 FR SME grant holders, i.e., 15.54% of total FR participation
- EUR 245.10m, i.e., 10.91% of total FR budget share

**Top 3 collaborative links with**

- DE - Germany (4 727)
- UK - United Kingdom (3 623)
- IT - Italy (2 962)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 10th | |
| - Above EU-27 average | | |
| - Innovation Follower | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 25 170 | |
| (9.44%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 8 884.21 | |
| (10.06%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 6 529 | |
| (11.03%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 2 357.51 | |
| (12.91%) | 18 262.02 | |
| Success rate FP7 applicants | 25.9% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 26.5% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 5 803 | |
| (11.32%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 2 247.34 | |
| (13.56%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 1 197 | |
| (20.63%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 902 | |
| (15.54%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 245.10 | |
| (10.91%) | 2 207.73 | |
| (13.32%) | | |



## TABLE 1

## FR - France - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 5738 | 2267.08 | 1138 | 19.83% | 448.59 | 19.79% |
| Marie-Curie Actions | 4119 | n/a | 1019 | 24.74% | n/a | n/a |
| Transport (including Aeronautics) | 2368 | 738.23 | 808 | 34.12% | 272.68 | 36.94% |
| Health | 2366 | 1131.47 | 618 | 26.12% | 296.98 | 26.25% |
| Research for the benefit of SMEs | 1387 | 213.26 | 284 | 20.48% | 45.95 | 21.55% |
| European Research Council | 1314 | 1941.26 | 237 | 18.04% | 388.86 | 20.03% |

## TABLE 2

## FR - France - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all FR grant holders | EC contribution (EUR million) | % of total EC contribution to FR |
|---|---|---|---|---|
| Information and Communication Technologies | 1120 | 19.30% | 395.72 | 17.61% |
| ERC | 227 | 3.91% | 324.37 | 14.43% |
| Health | 600 | 10.34% | 275.44 | 12.26% |
| Transport (including Aeronautics) | 677 | 11.67% | 207.50 | 9.23% |
| Marie-Curie Actions | 812 | 13.99% | 192.78 | 8.58% |
| Research Infrastructures | 300 | 5.17% | 127.67 | 5.68% |

*Notes:* Report generated on: 2011/03/25.04:39 PM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## FR - France - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| PRC | 8077 | 2516.58 | 2161 | 26.75% | 705.42 | 28.03% | 1981 | 581.77 | 25.89% |
| REC | 7511 | 2489.35 | 2240 | 29.82% | 813.41 | 32.68% | 2441 | 1164.45 | 51.81% |
| HES | 5757 | 1294.78 | 1169 | 20.31% | 233.05 | 18.00% | 954 | 298.68 | 13.29% |
| OTH | 1579 | 375.08 | 404 | 25.59% | 95.28 | 25.40% | 189 | 159.42 | 7.09% |
| PUB | 940 | 268.14 | 321 | 34.15% | 121.70 | 45.38% | 238 | 43.03 | 1.91% |
| | | | | | | | | | |
| SME | 5816 | 1602.71 | 1328 | 22.83% | 345.91 | 21.58% | 902 | 245.10 | 10.91% |

PRC - Private for profit (excl. education), REC - Research organisations, HES - Higher or secondary education, OTH - Others, PUB - Public body (excl. research and education)

## TABLE 4

## FR - France - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| FR - France region | Number of grant holders | % of all FR - France grant holders | EC contribution (M euro) | % of total EC contribution to FR |
|---|---|---|---|---|
| Paris (FR101) | 2777 | 47.85% | 1192.40 | 53.06% |
| Hauts-de-Seine (FR105) | 519 | 8.94% | 193.64 | 8.62% |
| Yvelines (FR103) | 244 | 4.20% | 103.71 | 4.61% |
| Haute-Garonne (FR623) | 228 | 3.93% | 81.01 | 3.60% |
| Rhône (FR716) | 208 | 3.58% | 51.51 | 2.29% |

## TABLE 5

## FR - France - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all FR grant holders | EC contribution (M euro) | % of total EC contribution to FR grant holders |
|---|---|---|---|---|
| Centre National de la Recherche Scientifique (CNRS) | 733 | 12.63% | 354.33 | 15.77% |
| Commissariat à l'Énergie Aatomique et aux Énergies Alternatives (CEA) | 370 | 6.38% | 188.76 | 8.40% |
| Fondation Europeenne de la Science | 12 | 0.21% | 124.90 | 5.56% |
| Institut National de la Santé et de la Recherche Médicale (INSERM) | 224 | 3.86% | 113.52 | 5.05% |
| Institut National de Recherche en Informatique et en Automatique (INRIA) | 125 | 2.15% | 60.98 | 2.71% |

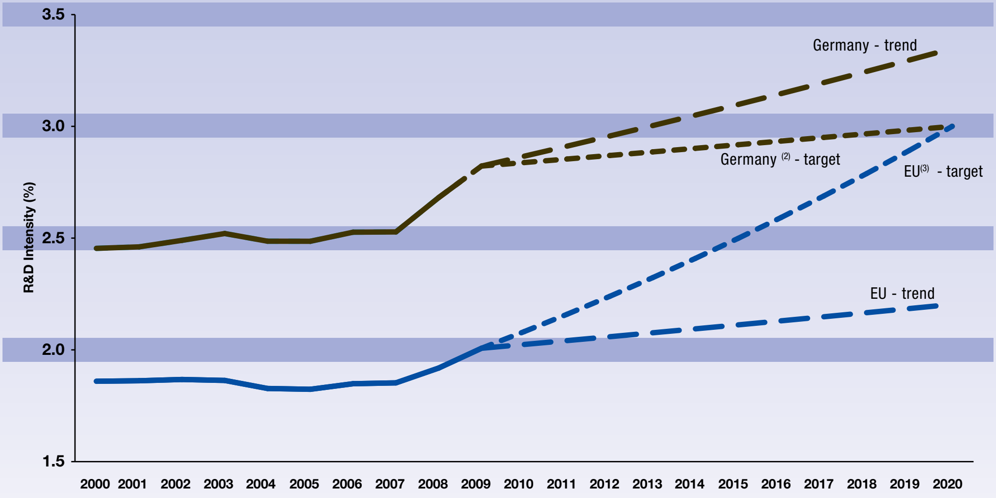
# COUNTRY PROFILE

# DE - Germany

## Progress towards meeting the Europe 2020 R&D intensity target

In the last decade, R&D intensity grew in Germany above the EU average, passing from 2.43% in 2000 to 2.63% in 2008 and 2.82% in 2009. As a result, Germany is already closely approaching in 2010 its national R&D target of 3% which it plans to reach by 2015, even if it is possible that R&D intensity slips back in 2010, due to the sharp rise in GDP. The agreement reached between the Federal Government and the Länders to increase the public budget for R&D and Higher Education by 12 billion euro between 2009-2014, by around 6 billion euro for R&D and 6 billion euro for higher education, is likely to allow Germany to reach the 3% target in the next years. In this context, the 3% R&D target for 2020 would represent a limited rate of increase between 2010 and 2020 and zero growth between 2015 and 2020. Per comparison, South Korea has set a target of 5% for 2014 and China a target of 2.5% for 2020.

GERMANY **R&D Intensity projections, 2000-2020(1)**



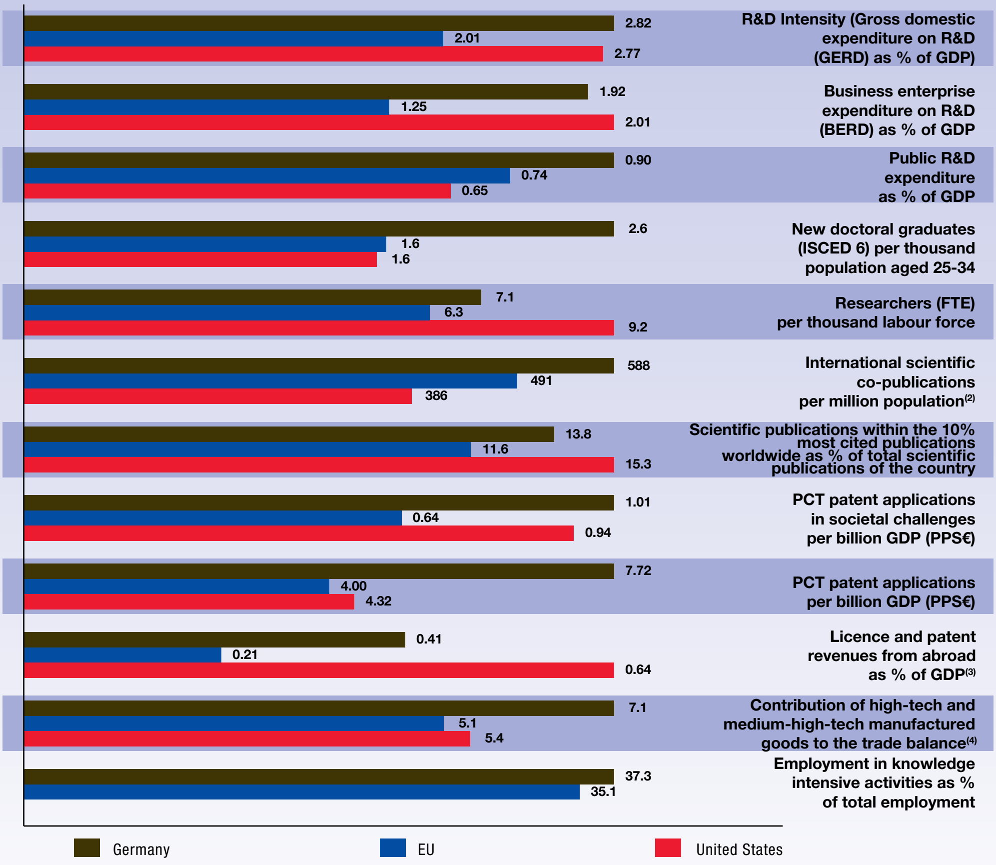
*Source:* DG Research and Innovation **Innovation Union Competitiveness Report 2011**
*Data:* DG Research and Innovation, Eurostat
*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity 2000-2009.
(2) DE: This projection is based on a tentative R&D Intensity target of 3.0% for 2020.
(3) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.

## Research and Innovation Performance

In addition to relative strong R&D investments, Germany is characterised by a very good innovation culture, both in indigenous large multinational enterprises and SMEs, ("Mittelstand"). The dual vocational training system and the internship practices in the engineering sectors support innovation. The aim of strengthening innovation of small and medium-sized companies is to improve the funding of innovations and to intensify the exploitation of research results. Areas of potential

# GERMANY

## R&D profile, 2009(1)



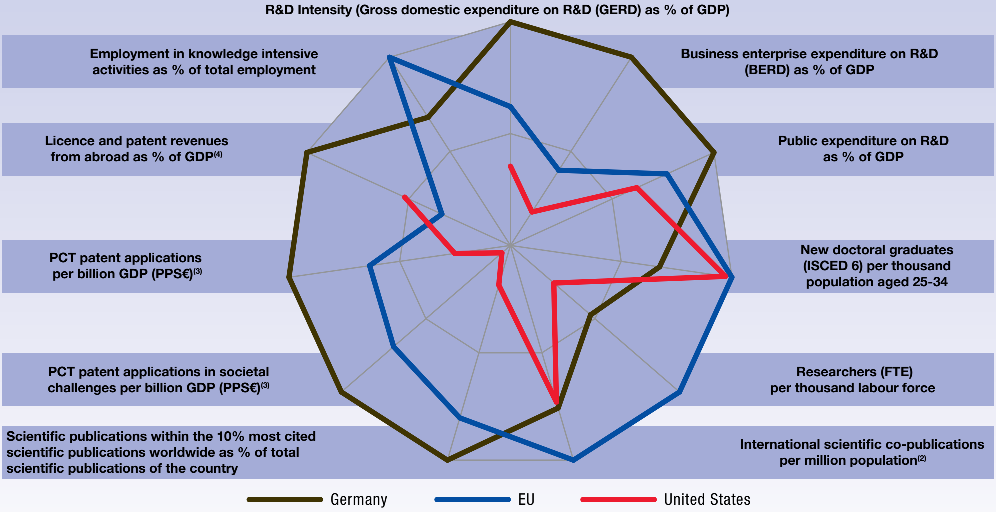
**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

concern are the service economy sectors, which might be set aside by the manufacturing oriented business culture. The German High-Tech strategy aims at addressing this issue. Knowledge creation is well advanced as evidenced by the high number of new doctoral graduates per thousand population aged 25-34, much higher than in the EU on average or the United States, the proportion of high-quality scientific publications or the number of international co-publications per million population. There is an imminent shortage of skilled labour in both academia and industry which is recognised by the Federal Government in its pact for higher education and commitment to spend 10% of GDP on education and research by 2015 : with an R&D target of 3%, this means a commitment to spend 7% of GDP on education. In terms of knowledge dissemination in the system, cooperation between business associations and public research is close. Moreover, in order to enhance the exploitation of research results by SMEs, specially targeted programmes are implemented, e.g. the High-tech Start-up Fund. As a result, Germany has an outstanding performance in patent application and nearly doubles the United States or the EU average. This in turn, reflects in the strong and highly competitive industrial structure, focused on medium-high tech goods, that allows for a positive trade balance. In absolute terms Germany overtook the United States as world leading exporter, far ahead of Japan and was only recently put to the second rank by China.

## GERMANY

## Average annual growth (%), 2000-2009(1)



**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average.
(3) Average annual growth refers to real growth.
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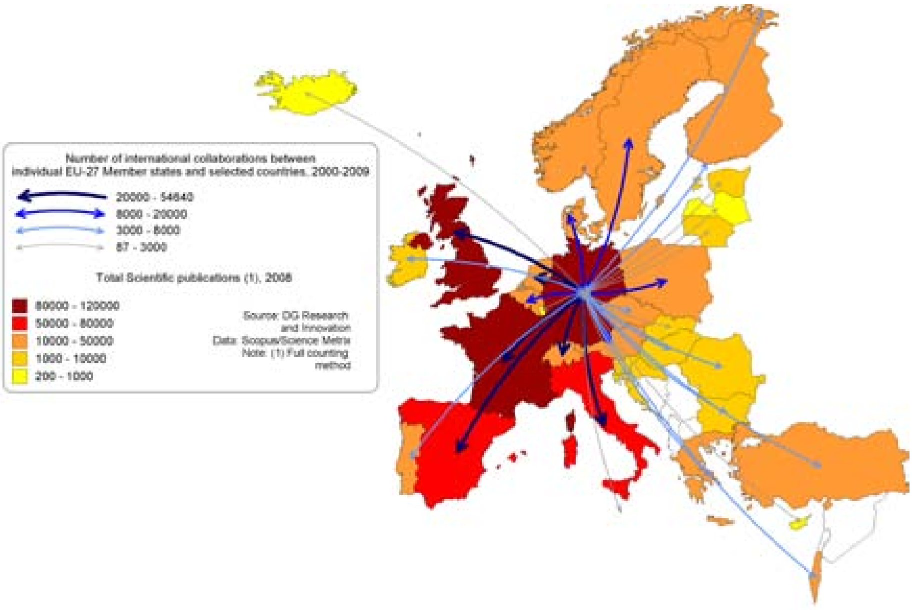
(5) Elements of estimation were involved in the compilation of the data.

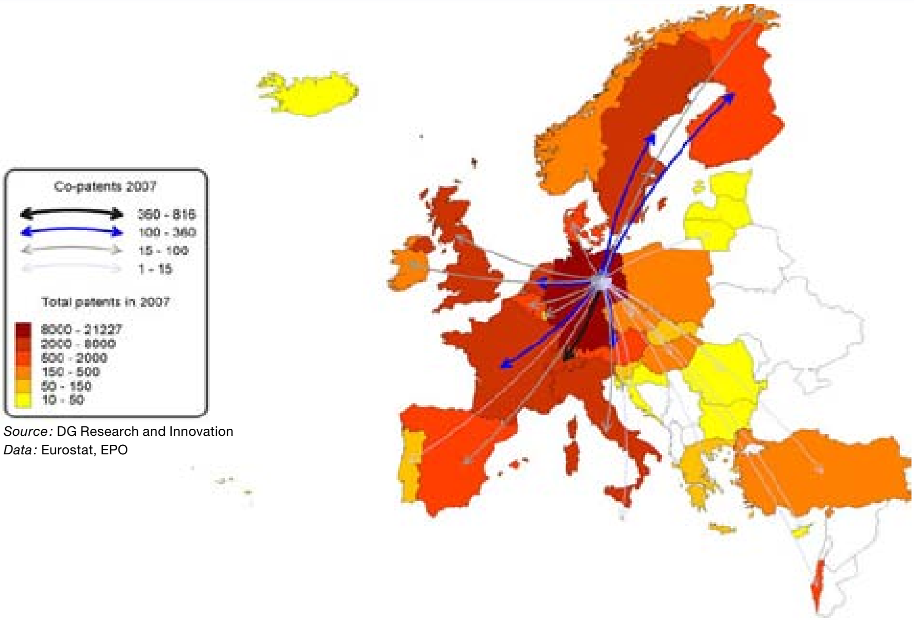
## GERMANY

## Co-publications between Germany and European Countries in 2000-2009



Source: DG Research and Innovation
Data: Scopus/Science Metrix
Note: (1) Full counting method

### Co-invented patent applications between Germany and European Countries, 2007



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

From a dynamic perspective, the indicators show that Germany has been doing good progress not only in increasing its public and private R&D investment, but also in translating this into high quality scientific and technological outputs, where it outperforms the EU average and the United States. A note of concern can be raised on the progress of the system to train new researchers or engage more researchers in the labour force. Moreover, the progress towards higher employment in knowledge intensive sectors has been below the EU average. These facts might be due to a certain weakness of high tech sectors in the industrial structure as Germany is focused on medium-high tech industries.

## Participation in the European Research Area: Scientific and Technological collaborations

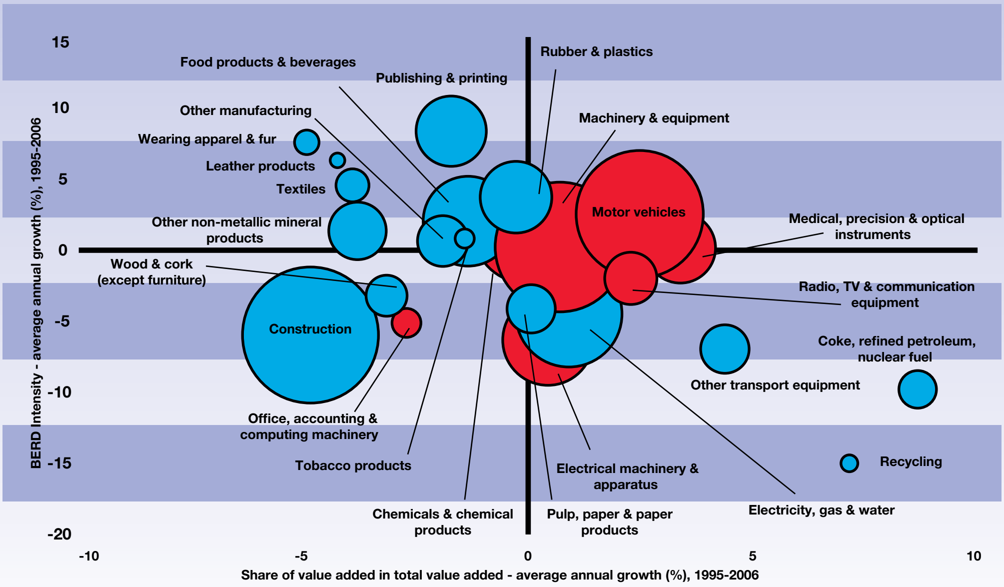
Germany is cooperating strongly in industrial related co-patenting with its language clustered neighbouring countries such as Switzerland and Austria, but also with the Netherlands, Sweden, Finland and France. In terms of scientific cooperation, the main partners are the larger counties like the United Kingdom, France, Italy and Spain and as well the neighbouring Switzerland and the Netherlands. The relatively low degree of co-patenting with countries such as the United Kingdom, Italy or Spain, as compared to the degree of scientific co-publications, may signal an untapped potential for fruitful economic cooperation to be further developed. This relatively low rate of co-patenting should be seen in the light of findings that the establishment of multinational companies has an impact on the co-patenting activity in a country

## Structural change towards more knowledge-intensive economy

In the last decade, private R&D intensity slightly increased from 1.73% in 2000 to 1.92% in 2009. This rise was mainly due to the increasing importance of some key medium-high and high tech sectors, such as medical precision and optical instrument, motor vehicles or machinery equipment, in the overall economy. The current structure of the innovation system has been the basis for Germany's position as a leading innovator as indicated inter alia by the turnover generated by new products and as world leader in export of industrial goods. In particular, the strong role of the medium-high technology manufacturing sectors makes the German economy one of the most research oriented. However countries such as France or Sweden count on higher research intensity in business enterprises, i.e. the proportion of private R&D investment over total value added, in the same sectors, which can endanger the long-term competitive edge of some sectors in Germany. The High-Tech strategy aims at responding to this challenge by encouraging a shift towards cutting-edge technology in the context of an overall objective of strengthening the innovation efforts of as many companies as possible regardless of sector or technology

# GERMANY

**Share of value added versus BERD Intensity - Average annual growth, 1995-2006**



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.
(2) 'Basic metals' and 'Fabricated metal products' are not visible on the graph.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 20 739 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 37 552 applicants from Germany (14.09% of EU-27*) and
- requesting EUR 14 316.14m of EC contribution (16.21% of EU-27*)

Among the EU-27* Germany (DE) ranks:

- 1st in terms of number of applicants and
- 1st in terms of requested EC contribution

### Success rates

- The DE applicant success rate of 23.9% is higher than the EU-27* applicant success rate of 21.6%.
- The DE EC financial contribution success rate of 24.2% is higher than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 4 540 proposals were retained for funding (21.9%)
- involving 8 973 (23.9%) successful applicants from Germany and
- requesting EUR 3 467.03m (24.2%) of EC financial contribution

Among the EU-27*, Germany (DE) ranks:

- 7th in terms of applicants success rate and
- 4th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Germany (DE) participates in

- 3 923 signed grant agreements
- involving 40 911 participants of which 8 002 (19.56%) are from Germany
- benefiting from a total of EUR 12 534.74m of EC financial contribution of which EUR 3 052.92m (24.36%) is dedicated to participants from Germany.

Among the EU-27* in all FP7 signed grant agreements, Germany (DE) ranks:

- 1st in number of participations and
- 1st in budget share

**SME performance and participation**

- The DE SME applicant success rate of 21.17% is higher than the EU-27* SME applicant success rate of 19.33%.
- The DE SME EC financial contribution success rate of 20.57% is higher than the corresponding EU-27* rate of 18.26%.

Specifically,

- 9421 DE SME applicants requesting EUR 2713.72m
- 1994 (21.17%) successful SMEs requesting EUR 558.33m (20.57%)

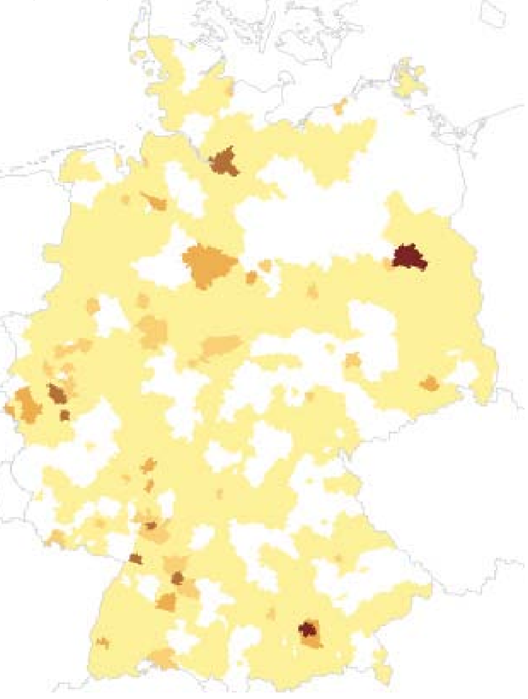
In signed grant agreements, as of 2011/03/16,

- 1317 DE SME grant holders, i.e., 16.46% of total DE participation
- EUR 356.68m, i.e., 11.68% of total DE budget share

**Top 3 collaborative links with**

- UK - United Kingdom (4352)
- FR - France (3983)
- IT - Italy (3554)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 3rd | |
| - Above EU-27 average | | |
| - Innovation Leader | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 37552 | |
| (14.09%) | 266507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 14316.14 | |
| (16.21%) | 88295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 8973 | |
| (15.16%) | 59199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 3467.03 | |
| (18.98%) | 18262.02 | |
| Success rate FP7 applicants | 23.9% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 24.2% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 8002 | |
| (15.60%) | 51279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 3052.92 | |
| (18.42%) | 16578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 1316 | |
| (16.45%) | 9383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 1317 | |
| (16.46%) | 8845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 356.68 | |
| (11.68%) | 2207.73 | |
| (13.32%) | | |



## TABLE 1

## DE - Germany - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 9995 | 4592.30 | 1965 | 19.66% | 941.65 | 20.50% |
| Marie-Curie Actions | 4573 | n/a | 1004 | 21.95% | n/a | n/a |
| Health | 3665 | 1856.85 | 881 | 24.04% | 423.16 | 22.79% |
| Transport (including Aeronautics) | 2962 | 1010.64 | 899 | 30.35% | 352.06 | 34.84% |
| Research for the benefit of SMEs | 2707 | 380.84 | 562 | 20.76% | 77.00 | 20.22% |
| Environment (including Climate Change) | 2222 | 654.88 | 510 | 22.95% | 141.71 | 21.64% |

## TABLE 2

## DE - Germany - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all DE grant holders | EC contribution (EUR million) | % of total EC contribution to DE |
|---|---|---|---|---|
| Information and Communication Technologies | 1990 | 24.87% | 862.67 | 28.26% |
| Health | 880 | 11.00% | 397.59 | 13.02% |
| ERC | 223 | 2.79% | 324.85 | 10.64% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 820 | 10.25% | 298.59 | 9.78% |
| Transport (including Aeronautics) | 708 | 8.85% | 230.39 | 7.55% |
| Marie-Curie Actions | 820 | 10.25% | 222.04 | 7.27% |

*Notes:* Report generated on: 2011/03/24.11:59 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## DE - Germany - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 12990 | 4208.50 | 2784 | 21.43% | 908.77 | 21.59% | 2788 | 1138.09 | 37.28% |
| PRC | 11140 | 3551.09 | 2860 | 25.67% | 982.24 | 27.66% | 2615 | 818.57 | 26.81% |
| REC | 9445 | 3736.32 | 2495 | 26.42% | 1012.64 | 27.10% | 2275 | 1023.59 | 33.53% |
| OTH | 1544 | 411.84 | 329 | 21.31% | 104.02 | 25.26% | 97 | 17.69 | 0.58% |
| PUB | 1023 | 237.02 | 277 | 27.08% | 54.06 | 22.81% | 227 | 54.97 | 1.80% |
| | | | | | | | | | |
| SME | 9421 | 2713.72 | 1994 | 21.17% | 558.33 | 20.57% | 1317 | 356.68 | 11.68% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education)

## TABLE 4

## DE - Germany - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| DE - Germany region | Number of grant holders | % of all DE - Germany grant holders | EC contribution (M euro) | % of total EC contribution to DE |
|---|---|---|---|---|
| Moo½oo½nchen, Kreisfreie Stadt (DE212) | 1318 | 16.47% | 595.42 | 19.50% |
| Berlin (DE300) | 595 | 7.44% | 203.85 | 6.68% |
| Koo½oo½ln, Kreisfreie Stadt (DEA23) | 319 | 3.99% | 129.80 | 4.25% |
| Stuttgart, Stadtkreis (DE111) | 275 | 3.44% | 100.65 | 3.30% |
| Heidelberg, Stadtkreis (DE125) | 266 | 3.32% | 148.38 | 4.86% |

## TABLE 5

## DE - Germany - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all DE grant holders | EC contribution (M euro) | % of total EC contribution to DE grant holders |
|---|---|---|---|---|
| Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V (Fraunhofer) | 491 | 6.14% | 225.11 | 7.37% |
| Max Planck Gesellschaft Zur Foerderung Der Wissenschaften E.V. (MPG) | 338 | 4.22% | 170.56 | 5.59% |
| Deutsches Zentrum Fuer Luft - Und Raumfahrt EV (DLR) | 201 | 2.51% | 92.01 | 3.01% |
| Karlsruher Institut Fuer Technologie (KIT) | 180 | 2.25% | 61.13 | 2.00% |
| European Molecular Biology Laboratory (EMBL) | 86 | 1.07% | 60.31 | 1.98% |

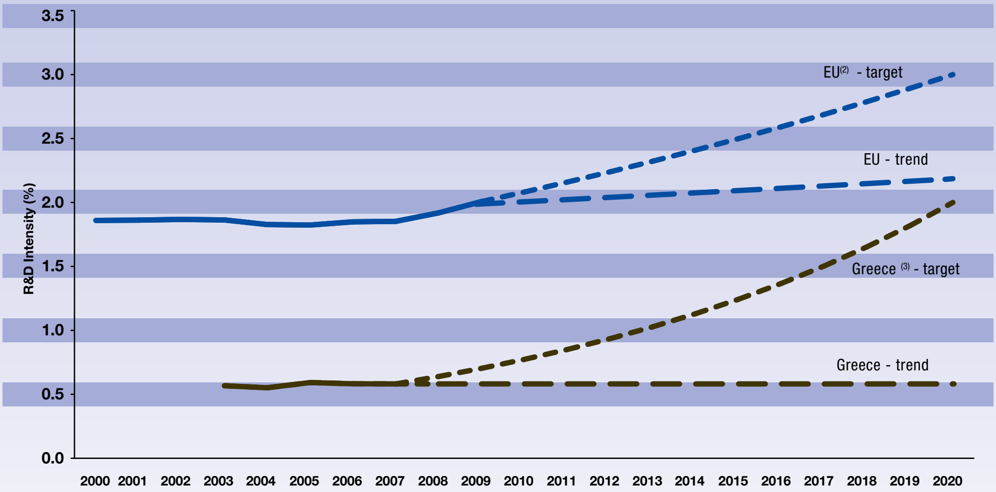
# COUNTRY PROFILE

# EL - Greece

## Progress towards meeting the Europe 2020 R&D intensity target

In the last decade, R&D intensity in Greece has stagnated remaining at 0.58% of GDP. This stagnation has been caused by a decrease in the already very low private R&D intensity, which fell from 0.19% to 0.16% in 2007, i.e. an average annual fall rate of 2.1%. Public R&D intensity, on the other hand, slightly increased, passing from 0.39% to 0.42%. It should be noted that overall GERD investment growth in Greece has been significant, but this growth was not as high as the rapid GDP growth during the years 2000-2006, hence the fall in R&D intensity.

**GREECE** **R&D Intensity projections, 2000-2020(1)**



**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* DG Research and Innovation, Eurostat
*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009 in the case of the EU and for 2001-2007 in the case of Greece.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) EL: This projection is based on a tentative R&D Intensity target of 2.0% for 2020.

## Research and Innovation Performance

Greece is one of the moderate innovators with a performance below the EU average[8]. Actions to foster the research and innovation capacity will depend significantly on the financing from EU Structural Funds both at national and regional level : over the period 2007-2013. Greece is expected to spend around 4 billion Euros on innovation. There is a large potential for job creation by strengthening the business environment, reinforcing R&D and innovation and making the relationship between the public and the private sector more dynamic. Existing and planned programs support R&D&I in enterprises, in particular SMEs. The success of these programmes is linked also with the need to increase the capacity of absorption of the R&D and innovation system. The innovativeness of the Greek economy is of a "catching-up" kind, depending on imported technology and know-how. It flourishes

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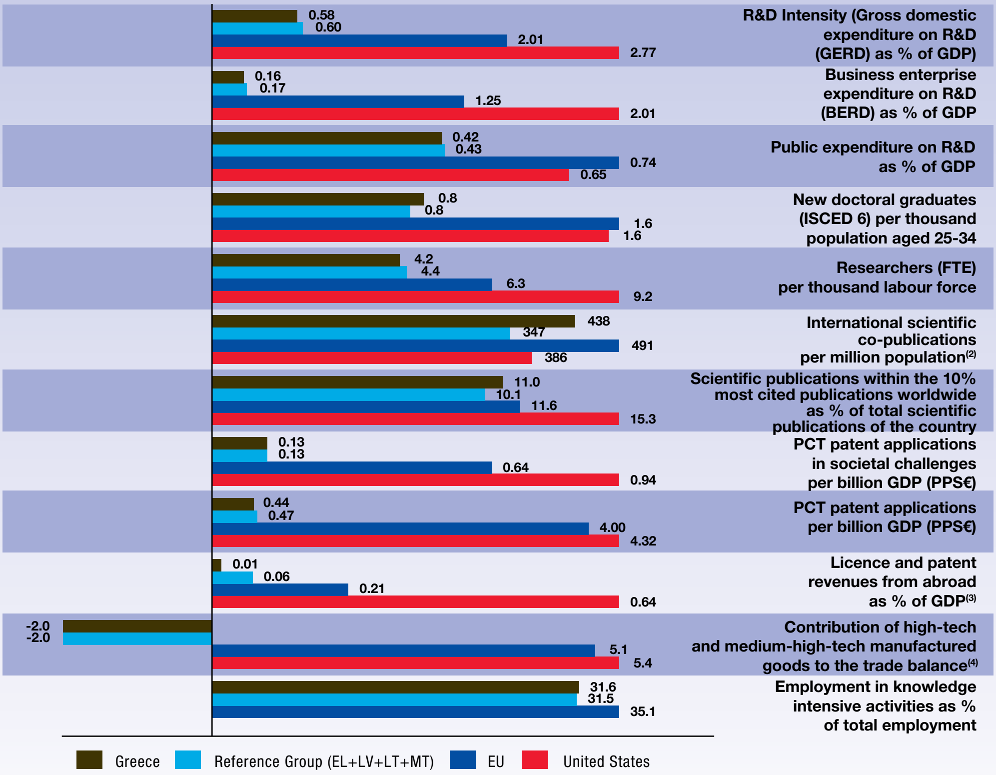
[8] IUS 2010

## GREECE

### R&D profile, 2009(1)



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU; (iii) LV, LT and MT are not included in the Reference Group.
(5) Elements of estimation were involved in the compilation of the data.

thanks to organisational and marketing innovations and less on the production and exploitation of new knowledge. EU programmes (the Research Framework Programme and the Structural Funds) play a major role in both R&D and innovation activity in Greece.

In the field of human resources for research, Greece is below the EU average with 4.2 researchers (FTE) per thousand labour force (the EU average is 6.3). While these figures are low the number of researchers and new doctoral graduates (ISCED 6) per thousand population aged 25-34 have been growing at a faster rate than the EU average (over the period 2000-2008), indicating that a catching up is underway.

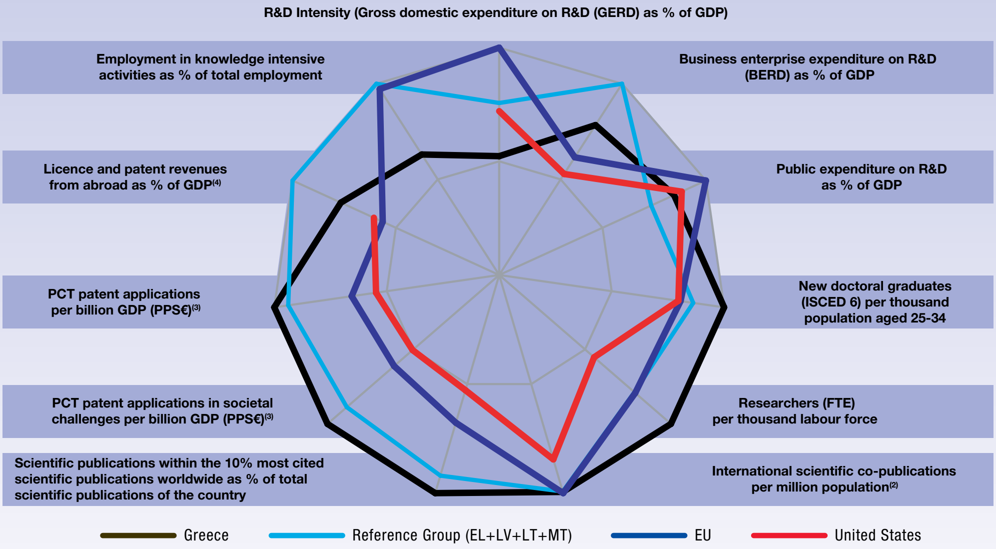
The Greek national innovation system has grown faster than the EU on average, enhancing human resources, scientific quality and technological capacity. However, the private sector is less dynamic in the respect of total expenditure on R&D, thus reflecting the low demand for research-based knowledge from business enterprises. Restricted access to capital, especially for new firms, due to the reluctance of the financial institutions to finance innovation and risky investments is also among the factors hindering mobilisation of resources for R&D.

### Participation in the European Research Area: Scientific and Technological collaborations

Greece is well placed regarding scientific production, reaching close to the average EU figures, 438 co-publications per million population against 491 for the EU average. Reinforcing this indicator, Greece is above the average in the scientific publications within the top 10% most cited publications worldwide as a percentage of total scientific publications of the country. These two results indicate that Greek research is of a good degree of quality and show a considerable achievement given

## GREECE

## Average annual growth (%), 2000-2009(1)

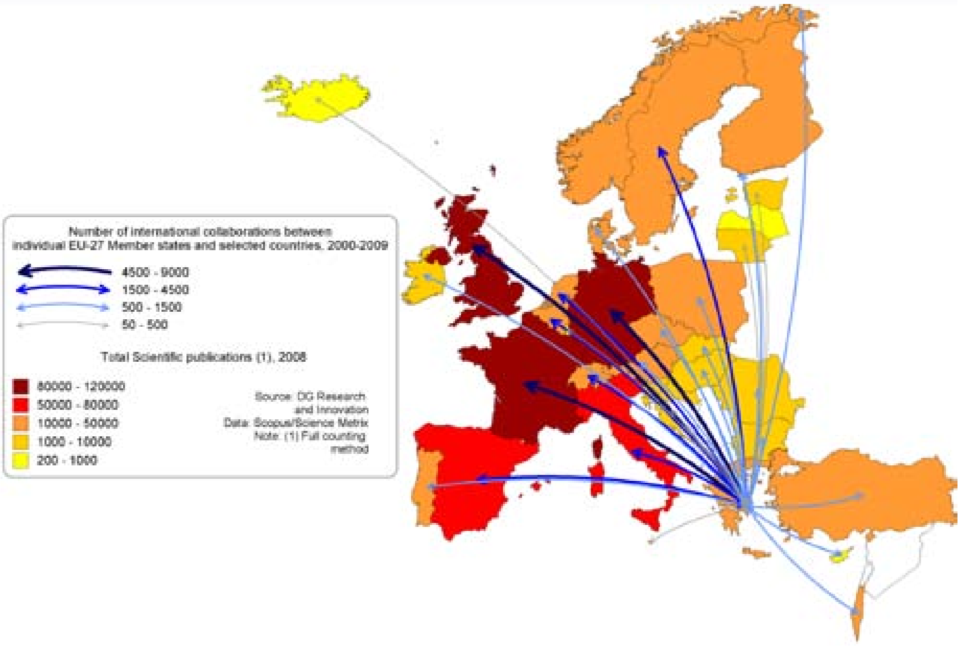


**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## GREECE

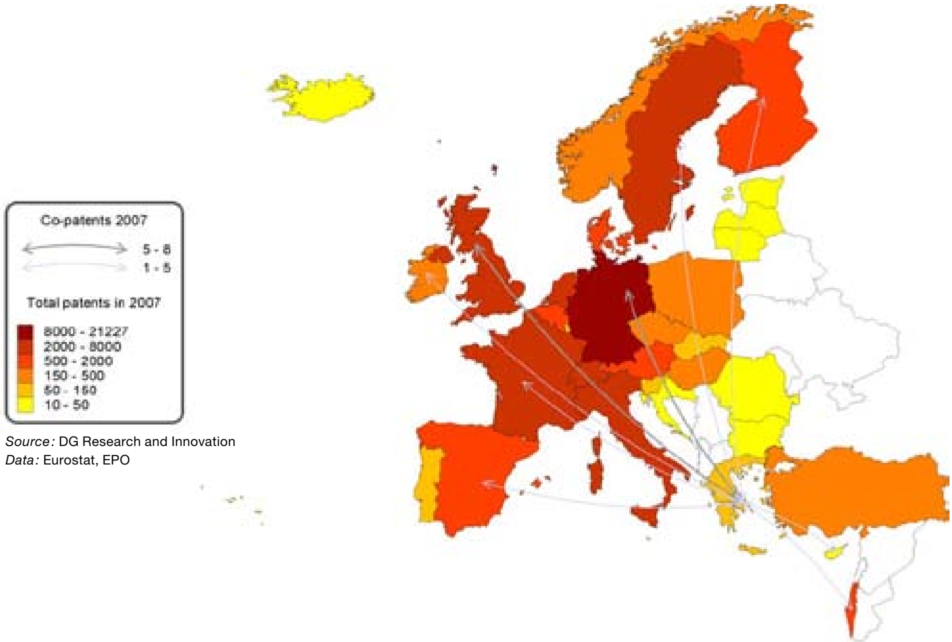
## Co-publications between Greece and European Countries in 2000-2009



Source: DG Research and Innovation
Data: Scopus/Science Metrix
Note: (1) Full counting method

## GREECE

### Co-invented patent applications between Greece and European Countries, 2007



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

the lower share of Greek researchers. In addition, Greece is in a leading position with regard to FP7 collaborative links with European countries per 1000 researchers FTE (see Part II, chapter 4 of this report). This favourable position is partly due to the fact that Greece has a smaller number of researchers than most of the EU countries.

Technological collaboration as expressed through co-patenting applications is very modest, when compared with the EU average. More than 65% of the total patent applications are made by a single inventor and thus less than 35% in collaboration. From these, 7.4% are co-patents involving a non EU country, a low figure which highlights the need for more collaboration and internationalisation of the technological innovation activities.

## Structural change towards more knowledge-intensive economy

Greece experienced big changes in its industrial structure after 1995. During the period 1995-2005, an increase was registered in the share of BERD by both manufacturing and services, manufacturing representing 56% and services 36%. Business R&D is concentrated in 4 sectors, accounting for more than 51% of BERD. In Greece, 12 sectors account for more than 80% of industrial R&D, with the Radio, TV and Communications Equipment sector and the Computer Services sector holding the leading share of 40%. Chemicals and chemical products forms the third sector, with a 9% share of total business enterprise R&D.

The graph below illustrates the lack of dynamism of the economy towards more research intensive sectors. The economic structure of the country has slightly shifted towards less research oriented activities. The small increase registered in BERD after 1995 (with a negative trend in the period post 2000) was caused by the increase in the research intensity of few individual sectors, in particular the chemicals and chemical products sector.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

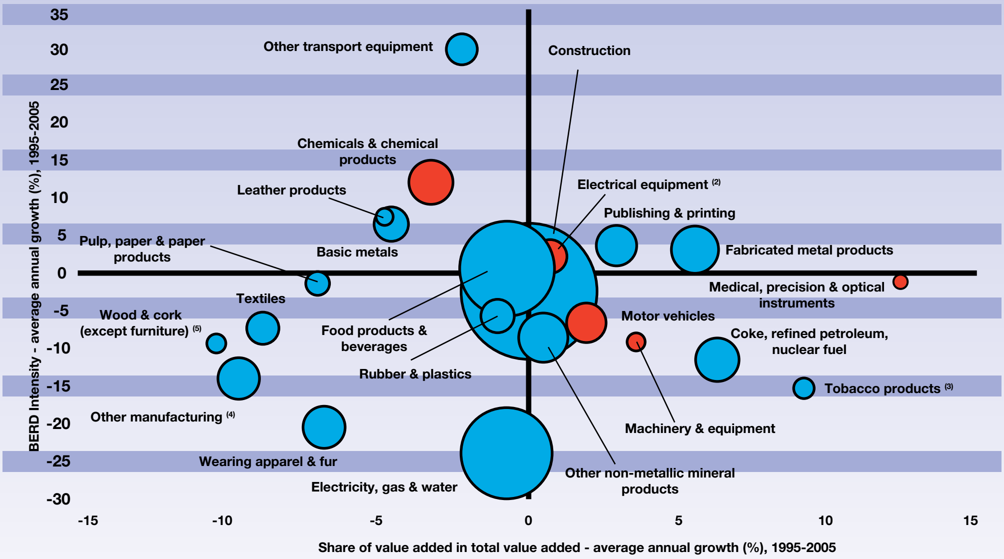
- 8157 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 12177 applicants from Greece (4.57% of EU-27*) and
- requesting EUR 3798.98m of EC contribution (4.30% of EU-27*)

Among the EU-27* Greece (EL) ranks:

- 7th in terms of number of applicants and
- 7th in terms of requested EC contribution

## GREECE

### Share of value added versus BERD Intensity - Average annual growth, 1995-2005



**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.
(2) Electrical equipment includes: 'Office, accounting and computing machinery', 'Electrical machinery and apparatus', and 'Radio, TV and communication equipment'.
(3) 'Tobacco products': average annual growth refers to 2000-2005.
(4) 'Other manufacturing': average annual growth refers to 1995-2003.
(5) 'Wood and cork (except furniture)': average annual growth refers to 1995-2004.
(6) 'Recycling' is not included on the graph.

### Success rates

- The EL applicant success rate of 16.2% is lower than the EU-27* applicant success rate of 21.6%.
- The EL EC financial contribution success rate of 13.0% is lower than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 1 371 proposals were retained for funding (16.8%)
- involving 1 976 (16.2%) successful applicants from Greece and
- requesting EUR 495.31m (13.0%) of EC financial contribution

Among the EU-27*, Greece (EL) ranks:

- 25th in terms of applicants success rate and
- 19th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Greece (EL) participates in

- 1 205 signed grant agreements
- involving 14 476 participants of which 1 769 (12.22%) are from Greece
- benefiting from a total of EUR 3 950.69m of EC financial contribution of which EUR 481.91m (12.20%) is dedicated to participants from Greece.

Among the EU-27* in all FP7 signed grant agreements, Greece (EL) ranks:

- 9th in number of participations and
- 9th in budget share

### SME performance and participation

- The EL SME applicant success rate of 12.87% is lower than the EU-27* SME applicant success rate of 19.33%.
- The EL SME EC financial contribution success rate of 11.28% is lower than the corresponding EU-27* rate of 18.26%.

Specifically,

- 3 373 EL SME applicants requesting EUR 840.81m
- 434 (12.87%) successful SMEs requesting EUR 94.85m (11.28%)

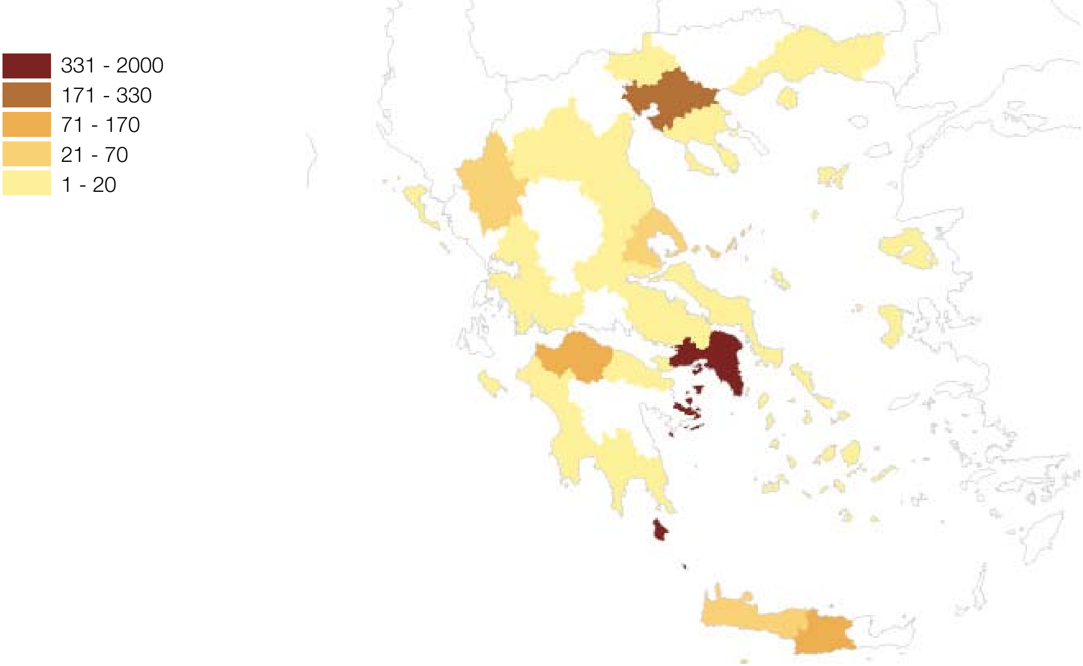
In signed grant agreements, as of 2011/03/16,

- 304 EL SME grant holders, i.e., 17.18% of total EL participation
- EUR 71.12m, i.e., 14.76% of total EL budget share

**Top 3 collaborative links with**

- DE - Germany (1 634)
- UK - United Kingdom (1 372)
- IT - Italy (1 232)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 18th | |
| - Below EU-27 average | | |
| - Moderate Innovator | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 12 177 | |
| (4.57%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 3 798.98 | |
| (4.30%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 1 976 | |
| (3.34%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 495.31 | |
| (2.71%) | 18 262.02 | |
| Success rate FP7 applicants | 16.2% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 13.0% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 1 769 | |
| (3.45%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 481.91 | |
| (2.91%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 352 | |
| (19.90%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 304 | |
| (17.18%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 71.12 | |
| (14.76%) | 2 207.73 | |
| (13.32%) | | |



## TABLE 1

## EL - Greece - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 3920 | 1381.00 | 461 | 11.76% | 169.81 | 12.30% |
| Research for the benefit of SMEs | 1215 | 146.64 | 199 | 16.38% | 20.73 | 14.14% |
| Marie-Curie Actions | 1124 | n/a | 297 | 26.42% | n/a | n/a |
| Transport (including Aeronautics) | 940 | 224.89 | 177 | 18.83% | 38.97 | 17.33% |
| Environment (including Climate Change) | 863 | 219.17 | 118 | 13.67% | 25.99 | 11.86% |
| Security | 538 | 152.67 | 84 | 15.61% | 24.39 | 15.98% |

## TABLE 2

## EL - Greece - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all EL grant holders | EC contribution (EUR million) | % of total EC contribution to EL |
|---|---|---|---|---|
| Information and Communication Technologies | 466 | 26.34% | 164.80 | 34.20% |
| Marie-Curie Actions | 236 | 13.34% | 37.48 | 7.78% |
| Research Potential | 31 | 1.75% | 34.24 | 7.11% |
| Transport (including Aeronautics) | 154 | 8.71% | 31.48 | 6.53% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 104 | 5.88% | 31.30 | 6.49% |
| Health | 82 | 4.64% | 26.83 | 5.57% |

*Notes:* Report generated on: 2011/03/25.04:37 PM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## EL - Greece - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 4 091 | 1 162.46 | 644 | 15.74% | 150.95 | 12.99% | 566 | 149.37 | 31.00% |
| REC | 3 360 | 1 135.05 | 666 | 19.82% | 178.48 | 15.72% | 661 | 208.39 | 43.24% |
| PRC | 3 253 | 822.26 | 476 | 14.63% | 111.93 | 13.61% | 459 | 116.63 | 24.20% |
| OTH | 680 | 137.80 | 97 | 14.26% | 12.52 | 9.08% | 32 | 3.23 | 0.67% |
| PUB | 428 | 73.20 | 81 | 18.93% | 17.80 | 24.32% | 51 | 4.29 | 0.89% |
| SME | 3 373 | 840.81 | 434 | 12.87% | 94.85 | 11.28% | 304 | 71.12 | 14.76% |

HES - Higher or secondary education, REC - Research organisations, PRC - Private for profit (excl. education), OTH - Others, PUB - Public body (excl. research and education)

## TABLE 4

## EL - Greece - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| EL - Greece region | Number of grant holders | % of all EL - Greece grant holders | EC contribution (M euro) | % of total EC contribution to EL |
|---|---|---|---|---|
| Attiki (EL300) | 1 033 | 58.39% | 291.58 | 60.51% |
| Thessaloniki (EL122) | 232 | 13.11% | 62.13 | 12.89% |
| Irakleio (EL431) | 172 | 9.72% | 51.16 | 10.62% |
| Achaia (EL232) | 111 | 6.27% | 29.84 | 6.19% |
| Magnisia (EL143) | 45 | 2.54% | 6.22 | 1.29% |

## TABLE 5

## EL - Greece - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all EL grant holders | EC contribution (M euro) | % of total EC contribution to EL grant holders |
|---|---|---|---|---|
| Foundation for Research and Technology Hellas (FORTH) | 147 | 8.31% | 47.73 | 9.91% |
| Centre for Research and Technology Hellas (CERTH) | 92 | 5.20% | 32.24 | 6.69% |
| National Technical University of Athens (NTUA) | 92 | 5.20% | 31.19 | 6.47% |
| National Center for Scientific Research "Demokritos" | 65 | 3.67% | 26.44 | 5.49% |
| Institute of Communication and Computer Systems (ICCS) | 64 | 3.62% | 25.06 | 5.20% |

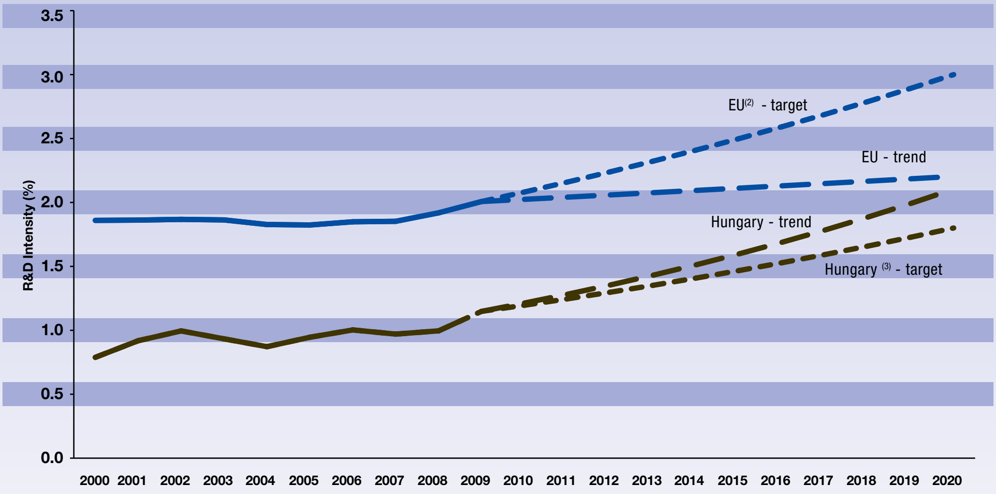
# COUNTRY PROFILE

# HU - Hungary

## Progress towards meeting the Europe 2020 R&D intensity target

Over the period 2000-2009, Hungary's R&D intensity had a cyclical evolution. Even if the business R&D intensity has grown, the low level of overall innovation activity in the private sector is a major challenge. The Hungarian government set a R&D intensity target of 1.8% of GDP by 2020.

**HUNGARY** **R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation

*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009 in the case of the EU and for 2004-2009 in the case of Hungary.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) HU: This projection is based on a tentative R&D Intensity target of 1.8% for 2020.
(4) HU: There is a break in series between 2004 and the previous years.

**Innovation Union Competitiveness Report 2011**

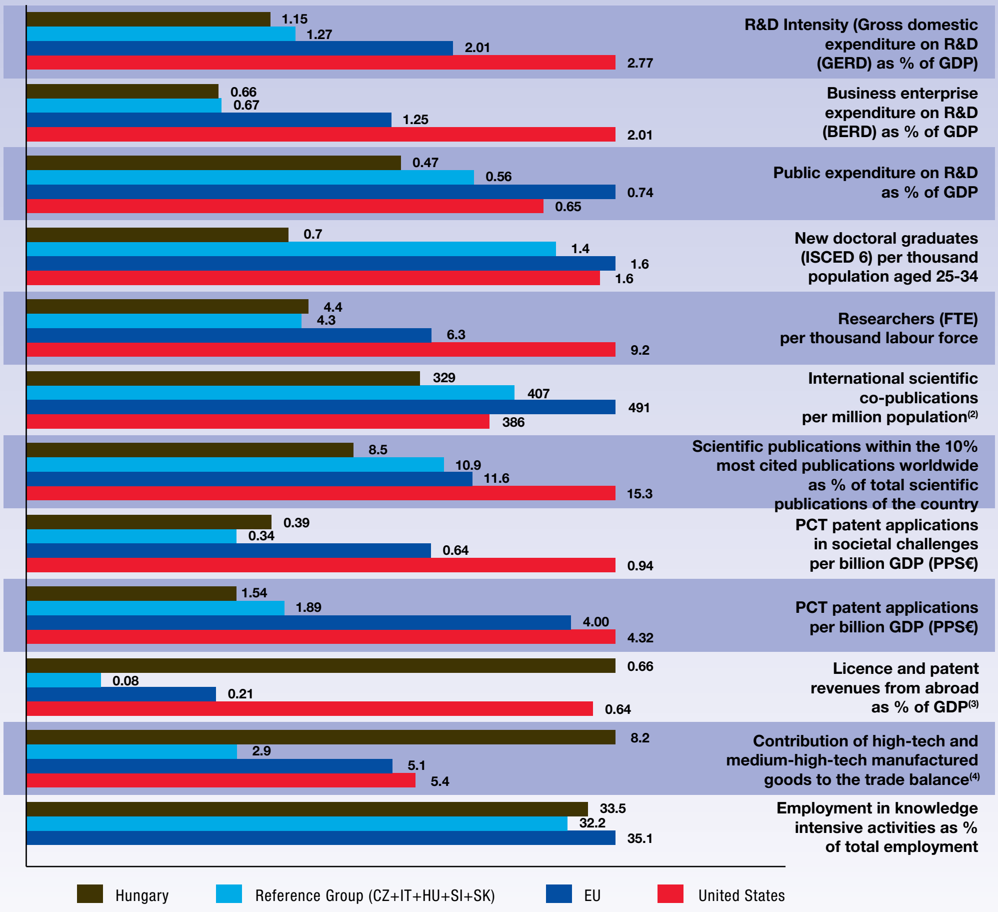
## Research and Innovation Performance

According to the Innovation Union Scoreboard 2010, Hungary belongs to the 'moderate innovators' group of countries, which means an improvement over the last decade although the research and innovation profile has remained mainly unchanged in the recent years. Research and innovation are rather concentrated in large foreign-owned enterprises and in a few sectors.

There is some improvement in human resources in science and technology such as the employment rate in knowledge intensive activities as percentage of total employment which is very close to the EU average. Also noticeable is the excellent performance of Hungary as regards the licence and patent revenues from abroad and the contribution of high-tech and medium-high-tech manufactured goods to the trade balance. This demonstrates a good positioning in new sectors as

## HUNGARY

### R&D profile, 2009(1)



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

well as a progressive structural change towards more knowledge-intensive sectors, as illustrated in the last graph of the present profile.

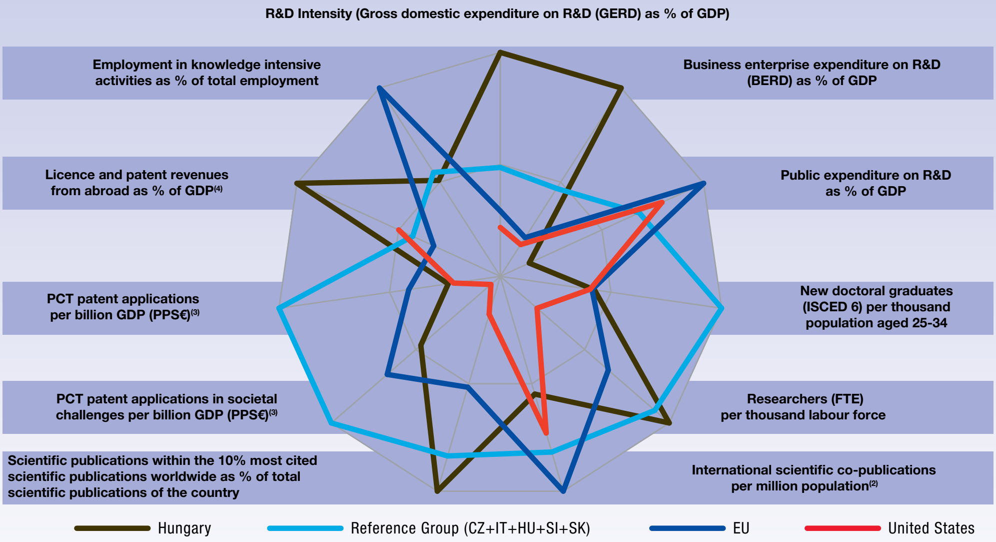
In dynamic terms, the Hungarian research and innovation system is improving private sector financial input and overall R&D intensity, alongside scientific quality and patent revenues. However, public sector R&D intensity and the internationalisation of science is less dynamic than the EU average or countries with a similar industrial structure and knowledge capacity to Hungary.

## Participation in the European Research Area: Scientific and Technological collaborations

Hungary is rather well interconnected in terms of co-publications with Germany, the United Kingdom and France. Its interconnections in terms of co-invented patent applications are much more limited, with links notably with Germany and Sweden, but at a low level.

## HUNGARY

## Average annual growth (%), 2000-2009(1)

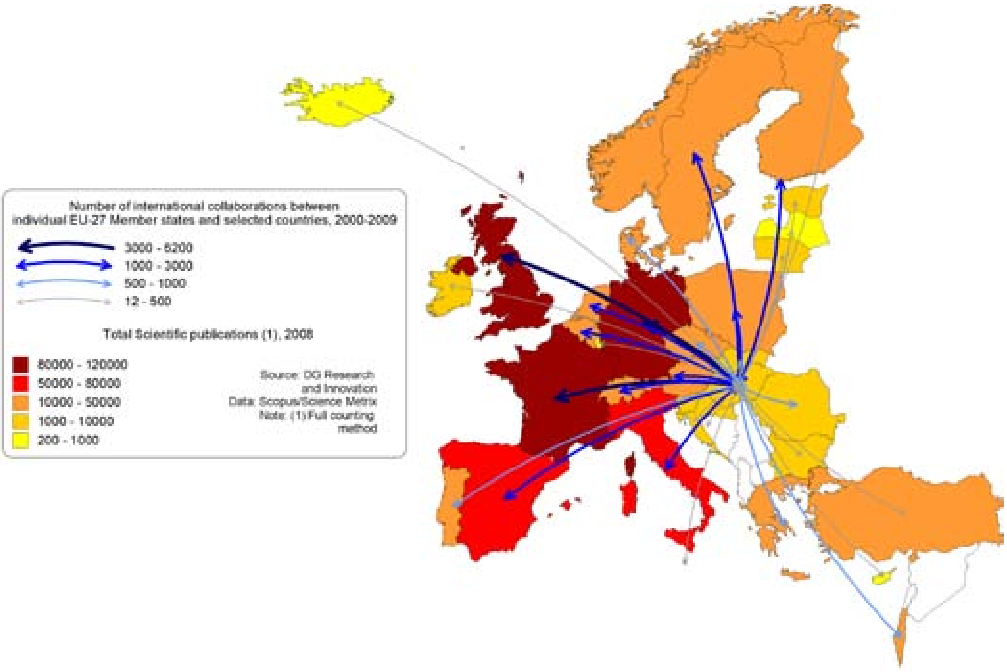


**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average.
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## HUNGARY

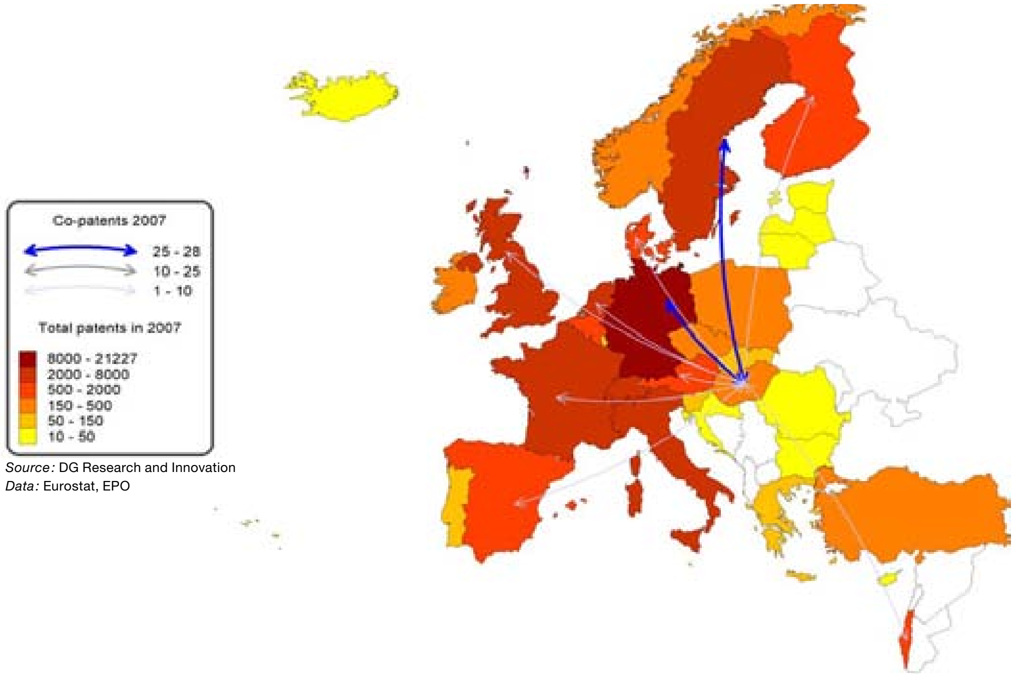
## Co-publications between Hungary and European Countries in 2000-2009



Source: DG Research and Innovation
Data: Scopus/Science Metrix
Note: (1) Full counting method

## HUNGARY

## Co-invented patent applications between Hungary and European Countries, 2007



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

Moreover, as seen in the report, Hungary's share of international scientific co-publications per million population, and respectively the PCT patent applications per billion GDP, are under the EU average.

### Structural change towards more knowledge-intensive economy

Manufacturing is important for Hungary with a percentage of value added in 2008 of 21%, superior to the average EU level of 17% for the same year. Hungary is specialised in sectors demanding low skills but it also counts on a growing and promising trend of specialisation in high-tech sectors. Among the medium-low-tech sector, the speed of increase of R&D intensity of the publishing and printing sector is particularly noticeable. The key challenge for the Hungarian authorities is how to support structural changes towards a more research and innovation intensive business sector. Private investments in R&D are primarily carried out by a small number of big foreign-owned enterprises, making the growth relatively vulnerable. With the renewal and the implementation of the research and innovation strategies until the end of 2011, the government is planning measures to encourage SMEs participation in innovation activities, including non-technological innovation, to reduce the relative high level of administrative burden and to strengthen the links and networks between public and private research.

### FP7 Key facts and figures

**Applications**

As of 2011/03/16, a total of

- 3 491 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 4 436 applicants from Hungary (1.66% of EU-27*) and
- requesting EUR 1 001.20m of EC contribution (1.13% of EU-27*)

Among the EU-27* Hungary (HU) ranks:

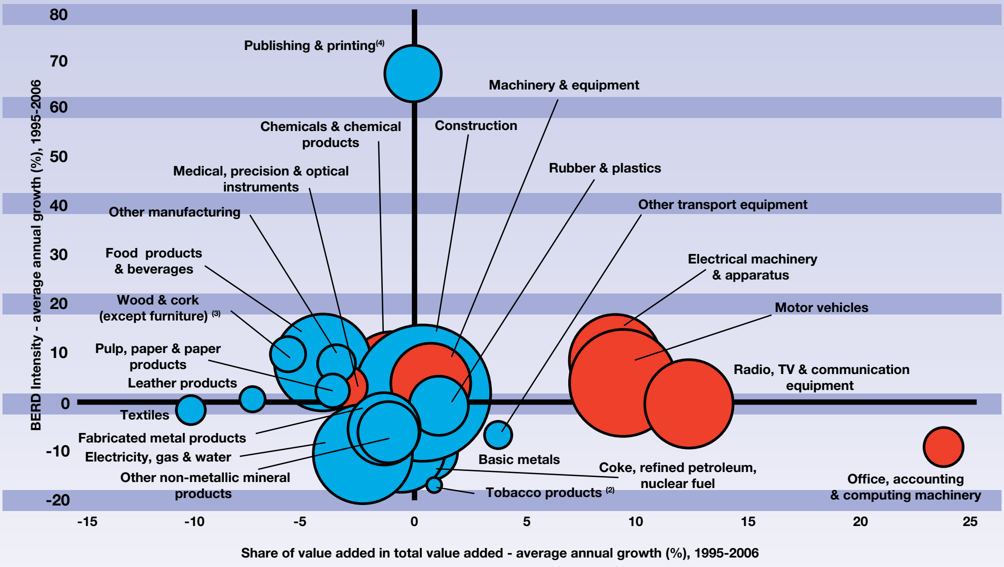
- 15th in terms of number of applicants and
- 16th in terms of requested EC contribution

**Success rates**

- The HU applicant success rate of 20.7% is similar to the EU-27* applicant success rate of 21.6%.

# HUNGARY

## Share of value added versus BERD Intensity - Average annual growth, 1995-2006



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.
(2) 'Tobacco products': average annual growth refers to 1995-2005.
(3) 'Wood and cork (except furniture)': average annual growth refers to 1999-2006.
(4) 'Publishing and printing': average annual growth refers to 1996-2006.
(5) 'Wearing apparel and fur' and 'Recycling' are not included on the graph.

- The HU EC financial contribution success rate of 14.4% is lower than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 726 proposals were retained for funding (20.8%)
- involving 917 (20.7%) successful applicants from Hungary and
- requesting EUR 144.05m (14.4%) of EC financial contribution

Among the EU-27*, Hungary (HU) ranks:

- 14th in terms of applicants success rate and
- 17th in terms of EC financial contribution success rate

Signed grant agreements

As of 2011/03/16, Hungary (HU) participates in

- 638 signed grant agreements
- involving 8 596 participants of which 788 (9.17%) are from Hungary
- benefiting from a total of EUR 2 079.19m of EC financial contribution of which EUR 133.04m (6.40%) is dedicated to participants from Hungary.

Among the EU-27* in all FP7 signed grant agreements, Hungary (HU) ranks:

- 15th in number of participations and
- 16th in budget share

### SME performance and participation

- The HU SME applicant success rate of 17.08% is lower than the EU-27* SME applicant success rate of 19.33%.
- The HU SME EC financial contribution success rate of 12.79% is lower than the corresponding EU-27* rate of 18.26%.

Specifically,

- 1 546 HU SME applicants requesting EUR 314.73m

- 264 (17.08%) successful SMEs requesting EUR 40.24m (12.79%)

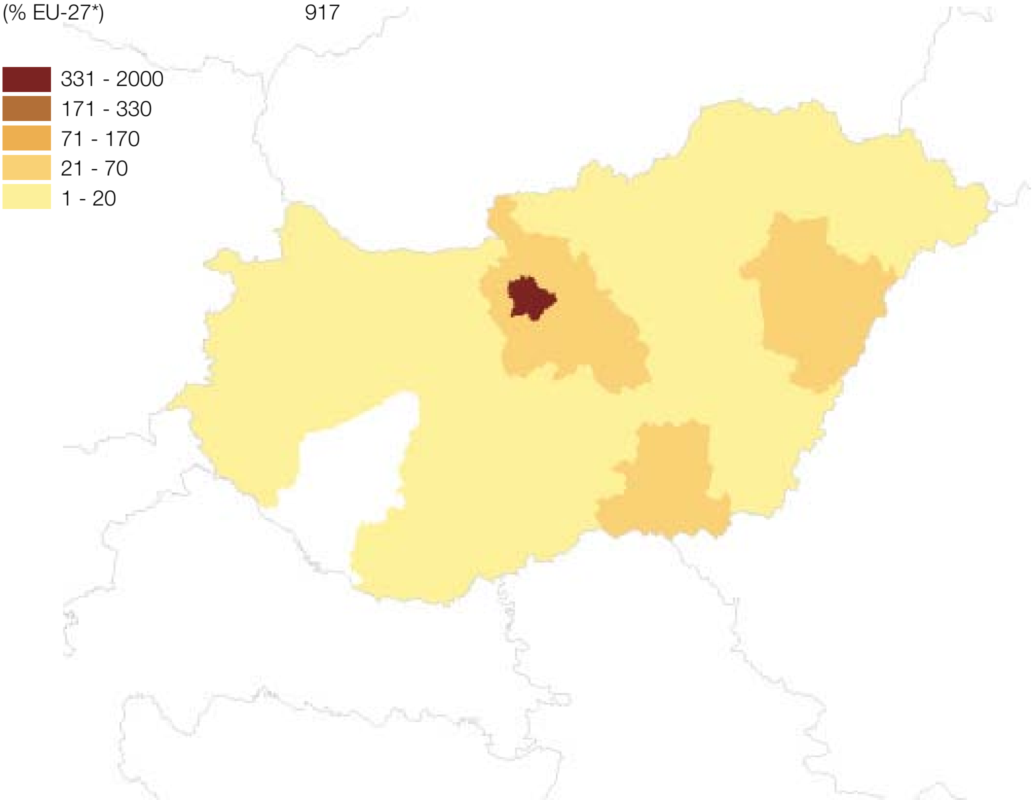
In signed grant agreements, as of 2011/03/16,

- 182 HU SME grant holders, i.e., 23.10% of total HU participation
- EUR 31.07m, i.e., 23.35% of total HU budget share

**Top 3 collaborative links with**

- DE - Germany (1 025)
- UK - United Kingdom (742)
- FR - France (701)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 22nd | |
| - Below EU-27 average | | |
| - Moderate Innovator | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 4 436 | |
| (1.66%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 1 001.20 | |
| (1.13%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 917 | |
| (1.55%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 144.05 | |
| (0.79%) | 18 262.02 | |
| Success rate FP7 applicants | 20.7% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 14.4% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 788 | |
| (1.54%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 133.04 | |
| (0.80%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 98 | |
| (12.44%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 182 | |
| (23.10%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 31.07 | |
| (23.35%) | 2 207.73 | |
| (13.32%) | | |



## TABLE 1

## HU - Hungary - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 797 | 223.08 | 104 | 13.05% | 26.08 | 11.69% |
| Research for the benefit of SMEs | 465 | 51.38 | 86 | 18.49% | 9.20 | 17.90% |
| Marie-Curie Actions | 444 | n/a | 170 | 38.29% | n/a | n/a |
| Socio-economic sciences and Humanities | 429 | 63.96 | 43 | 10.02% | 5.53 | 8.64% |
| Health | 417 | 154.35 | 57 | 13.67% | 11.77 | 7.62% |
| Environment (including Climate Change) | 291 | 54.46 | 47 | 16.15% | 6.15 | 11.29% |

## TABLE 2

## HU - Hungary - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all HU grant holders | EC contribution (EUR million) | % of total EC contribution to HU |
|---|---|---|---|---|
| Information and Communication Technologies | 107 | 13.58% | 23.09 | 17.36% |
| ERC | 18 | 2.28% | 18.16 | 13.65% |
| Marie-Curie Actions | 117 | 14.85% | 15.32 | 11.51% |
| Health | 55 | 6.98% | 9.42 | 7.08% |
| Research Infrastructures | 52 | 6.60% | 8.85 | 6.65% |
| Energy | 25 | 3.17% | 7.68 | 5.77% |

*Notes:* Report generated on: 2011/03/25.04:39 PM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## HU - Hungary - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 1 602 | 304.86 | 295 | 18.41% | 34.07 | 11.18% | 292 | 49.50 | 37.21% |
| PRC | 1 115 | 235.90 | 204 | 18.30% | 32.37 | 13.72% | 205 | 33.66 | 25.30% |
| REC | 871 | 161.05 | 218 | 25.03% | 27.68 | 17.19% | 192 | 34.21 | 25.71% |
| OTH | 398 | 67.25 | 82 | 20.60% | 12.04 | 17.91% | 19 | 2.21 | 1.66% |
| PUB | 283 | 41.47 | 98 | 34.63% | 12.48 | 30.09% | 80 | 13.47 | 10.12% |
| SME | 1 546 | 314.73 | 264 | 17.08% | 40.24 | 12.79% | 182 | 31.07 | 23.35% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education)

## TABLE 4

## HU - Hungary - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| HU - Hungary region | Number of grant holders | % of all HU - Hungary grant holders | EC contribution (M euro) | % of total EC contribution to HU |
|---|---|---|---|---|
| Budapest (HU101) | 528 | 67.01% | 91.42 | 68.72% |
| Pest (HU102) | 52 | 6.60% | 12.17 | 9.14% |
| Hajdu-Bihar (HU321) | 51 | 6.47% | 8.36 | 6.28% |
| Csongrad (HU333) | 35 | 4.44% | 7.80 | 5.86% |
| Gyor-Moson-Sopron (HU221) | 18 | 2.28% | 1.55 | 1.16% |

## TABLE 5

## HU - Hungary - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all HU grant holders | EC contribution (M euro) | % of total EC contribution to HU grant holders |
|---|---|---|---|---|
| Budapesti Muszaki Es Gazdasagtudomanyi Egyetem (Bme) | 64 | 8.12% | 12.83 | 9.64% |
| Eötvös Loránd Tudományegyetem (Elte) | 23 | 2.92% | 6.65 | 5.00% |
| Nemzeti Innovacios Hivatal (Nih) | 28 | 3.55% | 5.78 | 4.34% |
| Magyar Tudomanyos Akademia Szamitastechnikai Es Automatizalasi Kutato Intezet | 18 | 2.28% | 5.70 | 4.29% |
| Debreceni Egyetem | 28 | 3.55% | 5.22 | 3.93% |

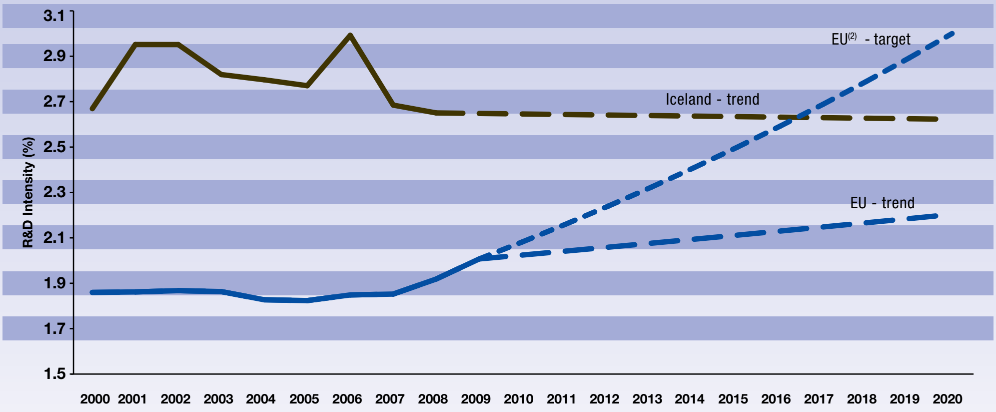
# COUNTRY PROFILE

# IS - Iceland

## Progress towards increasing the R&D intensity

The most recent figures for Iceland on R&D intensity are 3.1% for 2009 (of which 1.25% public and 1.51% private - apart from abroad sources). The figure below shows Eurostat data, which is slightly below the data in national statistics. Comparing to other European countries, the most noticeable is Iceland's very high public expenditure on R&D. Even if Iceland as an associated country to the European research cooperation does not form part of the Europe 2020 strategy of the European Union, certain associated countries do envisage fixing an objective for research investment and initiatives for fast growing innovative enterprises. This is the case for Iceland, which has set an R&D intensity target of 4% of GDP for 2020.

**ICELAND** **R&D Intensity projections, 2000-2020[1]**

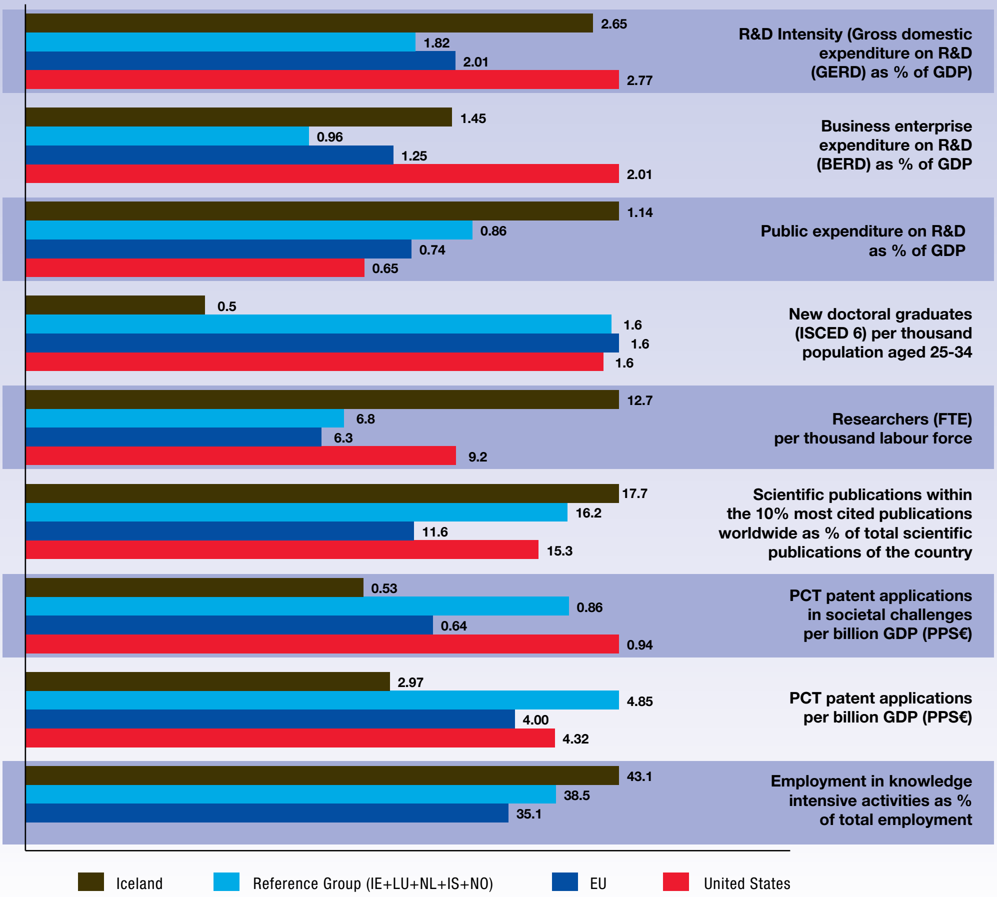


*Source:* DG Research and Innovation
*Data:* DG Research and Innovation, Eurostat
*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009 in the case of the EU and for 2000-2008 in the case of Iceland.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.

**Innovation Union Competitiveness Report 2011**

## ICELAND

R&D profile, 2009[1]



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) Elements of estimation were involved in the compilation of the data.

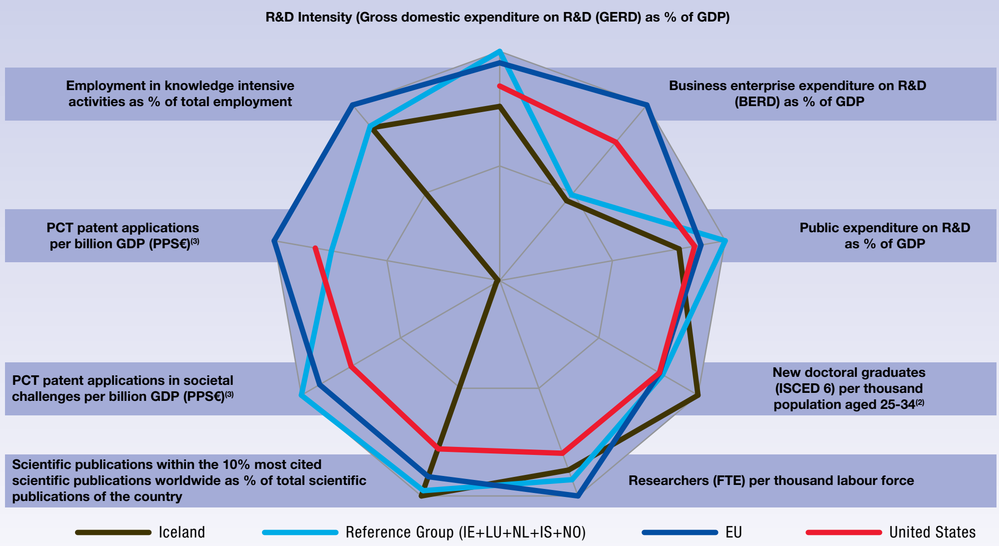
## Research and Innovation Performance

Iceland is a very knowledge-intensive country, with over 43% of employment in knowledge-intensive activities and R&D intensity far above other countries with a comparable industrial structure and knowledge capacity (see reference group). Iceland counts on a strong public science system with high funding and excellent research quality (17.7% of Iceland's scientific articles are among the 10% most cited articles in the world, which is one of the highest ratios in the world). Iceland also has achieved remarkably high researcher intensity in the labour force. However, it is a challenge to maintain this strength given a relatively low level of new doctoral graduates per thousand population. A relative weakness compared to the other countries is the patenting activity, measured by PCT patent intensity. The report shows that also for EPO patent application per billion GDP, Iceland is well below the EU average with a decreasing trend over the period 2000-2007.

The dynamic picture below shows that over the period 2000-2009, Iceland reinforced its strengths and weaknesses in its research and innovation system with a stable and strong public research system and human resources, but with a business dynamics showing lower average annual growth in R&D investment and lower patenting intensity growth than comparable countries and the EU on average.

## ICELAND

### Average annual growth (%), 2000-2009(1)

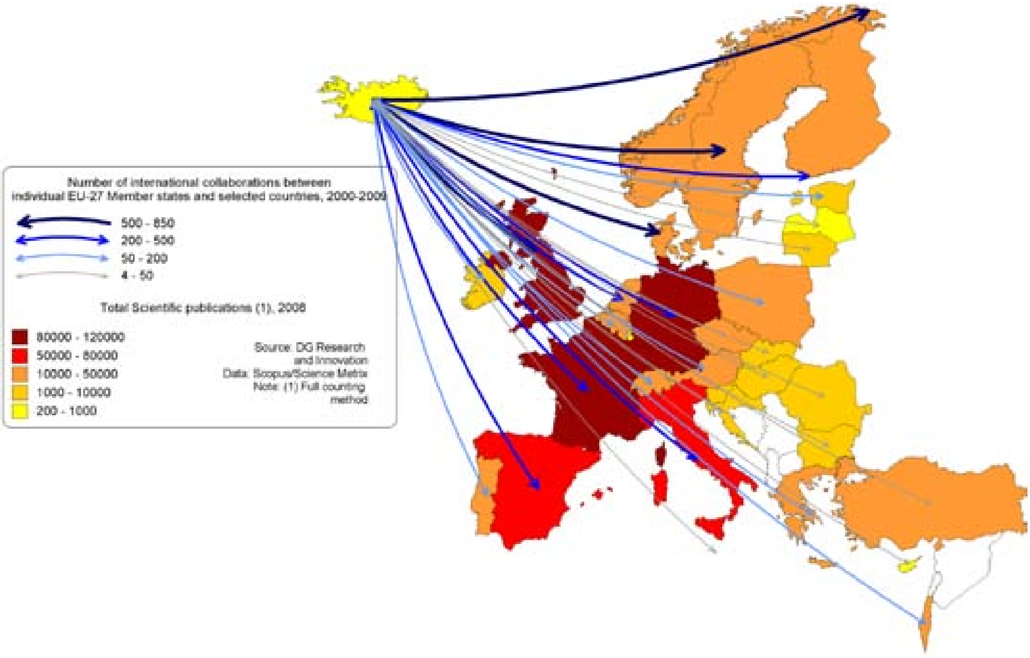


**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) LU is not included in the Reference Group.
(3) Average annual growth refers to real growth.
(4) Elements of estimation were involved in the compilation of the data.

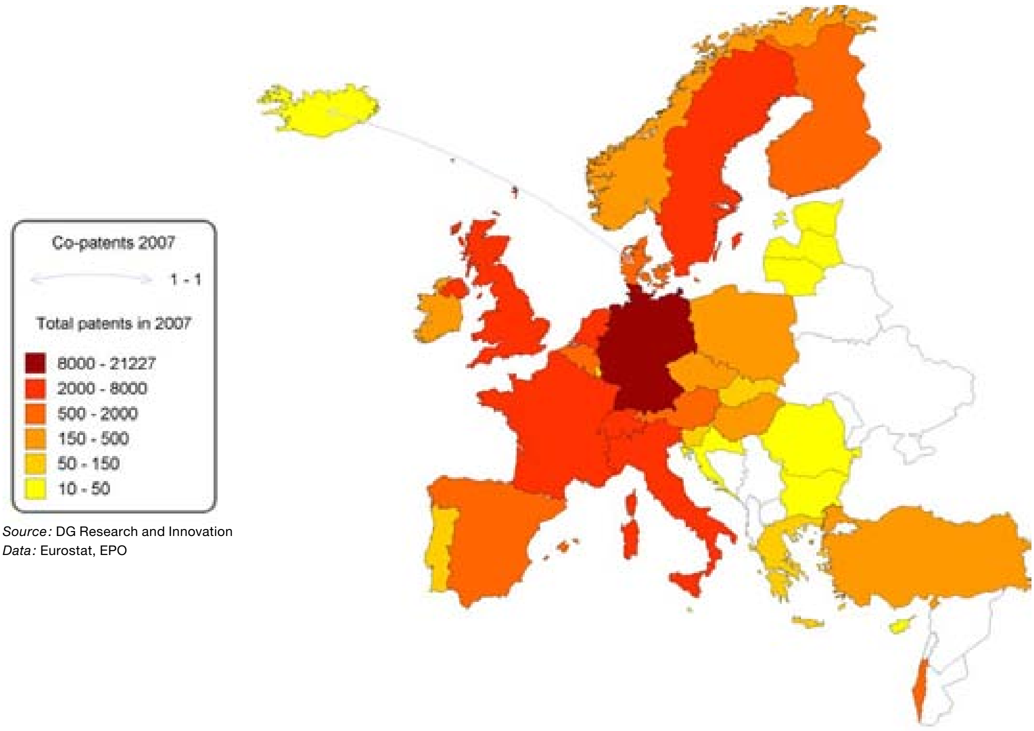
## ICELAND

### Co-publications between Iceland and European Countries in 2000-2009



## ICELAND

**Co-invented patent applications between Iceland and European Countries, 2007**



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

### Participation in the European Research Area: Scientific and Technological collaborations

Iceland's scientific cooperation (measured by co-publications) with other European countries is much broader and more intense than its technological cooperation (measured by co-patents). This reflects the strong public research base and the excellent science output in Iceland and it provides a potential for growing internationalisation also of technology cooperation. The main scientific partner countries are the Nordic neighbours and the United Kingdom. As a difference from technological cooperation, co-publications are intensive with almost all EU Member States and with associated countries to the European Research Area. However, overall network maps in the report shows that while Iceland does count on relatively well distributed scientific cooperation, the scale is too small to be visible in the dominant European scientific co-publication networks.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 423 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 570 applicants from Iceland (9.25% of Candidate Countries) and
- requesting EUR 162.75m of EC contribution (7.83% of Candidate Countries)

Among the Candidate Countries Iceland (IS) ranks:

- 3rd in terms of number of applicants and
- 3rd in terms of requested EC contribution

### Success rates

- The IS applicant success rate of 22.8% is higher than the Candidate Countries applicant success rate of 17.9%.
- The IS EC financial contribution success rate of 16.1% is higher than the Candidate Countries rate of 7.3%.

Specifically, following evaluation and selection, a total of

- 112 proposals were retained for funding (26.5%)
- involving 130 (22.8%) successful applicants from Iceland and
- requesting EUR 26.22m (16.1%) of EC financial contribution

Among the Candidate Countries, Iceland (IS) ranks:

- 2nd in terms of applicants success rate and
- 1st in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Iceland (IS) participates in

- 97 signed grant agreements
- involving 1 464 participants of which 105 (7.17%) are from Iceland
- benefiting from a total of EUR 288.61m of EC financial contribution of which EUR 22.56m (7.82%) is dedicated to participants from Iceland.

Among the Candidate Countries in all FP7 signed grant agreements, Iceland (IS) ranks:

- 3rd in number of participations and
- 3rd in budget share

### SME performance and participation

- The IS SME applicant success rate of 19.81% is higher than the Candidate Countries SME applicant success rate of 15.12%.
- The IS SME EC financial contribution success rate of 16.66% is higher than the corresponding Candidate Countries rate of 10.71%.

Specifically,

- 207 IS SME applicants requesting EUR 50.28m
- 41 (19.81%) successful SMEs requesting EUR 8.38m (16.66%)

In signed grant agreements, as of 2011/03/16,

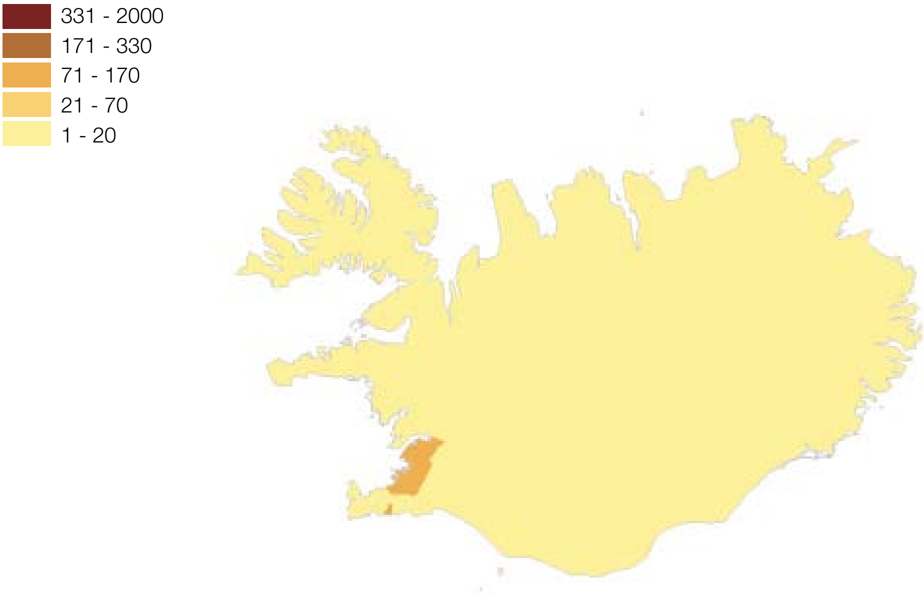
- 20 IS SME grant holders, i.e., 19.05% of total IS participation
- EUR 9.38m, i.e., 41.58% of total IS budget share

### Top 3 collaborative links with

- UK - United Kingdom (159)
- FR - France (97)
- DE - Germany (95)

| | | |
|---|---|---|
| Nr. of FP7 applicants | | |
| (% Candidate Countries) | 570 | |
| (9.25%) | 6 161 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% Candidate Countries) | 162.75 | |
| (7.83%) | 2 079 | |
| Nr. of successful FP7 applicants | | |
| (% Candidate Countries) | 130 | |
| (12.13%) | 1 072 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% Candidate Countries) | 26.22 | |
| (17.19%) | 152.58 | |
| Success rate FP7 applicants | 22.8% | 17.9% |
| Success rate | | |
| FP7 EC contribution | 16.1% | 7.3% |
| Nr. of FP7 grant holders | | |
| (% Candidate Countries) | 105 | |
| (12.03%) | 873 | |
| EC contribution | | |

| | | | |
|---|---|---|---|
| to FP7 grant holders | | (% of grant holders) | 20 |
| in EUR million | | (19.05%) | 131 |
| (% Candidate Countries) | 22.56 | (15.01%) | |
| (16.68%) | 135.27 | EC contribution to FP7 SME | |
| Nr. of FP7 coordinators | | grant holders in EUR million | |
| (% of grant holders) | 23 | (% of grant holders) | 9.38 |
| (21.90%) | 195 | (41.58%) | 30.20 |
| (22.34%) | | (22.32%) | |
| Nr. of FP7 SME grant holders | | | |



## TABLE 1

## IS - Iceland - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Research for the benefit of SMEs | 104 | 14.99 | 21 | 20.19% | 2.79 | 18.64% |
| Marie-Curie Actions | 87 | n/a | 26 | 29.89% | n/a | n/a |
| Information and Communication Technologies | 71 | 21.39 | 5 | 7.04% | 1.12 | 5.24% |
| Health | 56 | 31.09 | 17 | 30.36% | 9.40 | 30.23% |
| Food, Agriculture and Fisheries, and Biotechnology | 52 | 16.24 | 10 | 19.23% | 2.34 | 14.38% |
| Environment (including Climate Change) | 49 | 12.43 | 14 | 28.57% | 3.10 | 24.89% |

## TABLE 2

## IS - Iceland - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all IS grant holders | EC contribution (EUR million) | % of total EC contribution to IS |
|---|---|---|---|---|
| Health | 13 | 12.38% | 5.94 | 26.32% |
| Marie-Curie Actions | 20 | 19.05% | 5.10 | 22.63% |
| Environment (including Climate Change) | 14 | 13.33% | 2.44 | 10.81% |
| ERC | 1 | 0.95% | 2.40 | 10.64% |
| Food, Agriculture and Fisheries, and Biotechnology | 9 | 8.57% | 2.08 | 9.22% |
| Information and Communication Technologies | 5 | 4.76% | 1.06 | 4.69% |

*Notes:* Report generated on: 2011/03/28.11:32 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## IS - Iceland - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 198 | 42.02 | 35 | 17.68% | 4.91 | 11.68% | 30 | 7.84 | 34.73% |
| PRC | 164 | 47.32 | 31 | 18.90% | 9.77 | 20.64% | 23 | 9.64 | 42.72% |
| REC | 84 | 18.92 | 26 | 30.95% | 3.30 | 17.44% | 19 | 3.68 | 16.29% |
| PUB | 66 | 9.68 | 26 | 39.39% | 2.35 | 24.27% | 33 | 1.41 | 6.26% |
| OTH | 37 | 6.24 | 11 | 29.73% | 2.41 | 38.63% | 0 | 0.00 | 0.00% |
| | | | | | | | | | |
| SME | 207 | 50.28 | 41 | 19.81% | 8.38 | 16.66% | 20 | 9.38 | 41.58% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, PUB - Public body (excl. research and education), OTH - Others

## TABLE 4

## IS - Iceland - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| IS - Iceland region | Number of grant holders | % of all IS - Iceland grant holders | EC contribution (M euro) | % of total EC contribution to IS |
|---|---|---|---|---|
| Höfuðborgarsvæði (IS001) | 100 | 95.24% | 22.15 | 98.16% |
| Landsbyggð (IS002) | 3 | 2.86% | 0.18 | 0.82% |

## TABLE 5

## IS - Iceland - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all IS grant holders | EC contribution (M euro) | % of total EC contribution to IS grant holders |
|---|---|---|---|---|
| Islensk Erfdagreining Ehf (DECODE) | 14 | 13.33% | 8.60 | 38.10% |
| Haskoli Islands | 21 | 20.00% | 6.14 | 27.21% |
| Hafrannsoknastofnunin | 6 | 5.71% | 1.66 | 7.34% |
| The Icelandic Centre For Research (RANNIS) | 29 | 27.62% | 1.27 | 5.63% |
| Haskolinn I Reykjavik Ehf | 5 | 4.76% | 1.27 | 5.61% |

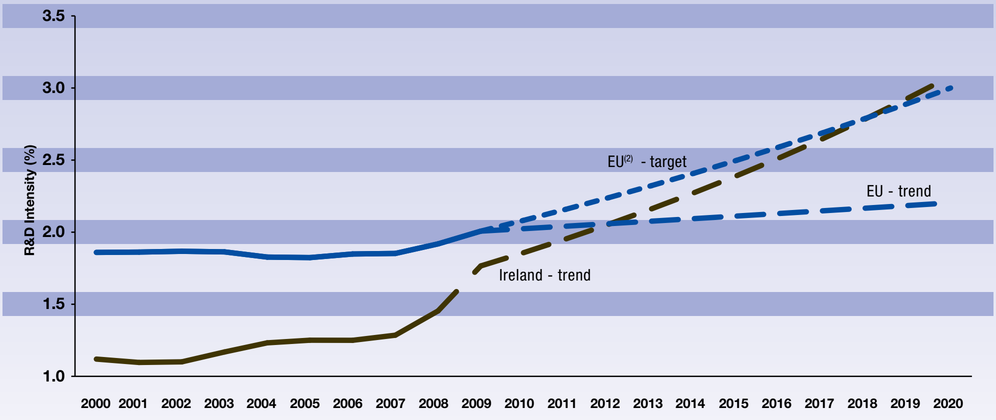
# COUNTRY PROFILE

# IE - Ireland

## Progress towards meeting the Europe 2020 R&D intensity target

In the last decade, overall R&D investment grew strong in real terms, and despite the relatively important GDP growth, R&D intensity in Ireland increased from 1.12% in 2000, to 1.45% in 2008 and up to 1.77% in 2009. However, the sharp acceleration of R&D intensity over the last two years can be largely attributed to the sharp drop in GDP in 2008 and 2009, when Ireland was particularly hit by the international economic and financial crisis. The current financial difficulties that the country is experiencing can cast some doubts about the capacity of both the public and private sectors to maintain and increase their R&D investments in the short term, but R&D investment still remains a high priority for the country in order to boost its productivity and maintain its economic competitiveness and social progress.

**IRELAND** **R&D Intensity projections, 2000-2020**(1)



*Source:* DG Research and Innovation

*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.

**Innovation Union Competitiveness Report 2011**

## Research and Innovation Performance

The Irish Research and innovation system is characterised by a strong high-quality scientific performance thanks to a well established number of renowned universities, and a large presence of foreign multinational companies, who account for a large share of the Irish scientific and technological performance and contribute to the positive manufacturing trade balance[9] in high-tech and medium high-tech products.

In general, Ireland performs quite well in most indicators, reaching similar values to the EU average and the group of countries sharing similar research and innovation characteristics. Perhaps, the exception lies on the level of inventiveness of the economy as measured by the number of PCT patents, which falls short in comparison to the EU or other similar systems. Given the relatively strong scientific performance and the relatively recent development of the research base, this may rather reflect a time-lag in bringing new ideas to market or

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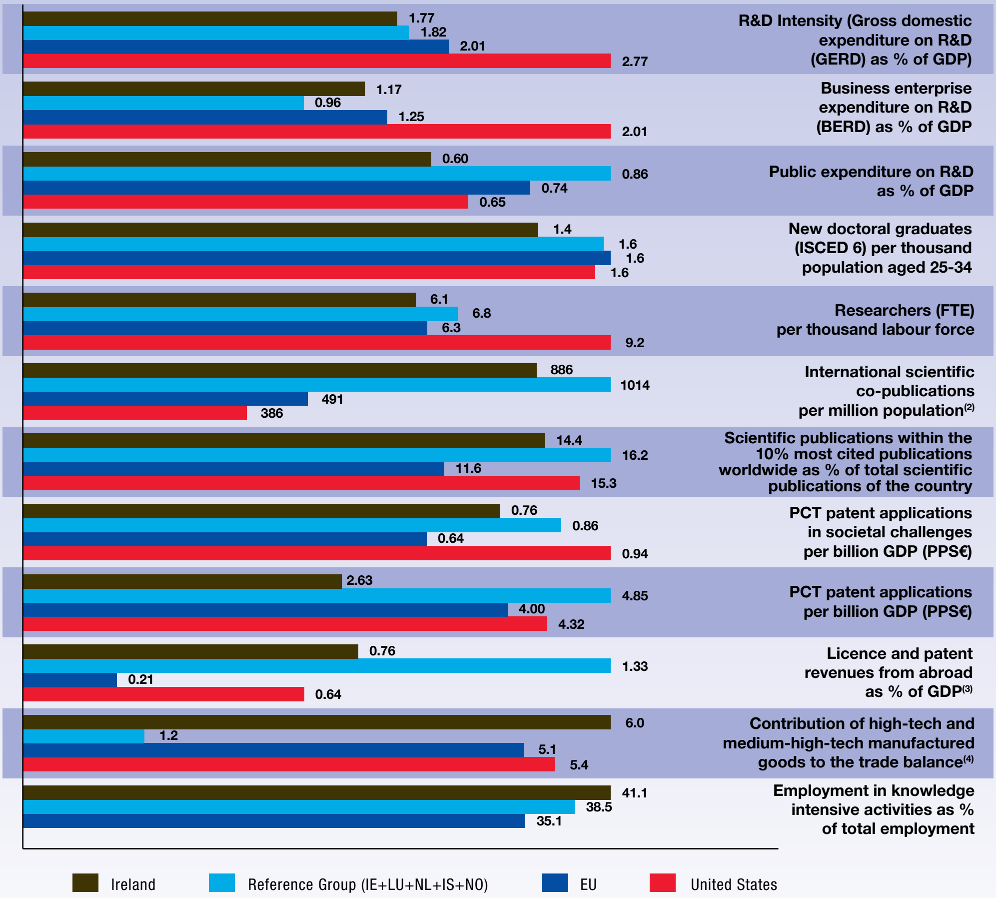
[9] The manufacturing trade balance is an indicator of competitive advantage

## IRELAND

### R&D profile, 2009(1)



Innovation Union Competitiveness Report 2011

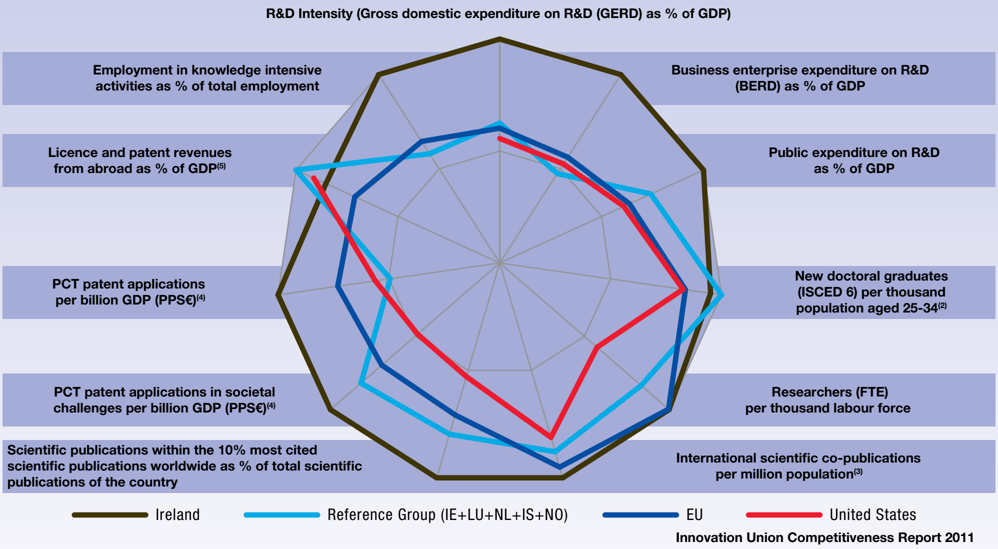
*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) (i) The EU value refers to the median rather than to the average (ii) IS and NO are not included in the Reference Group.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU; (iii) IS and NO are not included in the Reference Group.
(5) Elements of estimation were involved in the compilation of the data.

be due to the fact that in ICT, IP is often held in the country of head office and comprises copyright rather than patents. Current policy calls for multinationals present in Ireland to increase R&D activities in their core business that may lead to indigenous inventions and for more support for the emergence of technological based fast growing innovative local firms.

From a dynamic perspective, in the last decade, the Irish research and innovation system made good progress in all dimensions, from R&D investments to scientific and technological performance or shifts towards more knowledge intensive activities. Ireland outperformed not only the EU average or the United States, but also the average of the reference group of countries with similar research characteristics. This good performance has allowed Ireland to rapidly catch-up with some strong scientific and technological performing countries in Europe, such as the Netherlands and approach values closer to the EU average.

## IRELAND

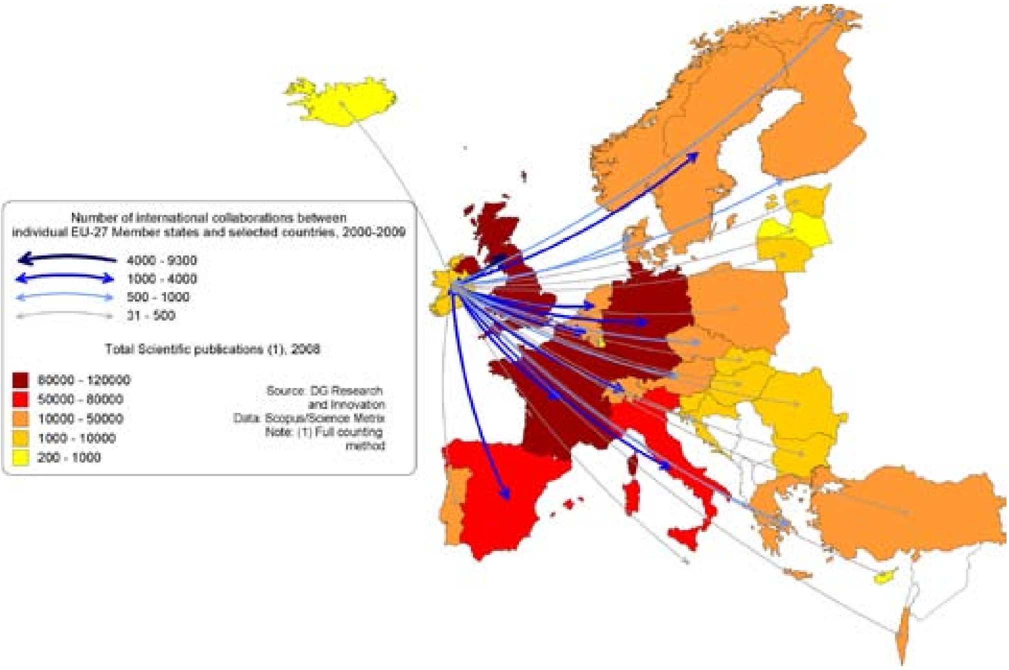
## Average annual growth (%), 2000-2009(1)



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) LU is not included in the Reference Group.
(3) (i) The EU value refers to the median rather than to the average; (ii) IS and NO are not included in the Reference Group.
(4) Average annual growth refers to real growth.
(5) EU refers to extra-EU.
(6) Elements of estimation were involved in the compilation of the data.

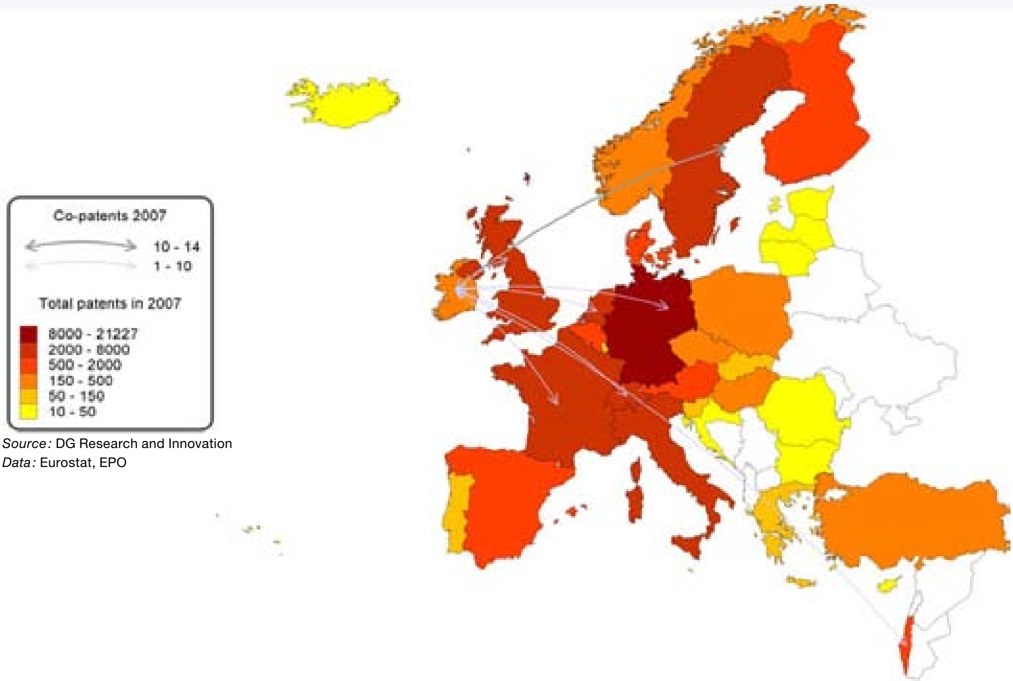
## IRELAND

## Co-publications between Ireland and European Countries in 2000-2009



IRELAND

## Co-invented patent applications between Ireland and European Countries, 2007



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

### Participation in the European Research Area: Scientific and Technological collaborations

Ireland is a small and open economy and this reflects in its research and innovation system. The high level of co-publications evidences the openness of its scientific system. The strong links with the United Kingdom, the main scientific partner and one of the strongholds of scientific excellence and knowledge hubs in Europe, suggests a high capacity of the country to tap into international knowledge and potentially benefit from strong knowledge spillovers. In addition to the United Kingdom, Ireland also establishes strong links with other EU Member States and Associated countries such as Germany, France, Belgium, the Netherlands or Switzerland. This constitutes a strong asset for Ireland to host internationally attractive research centres.

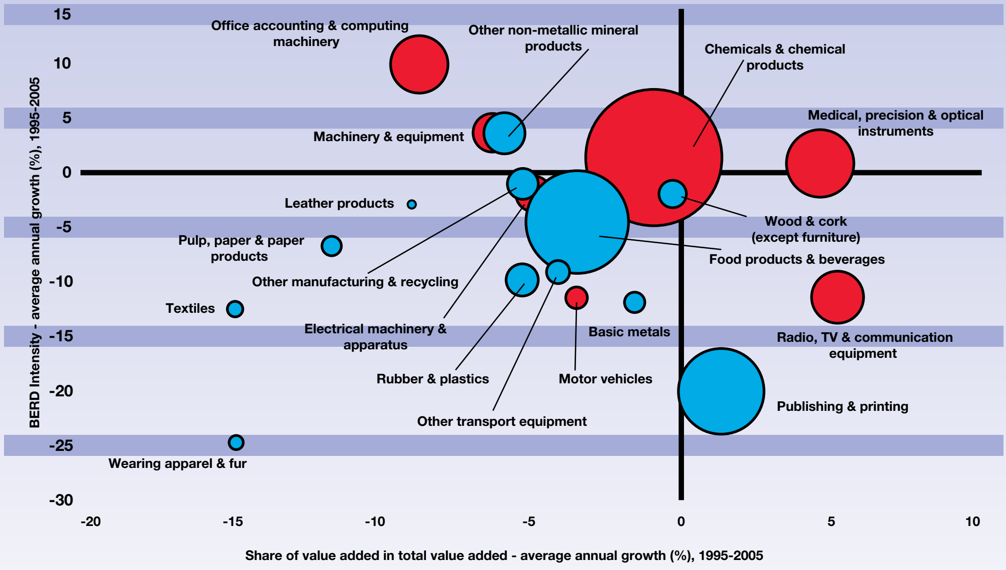
In terms of co-patents patents, however, the linkages are much weaker in general and somehow evidence the relatively weaker position of Ireland in patenting. Addressing this weakness might be decisive in taking better economic advantage of the strong integration of Ireland in the European Research Area.

### Structural change towards more knowledge-intensive economy

In the last decade, private R&D intensity grew from 0.8% in 2000 to 1.17% in 2009. This relative progress was achieved mainly due to the rise in importance of some medium-high tech and high-tech sectors, such as medical, precision and optical instruments in the overall economy, and the move towards higher research-intensive segments in research intensity sectors such as office accounting and computing machinery. The weight and research intensity of the chemicals and chemical products sector are noticeable and constitute strong assets for the country. As a whole, the Irish economy is relatively well diversified and its trend towards a more knowledge and innovation intensive economy is a realistic prospect in spite of the current severe financial constraint. This will largely depend on the ability to maintain favourable framework conditions throughout the sectors and to encourage investment in R&I by less intensive sectors such as food products and beverages or publishing and printing.

## IRELAND

### Share of value added versus BERD Intensity - Average annual growth, 1995-2005



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.
(2) 'Coke, refined petroleum products and nuclear fuel', 'Construction' and 'Electricity, gas and water' are not included on the graph.
(3) 'Fabricated metal products' is not visible on the graph.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 3240 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 4097 applicants from Ireland (1.54% of EU-27*) and
- requesting EUR 1359.44m of EC contribution (1.54% of EU-27*)

Among the EU-27* Ireland (IE) ranks:

- 17th in terms of number of applicants and
- 15th in terms of requested EC contribution

### Success rates

- The IE applicant success rate of 23.3% is higher than the EU-27* applicant success rate of 21.6%.
- The IE EC financial contribution success rate of 18.4% is lower than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 747 proposals were retained for funding (23.1%)
- involving 953 (23.3%) successful applicants from Ireland and
- requesting EUR 250.56m (18.4%) of EC financial contribution

Among the EU-27*, Ireland (IE) ranks:

- 8th in terms of applicants success rate and
- 10th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Ireland (IE) participates in

- 624 signed grant agreements
- involving 7291 participants of which 778 (10.67%) are from Ireland
- benefiting from a total of EUR 2203.49m of EC financial contribution of which EUR 243.98m (11.07%) is dedicated to participants from Ireland.

Among the EU-27* in all FP7 signed grant agreements, Ireland (IE) ranks:

- 16th in number of participations and
- 13th in budget share

### SME performance and participation

- The IE SME applicant success rate of 23.30% is higher than the EU-27* SME applicant success rate of 19.33%.
- The IE SME EC financial contribution success rate of 23.38% is higher than the corresponding EU-27* rate of 18.26%.

Specifically,

- 1 073 IE SME applicants requesting EUR 283.33m
- 250 (23.30%) successful SMEs requesting EUR 66.24m (23.38%)

In signed grant agreements, as of 2011/03/16,

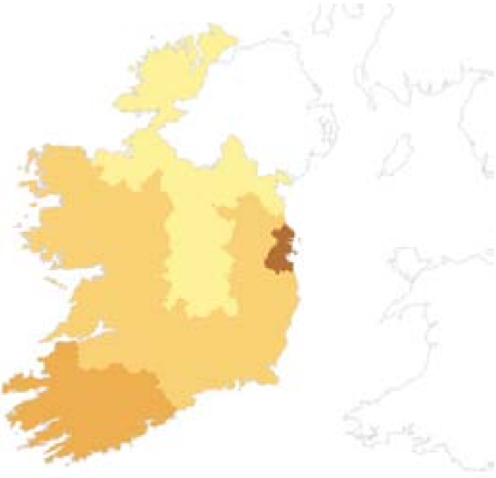
- 172 IE SME grant holders, i.e., 22.11% of total IE participation
- EUR 50.03m, i.e., 20.50% of total IE budget share

### Top 3 collaborative links with

- UK - United Kingdom (835)
- DE - Germany (801)
- FR - France (634)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 9th | |
| - Above EU-27 average | | |
| - Innovation Follower | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 4 097 | |
| (1.54%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 1 359.44 | |
| (1.54%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 953 | |
| (1.61%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 250.56 | |
| (1.37%) | 18 262.02 | |
| Success rate FP7 applicants | 23.3% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 18.4% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 778 | |
| (1.52%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 243.98 | |
| (1.47%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 181 | |
| (23.26%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 172 | |
| (22.11%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 50.03 | |
| (20.50%) | 2 207.73 | |
| (13.32%) | | |

🟥 331 - 2000
🟫 171 - 330
🟧 71 - 170
🟨 21 - 70
🟨 1 - 20



## TABLE 1

## IE - Ireland - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 1 023 | 416.38 | 189 | 18.48% | 73.86 | 17.74% |
| Marie-Curie Actions | 684 | n/a | 183 | 26.75% | n/a | n/a |
| Research for the benefit of SMEs | 478 | 78.35 | 118 | 24.69% | 17.51 | 22.35% |
| Health | 327 | 143.51 | 75 | 22.94% | 34.58 | 24.09% |
| Food, Agriculture and Fisheries, and Biotechnology | 232 | 79.65 | 53 | 22.84% | 14.41 | 18.09% |
| European Research Council | 196 | 301.93 | 14 | 7.14% | 20.46 | 6.78% |

## TABLE 2

## IE - Ireland - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all IE grant holders | EC contribution (EUR million) | % of total EC contribution to IE |
|---|---|---|---|---|
| Information and Communication Technologies | 176 | 22.62% | 65.60 | 26.89% |
| Marie-Curie Actions | 143 | 18.38% | 42.78 | 17.53% |
| Health | 73 | 9.38% | 31.06 | 12.73% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 54 | 6.94% | 19.92 | 8.17% |
| ERC | 12 | 1.54% | 15.33 | 6.28% |
| Energy | 24 | 3.08% | 11.41 | 4.68% |

*Notes:* Report generated on: 2011/03/25.04:39 PM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## IE - Ireland - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 2 203 | 645.24 | 497 | 22.56% | 127.88 | 19.82% | 448 | 154.67 | 63.40% |
| PRC | 1 079 | 291.83 | 256 | 23.73% | 70.70 | 24.23% | 219 | 62.02 | 25.42% |
| REC | 229 | 45.49 | 78 | 34.06% | 13.99 | 30.76% | 64 | 16.10 | 6.60% |
| OTH | 228 | 52.30 | 51 | 22.37% | 10.42 | 19.92% | 13 | 2.49 | 1.02% |
| PUB | 162 | 22.66 | 57 | 35.19% | 7.11 | 31.38% | 34 | 8.70 | 3.57% |
| | | | | | | | | | |
| SME | 1 073 | 283.33 | 250 | 23.30% | 66.24 | 23.38% | 172 | 50.03 | 20.50% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education)

## TABLE 4

## IE - Ireland - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| IE - Ireland region | Number of grant holders | % of all IE - Ireland grant holders | EC contribution (M euro) | % of total EC contribution to IE |
|---|---|---|---|---|
| Dublin (IE021) | 381 | 48.97% | 122.70 | 50.29% |
| South-West (IRL) (IE025) | 136 | 17.48% | 42.13 | 17.27% |
| West (IE013) | 85 | 10.93% | 27.37 | 11.22% |
| South-East (IRL) (IE024) | 56 | 7.20% | 15.24 | 6.25% |
| Mid-West (IE023) | 38 | 4.88% | 12.07 | 4.95% |

## TABLE 5

## IE - Ireland - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all IE grant holders | EC contribution (M euro) | % of total EC contribution to IE grant holders |
|---|---|---|---|---|
| The Provost Fellows & Scholars Of The College Of The Holy And Undivided Trinity Of Queen Elizabeth Near Dublin (Trinity College Dubl) | 86 | 11.05% | 34.04 | 13.95% |
| University College Cork, National University Of Ireland, Cork | 91 | 11.70% | 31.01 | 12.71% |
| University College Dublin, National University Of Ireland, Dublin | 82 | 10.54% | 27.45 | 11.25% |
| National University Of Ireland, Galway (NUI Galway) | 58 | 7.46% | 21.17 | 8.68% |
| University Of Limerick (University Of Limeri) | 27 | 3.47% | 9.30 | 3.81% |

# COUNTRY PROFILE

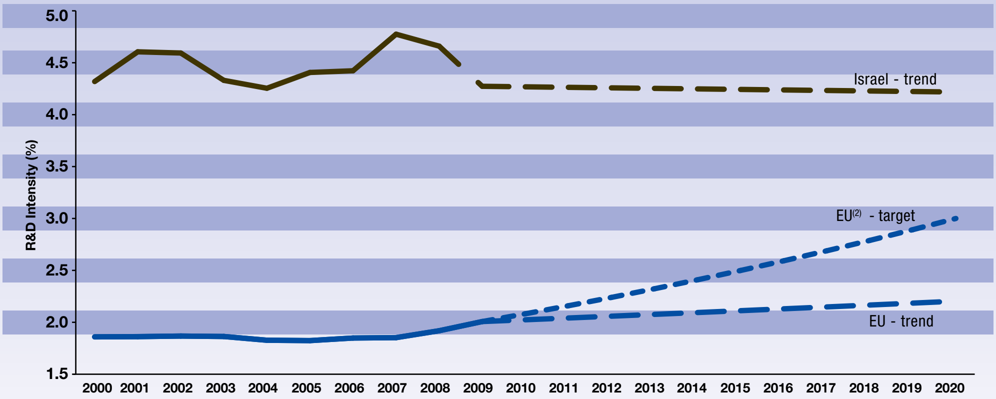
# IL - Israel

## Progress towards increasing the R&D intensity

The most recent figures for Israel on R&D intensity are 4.27% for 2009, which is the highest intensity in the world. The evolution of R&D intensity in Israel fluctuated over the period 2000-2009 with a slight increase. However, contrary to the EU average, since 2007 there has been a downward trend, partly reflecting a low average annual growth rate of public R&D expenditures as% of GDP. Concerning the overall public and private expenditure of R&D (GERD), Israel has had an annual average growth rate of 2.8% over the period 2000-2009, which is slightly above the EU average and the US growth of 2.5% and 2.4% respectively. Even if the associated countries to the European research cooperation do not form part of the Europe 2020 strategy of the European Union, certain countries do envisage fixing an objective for research investment and initiatives for fast growing innovative enterprises. This strategy could be justified if based on a consultation with the stakeholders in the country.

**ISRAEL**

**R&D Intensity projections, 2000-2020**(1)



*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* DG Research and Innovation, Eurostat

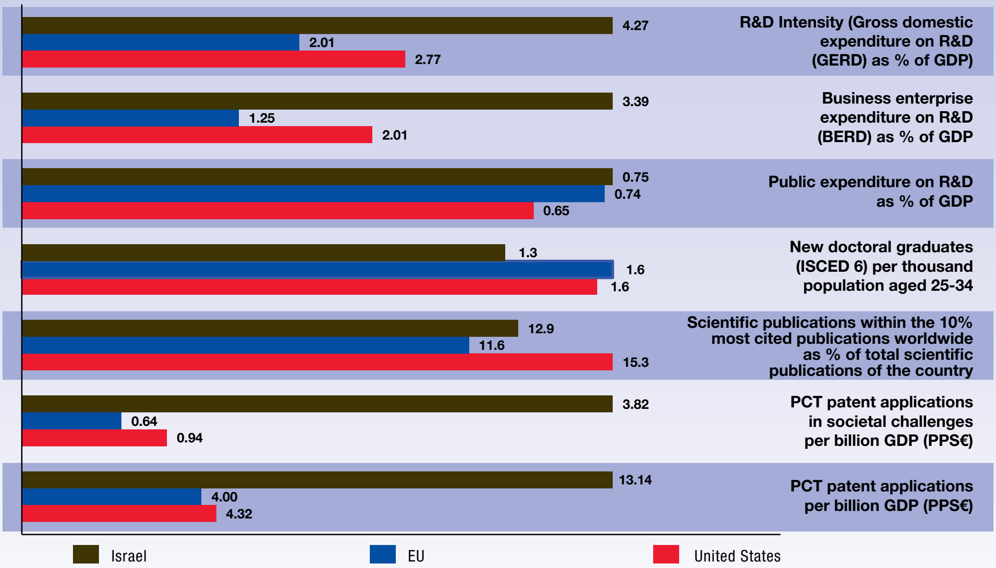
*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.

## Research and Innovation Performance

Israel is a relatively knowledge-intensive country, with strong business sector dynamics. Israel's main strengths are the research-intensity of its private sector, as indicated in a very high business expenditure on R&D and patenting activity. The report shows that Israel has also increased its EPO patenting activity between 2000 and 2007, to reach the highest share of EPO patent applications per billion GDP. Considering high-tech EPO patent applications, Israel holds the third place, behind Finland and Sweden. A weaker dimension is the dynamics of human resources for research, with a lower ratio of new doctoral graduates per thousand population in a comparable age group. The quality of the scientific production in Israel, counting a ratio of 12.9% of the scientific articles among the 10% most cited worldwide, is higher than the EU average, but below that of the United States.

# ISRAEL

## R&D profile, 2009[1]



**Innovation Union Competitiveness Report 2011**

*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) Elements of estimation were involved in the compilation of the data.

The dynamic picture below reinforces the strengths and weaknesses in the Israeli science and innovation system with an enhanced private research system but with a public R&D expenditure showing lower average annual growth compared to the EU and the United States. However, there was a slight reinforcement of the new human resources for research over the period 2000-2009.

## Participation in the European Research Area: Scientific and Technological collaborations

Contrary to many other countries in the European Research Area, Israel's scientific cooperation (measured by co-publications) with other European countries is very similar in scope to its technological cooperation (measured by co-patents), showing the noticeable strong patenting activity in Israel. In both scientific and technological cooperation, Israel is well integrated in the European Research Area with partners in almost all European countries. The main scientific partner countries in absolute terms are the larger research countries such as the United Kingdom, Germany, France and Italy. However, the report describes the overall European research and technology cooperation networks, where Israel holds a marginal position in the overall size of co-publication and co-patenting. The centre of the European networks is in the Western and Central part of Europe.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 3 778 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 4 790 applicants from Israel (23.68% of Associated Countries) and
- requesting EUR 2 209.42m of EC contribution (28.02% of Associated Countries)

Among the Associated Countries Israel (IL) ranks:

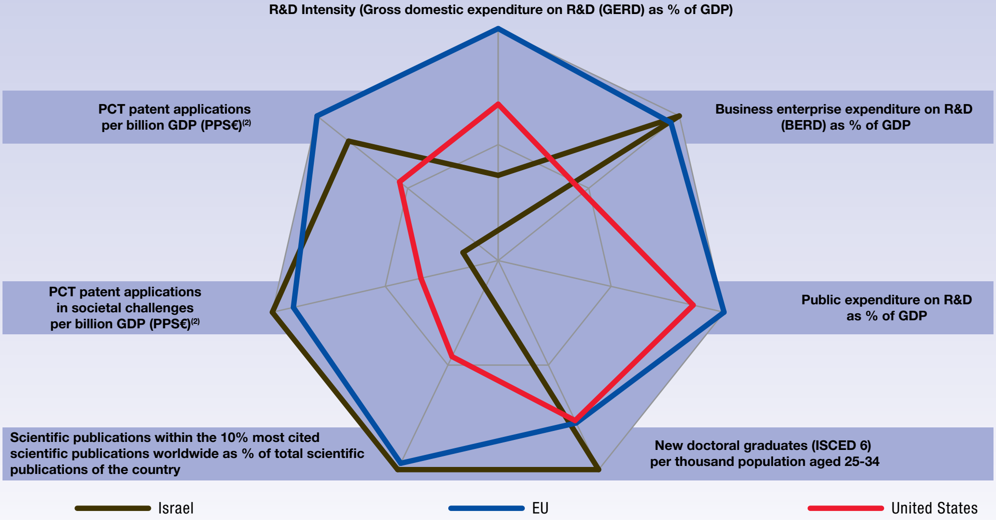
- 3rd in terms of number of applicants and
- 2nd in terms of requested EC contribution

### Success rates

- The IL applicant success rate of 21.5% is lower than the Associated Countries applicant success rate of 23.5%.

ISRAEL

## Average annual growth (%), 2000-2009[1]

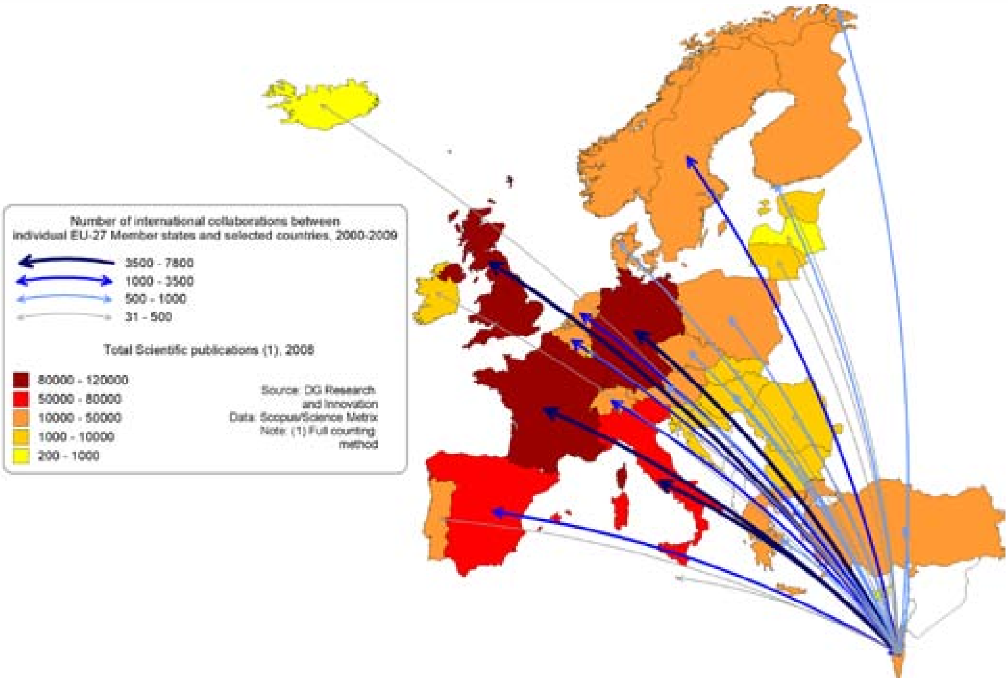


**Innovation Union Competitiveness Report 2011**

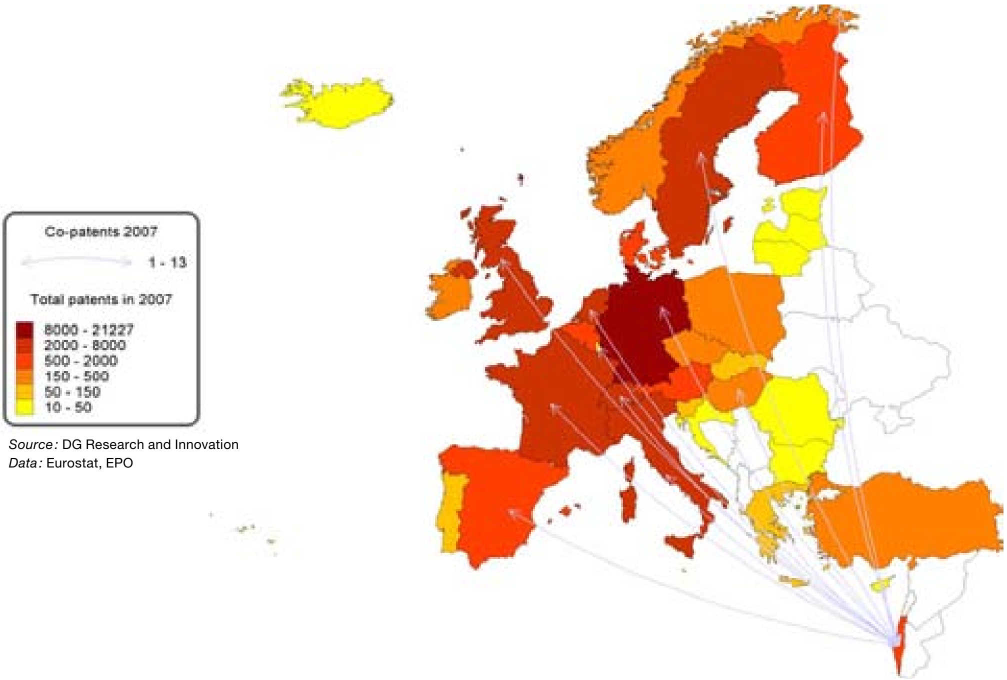
*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) Average annual growth refers to real growth.
(3) Elements of estimation were involved in the compilation of the data.

ISRAEL

## Co-publications between Israel and European Countries in 2000-2009



## Co-invented patent applications between Israel and European Countries, 2007



*Source:* DG Research and Innovation
*Data:* Eurostat, EPO

- The IL EC financial contribution success rate of 16.7% is lower than the Associated Countries rate of 21.7%.

Specifically, following evaluation and selection, a total of

- 842 proposals were retained for funding (22.3%)
- involving 1 030 (21.5%) successful applicants from Israel and
- requesting EUR 369.90m (16.7%) of EC financial contribution

Among the Associated Countries, Israel (IL) ranks:

- 4th in terms of applicants success rate and
- 5th in terms of EC financial contribution success rate

**Signed grant agreements**

As of 2011/03/16, Israel (IL) participates in

- 754 signed grant agreements
- involving 6 729 participants of which 919 (13.66%) are from Israel
- benefiting from a total of EUR 2 261.74m of EC financial contribution of which EUR 352.03m (15.56%) is dedicated to participants from Israel.

Among the Associated Countries in all FP7 signed grant agreements, Israel (IL) ranks:

- 3rd in number of participations and
- 2nd in budget share

**SME performance and participation**

- The IL SME applicant success rate of 15.88% is lower than the Associated Countries SME applicant success rate of 20.42%.
- The IL SME EC financial contribution success rate of 13.24% is lower than the corresponding Associated Countries rate of 18.51%.

Specifically,

- 1 102 IL SME applicants requesting EUR 389.21m
- 175 (15.88%) successful SMEs requesting EUR 51.51m (13.24%)

In signed grant agreements, as of 2011/03/16,

- 126 IL SME grant holders, i.e., 13.71% of total IL participation
- EUR 42.32m, i.e., 12.02% of total IL budget share

**Top 3 collaborative links with**

- DE - Germany (815)
- UK - United Kingdom (616)
- IT - Italy (584)

| | | |
|---|---|---|
| Nr. of FP7 applicants | | |
| (% Associated Countries) | 4 790 | |
| (23.68%) | 20 227 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% Associated Countries) | 2 209.42 | |
| (28.02%) | 7 884 | |
| Nr. of successful FP7 applicants | | |
| (% Associated Countries) | 1 030 | |
| (21.45%) | 4 802 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% Associated Countries) | 369.90 | |
| (21.62%) | 1 711.27 | |
| Success rate FP7 applicants | 21.5% | 23.5% |
| Success rate | | |
| FP7 EC contribution | 16.7% | 21.7% |
| Nr. of FP7 grant holders | | |
| (% Associated Countries) | 919 | |
| (22.46%) | 4 092 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% Associated Countries) | 352.03 | |
| (22.93%) | 1 535.13 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 329 | |
| (35.80%) | 915 | |
| (22.36%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 126 | |
| (13.71%) | 634 | |
| (15.49%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 42.32 | |
| (12.02%) | 175.41 | |
| (11.43%) | | |

## TABLE 1

## IL - Israel - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 1 201 | 512.14 | 179 | 14.90% | 78.25 | 15.28% |
| Marie-Curie Actions | 776 | n/a | 329 | 42.40% | n/a | n/a |
| European Research Council | 540 | 916.61 | 96 | 17.78% | 160.84 | 17.55% |
| Health | 533 | 248.71 | 84 | 15.76% | 35.04 | 14.09% |
| Security | 316 | 127.45 | 54 | 17.09% | 21.15 | 16.60% |
| Food, Agriculture and Fisheries, and Biotechnology | 232 | 70.31 | 27 | 11.64% | 6.87 | 9.77% |

## TABLE 2

## IL - Israel - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all IL grant holders | EC contribution (EUR million) | % of total EC contribution to IL |
|---|---|---|---|---|
| ERC | 97 | 10.55% | 134.91 | 38.33% |
| Information and Communication Technologies | 183 | 19.91% | 73.76 | 20.95% |
| Marie-Curie Actions | 275 | 29.92% | 33.62 | 9.55% |
| Health | 78 | 8.49% | 31.63 | 8.99% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 63 | 6.86% | 26.94 | 7.65% |
| Security | 37 | 4.03% | 15.01 | 4.26% |

*Notes:* Report generated on: 2011/03/28.11:36 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## IL - Israel - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 2177 | 551.01 | 540 | 24.80% | 89.62 | 16.26% | 586 | 247.31 | 70.25% |
| PRC | 1377 | 562.64 | 235 | 17.07% | 95.72 | 17.01% | 218 | 87.59 | 24.88% |
| PUB | 307 | 69.12 | 96 | 31.27% | 11.47 | 16.59% | 70 | 8.26 | 2.35% |
| REC | 254 | 72.93 | 42 | 16.54% | 8.46 | 11.60% | 36 | 7.45 | 2.12% |
| OTH | 135 | 37.11 | 21 | 15.56% | 3.78 | 10.20% | 9 | 1.43 | 0.41% |
| SME | 1102 | 389.21 | 175 | 15.88% | 51.51 | 13.24% | 126 | 42.32 | 12.02% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), PUB - Public body (excl. research and education), REC - Research organisations, OTH - Others

## TABLE 4

## IL - Israel - Most active organisations in terms of EC contribution granted to the FP7 research projects

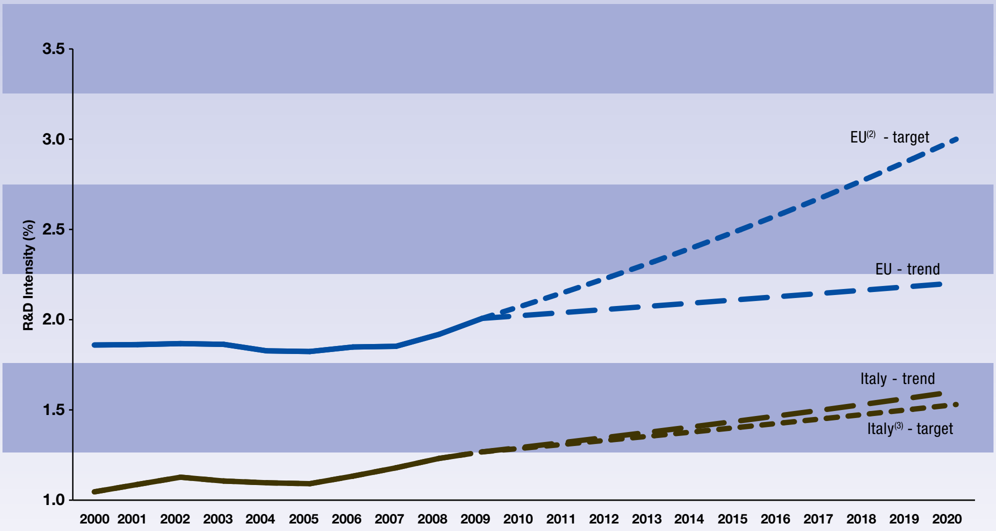
| Legal Name | Number of Participations | % of all IL grant holders | EC contribution (M euro) | % of total EC contribution to IL grant holders |
|---|---|---|---|---|
| The Hebrew University of Jerusalem (HUJI) | 119 | 12.95% | 67.44 | 19.16% |
| Weizmann Institute of Science (WEIZMANN) | 107 | 11.64% | 67.24 | 19.10% |
| Technion - Israel Institute of Technology (IIT) | 103 | 11.21% | 42.00 | 11.93% |
| Tel aviv university (TAU) | 99 | 10.77% | 27.32 | 7.76% |
| IBM Israel - Science and Technology Ltd (IBM Israel) | 30 | 3.26% | 20.11 | 5.71% |

# IT – Italy

## Progress towards meeting the Europe 2020 R&D intensity target

R&D intensity in Italy increased around 2.3% annually over the 2000-2009 period, passing from 1.05% of GDP in 2000 to 1.27% in 2009. Both public and private R&D have grown during the period, but modestly. In 2009, public R&D intensity was 0.57% and private R&D intensity was 0.64%. Considering the 2020 R&D target, Italy set the value of 1.53%. Given the trend scenario presented below, this target is achievable but is not ambitious. The difference between Italy's R&D intensity (1.27%) and the EU-average (1.90%) is mainly due to lower industrial R&D (business R&D intensity in Italy is 0.64% of GDP compared to an EU-27 average of 1.23% of GDP).

**ITALY** **R&D Intensity projections, 2000-2020(1)**



**Innovation Union Competitiveness Report 2011**

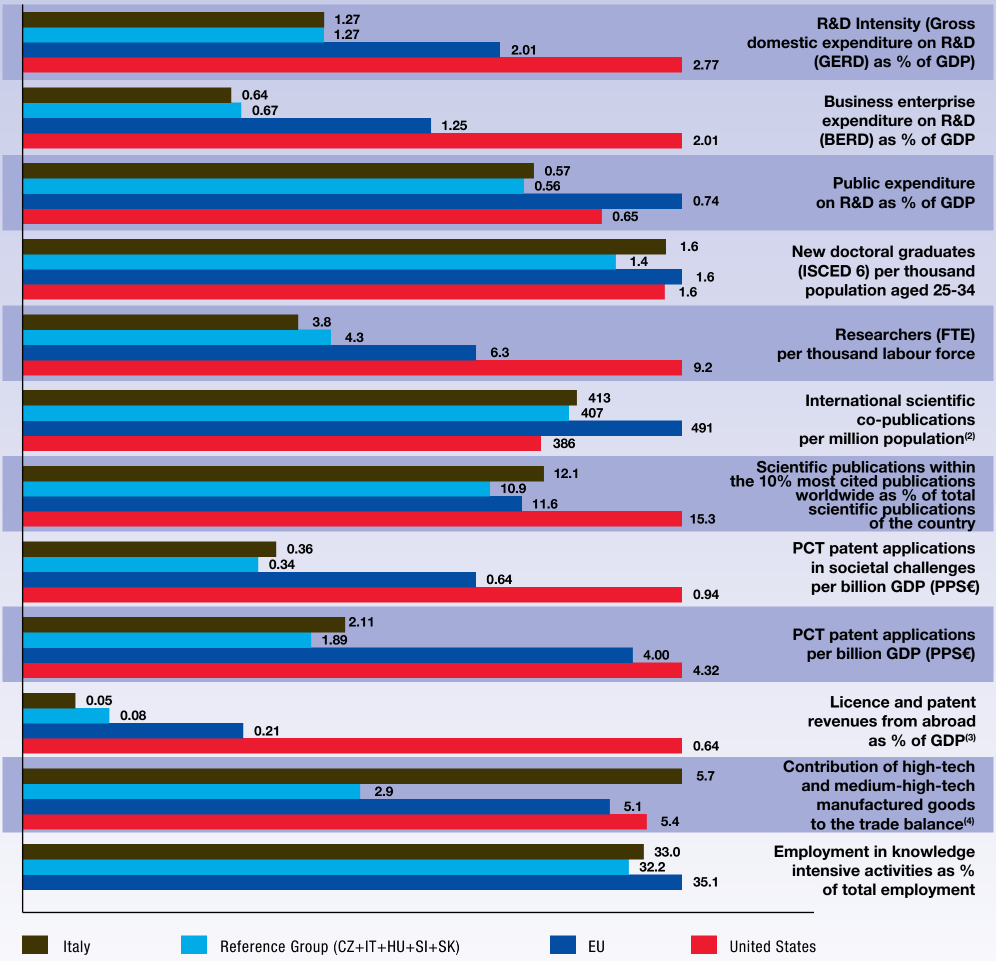
*Source:* DG Research and Innovation
*Data:* DG Research and Innovation, Eurostat
*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) EU: IT: This projection is based on a tentative R&D Intensity target of 1.53% for 2020.

## Research and Innovation Performance

The Italian R&D and innovation system shows positive and negative aspects. In innovation, Italy ranks below the EU average as a moderate innovator. Policy intervention has opened many possibilities which have not been completely exploited due to two types of structural weaknesses: inertia regarding modernisation within the public research system and the difficulty to realise growth and innovation within the industrial system, particularly with regard to the most high-tech sectors. The levels of population with tertiary education (11.6%) and participation in life-long learning (6.8%) are below the EU averages of 22.8% and

# ITALY

## R&D profile 2009(1)



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

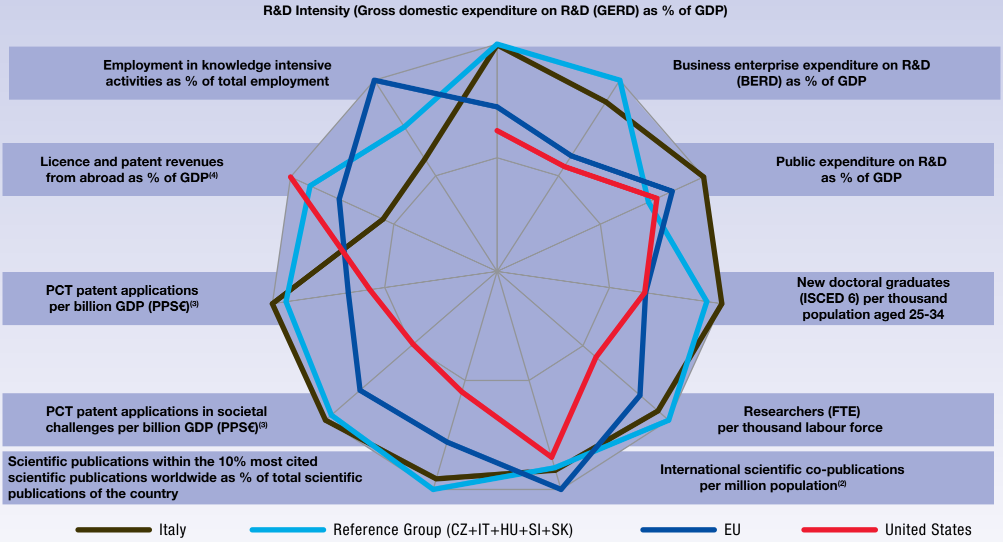
**Innovation Union Competitiveness Report 2011**

9.8% respectively. The total number of researchers (FTE) had an annual average growth rate of almost 4% between 2000 and 2009, but is still well below the EU average (3.38 researchers versus 6.3 in 2009). The number of foreign researchers that choose Italy as a place to perform research is lower than the number of Italian researchers choosing to work abroad. However, the quality of the scientific base as measured by the scientific publications within the 10% most cited publications worldwide as a percentage of the total scientific publications of the country is above the EU average. The positive contribution of high-tech and medium-high-tech manufactured goods to the trade balance also demonstrates the potential of the country to steer reforms of the R&I system and to derive economic benefits from future efforts.

The business sector in Italy is characterised by a large number of small and medium-sized firms, specialised in products that require high-quality design and engineering, whose average size is significantly smaller than the EU average. Italy scores clearly above the EU average concerning the share of high-growth enterprises and slightly above average concerning time required to start a business, the enterprise survival rate after two years and bank loan conditions deemed acceptable by companies. However, it scores clearly below the average concerning early stage financing and the business churn.

## ITALY

## Average annual growth (%), 2000-2009(1)



*Source:* DG Research and Innovation

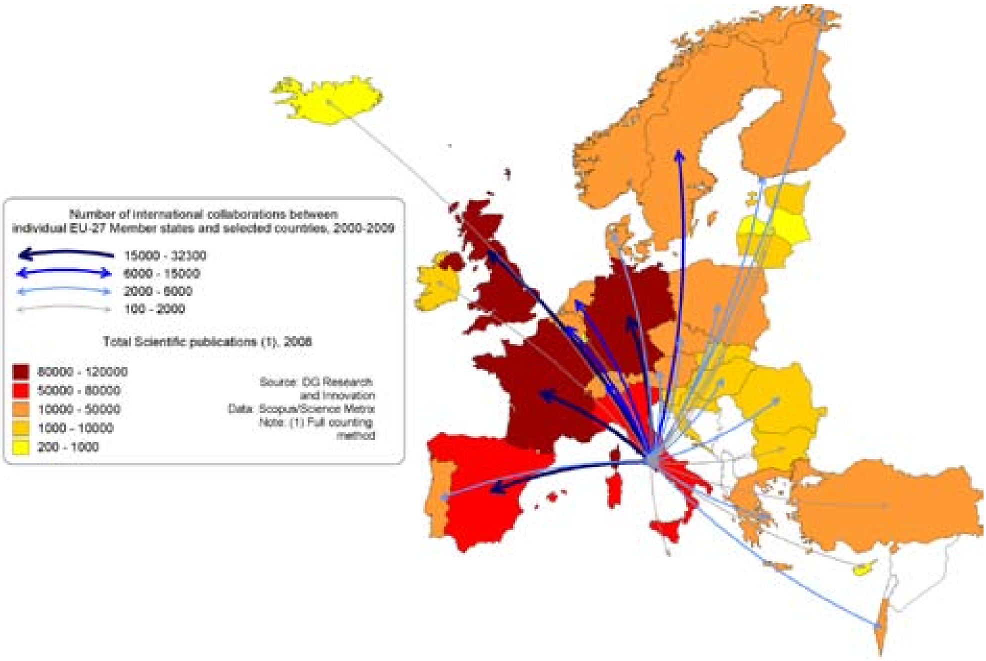
**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average.
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

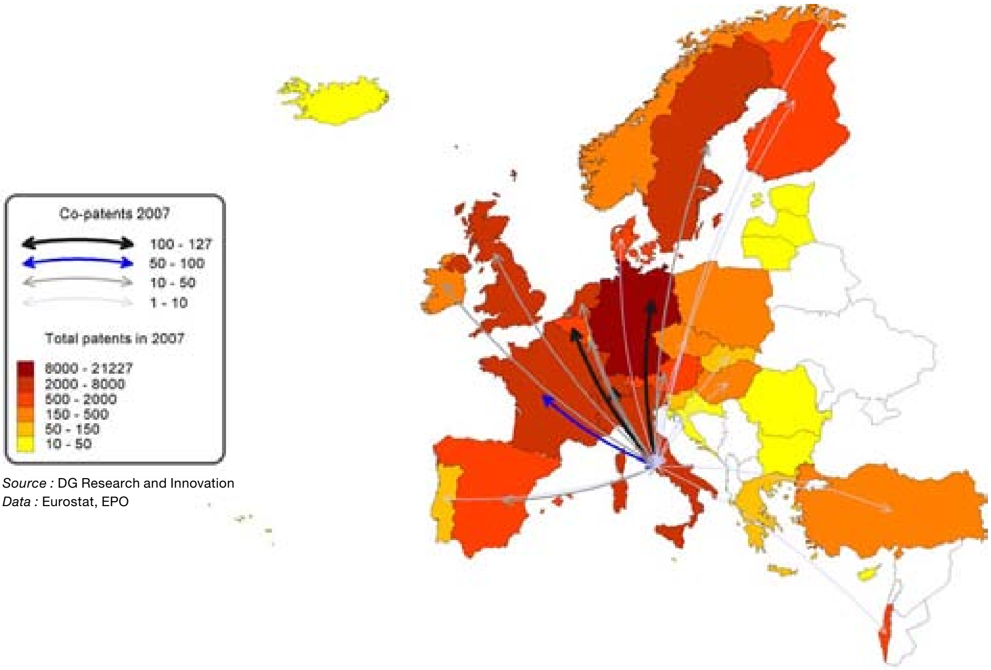
## ITALY

## Co-publications between Italy and European Countries in 2000-2009



Source: DG Research and Innovation
Data: Scopus/Science Metrix
Note: (1) Full counting method

## Co-invented patent applications between Italy and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

### Participation in the European Research Area : Scientific and Technological collaborations

Italy is well integrated in the European research and innovation system. Together with Germany, France and the United Kingdom, Italy is among the highest producers of overall publications and of cross-border co-publications. The preferred partners for scientific collaboration with Italy are among these three countries plus Spain and Switzerland.

The same partnerships are verified in the technological cooperation, co-patents being mainly with the same countries. However, Italy is, in general, less international in technological cooperation, since co-patents are only half of all the Italian patents (the EU average share of co-patents in the total patent applications is around 64%). The level of co-patents applications with third countries (non EU) also represents a very small share with 5.1% of the total.

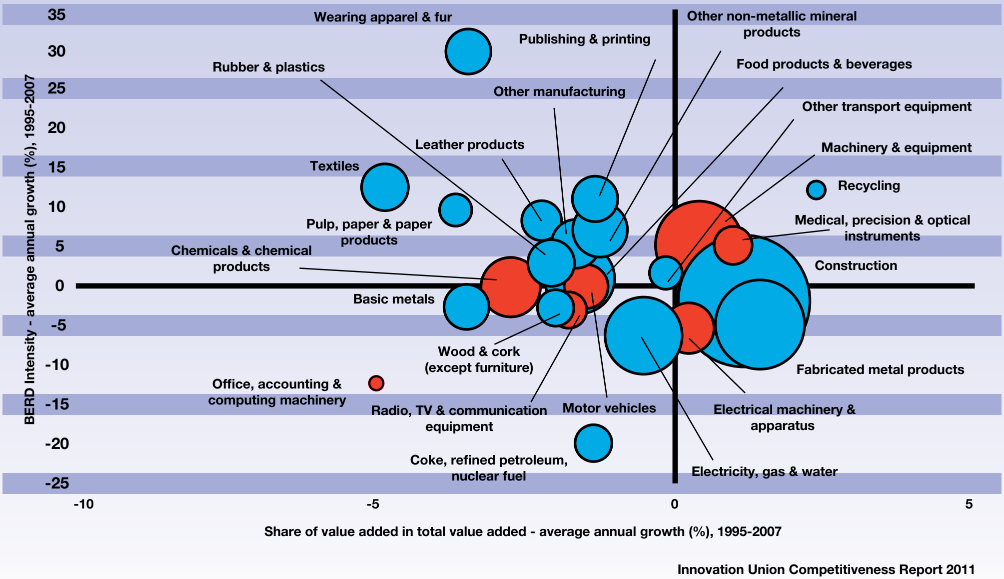
In the context of the EU Framework Programmes Italy has built a solid position and in the networking constitutes one of the central links, together with Germany, the United Kingdom and France.

### Structural change towards a more knowledge-intensive economy

Manufacturing accounts for a larger share in the economy in Italy than in the EU in 2009 (19.3% of total employment versus 15.7% for the EU). This is mainly due to the specialisation in some traditional sectors such as footwear, textiles and clothing and, to a lesser extent, other machinery, basic metal products and non-metallic mineral products. These sectors have lower R&D intensities when compared with similar sectors in other countries (see for example, the box on the textile sector in chapter 3, Part III of this report). Thus the potential to incorporate additional knowledge in the relevant sectors is considerable, if facilitated by a structural change in the traditional sectors and a supply of high and high-intermediate skills. In services, Italy's sectoral composition follows the EU picture, with a share slightly smaller than the average. Over the period 2000-2009 the R&D intensity increased moderately reaching 1.27% in 2009, with equally modest contributions from both the public and the private sectors. Overall, the R&D intensity of existing sectors increased in the last decade, but only to reach levels that remain very far from the countries

# ITALY

## Share of value added versus BERD Intensity - Average annual growth, 1995-2007



*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.
(2) 'Tobacco products' is not included on the graph.

at the technology frontier, thus suggesting a trend towards a specialisation in lower technology intensive products. The BERD intensity slightly increased in the period 1995-2007 mainly due to increases in the BERD sectoral intensities without changes in the research orientation of the economy.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 18053 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 33015 applicants from Italy (12.39% of EU-27*) and
- requesting EUR 11009.55m of EC contribution (12.47% of EU-27*)

Among the EU-27* Italy (IT) ranks:

- 3rd in terms of number of applicants and
- 3rd in terms of requested EC contribution

### Success rates

- The IT applicant success rate of 18.3% is lower than the EU-27* applicant success rate of 21.6%.
- The IT EC financial contribution success rate of 15.9% is lower than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 3342 proposals were retained for funding (18.5%)
- involving 6057 (18.3%) successful applicants from Italy and
- requesting EUR 1750.61m (15.9%) of EC financial contribution

Among the EU-27*, Italy (IT) ranks:

- 22nd in terms of applicants success rate and
- 14th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Italy (IT) participates in

- 2875 signed grant agreements
- involving 32340 participants of which 5321 (16.45%) are from Italy
- benefiting from a total of EUR 9177.46m of EC financial contribution of which EUR 1533.27m (16.71%) is dedicated to participants from Italy.

Among the EU-27* in all FP7 signed grant agreements, Italy (IT) ranks:

- 4th in number of participations and
- 4th in budget share

**SME performance and participation**

- The IT SME applicant success rate of 15.73% is lower than the EU-27* SME applicant success rate of 19.33%.
- The IT SME EC financial contribution success rate of 13.93% is lower than the corresponding EU-27* rate of 18.26%.

Specifically,

- 8655 IT SME applicants requesting EUR 2243.88m
- 1361 (15.73%) successful SMEs requesting EUR 312.47m (13.93%)

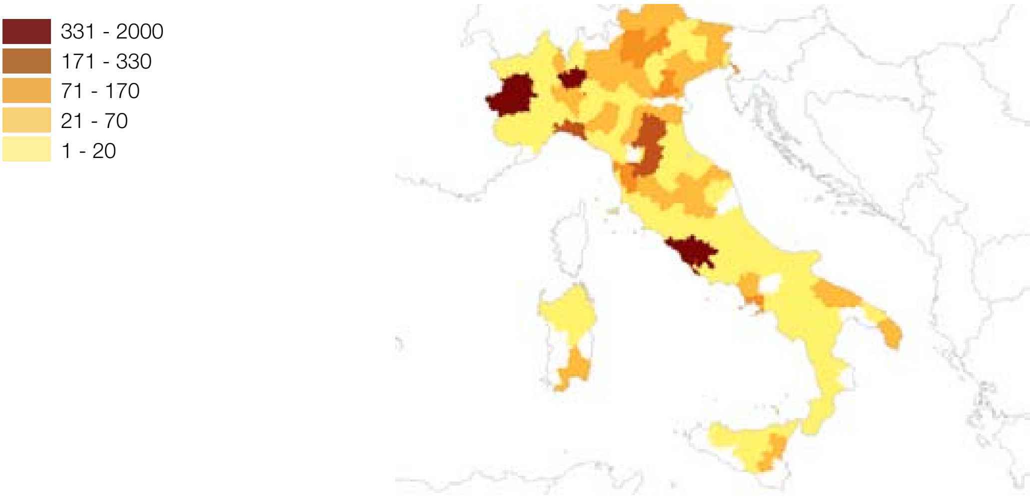
In signed grant agreements, as of 2011/03/16,

- 959 IT SME grant holders, i.e., 18.02% of total IT participation
- EUR 218.67m, i.e., 14.26% of total IT budget share

**Top 3 collaborative links with**

- DE - Germany (4229)
- UK - United Kingdom (3310)
- FR - France (3100)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 19th | |
| - Below EU-27 average | | |
| - Moderate Innovator | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 33015 | |
| (12.39%) | 266507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 11009.55 | |
| (12.47%) | 88295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 6057 | |
| (10.23%) | 59199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 1750.61 | |
| (9.59%) | 18262.02 | |
| Success rate FP7 applicants | 18.3% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 15.9% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 5321 | |
| (10.38%) | 51279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 1533.27 | |
| (9.25%) | 16578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 871 | |
| (16.37%) | 9383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 959 | |
| (18.02%) | 8845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 218.67 | |
| (14.26%) | 2207.73 | |
| (13.32%) | | |



## TABLE 1

## IT - Italy - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 8234 | 2986.57 | 1198 | 14.55% | 423.31 | 14.17% |
| Marie-Curie Actions | 3230 | n/a | 749 | 23.19% | n/a | n/a |
| Health | 3051 | 1380.21 | 519 | 17.01% | 205.80 | 14.91% |
| Research for the benefit of SMEs | 3000 | 421.49 | 485 | 16.17% | 69.31 | 16.44% |
| Transport (including Aeronautics) | 2487 | 711.36 | 594 | 23.88% | 182.41 | 25.64% |
| Environment (including Climate Change) | 2148 | 570.57 | 341 | 15.88% | 78.00 | 13.67% |

## TABLE 2

## IT - Italy - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all AT grant holders | EC contribution (EUR million) | % of total EC contribution to IT |
|---|---|---|---|---|
| Information and Communication Technologies | 1205 | 22.65% | 397.18 | 25.90% |
| Health | 511 | 9.60% | 181.19 | 11.82% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 471 | 8.85% | 145.01 | 9.46% |
| ERC | 127 | 2.39% | 135.45 | 8.83% |
| Transport (including Aeronautics) | 455 | 8.55% | 124.89 | 8.15% |
| Marie-Curie Actions | 558 | 10.49% | 107.19 | 6.99% |

*Notes :* Report generated on: 2011/03/25.04:40 PM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## IT - Italy - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 10 914 | 3 081.59 | 1 975 | 18.10% | 486.27 | 15.78% | 1 784 | 542.98 | 35.41% |
| PRC | 10 106 | 2 836.29 | 1 845 | 18.26% | 511.56 | 18.04% | 1 708 | 441.95 | 28.82% |
| REC | 6 439 | 2 062.99 | 1 458 | 22.64% | 431.75 | 20.93% | 1 514 | 489.06 | 31.90% |
| OTH | 2 096 | 509.18 | 359 | 17.13% | 89.26 | 17.53% | 112 | 20.46 | 1.33% |
| PUB | 1 448 | 303.50 | 294 | 20.30% | 51.62 | 17.01% | 203 | 38.82 | 2.53% |
| | | | | | | | | | |
| SME | 8 655 | 2 243.88 | 1 361 | 15.73% | 312.47 | 13.93% | 959 | 218.67 | 14.26% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education

## TABLE 4

## IT - Italy - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| IT - Italy region | Number of grant holders | % of all IT - Italy grant holders | EC contribution (M euro) | % of total EC contribution to IT |
|---|---|---|---|---|
| Roma (ITE43) | 1 380 | 25.93% | 393.61 | 25.67% |
| Milano (ITC45) | 826 | 15.52% | 277.18 | 18.08% |
| Torino (ITC11) | 417 | 7.84% | 111.73 | 7.29% |
| Genova (ITC33) | 248 | 4.66% | 74.73 | 4.87% |
| Firenze (ITE14) | 232 | 4.36% | 62.91 | 4.10% |

## TABLE 5

## IT - Italy - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all IT grant holders | EC contribution (M euro) | % of total EC contribution to IT grant holders |
|---|---|---|---|---|
| Consiglio Nazionale Delle Ricerche (CNR) | 338 | 6.35% | 116.14 | 7.57% |
| Politecnico di Milano (POLIMI) | 106 | 1.99% | 37.85 | 2.47% |
| Universita Degli Studi di Roma la Sapienza | 106 | 1.99% | 37.14 | 2.42% |
| Alma Mater Studiorum-Universita di Bologna (Unibo) | 118 | 2.22% | 35.14 | 2.29% |
| Centro Ricerche Fiat Scpa (Centro Ricerche Fiat) | 88 | 1.65% | 33.57 | 2.19% |

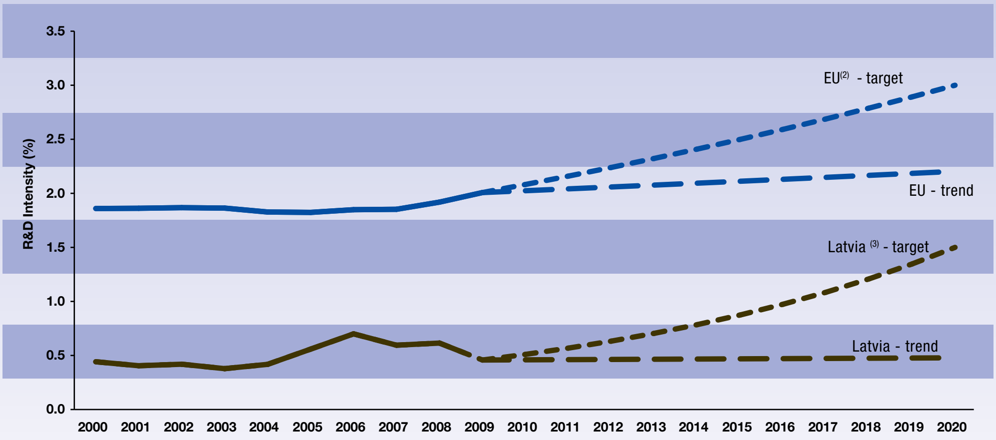
# COUNTRY PROFILE

# LV - Latvia

## Progress towards meeting the Europe 2020 R&D intensity target

Latvia is aware that an effort in R&D is necessary to ensure a sustainable development of the country, which has badly suffered from the financial crisis. Latvia increased its R&D intensity during the 2000-2008 period by an average annual growth rate of 4.1%, passing from 0.44% in the year 2000 to 0.61% in 2008. This increase has been fuelled thanks to an increase in public R&D investment, which rose at an average annual growth rate of 7.1% (from 0.26% to 0.46%). On the other hand, private R&D fell from 0.18% to 0.15%. However, with the deterioration of the economic situation in the country, the public and private sector investment in R&D decreased in 2009 (0.46%) and again in 2010.

**LATVIA** **R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation

*Data:* DG Research and Innovation, Eurostat

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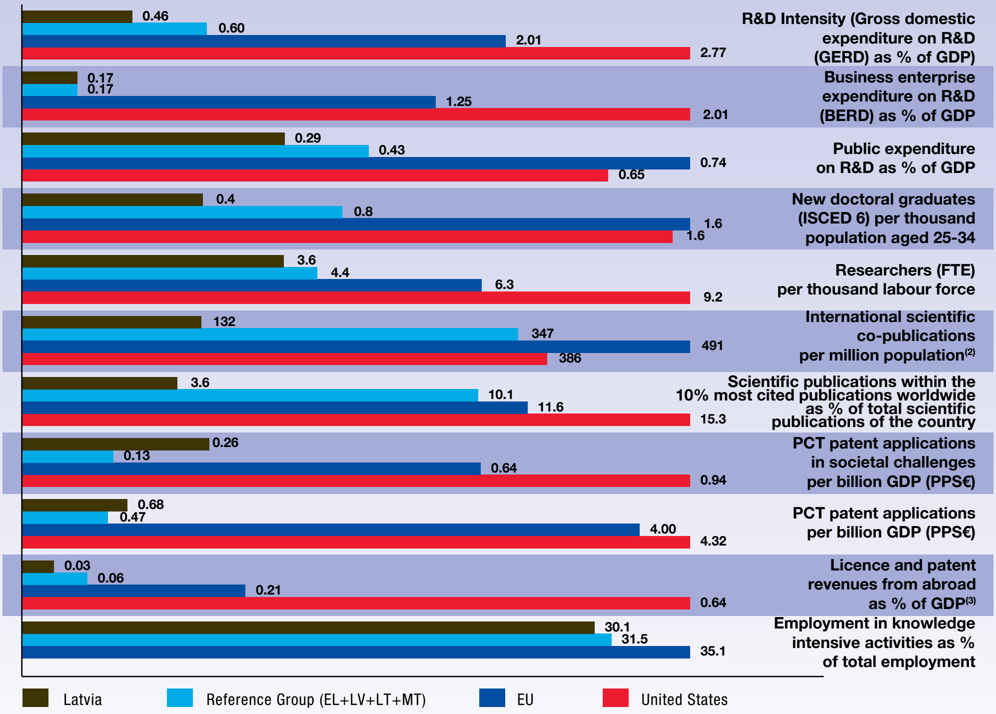
*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) LV: This projection is based on a tentative R&D Intensity target of 1.5% for 2020.

# LATVIA

## R&D profile, 2009(1)



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) Elements of estimation were involved in the compilation of the data.

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## Research and Innovation Performance

Latvia is characterised by a very weak performance in terms of Research and Innovation performance both in comparison to the EU in general but also in comparison to the reference group (see composition in the following graph). While a strong and innovative industry is a means to ensure investment in R&D, Latvia is characterised by a weak funding and participation of industry in R&D.

Latvia's growth since independence has been very much built on low labour costs and production of products of low added value. As costs and incomes start to converge with wider EU norms, companies need to shift the base of their competitiveness. In that respect creation and growth of innovative firms is a key to economic regeneration.

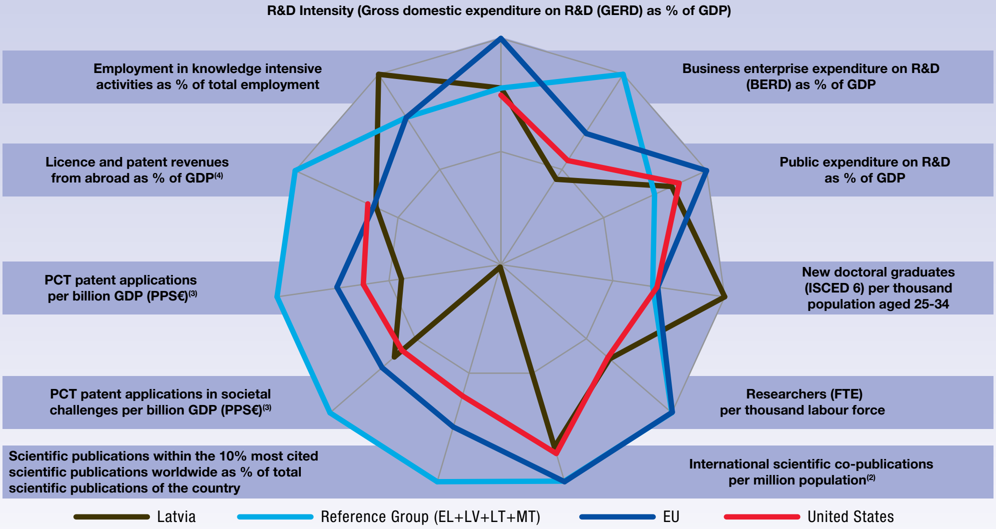
While other indicators such as employment in knowledge intensive activities as% of total employment and growth of the number of PhDs progress, albeit from a low basis, they point to a real problem in internationalisation and international publication of research. Latvian researchers publish in Latvian journals instead of trying to publish in international journals. Access to international journals and international publication databases is a problem, owing to cost. International collaboration can sometimes give indirect access.

## Participation in the European Research Area : Scientific and Technological collaborations

The low level of Latvia's participation in the European Research Area reflects the global level of its R&D performance. Co-publications are significant with its neighbours (Sweden, Finland, and Estonia), but also with Germany and Denmark, while co-patenting activity in absolute values stayed at a low level in 2007.

## LATVIA

## Average annual growth (%), 2000-2009(1)



*Source:* DG Research and Innovation

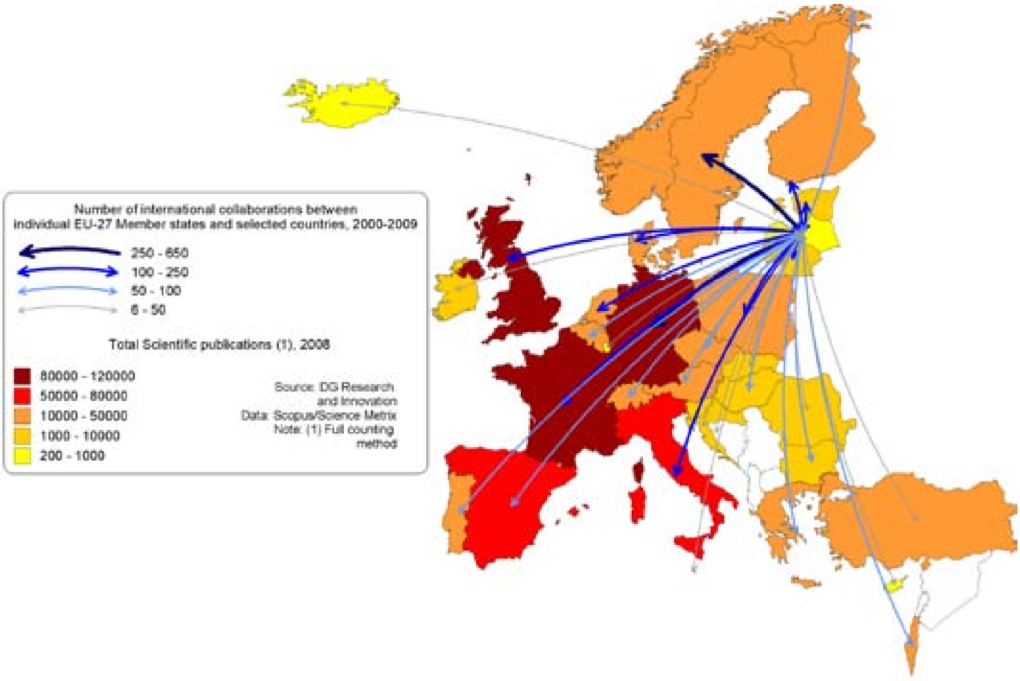
**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average.
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## LATVIA

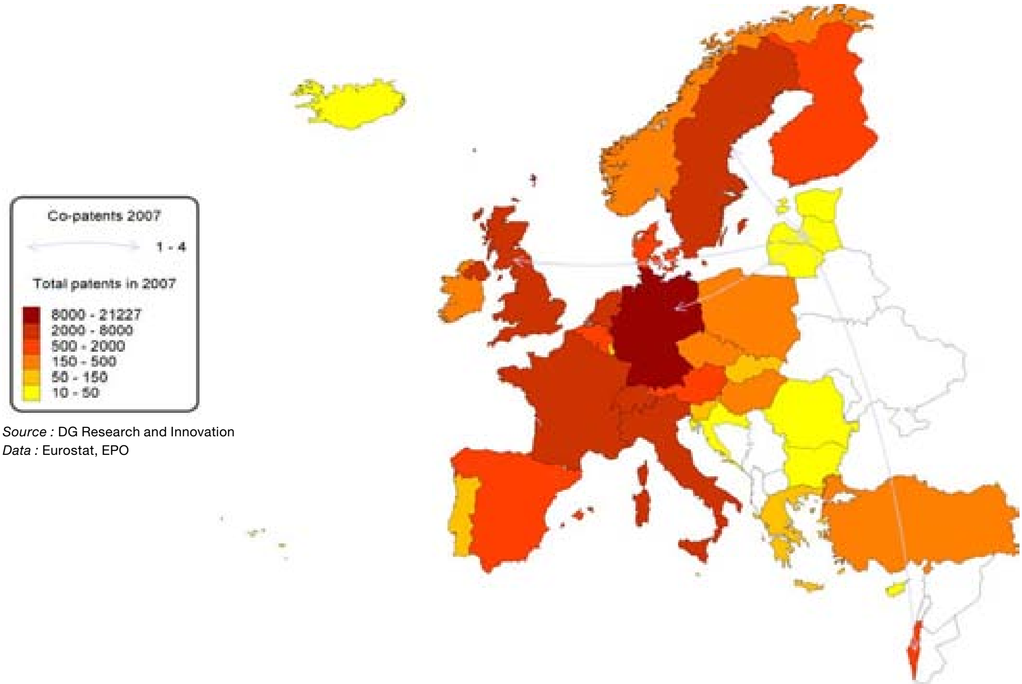
## Co-publications between Latvia and European Countries in 2000-2009



Source: DG Research and Innovation
Data: Scopus/Science Metrix
Note: (1) Full counting method

## LATVIA

## Co-invented patent applications between Latvia and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 636 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 800 applicants from Latvia (0.30% of EU-27*) and
- requesting EUR 150.66m of EC contribution (0.17% of EU-27*)

Among the EU-27* Latvia (LV) ranks:

- 25th in terms of number of applicants and
- 25th in terms of requested EC contribution

### Success rates

- The LV applicant success rate of 22.1% is similar to the EU-27* applicant success rate of 21.6%.
- The LV EC financial contribution success rate of 11.2% is lower than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 131 proposals were retained for funding (20.6%)
- involving 177 (22.1%) successful applicants from Latvia and
- requesting EUR 16.81m (11.2%) of EC financial contribution

Among the EU-27*, Latvia (LV) ranks:

- 11th in terms of applicants success rate and
- 24th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Latvia (LV) participates in

- 122 signed grant agreements
- involving 2 136 participants of which 165 (7.72%) are from Latvia
- benefiting from a total of EUR 471.83m of EC financial contribution of which EUR 15.19m (3.22%) is dedicated to participants from Latvia.

Among the EU-27* in all FP7 signed grant agreements, Latvia (LV) ranks:

- 26th in number of participations and
- 27th in budget share

**SME performance and participation**

- The LV SME applicant success rate of 17.74% is lower than the EU-27* SME applicant success rate of 19.33%.
- The LV SME EC financial contribution success rate of 14.32% is lower than the corresponding EU-27* rate of 18.26%.

Specifically,

- 310 LV SME applicants requesting EUR 57.29m
- 55 (17.74%) successful SMEs requesting EUR 8.20m (14.32%)

In signed grant agreements, as of 2011/03/16,

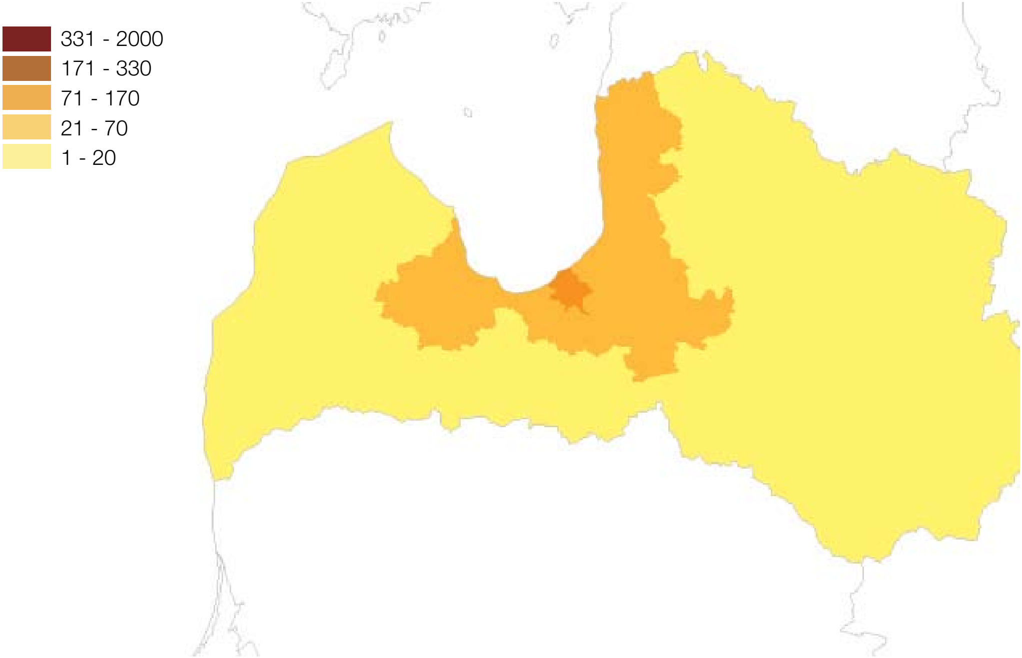
- 20 LV SME grant holders, i.e., 12.12% of total LV participation
- EUR 3.11m, i.e., 20.44% of total LV budget share

**Top 3 collaborative links with**

- UK - United Kingdom (157)
- DE - Germany (141)
- IT - Italy (136)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 26th | |
| - Below EU-27 average | | |
| - Catching-up Country | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 800 | |
| (0.30%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 150.66 | |
| (0.17%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 177 | |
| (0.30%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 16.81 | |
| (0.09%) | 18 262.02 | |
| Success rate FP7 applicants | 22.1% | 21.6% |

| | | |
|---|---|---|
| Success rate | | |
| FP7 EC contribution | 11.2% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 165 | |
| (0.32%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 15.19 | |
| (0.09%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 12 | |
| (7.27%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 20 | |
| (12.12%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 3.11 | |
| (20.44%) | 2 207.73 | |
| (13.32%) | | |



## TABLE 1

## LV - Latvia - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 8234 | 2986.57 | 1198 | 14.55 % | 423.31 | 14.17 % |
| Marie-Curie Actions | 3230 | n/a | 749 | 23.19 % | n/a | n/a |
| Health | 3051 | 1380.21 | 519 | 17.01 % | 205.80 | 14.91 % |
| Research for the benefit of SMEs | 3000 | 421.49 | 485 | 16.17 % | 69.31 | 16.44 % |
| Transport (including Aeronautics) | 2487 | 711.36 | 594 | 23.88 % | 182.41 | 25.64 % |
| Environment (including Climate Change) | 2148 | 570.57 | 341 | 15.88 % | 78.00 | 13.67 % |

## TABLE 2

## LV - Latvia - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all LV grant holders | EC contribution (EUR million) | % of total EC contribution to LV |
|---|---|---|---|---|
| Research Potential | 3 | 1.82% | 2.17 | 14.29% |
| Information and Communication Technologies | 9 | 5.45% | 1.63 | 10.75% |
| Research Infrastructures | 16 | 9.70% | 1.60 | 10.55% |
| Research for the benefit of SMEs | 12 | 7.27% | 1.59 | 10.45% |
| Marie-Curie Actions | 44 | 26.67% | 1.48 | 9.77% |
| Food, Agriculture and Fisheries, and Biotechnology | 11 | 6.67% | 1.44 | 9.47% |

*Notes :* Report generated on: 2011/03/28.10:45 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## LV - Latvia - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 312 | 49.38 | 76 | 24.36% | 5.97 | 12.08% | 71 | 6.65 | 43.79% |
| PRC | 186 | 31.92 | 26 | 13.98% | 3.19 | 10.00% | 16 | 2.48 | 16.31% |
| REC | 132 | 28.38 | 40 | 30.30% | 3.91 | 13.79% | 49 | 4.06 | 26.72% |
| OTH | 76 | 12.47 | 12 | 15.79% | 1.01 | 8.13% | 6 | 0.78 | 5.13% |
| PUB | 73 | 10.25 | 22 | 30.14% | 2.59 | 25.27% | 23 | 1.22 | 8.05% |
| | | | | | | | | | |
| SME | 310 | 57.29 | 55 | 17.74% | 8.20 | 14.32% | 20 | 3.11 | 20.44% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education

## TABLE 4

## LV - Latvia - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| LV - Latvia region | Number of grant holders | % of all LV - Latvia grant holders | EC contribution (M euro) | % of total EC contribution to LV |
|---|---|---|---|---|
| Riga (LV006) | 90 | 54.55% | 8.53 | 56.16% |
| Pieriga (LV007) | 52 | 31.52% | 4.99 | 32.82% |
| Latgale (LV005) | 7 | 4.24% | 0.04 | 0.23% |
| Kurzeme (LV003) | 6 | 3.64% | 0.24 | 1.59% |
| Zemgale (LV009) | 5 | 3.03% | 1.12 | 7.36% |

## TABLE 5

## LV - Latvia - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all LV grant holders | EC contribution (M euro) | % of total EC contribution to LV grant holders |
|---|---|---|---|---|
| Rigas Tehniska Universitate (RTU) | 17 | 10.30% | 1.92 | 12.63% |
| Latvijas Valsts Koksnes Kimijas Instituts (LSIWC) | 7 | 4.24% | 1.83 | 12.02% |
| Latvijas Universitate (LU) | 19 | 11.52% | 1.73 | 11.38% |
| Latvijas Lauksaimniecibas Universitate (LLU) | 5 | 3.03% | 1.12 | 7.36% |
| Tilde Sia (Tilde) | 3 | 1.82% | 1.00 | 6.60% |

# COUNTRY PROFILE

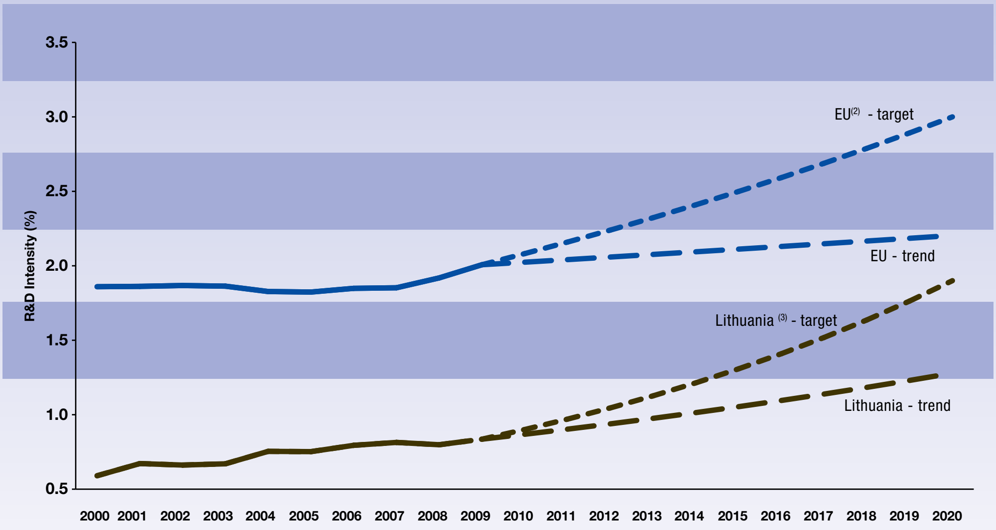
# LT - Lithuania

## Progress towards meeting the Europe 2020 R&D intensity target

In the last decade, R&D intensity in Lithuania increased from 0.59% of GDP in 2000 to 0.84% in 2009, i.e. an annual average growth rate of 3.9%. It is to be noted that the increase in R&D intensity in 2009 compared to 2008 (0.80% of GDP) is due to a more severe drop in GDP than in nominal R&D expenditure. Lithuania's R&D intensity is still among the lowest in the European Union. In order to maintain and increase its economic competitiveness and secure high-quality jobs, Lithuania will have to sharply increase its investments in research and innovation.

Lithuanian authorities have recognised this and have set a very ambitious national R&D target for 2020: R&D intensity in Lithuania should account for 1.9% of the national GDP in 2020. This net increase of around 1.1% would be similar to the one needed for the EU to reach the 3% R&D target.

**LITHUANIA** **R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation

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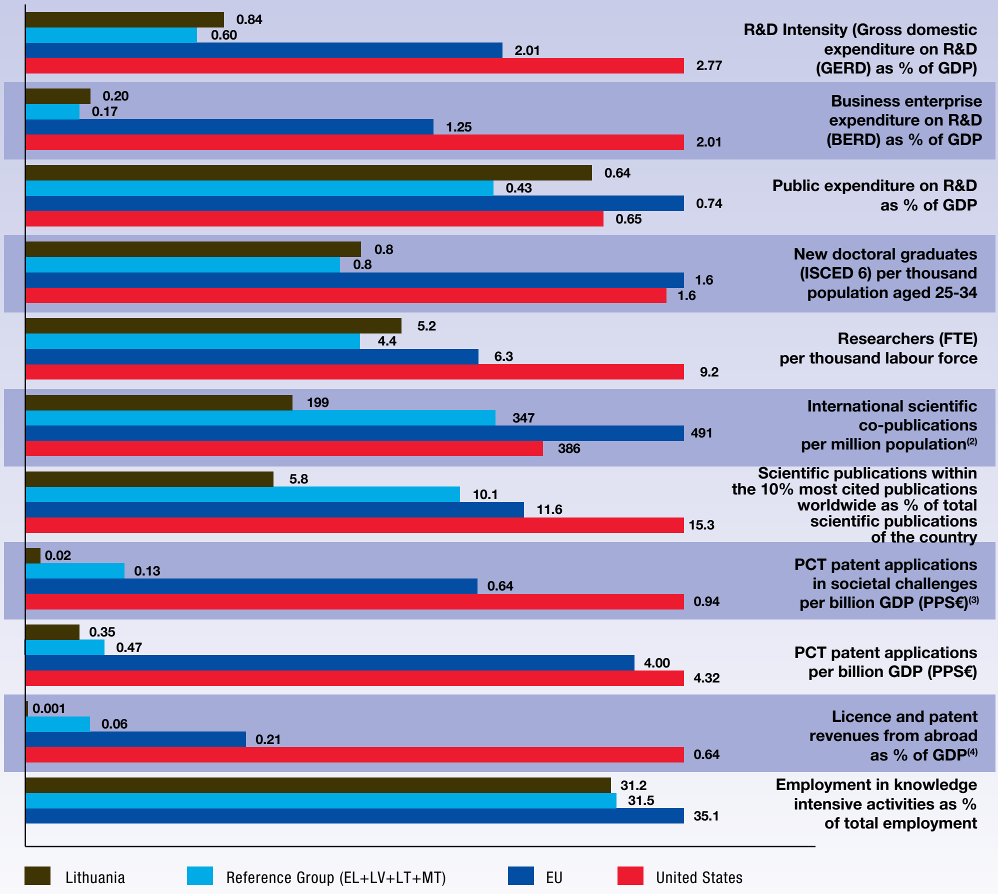
*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) LT: This projection is based on a tentative R&D Intensity target of 1.9% for 2020.

## LITHUANIA R&D profile, 2009[1]



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) Elements of estimation were involved in the compilation of the data.

**Innovation Union Competitiveness Report 2011**

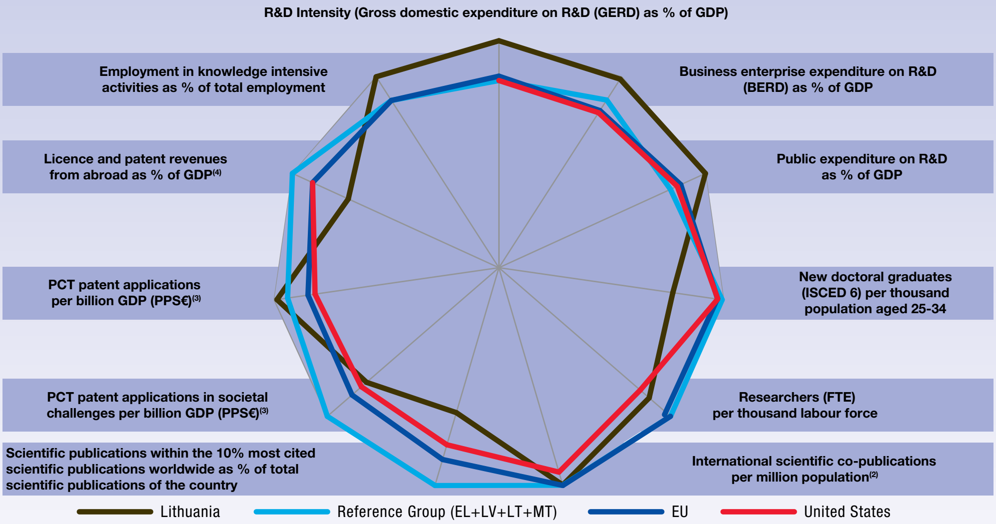
## Research and Innovation Performance

The low level of R&D expenditure in Lithuania, in particular in the business sector, gives rise to a poor scientific and technological performance. Compared to the EU average, but also compared to countries of similar scientific and technological profile, Lithuania scores low in all indicators except R&D expenditure in the public sector and employment activities, whose levels in Lithuania are closer to the EU value. The number of researchers in the labour force is also among the relative strengths of Lithuania. However, the science base appears relatively closed and very few of the scientific publications involving authors based in Lithuania have a high impact. Exploitation of R&D results by the business sector is extremely limited with low business R&D expenditure and very few patented inventions — to the point that Lithuania has virtually no licence and patent revenue from abroad.

In dynamic terms, Lithuania has been progressing in input indicators at a similar pace as the average of the countries that have a similar scientific and technological profile, except in new doctoral graduates where progress in Lithuania is slower. Progress of Lithuania in outputs was less rapid than in comparable countries, except in the overall level of PCT patents. If this trend continues, it could have important consequences for the future international economic competitiveness of Lithuania.

## LITHUANIA

## Average annual growth (%), 2000-2009(1)



*Source:* DG Research and Innovation

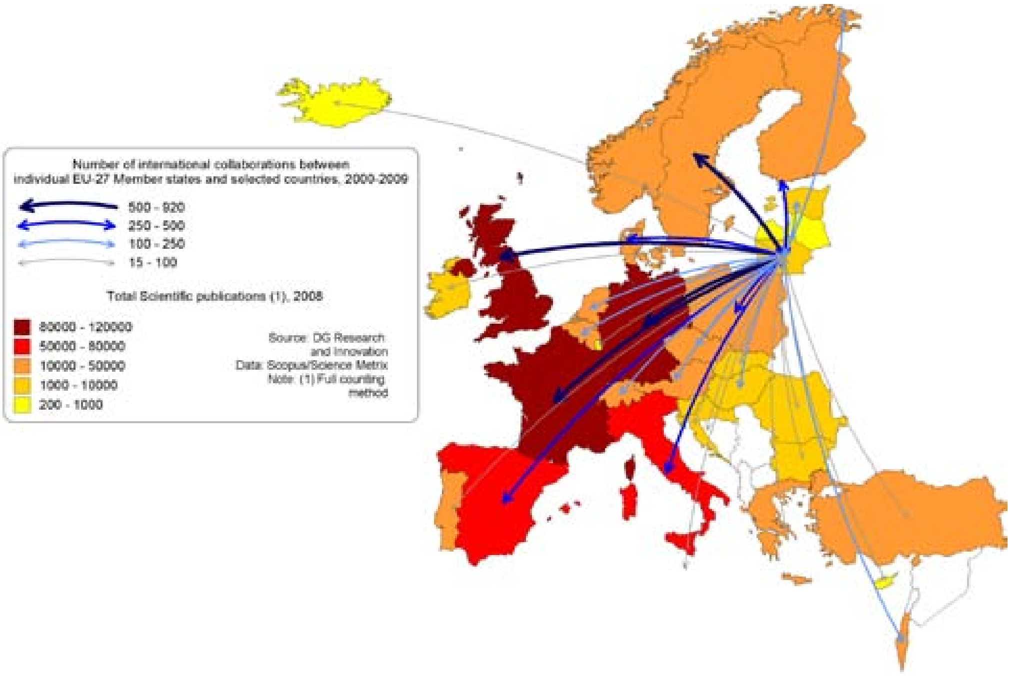
**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

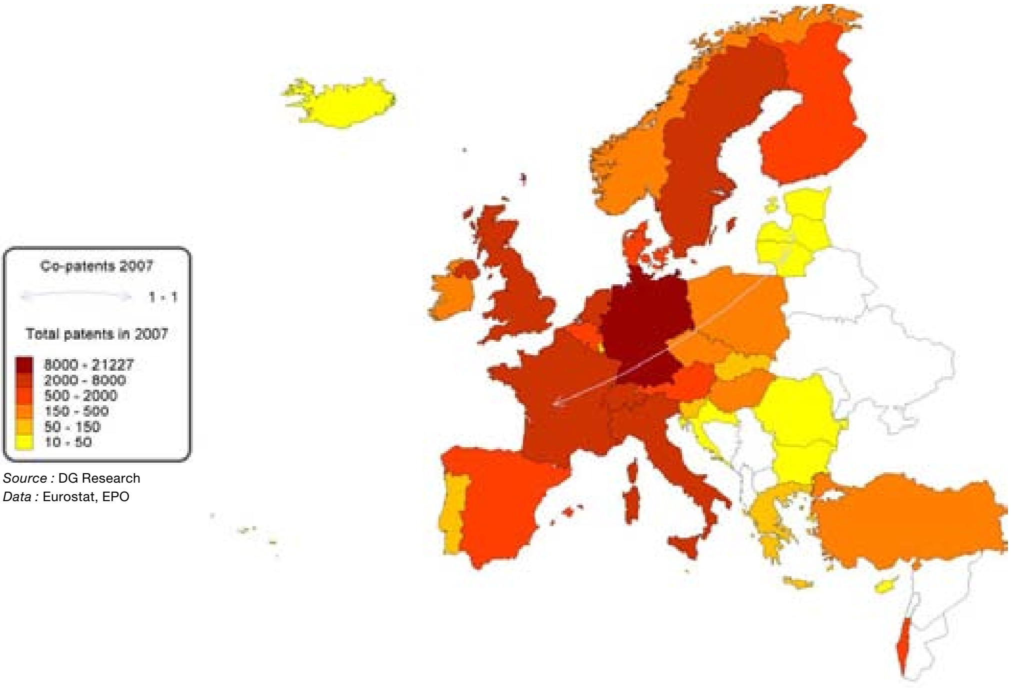
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average.
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## LITHUANIA

## Co-publications between Lithuania and European Countries in 2000-2009



**Co-invented EPO patent applications between Lithuania and European Countries, 2007**



*Source :* DG Research
*Data :* Eurostat, EPO

## Participation in the European Research Area : Scientific and Technological collaborations

As shown in the R&D profile above, Lithuania is one of the European countries with the lowest rates of overall co-publications per million population. This suggests that the country is not actively participating in, and benefiting from, the international scientific knowledge flows favoured by the construction of the European Research Area. The main scientific partners of Lithuania are Germany, France and the United Kingdom, largely reflecting the size of the national research systems of these countries. Lithuania has also important linkages with Sweden, Finland, Denmark — probably due to geographical proximity.

Lithuania is virtually unconnected with other countries in patenting activities. In 2007, only one EPO patent application was co-invented by an inventor based in Lithuania and an inventor(s) based in another European country (France).

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 986 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 1 208 applicants from Lithuania (0.45% of EU-27*) and
- requesting EUR 199.80m of EC contribution (0.23% of EU-27*)

Among the EU-27* Lithuania (LT) ranks:

- 24th in terms of number of applicants and
- 24th in terms of requested EC contribution

**Success rates**

- The LT applicant success rate of 20.9% is similar to the EU-27* applicant success rate of 21.6%.
- The LT EC financial contribution success rate of 15.9% is lower than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 196 proposals were retained for funding (19.9%)
- involving 252 (20.9%) successful applicants from Lithuania and
- requesting EUR 31.78m (15.9%) of EC financial contribution

Among the EU-27*, Lithuania (LT) ranks:

- 13th in terms of applicants success rate and
- 13th in terms of EC financial contribution success rate

**Signed grant agreements**

As of 2011/03/16, Lithuania (LT) participates in

- 163 signed grant agreements
- involving 2709 participants of which 209 (7.72%) are from Lithuania
- benefiting from a total of EUR 647.89m of EC financial contribution of which EUR 25.23m (3.89%) is dedicated to participants from Lithuania.

Among the EU-27* in all FP7 signed grant agreements, Lithuania (LT) ranks:

- 24th in number of participations and
- 25th in budget share

**SME performance and participation**

- The LT SME applicant success rate of 18.91% is similar to the EU-27* SME applicant success rate of 19.33%.
- The LT SME EC financial contribution success rate of 14.64% is lower than the corresponding EU-27* rate of 18.26%.

Specifically,

- 386 LT SME applicants requesting EUR 67.55m
- 73 (18.91%) successful SMEs requesting EUR 9.89m (14.64%)

In signed grant agreements, as of 2011/03/16,

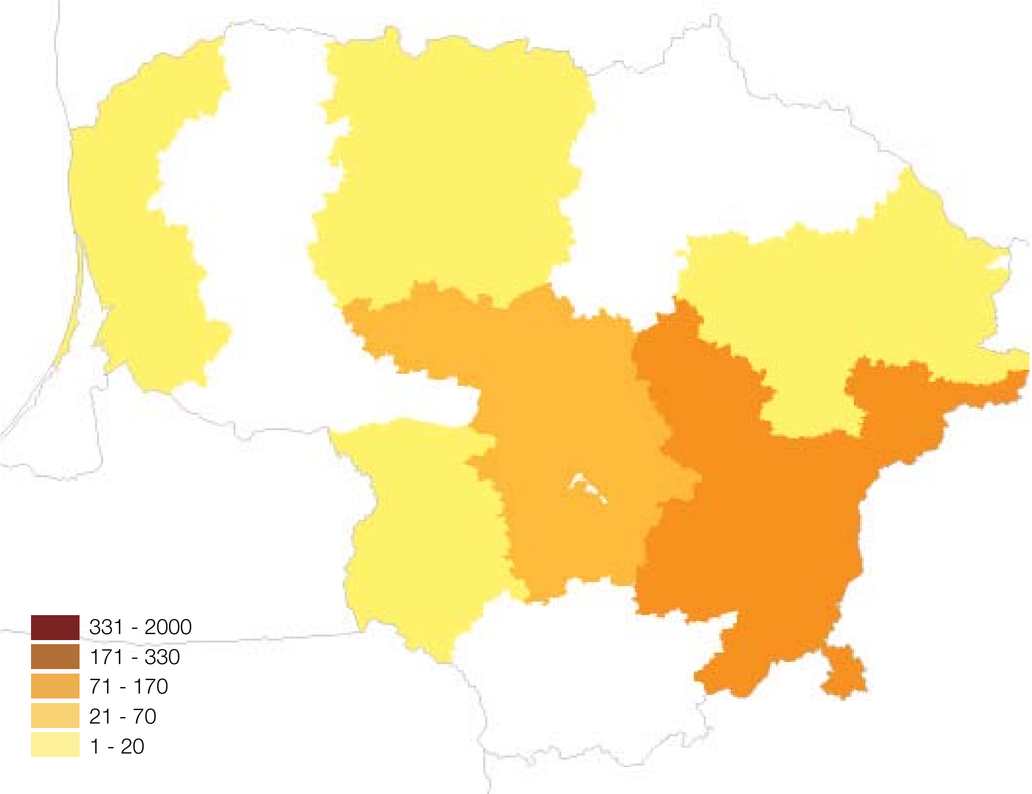
- 36 LT SME grant holders, i.e., 17.22% of total LT participation
- EUR 6.52m, i.e., 25.83% of total LT budget share

**Top 3 collaborative links with**

- UK - United Kingdom (249)
- DE - Germany (234)
- FR - France (212)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 24th | |
| - Below EU-27 average | | |
| - Moderate Innovator | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 1 208 | |
| (0.45%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 199.80 | |
| (0.23%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 252 | |
| (0.43%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 31.78 | |
| (0.17%) | 18 262.02 | |
| Success rate FP7 applicants | 20.9% | 21.6% |
| Success rate | | |

| | | |
|---|---|---|
| FP7 EC contribution | 15.9% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 209 | |
| (0.41%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 25.23 | |
| (0.15%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 8 | |
| (3.83%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 36 | |
| (17.22%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 6.52 | |
| (25.83%) | 2 207.73 | |
| (13.32%) | | |



## TABLE 1

## LT - Lithuania - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Research for the benefit of SMEs | 191 | 19.51 | 37 | 19.37% | 3.45 | 17.68% |
| Information and Communication Technologies | 150 | 32.30 | 14 | 9.33% | 1.96 | 6.08% |
| Socio-economic sciences and Humanities | 127 | 17.12 | 7 | 5.51% | 0.68 | 3.95% |
| Marie-Curie Actions | 102 | n/a | 42 | 41.18% | n/a | n/a |
| Health | 91 | 22.18 | 20 | 21.98% | 5.39 | 24.32% |
| Transport (including Aeronautics) | 76 | 13.69 | 18 | 23.68% | 1.32 | 9.64% |

## TABLE 2

## LT - Lithuania - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all LT grant holders | EC contribution (EUR million) | % of total EC contribution to LT |
|---|---|---|---|---|
| Energy | 19 | 9.09% | 3.99 | 15.81% |
| Health | 19 | 9.09% | 3.90 | 15.45% |
| Research for the benefit of SMEs | 29 | 13.88% | 3.74 | 14.84% |
| Research Potential | 4 | 1.91% | 2.46 | 9.74% |
| Information and Communication Technologies | 18 | 8.61% | 2.12 | 8.40% |
| Marie-Curie Actions | 24 | 11.48% | 1.74 | 6.88% |

*Notes :* Report generated on: 2011/03/25.04:40 PM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## LT - Lithuania - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 565 | 78.48 | 111 | 19.65% | 11.77 | 15.00% | 93 | 10.84 | 42.98% |
| PRC | 219 | 44.63 | 37 | 16.89% | 7.04 | 15.76% | 46 | 7.54 | 29.88% |
| REC | 187 | 30.10 | 45 | 24.06% | 5.68 | 18.85% | 28 | 2.76 | 10.93% |
| PUB | 99 | 12.59 | 38 | 38.38% | 4.68 | 37.20% | 37 | 3.62 | 14.33% |
| OTH | 99 | 14.20 | 21 | 21.21% | 2.61 | 18.38% | 5 | 0.48 | 1.88% |
| SME | 386 | 67.55 | 73 | 18.91% | 9.89 | 14.64% | 36 | 6.52 | 25.83% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, PUB - Public body (excl. research and education), OTH - Others

## TABLE 4

## LT - Lithuania - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| LT - Lithuania region | Number of grant holders | % of all LT - Lithuania grant holders | EC contribution (M euro) | % of total EC contribution to LT |
|---|---|---|---|---|
| Information and Communication Technologies | 8234 | 2986.57 | 1198 | 14.55 % |
| Marie-Curie Actions | 3230 | n/a | 749 | 23.19 % |
| Health | 3051 | 1380.21 | 519 | 17.01 % |
| Research for the benefit of SMEs | 3000 | 421.49 | 485 | 16.17 % |
| Transport (including Aeronautics) | 2487 | 711.36 | 594 | 23.88 % |

## TABLE 5

## LT - Lithuania - Most active organisations in terms of EC contribution granted to the FP7 research projects

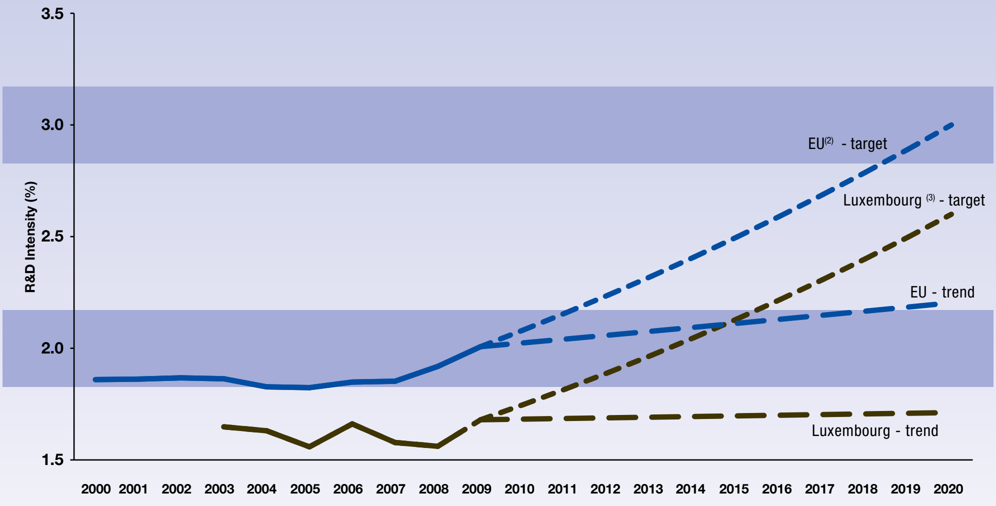
| Legal Name | Number of Participations | % of all LT grant holders | EC contribution (M euro) | % of total EC contribution to LT grant holders |
|---|---|---|---|---|
| Vilniaus Universitetas (VU) | 29 | 13.88% | 5.33 | 21.12% |
| Kauno Technologijos Universitetas (KTU) | 26 | 12.44% | 2.88 | 11.42% |
| Birstono Savivaldynes Taryba | 1 | 0.48% | 1.48 | 5.85% |
| Uab Modernios E-Technologijos | 2 | 0.96% | 1.10 | 4.36% |
| Valstybinis Moksliniu Tyrimu Institutas Fiziniu ir Technologijos Mokslu Centras (FTMC) | 7 | 3.35% | 0.97 | 3.85% |

# LU - Luxembourg

## Progress towards meeting the Europe 2020 R&D intensity target

R&D intensity in Luxembourg has fluctuated over the last decade. More precisely, it decreased from 1.65% in 2000 to 1.56% in 2005, increased to 1.66% in 2006 and slightly decreased to 1.56% in 2008, before increasing to 1.68% in 2009. These fluctuations are mirrored by fluctuations in the R&D intensity of the private sector over the same period. Public sector (government plus higher education) has increased steadily, even if it has remained relatively low, from 0.12% in 2000 to 0.44% in 2009. This shows that R&D financed by the business sector is the component most affected by the business cycle. The economic crisis did not trigger any cuts in public sector expenditure on R&D. The country was able to increase his nominal R&D budget. This indicates that Luxembourg regards R&D as a priority and as a means of ensuring a better and more rapid economic recovery and economic growth in the longer term. In this context, Luxembourg has set an ambitious, albeit realistic R&D intensity target of 2.6% of GDP for 2020. The private sector would contribute 1.8-1.9% of GDP, i.e. approximately 70%, and the public sector 0.70- 0.80%, i.e. around 30%.

**LUXEMBOURG R&D Intensity projections, 2000-2020(1)**



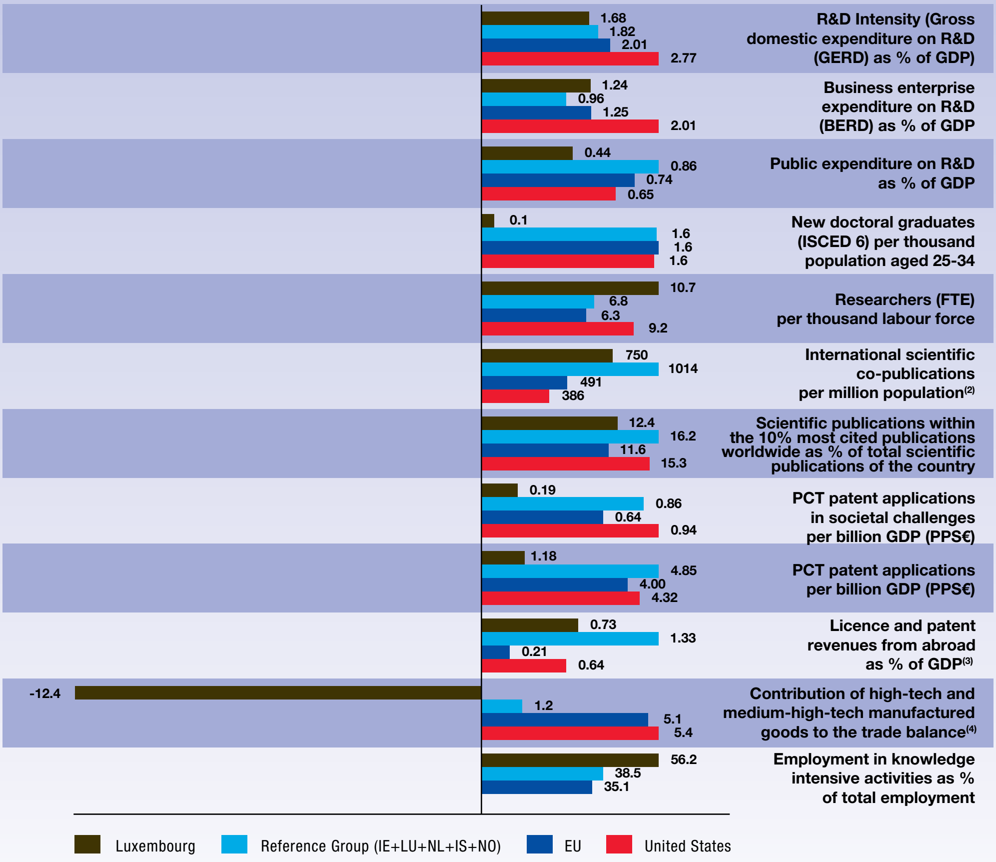
*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) LU: This projection is based on a tentative R&D Intensity target of 2.6% for 2020.

## LUXEMBOURG **R&D profile, 2009**(1)



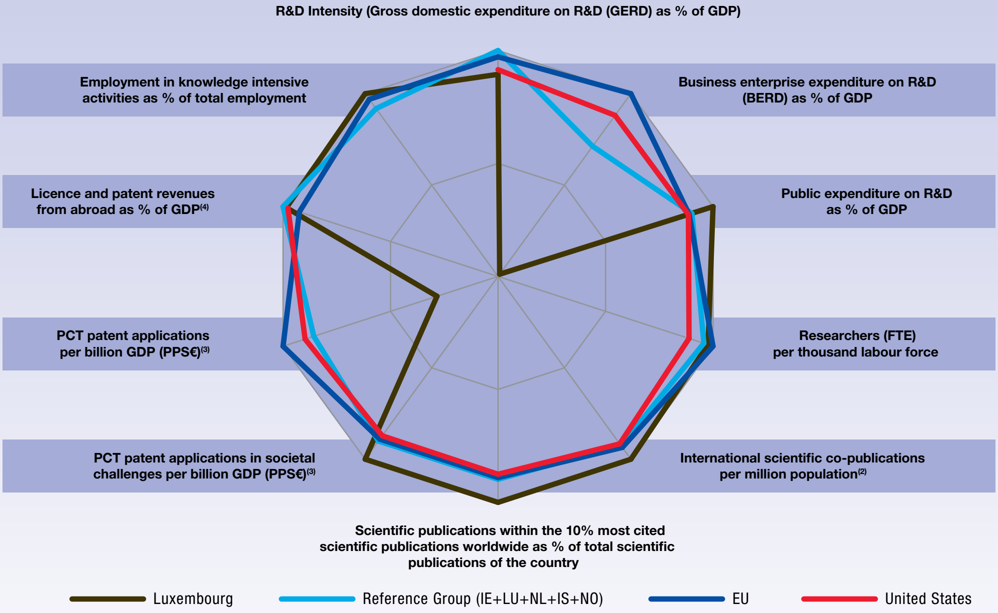
*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) (i) The EU value refers to the median rather than to the average (ii) IS and NO are not included in the Reference Group.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU; (iii) IS and NO are not included in the Reference Group.
(5) Elements of estimation were involved in the compilation of the data.

**Innovation Union Competitiveness Report 2011**

## Research and Innovation Performance

The country's research and innovation performance shows strengths and weaknesses. In terms of strengths, Luxembourg scores higher than the EU average in the share of high-impact scientific publications, licence and patent revenues from abroad as percentage of GDP and employment in knowledge intensive activities. Moreover, although Luxembourg's higher education system produces less doctoral graduates relative to its population aged 25-34 than the average in the EU, the country is above the EU average in the number of researchers in the labour force. All these indicators evidence the importance of knowledge intensive activities in the national economy. But there are also some weaknesses in the research and innovation system. As previously mentioned, R&D intensity is below the EU average and the reference group countries average. The reason for proportionally lower investment lies mainly in the relatively low public R&D investment, which remains at 0.44% in 2009, well below the EU average. As a result, the technological inventiveness of the country and the contribution of high-tech and medium-high-tech manufactured goods to the trade balance is lower than the EU average. To a large extent, this is linked to Luxembourg's economy structure, largely based on the financial sector and other business services, which account for almost half of the economy total value added.

## LUXEMBOURG Average annual growth (%), 2000-2009(1)



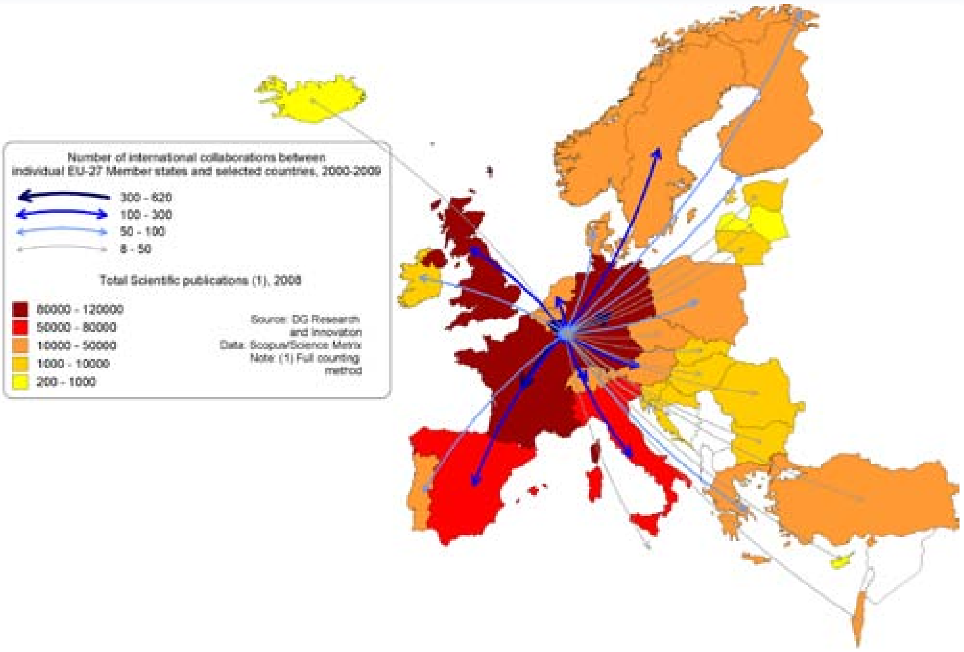
*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

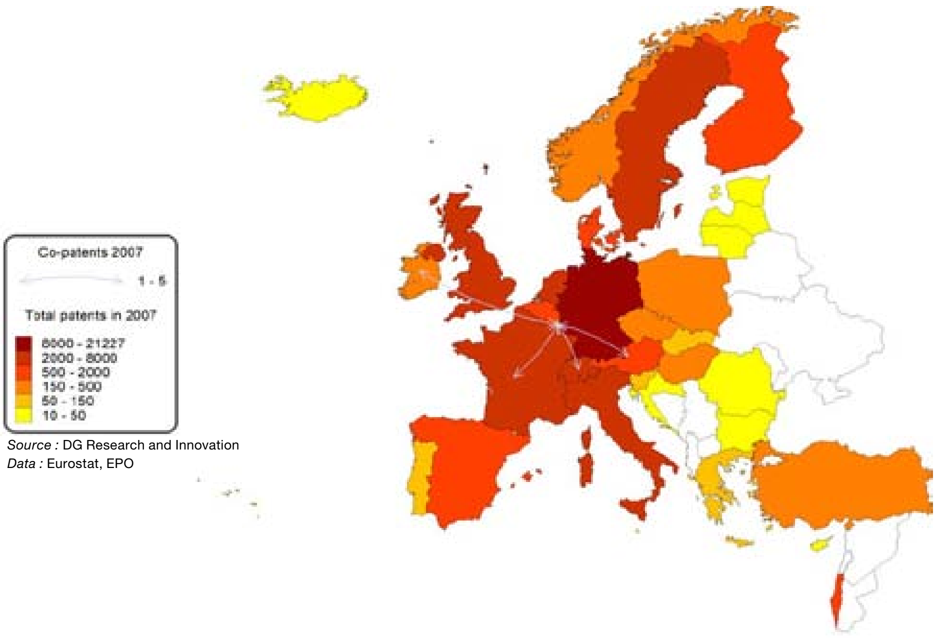
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) (i) The EU value refers to the median rather than to the average; (ii) IS and NO are not included in the Reference Group.
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## LUXEMBOURG Co-publications between Luxembourg and European Countries in 2000-2009



# LUXEMBOURG

## Co-invented patent applications between Luxembourg and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

In the last decade, Luxembourg has made good progress in several fronts, including its public R&D investment, high quality scientific performance measured by high-impact publications and the transition towards an even more knowledge intensive economy. Nevertheless, in the same period, private R&D investment and the technological inventiveness of the economy, measured by PCT patent applications, declined.

The business sector still finances the lion's share of R&D, but Luxembourg lags behind the EU average in terms of private R&D intensity. Moreover, in the context of the financial and economic downturn, private investments in R&D can be further affected.

### Participation in the European Research Area : Scientific and Technological collaborations

Luxembourg is a small economy that also reflects on its scientific collaborations. In this respect, although Luxembourg counts on a larger number of international scientific co-publications than the EU average, it scores below other small and open economies. The main partners in science are, as it is expected, the neighbouring countries, i.e. France, Germany and Belgium, followed by the United Kingdom, Sweden, Italy, Spain, Switzerland and Austria.

In terms of co-inventions of patents, Luxembourg scores very low, despite recent intellectual property tax incentives (in particularly, since January 2008 it offers an 80% tax cut on intellectual property profits). This is a reflection of the size of the country, the low number of overall patents and the economic structure, based on knowledge intensive services. The main technological partners are France and Switzerland, followed by Ireland and Austria.

### FP7 Key facts and figures

**Applications**

As of 2011/03/16, a total of

- 444 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 515 applicants from Luxembourg (0.19% of EU-27*) and
- requesting EUR 144.43m of EC contribution (0.16% of EU-27*)

Among the EU-27* Luxembourg (LU) ranks:

- 27th in terms of number of applicants and
- 26th in terms of requested EC contribution

### Success rates

- The LU applicant success rate of 18.6% is lower than the EU-27* applicant success rate of 21.6%.
- The LU EC financial contribution success rate of 11.3% is lower than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 88 proposals were retained for funding (19.8%)
- involving 96 (18.6%) successful applicants from Luxembourg and
- requesting EUR 16.36m (11.3%) of EC financial contribution

Among the EU-27*, Luxembourg (LU) ranks:

- 21st in terms of applicants success rate and
- 22nd in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Luxembourg (LU) participates in

- 87 signed grant agreements
- involving 1 386 participants of which 94 (6.78%) are from Luxembourg
- benefiting from a total of EUR 368.59m of EC financial contribution of which EUR 19.21m (5.21%) is dedicated to participants from Luxembourg.

Among the EU-27* in all FP7 signed grant agreements, Luxembourg (LU) ranks:

- 28th in number of participations and
- 26th in budget share

### SME performance and participation

- The LU SME applicant success rate of 16.29% is lower than the EU-27* SME applicant success rate of 19.33%.
- The LU SME EC financial contribution success rate of 12.21% is lower than the corresponding EU-27* rate of 18.26%.

Specifically,

- 178 LU SME applicants requesting EUR 44.43m
- 29 (16.29%) successful SMEs requesting EUR 5.42m (12.21%)

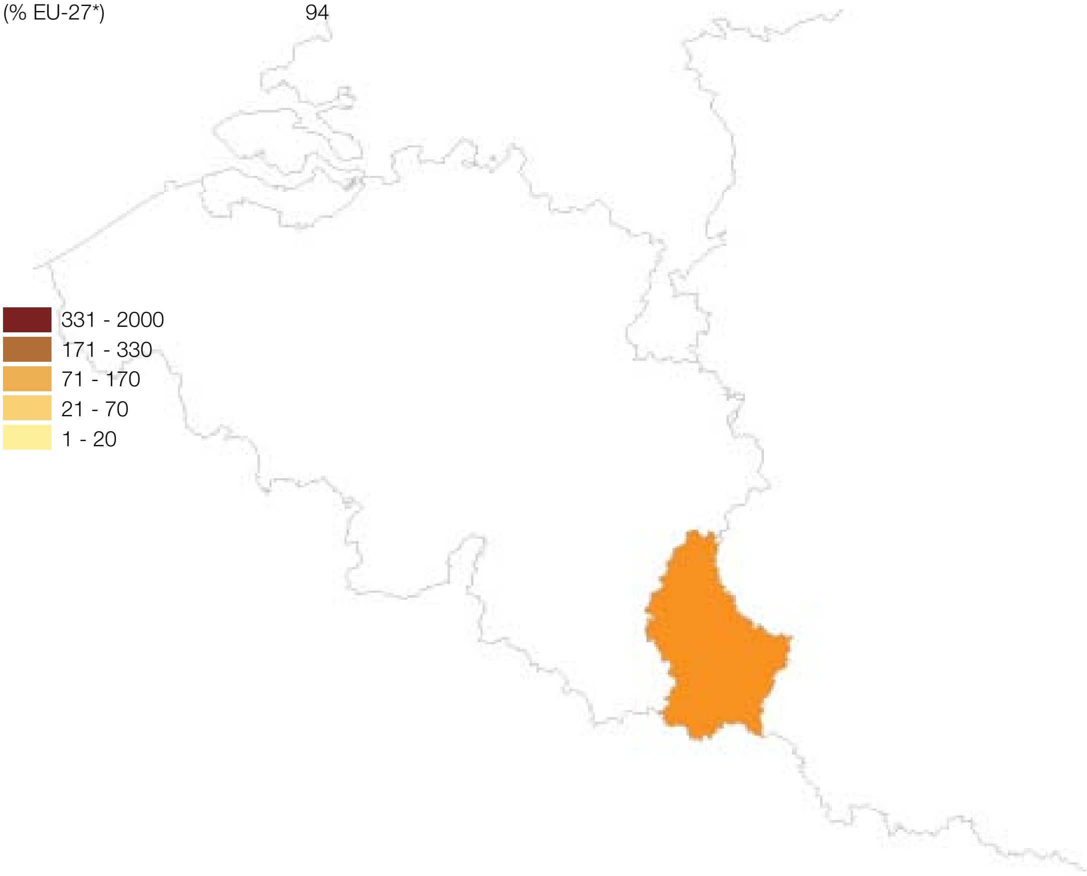
In signed grant agreements, as of 2011/03/16,

- 13 LU SME grant holders, i.e., 13.83% of total LU participation
- EUR 3.21m, i.e., 16.69% of total LU budget share

### Top 3 collaborative links with

- DE - Germany (136)
- FR - France (116)
- IT - Italy (90)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 7th | |
| - Above EU-27 average | | |
| - Innovation Follower | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 515 | |
| (0.19%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 144.43 | |
| (0.16%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 96 | |
| (0.16%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 16.36 | |
| (0.09%) | 18 262.02 | |
| Success rate FP7 applicants | 18.6% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 11.3% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 94 | |
| (0.18%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 19.21 | |
| (0.12%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 12 | |
| (12.77%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 13 | |
| (13.83%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 3.21 | |
| (16.69%) | 2 207.73 | |
| (13.32%) | | |



## TABLE 1

### LU - Luxembourg - most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 167 | 55.69 | 22 | 13.17% | 5.30 | 9.53% |
| Security | 51 | 12.21 | 9 | 17.65% | 2.50 | 20.48% |
| Transport (including Aeronautics) | 50 | 11.81 | 12 | 24.00% | 2.20 | 18.62% |
| Health | 37 | 12.61 | 4 | 10.81% | 0.78 | 6.17% |
| Marie-Curie Actions | 35 | n/a | 11 | 31.43% | n/a | n/a |
| Environment (including Climate Change) | 34 | 5.26 | 6 | 17.65% | 0.44 | 8.44% |

## TABLE 2

### LU - Luxembourg - most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all LU grant holders | EC contribution (EUR million) | % of total EC contribution to LU |
|---|---|---|---|---|
| Information and Communication Technologies | 24 | 25.53% | 5.84 | 30.42% |
| Marie-Curie Actions | 10 | 10.64% | 4.92 | 25.62% |
| Energy | 5 | 5.32% | 2.05 | 10.65% |
| Security | 6 | 6.38% | 1.64 | 8.51% |
| Health | 6 | 6.38% | 1.12 | 5.82% |
| Transport (including Aeronautics) | 7 | 7.45% | 1.02 | 5.33% |

*Notes :* Report generated on: 2011/03/28.10:45 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## LU - Luxembourg - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| PRC | 222 | 66.68 | 38 | 17.12% | 9.61 | 14.42% | 50 | 10.14 | 52.76% |
| HES | 97 | 25.39 | 12 | 12.37% | 2.31 | 9.10% | 9 | 2.20 | 11.45% |
| REC | 88 | 30.61 | 10 | 11.36% | 1.01 | 3.31% | 10 | 1.59 | 8.27% |
| OTH | 56 | 9.48 | 17 | 30.36% | 2.15 | 22.63% | 12 | 1.57 | 8.19% |
| PUB | 46 | 5.65 | 19 | 41.30% | 1.28 | 22.67% | 13 | 3.71 | 19.33% |
| | | | | | | | | | |
| SME | 178 | 44.43 | 29 | 16.29% | 5.42 | 12.21% | 13 | 3.21 | 16.69% |

PRC - Private for profit (excl. education), HES - Higher or secondary education, REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education

## TABLE 4

## LU - Luxembourg - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| LU - Luxembourg region | Number of grant holders | % of all LU - Luxembourg grant holders | EC contribution (M euro) | % of total EC contribution to LU |
|---|---|---|---|---|
| Luxembourg (Grand-Duché) (LU000) | 93 | 98.94% | 18.93 | 98.51% |

## TABLE 5

## LU - Luxembourg - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all LU grant holders | EC contribution (M euro) | % of total EC contribution to LU grant holders |
|---|---|---|---|---|
| Fonds National de la Recherche | 10 | 10.64% | 3.53 | 18.38% |
| Universite du Luxembourg (UI) | 9 | 9.57% | 2.20 | 11.45% |
| Intrasoft International Sa | 6 | 6.38% | 1.72 | 8.96% |
| Ses Astra Techcom Sa (SES) | 4 | 4.26% | 1.44 | 7.49% |
| Soil-Concept Sa (Soil-Concept) | 1 | 1.06% | 1.15 | 5.96% |

# COUNTRY PROFILE

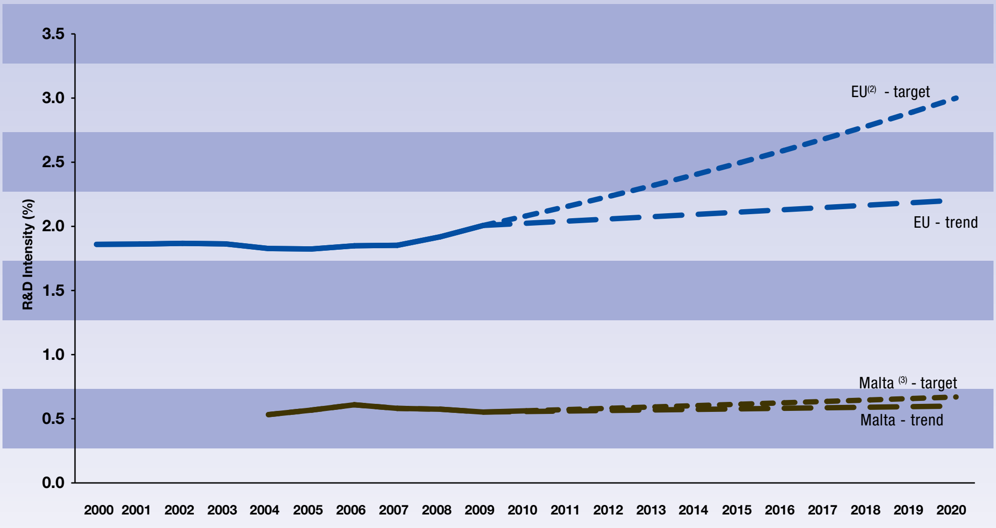
# MT - Malta

## Progress towards meeting the Europe 2020 R&D intensity target

In the last decade, R&D intensity in Malta reached a peak of 0.61% in 2006 and a decline to 0.55% in 2009. Despite this overall progress in R&D intensity, Malta still scores very low and far from the EU average. An economic structure organised around the service sector, dominated by micro enterprises with less than 10 employees, somehow determines the capacity of the country to increase its overall R&D intensity.

As a result, Malta has set a R&D target of 0.67% to be achieved by 2020. Given the size of the country and the capacity of the research system, Malta will need to specialise its R&D investments in particular niche fields where the system can achieve sufficient critical mass to support the local economy. Presently, Malta has identified health and biotechnology, energy and environmental technologies, ICT and value added manufacturing and services as potential areas to focus on.

**MALTA** **R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation

*Data:* DG Research and Innovation, Eurostat

**Innovation Union Competitiveness Report 2011**

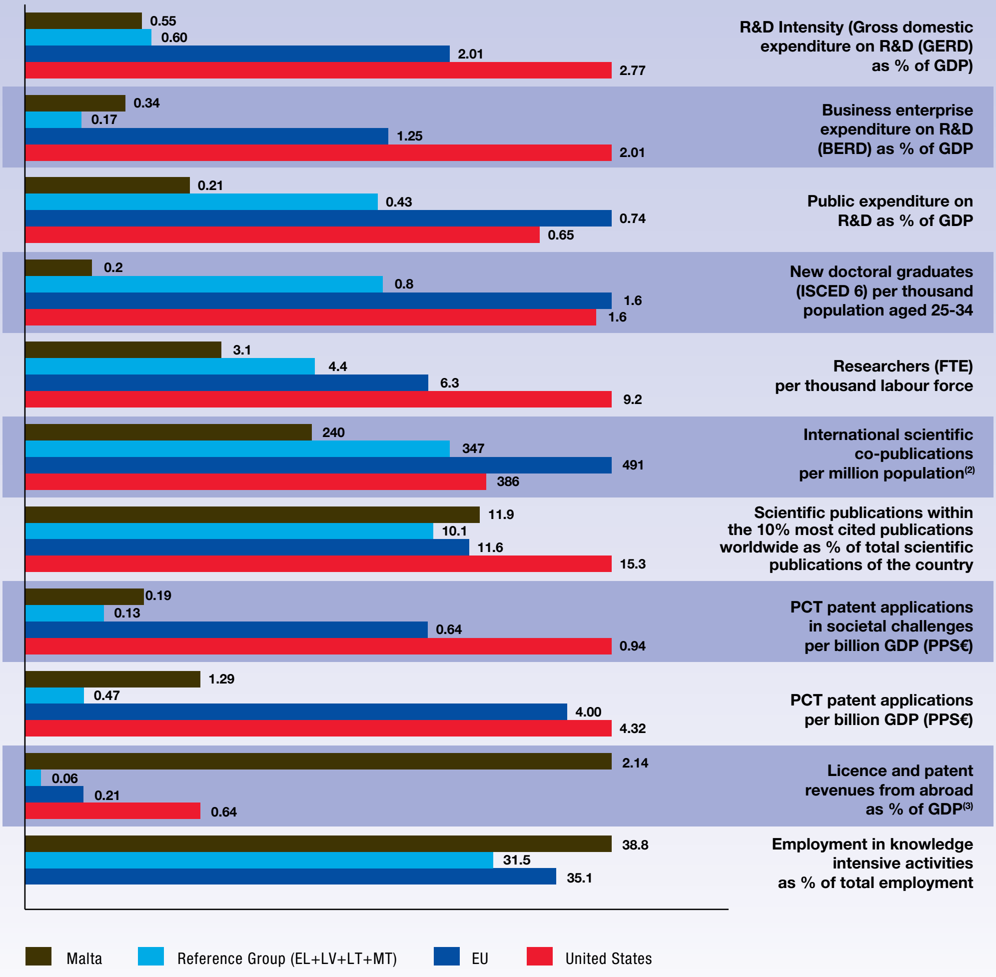
*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009 in the case of the EU and for 2004-2009 in the case of Malta.

(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.

(3) MT: This projection is based on a tentative R&D Intensity target of 0.67% for 2020.

## MALTA

### R&D profile, 2009(1)



*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) Elements of estimation were involved in the compilation of the data.

## Research and Innovation Performance

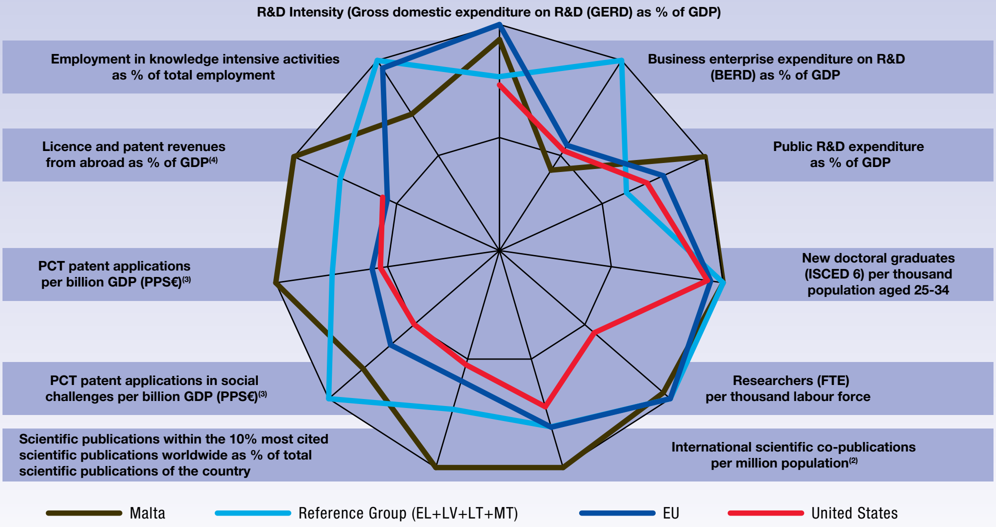
To some extent, the Maltese research and innovation system is characterised by its need to increase its research capacity and reach out more to the business sector. Until quite recently, R&D intensity in Malta was very low, with low rates of public research that have resulted in a shortage of research skills in key areas such as science or engineering.

Research and Innovation activities have traditionally concentrated around a cluster of large firms that have significantly increased their R&D investments in the last years, but there are still numerous indigenous small and micro-enterprises that undertake minimal or no research activities.

In dynamic terms, as mentioned earlier, Malta has been progressing in terms of R&D investments and this also reflects in its scientific and technological outputs. However, in absolute terms, they still remain relatively modest. The recognised need to specialise in particular promising fields where Malta can build on its

## MALTA

## Average annual growth (%), 2000-2009[1]



*Source:* DG Research and Innovation

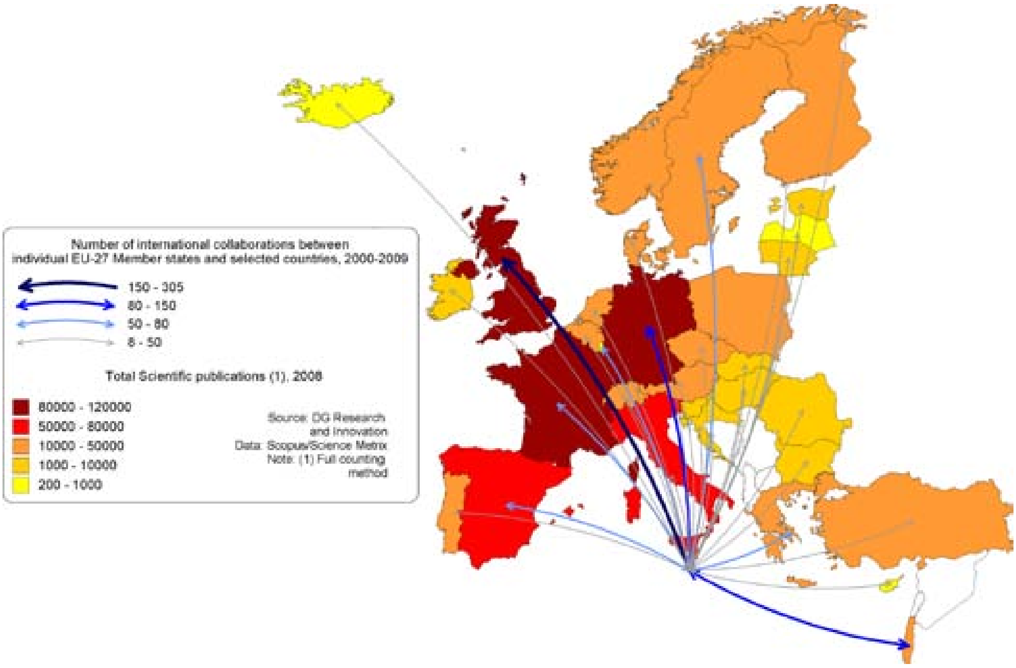
**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average.
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## MALTA

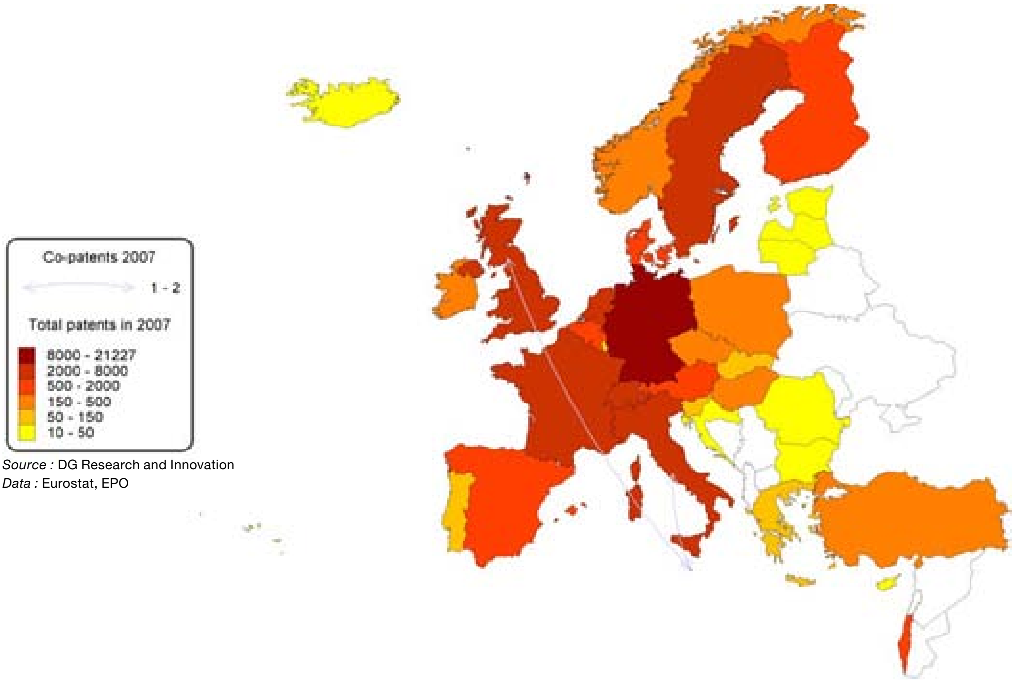
## Co-publications between Malta and European Countries in 2000-2009



Source: DG Research and Innovation
Data: Scopus/Science Metrix
Note: (1) Full counting method

MALTA

## Co-invented patent applications between Malta and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

strengths and create a competitive position can provide optimal results for the future scientific, technological and economic development of the country.

### Participation in the European Research Area : Scientific and Technological collaborations

Malta is participating in international scientific networks in the European Research Area. Although the total number of co-publications is relatively small, this is proportionate to the total number of scientific publications. As it would be expected, Malta depicts stronger scientific links with the main European scientific countries, and especially with the United Kingdom, the main scientific partner, due to historical, linguistic and cultural ties.

In terms of co-patenting, the relatively weak technological production of Malta is also reflected in the technological collaborations with ERA countries. Malta counts only two co-patents with the United Kingdom.

### FP7 Key facts and figures

**Applications**

As of 2011/03/16, a total of

- 500 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 575 applicants from Malta (0.22% of EU-27*) and
- requesting EUR 92.93m of EC contribution (0.11% of EU-27*)

Among the EU-27* Malta (MT) ranks:

- 26th in terms of number of applicants and
- 27th in terms of requested EC contribution

**Success rates**

- The MT applicant success rate of 19.1% is lower than the EU-27* applicant success rate of 21.6%.
- The MT EC financial contribution success rate of 11.1% is lower than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 98 proposals were retained for funding (19.6%)

- involving 110 (19.1%) successful applicants from Malta and
- requesting EUR 10.35m (11.1%) of EC financial contribution

Among the EU-27*, Malta (MT) ranks:

- 20th in terms of applicants success rate and
- 25th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Malta (MT) participates in

- 85 signed grant agreements
- involving 1 575 participants of which 95 (6.03%) are from Malta
- benefiting from a total of EUR 351.02m of EC financial contribution of which EUR 8.34m (2.38%) is dedicated to participants from Malta.

Among the EU-27* in all FP7 signed grant agreements, Malta (MT) ranks:

- 27th in number of participations and
- 28th in budget share

### SME performance and participation

- The MT SME applicant success rate of 14.43% is lower than the EU-27* SME applicant success rate of 19.33%.
- The MT SME EC financial contribution success rate of 11.95% is lower than the corresponding EU-27* rate of 18.26%.

Specifically,

- 291 MT SME applicants requesting EUR 48.96m
- 42 (14.43%) successful SMEs requesting EUR 5.85m (11.95%)

In signed grant agreements, as of 2011/03/16,

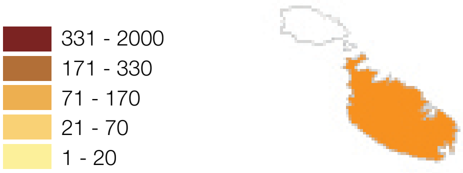
- 23 MT SME grant holders, i.e., 24.21% of total MT participation
- EUR 3.80m, i.e., 45.56% of total MT budget share

### Top 3 collaborative links with

- UK - United Kingdom (108)
- IT - Italy (104)
- ES - Spain (104)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 20th | |
| - Below EU-27 average | | |
| - Moderate Innovator | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 575 | |
| (0.22%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 92.93 | |
| (0.11%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 110 | |
| (0.19%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 10.35 | |
| (0.06%) | 18 262.02 | |
| Success rate FP7 applicants | 19.1% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 11.1% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 95 | |

| | |
|---|---|
| (0.19%) | 51 279 |
| EC contribution | |
| to FP7 grant holders | |
| in EUR million | |
| (% EU-27*) | 8.34 |
| (0.05%) | 16 578.15 |
| Nr. of FP7 coordinators | |
| (% of grant holders) | 8 |
| (8.42%) | 9 383 |
| (18.30%) | |
| Nr. of FP7 SME grant holders | |
| (% of grant holders) | 23 |
| (24.21%) | 8 845 |
| (17.25%) | |
| EC contribution to FP7 SME | |
| grant holders in EUR million | |
| (% of grant holders) | 3.80 |
| (45.56%) | 2 207.73 |
| (13.32%) | |



## TABLE 1

## MT - Malta - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Research for the benefit of SMEs | 116 | 14.10 | 25 | 21.55% | 2.98 | 21.11% |
| Information and Communication Technologies | 69 | 16.47 | 6 | 8.70% | 1.16 | 7.03% |
| Environment (including Climate Change) | 50 | 9.49 | 6 | 12.00% | 0.26 | 2.76% |
| Socio-economic sciences and Humanities | 48 | 5.37 | 9 | 18.75% | 0.61 | 11.43% |
| Science in Society | 46 | 5.29 | 11 | 23.91% | 1.01 | 19.10% |
| Food, Agriculture and Fisheries, and Biotechnology | 38 | 7.21 | 4 | 10.53% | 0.24 | 3.33% |

## TABLE 2

## MT - Malta - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all MT grant holders | EC contribution (EUR million) | % of total EC contribution to MT |
|---|---|---|---|---|
| Research for the benefit of SMEs | 17 | 17.89% | 1.98 | 23.67% |
| Information and Communication Technologies | 8 | 8.42% | 1.00 | 11.94% |
| Transport (including Aeronautics) | 5 | 5.26% | 0.75 | 8.94% |
| Socio-economic sciences and Humanities | 8 | 8.42% | 0.59 | 7.12% |
| Marie-Curie Actions | 10 | 10.53% | 0.50 | 5.99% |
| Space | 4 | 4.21% | 0.44 | 5.30% |

*Notes :* Report generated on: 2011/03/28.10:46 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## MT - Malta - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| PRC | 203 | 32.18 | 29 | 14.29% | 4.39 | 13.63% | 28 | 3.81 | 45.70% |
| HES | 142 | 29.27 | 19 | 13.38% | 1.88 | 6.41% | 16 | 1.35 | 16.22% |
| PUB | 97 | 11.56 | 34 | 35.05% | 2.24 | 19.41% | 44 | 2.39 | 28.68% |
| OTH | 83 | 12.53 | 10 | 12.05% | 0.78 | 6.23% | 3 | 0.19 | 2.29% |
| REC | 48 | 5.10 | 18 | 37.50% | 1.06 | 20.88% | 4 | 0.59 | 7.11% |
| | | | | | | | | | |
| SME | 291 | 48.96 | 42 | 14.43% | 5.85 | 11.95% | 23 | 3.80 | 45.56% |

PRC - Private for profit (excl. education), HES - Higher or secondary education, PUB - Public body (excl. research and education), OTH - Others, REC - Research organisations

## TABLE 4

## MT - Malta - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| MT - Malta region | Number of grant holders | % of all MT - Malta grant holders | EC contribution (M euro) | % of total EC contribution to MT |
|---|---|---|---|---|
| Malta (MT001) | 82 | 86.32% | 6.56 | 78.65% |

## TABLE 5

## MT - Malta - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all MT grant holders | EC contribution (M euro) | % of total EC contribution to MT grant holders |
|---|---|---|---|---|
| Malta Council for Science and Technology (MCST) | 30 | 31.58% | 1.46 | 17.55% |
| Universita ta Malta (UOM) | 16 | 16.84% | 1.35 | 16.22% |
| Integrated Resources Management (IRM) Company Limited (IRMCO) | 4 | 4.21% | 0.75 | 8.99% |
| Electronic Systems Design Ltd (ESDL) | 2 | 2.11% | 0.46 | 5.54% |
| Chadwick Mushroom Farm Ltd | 3 | 3.16% | 0.40 | 4.82% |

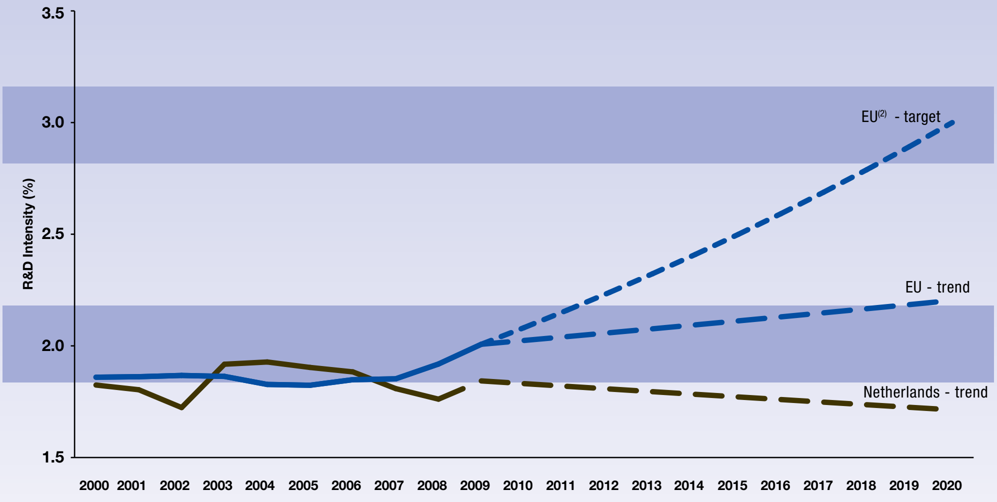
# COUNTRY PROFILE

# NL - Netherlands

## Progress towards meeting the Europe 2020 R&D intensity target

The national target for the Netherlands in 2010 was set to 3% by the former government. The Dutch R&D intensity in 2009 was at the same level as in 2000, particularly with a sharp decrease between 2006 and 2008 at an average annual rate of 4.31%. The decreasing trend has accentuated since 2006, leading the Netherlands to perform below the EU average. In 2009 the R&D intensity amounted to 1.84%[10]. The drop in R&D intensity between 2004 and 2008 was due to a decrease in the R&D intensity of the private sector, while public R&D remained stable at around 0.96% in 2009. If the present trend continued, R&D intensity in the Netherlands would fall short of the EU average in 2020. However, the Government Agreement signed in September 2010 set down that the Netherlands aspires to be one of the top five knowledge economies worldwide. As yet no national R&D target for 2020 has been set.

**NETHERLANDS** **R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009 in the case of the EU and for 2003-2009 in the case of the Netherlands.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) NL: There is a break in series between 2003 and the previous years.

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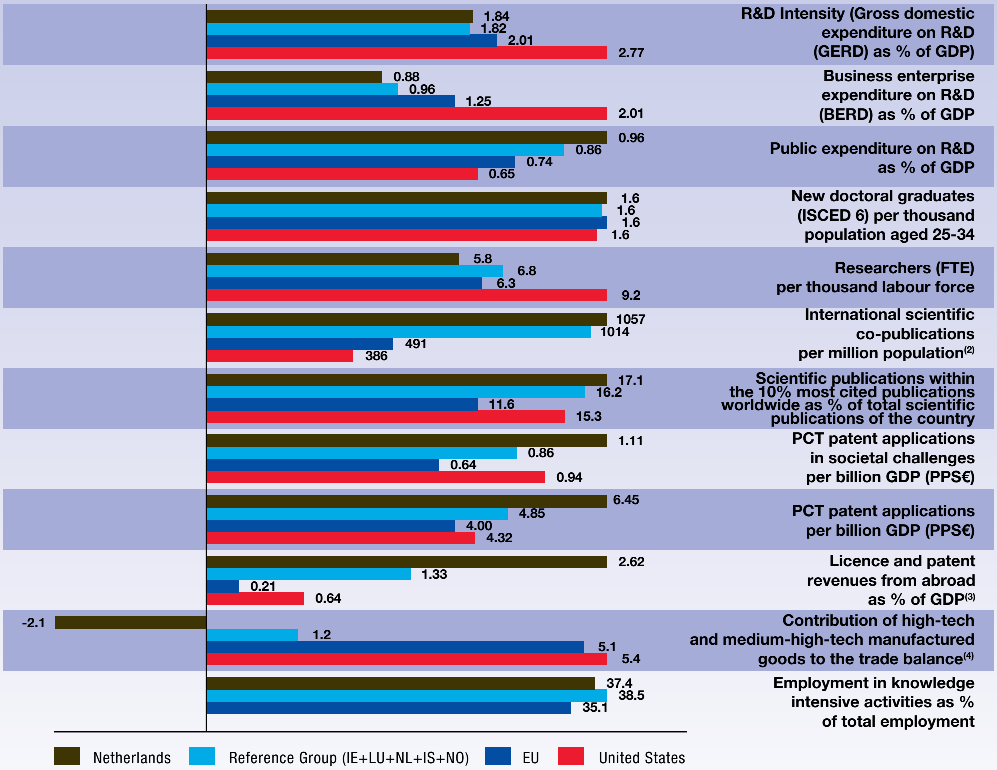
[10] Provisional data from Eurostat. National sources stipulate 1.82%.

## NETHERLANDS R&D profile, 2009[1]



*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

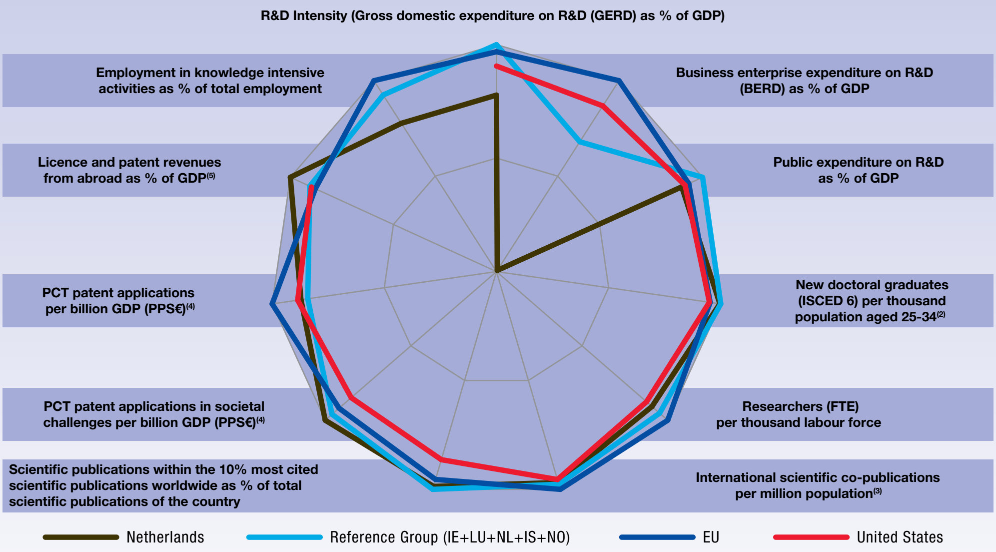
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) (i) The EU value refers to the median rather than to the average (ii) IS and NO are not included in the Reference Group.
(3) EU refers to extra-EU.
(4) (i)EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU; (iii) IS and NO are not included in the Reference Group.
(5) Elements of estimation were involved in the compilation of the data.

## Research and Innovation Performance

The Dutch research and innovation system presents a mixed picture with some weaknesses, especially in terms of private R&D investment, and strengths, in terms of scientific and technological output. More precisely, as previously indicated the Netherlands has a low and declining R&D intensity, 1.84% in 2009, below the EU average. The performance in human resources shows a mixed picture with researchers in the labour force below the EU average, but a higher employment in knowledge intensive activities. However, Dutch researchers are among the most productive in the world. The Netherlands benefits from a high-quality scientific production, managing to score 17% of its publications among the top 10% most cited publications worldwide. Moreover, the Netherlands has an economy with one of the highest patent intensities in the world and performs well in patents aimed at addressing societal challenges that can constitute potential sources of future economic growth.

From a dynamic perspective, the Dutch research and innovation system has managed to maintain its scientific and technological inventiveness capacity vis-à-vis the EU average, despite the fall in R&D intensity, especially in the private sector. This relative poor performance in R&D investments, if continued, could however jeopardise the future scientific and technological capacity of the country. The drop in the BERD percentage can be partly explained by the structure of the economy with a small high-technology sector concentrated in a few multinational companies. A policy encouraging investment in R&I by fast growing innovative firms might be particularly adapted to counterbalance this structure and provide future sources for smart growth. As for many other Member States, the most observable effect

## NETHERLANDS Average annual growth (%), 2000-2009[1]



*Source:* DG Research and Innovation

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

**Innovation Union Competitiveness Report 2011**

*Notes:*
(1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) LU is not included in the Reference Group.
(3) (i) The EU value refers to the median rather than to the average; (ii) IS and NO are not included in the Reference Group.
(4) Average annual growth refers to real growth.
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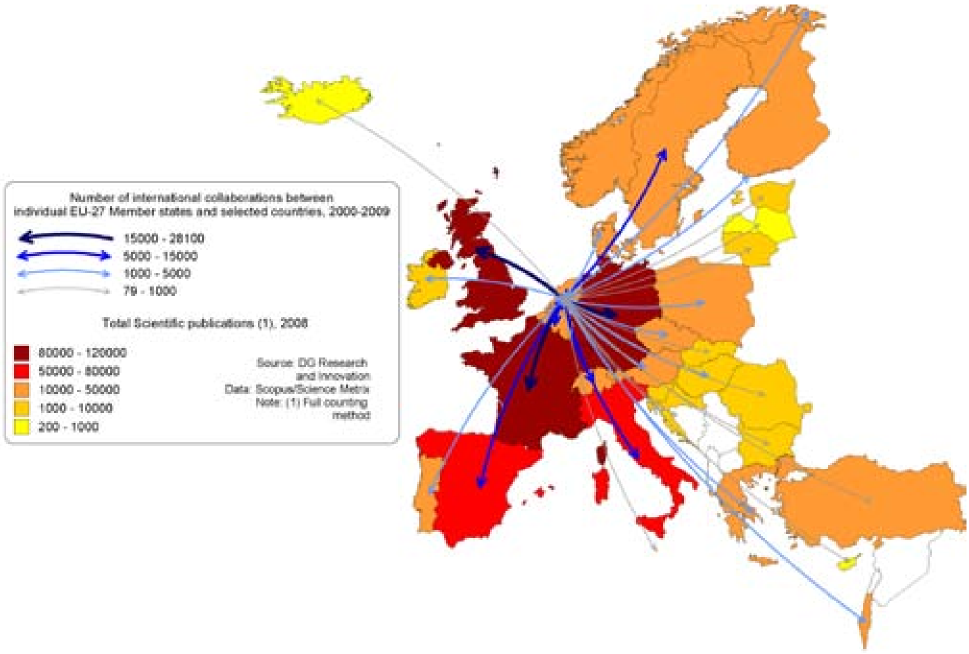
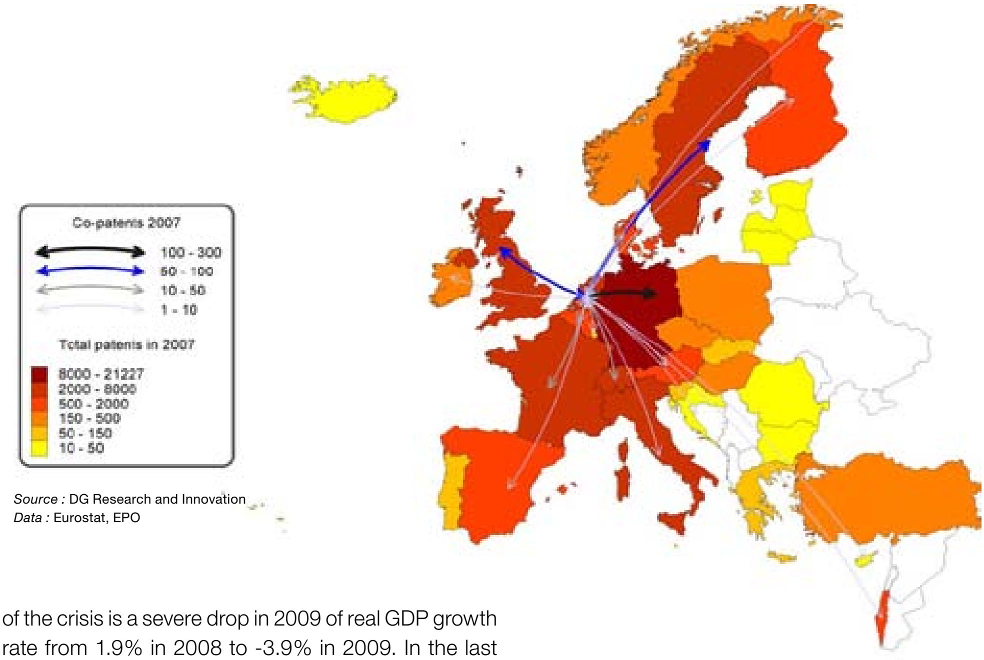
(6) Elements of estimation were involved in the compilation of the data.

## NETHERLANDS Co-publications between Netherlands and European Countries in 2000-2009



NETHERLANDS

## Co-invented patent applications between Netherlands and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

of the crisis is a severe drop in 2009 of real GDP growth rate from 1.9% in 2008 to -3.9% in 2009. In the last years, the crisis package put forward by the Dutch government has included measures with regard to R&D and innovation and particularly for leveraging greater private sector investments.

### Participation in the European Research Area : Scientific and Technological collaborations

The Dutch research and innovation system is very open as reflected by the high number of scientific co-publications and co-patents. This openness of the system allows tapping into international knowledge flows and benefiting from strong knowledge spillovers that reflect on the high capacity of the system to produce high quality scientific publications and patents. The current data available shows that the Netherlands has strongest links in S&T cooperation with France, Germany and the United Kingdom, the three main scientific hubs in Europe, and is well connected to Spain, Denmark and Italy. In terms of co-invented patents, due to the geographical, historical, size and nature of its industry, Germany is the main technological partner, followed by the United Kingdom. An untapped potential probably exists with France, if one compares the co-invented patent applications to the co-publications between the two countries.

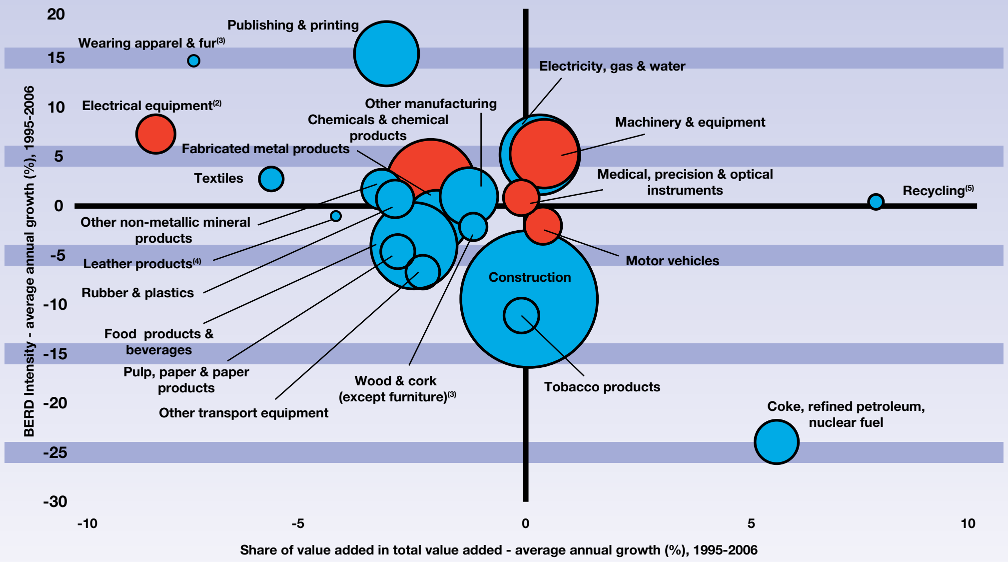
### Structural change towards more knowledge-intensive economy

Creating, exploiting and commercialising new technologies has become essential in the global race for competitiveness. High-technology or 'high-tech' sectors, where they are embedded in an innovative friendly economy, are key drivers of economic growth, productivity and social protection, and contribute to high value added and employment.

In the last decade, private R&D intensity declined in the Netherlands, indicating a shift towards less research-oriented activities. As the graph below shows, since 1995, there have been few changes in the economic structure to move towards more research intensive sectors. In general, research intensity, measured by the research investment over the value added of the sector, has remained largely stable, but some medium-high tech and high-tech sectors, e.g. electrical equipment or chemical and chemical products, have lost importance in the overall economic structure of the country. This is to a large extent the reflection of a larger shift of the Dutch economic structure towards a higher importance of the service sector, which until now has been, in general, less R&D prone, but can be very innovative as well.

# NETHERLANDS

## Share of value added versus BERD Intensity - Average annual growth, 1995-2006



*Source:* DG Research and Innovation
*Data:* OECD

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*Notes:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.
(2) Electrical equipment includes: 'Office, accounting and computing machinery', 'Electrical machinery and apparatus', and 'Radio, TV and communication equipment'.
(3) 'Wearing apparel and fur': average annual growth refers to 1996-2006.
(4) 'Leather products': average annual growth refers to 1996-2006.
(5) 'Recycling': average annual growth refers to 1996-2006.
(6) 'Basic metals' is not visible on the graph.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 10314 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 14800 applicants from Netherlands (5.55% of EU-27*) and
- requesting EUR 5614.93m of EC contribution (6.36% of EU-27*)

Among the EU-27* Netherlands (NL) ranks:

- 6th in terms of number of applicants and
- 6th in terms of requested EC contribution

### Success rates

- The NL applicant success rate of 26.0% is higher than the EU-27* applicant success rate of 21.6%.
- The NL EC financial contribution success rate of 24.4% is higher than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 2569 proposals were retained for funding (24.9%)
- involving 3844 (26.0%) successful applicants from Netherlands and
- requesting EUR 1369.60m (24.4%) of EC financial contribution

Among the EU-27*, Netherlands (NL) ranks:

- 2nd in terms of applicants success rate and
- 3rd in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Netherlands (NL) participates in

- 2208 signed grant agreements
- involving 25289 participants of which 3306 (13.07%) are from Netherlands
- benefiting from a total of EUR 7629.07m of EC financial contribution of which EUR 1243.37m (16.30%) is dedicated to participants from Netherlands.

Among the EU-27* in all FP7 signed grant agreements, Netherlands (NL) ranks:

- 6th in number of participations and
- 5th in budget share

**SME performance and participation**

- The NL SME applicant success rate of 23.64% is higher than the EU-27* SME applicant success rate of 19.33%.
- The NL SME EC financial contribution success rate of 22.87% is higher than the corresponding EU-27* rate of 18.26%.

Specifically,

- 3 371 NL SME applicants requesting EUR 928.38m
- 797 (23.64%) successful SMEs requesting EUR 212.28m (22.87%)

In signed grant agreements, as of 2011/03/16,

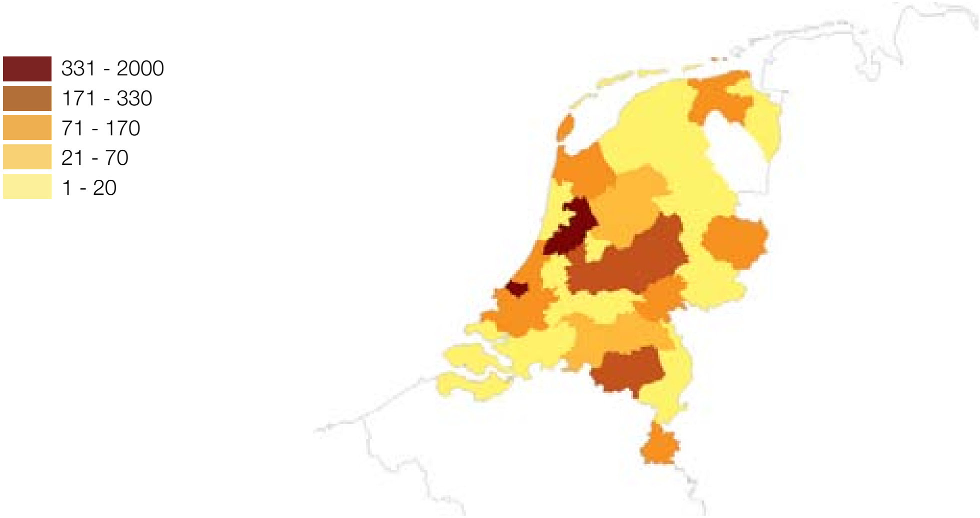
- 487 NL SME grant holders, i.e., 14.73% of total NL participation
- EUR 128.80m, i.e., 10.36% of total NL budget share

**Top 3 collaborative links with**

- DE - Germany (3 444)
- UK - United Kingdom (2 831)
- FR - France (2 258)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 11th | |
| - Above EU-27 average | | |
| - Innovation Follower | | |

| | | |
|---|---|---|
| Nr. of FP7 applicants | | |
| (% EU-27*) | 14 800 | |
| (5.55%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 5 614.93 | |
| (6.36%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 3 844 | |
| (6.49%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 1 369.60 | |
| (7.50%) | 18 262.02 | |
| Success rate FP7 applicants | 26.0% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 24.4% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 3 306 | |
| (6.45%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 1 243.37 | |
| (7.50%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 635 | |
| (19.21%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 487 | |
| (14.73%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 128.80 | |
| (10.36%) | 2 207.73 | |
| (13.32%) | | |



## TABLE 1

## NL - Netherlands - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 2667 | 1121.36 | 559 | 20.96% | 233.69 | 20.84% |
| Marie-Curie Actions | 2304 | n/a | 548 | 23.78% | n/a | n/a |
| Health | 1679 | 932.77 | 472 | 28.11% | 250.44 | 26.85% |
| Environment (including Climate Change) | 1204 | 378.50 | 333 | 27.66% | 108.53 | 28.67% |
| Transport (including Aeronautics) | 1122 | 353.35 | 338 | 30.12% | 93.31 | 26.41% |
| Food, Agriculture and Fisheries, and Biotechnology | 934 | 319.78 | 272 | 29.12% | 92.40 | 28.89% |

## TABLE 2

## NL - Netherlands - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all NL grant holders | EC contribution (EUR million) | % of total EC contribution to NL |
|---|---|---|---|---|
| Information and Communication Technologies | 565 | 17.09% | 221.08 | 17.78% |
| Health | 432 | 13.07% | 218.18 | 17.55% |
| ERC | 127 | 3.84% | 187.92 | 15.11% |
| Marie-Curie Actions | 420 | 12.70% | 107.04 | 8.61% |
| Food, Agriculture and Fisheries, and Biotechnology | 241 | 7.29% | 82.38 | 6.63% |
| Environment (including Climate Change) | 273 | 8.26% | 81.97 | 6.59% |

*Notes :* Report generated on: 2011/03/28.10:46 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## NL - Netherlands - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 6230 | 2012.31 | 1550 | 24.88% | 498.74 | 24.78% | 1471 | 673.00 | 54.13% |
| PRC | 3839 | 1040.65 | 946 | 24.64% | 242.06 | 23.26% | 858 | 213.50 | 17.17% |
| REC | 2765 | 1063.69 | 882 | 31.90% | 342.62 | 32.21% | 780 | 311.22 | 25.03% |
| OTH | 750 | 183.85 | 178 | 23.73% | 42.98 | 23.38% | 68 | 19.59 | 1.58% |
| PUB | 520 | 113.53 | 180 | 34.62% | 39.60 | 34.89% | 129 | 26.06 | 2.10% |
| | | | | | | | | | |
| SME | 3371 | 928.38 | 797 | 23.64% | 212.28 | 22.87% | 487 | 128.80 | 10.36% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education

## TABLE 4

## NL - Netherlands - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| NL - Netherlands region | Number of grant holders | % of all NL - Netherlands grant holders | EC contribution (M euro) | % of total EC contribution to NL |
|---|---|---|---|---|
| Groot-Amsterdam (NL326) | 547 | 16,55% | 235,16 | 18,91% |
| Delft en Westland (NL333) | 421 | 12,73% | 161,87 | 13,02% |
| Veluwe (NL221) | 326 | 9,86% | 108,94 | 8,76% |
| Utrecht (NL310) | 320 | 9,68% | 123,78 | 9,96% |
| Zuidoost-Noord-Brabant (NL414) | 261 | 7,89% | 109,42 | 8,80% |

## TABLE 5

## NL - Netherlands - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all NL grant holders | EC contribution (M euro) | % of total EC contribution to NL grant holders |
|---|---|---|---|---|
| Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek - TNO | 157 | 4.75% | 68.14 | 5.48% |
| Stichting Katholieke Universiteit (SKU/ Radboud Universi) | 112 | 3.39% | 66.85 | 5.38% |
| Technische Universiteit Delft (Tu Delft) | 158 | 4.78% | 63.73 | 5.13% |
| Vereniging voor Christelijk Hoger Onderwijs Wetenschappelijk Onderzoek en Patientenzorg (VUA) | 130 | 3.93% | 61.55 | 4.95% |
| Universiteit Utrecht | 118 | 3.57% | 55.53 | 4.47% |

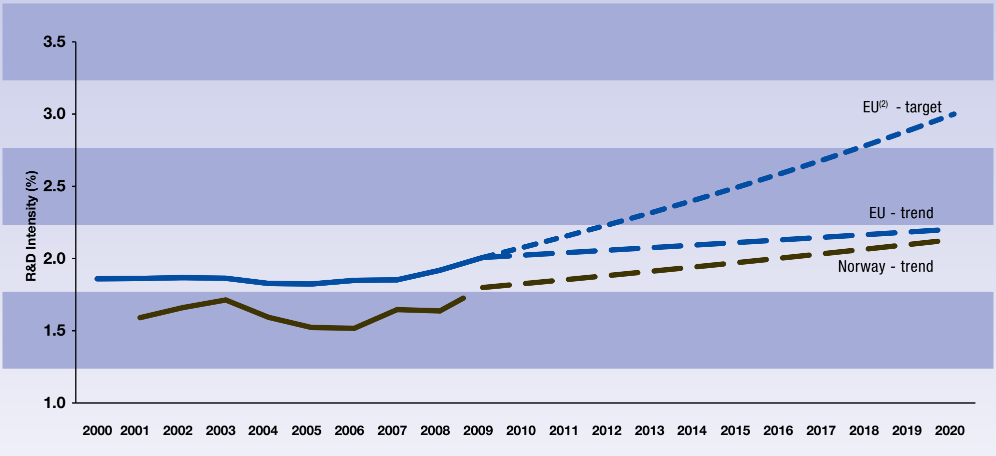
# COUNTRY PROFILE

# NO - Norway

## Progress towards increasing the R&D intensity

The most recent figures for Norway on R&D intensity are 1.80% for 2009 (0.85% public + 0.95% private), which represents a slight increase compared to the values of 2000, in particular visible for the period from 2007-2009. Comparing to other European countries, the most noticeable is Norway's business enterprise expenditure on R&D, which is below the EU average of 1.25% of GDP and far from the 2% level of the most R&D intensive countries in Europe. Norway is an outlier as concerns innovation with a low-tech but very knowledge-intensive industry based on raw material. The high profitability of companies in the petroleum sector means that the ratio of R&D investments as percentage of turnover is low, despite corporate spending on R&D to a competitive level. Over the period 2000-2009, Norway's gross domestic expenditure on R&D (GERD) had a real growth of 3.2%, which is above the 2.5% growth for the EU. Nevertheless, given the trend scenario presented below Norway would still be below the EU average in 2020, at an R&D intensity level slightly above 2%. Even if the associated countries to the European research cooperation do not form part of the Europe 2020 strategy of the European Union, certain countries do envisage fixing an objective for research investment and initiatives for fast growing innovative enterprises. This strategy could be justified if based on consultation with the stakeholders in the country.

**NORWAY** **R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation

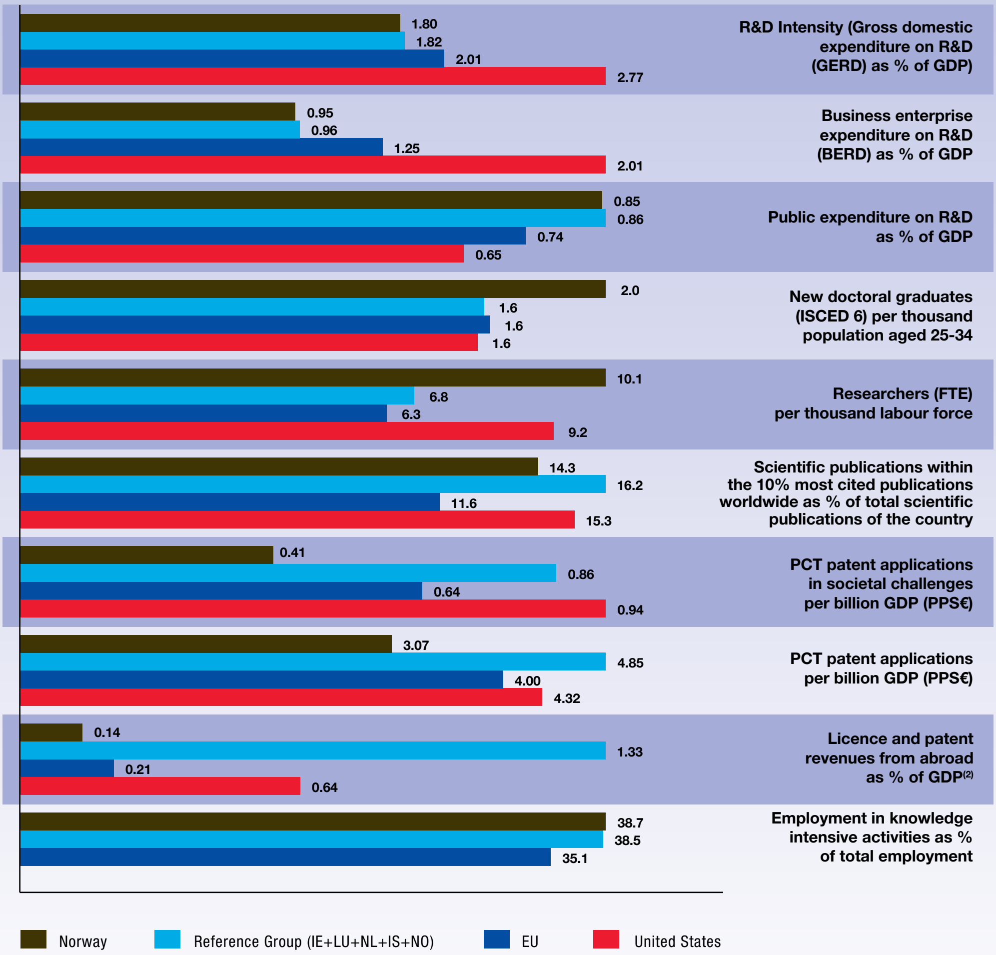
*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009 in the case of the EU and for 2001-2009 in the case of Norway.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.

**Innovation Union Competitiveness Report 2011**

# NORWAY

## R&D profile, 2009[1]



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) EU refers to extra-EU.
(3) Elements of estimation were involved in the compilation of the data.

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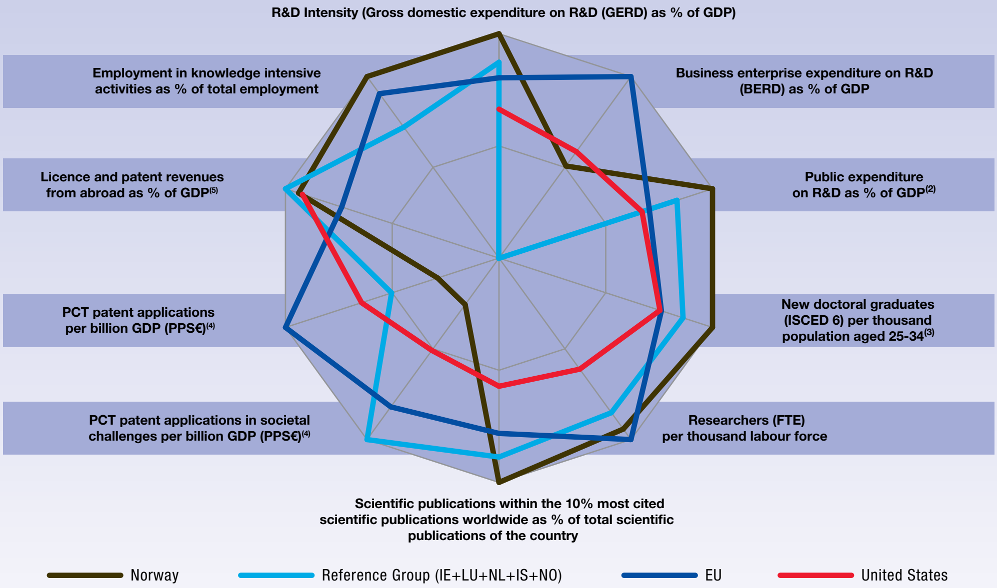
## Research and Innovation Performance

Given its specific industrial structure, Norway is a relatively knowledge-intensive country, with almost 39% of the work force employed in knowledge-intensive activities (which is not only similar to the level of the countries with a comparable industrial and knowledge structure, but also comparable with the 39% of Denmark and slightly below the level of 42% in Sweden). Norway's main strengths are its human resources, with a very high degree of full time researchers in the labour force and a strong dynamic of new doctoral graduates.

The public expenditure in R&D is at a similar level as comparable countries in its reference group, but below the top European countries, reaching above 1% of GDP. The Norwegian research system is also delivering high-quality output, with 14.3% of all scientific publication counting among the top 10% highly cited publications in the world. However, the Norwegian innovation system is less high-tech centred, and rather adapted to a low-tech but highly knowledge-intensive industry based on raw materials (petroleum, fish), supplemented by a strong service sector. In this context, process innovation is

## NORWAY

### Average annual growth (%), 2000-2009[1]



*Source:* DG Research and Innovation **Innovation Union Competitiveness Report 2011**
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) Average annual growth for Norway refers to 2007-2009 - there is a break in series between 2007 and the previous years.
(3) LU is not included in the Reference Group.
(4) Average annual growth refers to real growth.
(5) EU refers to extra-EU.
(6) Elements of estimation were involved in the compilation of the data.

highly important (not shown in the indicators below). Therefore, the PCT patenting level and the license and patent revenues from abroad are below the EU average. Concerning patent applications to the EPO per billion GDP, in 2007 (most recent year available) Norway was at a level below 2%, compared to the EU average above 4%.

The dynamic picture below reinforces the specific characteristics of the Norwegian science and innovation system with an enhanced public research system and human resources but with a business dynamics showing lower average annual growth in R&D investment and lower patenting intensity compared to the EU on average.

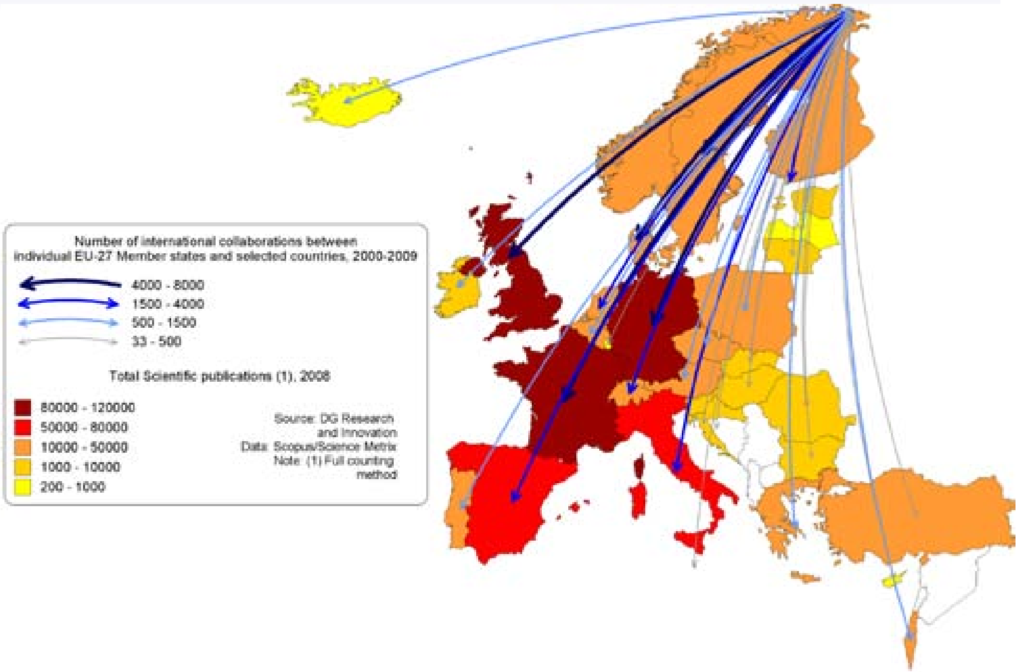
## Connecting to the scientific and technological collaborations in the European Research Area

Norway's scientific cooperation (measured by co-publications) with other European countries is broader and more intense than its technological cooperation (measured by co-patents), providing potential for growing internationalisation of the technology cooperation. The main scientific partner countries are the Nordic neighbours and the larger research countries such as the United Kingdom, Germany and France. As a difference from technological cooperation, co-publications are intensive with almost all EU Member States and with countries associated to the European Research Area. The report shows that while Norway is relatively well integrated in the European scientific co-publication networks, it holds a very marginal position in the main technological cooperation networks (as measured by co-patenting).

## Participation in the European Research Area : Scientific and Technological collaborations

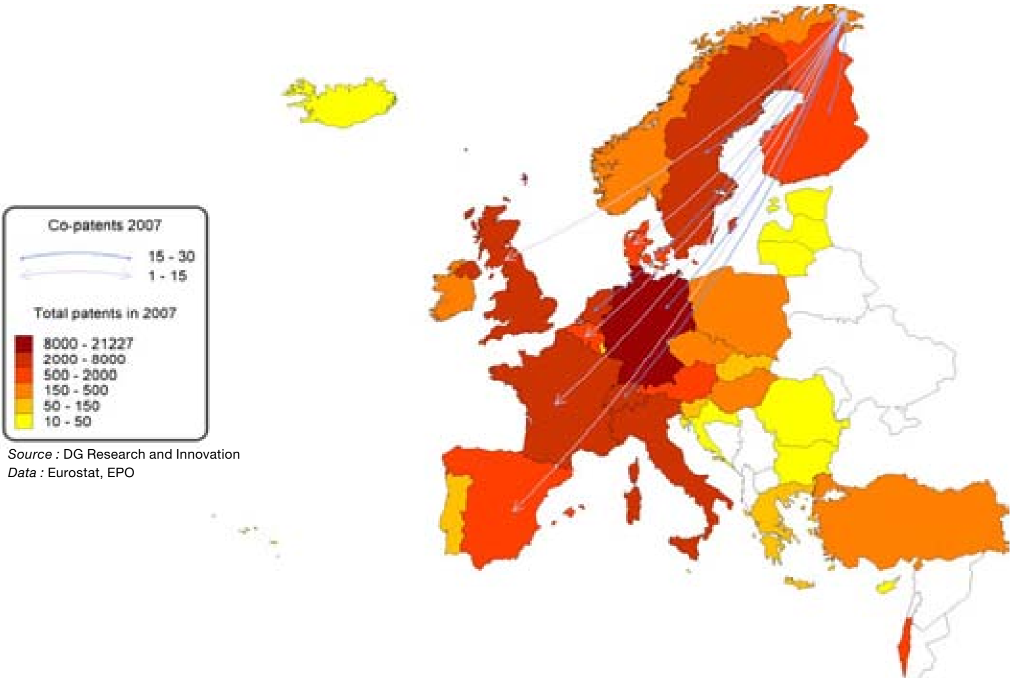
### NORWAY

### Co-publications between Norway and European Countries in 2000-2009



### NORWAY

### Co-invented patent applications between Norway and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 3 446 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 4 801 applicants from Norway (23.74% of Associated Countries) and
- requesting EUR 1 799.61m of EC contribution (22.83% of Associated Countries)

Among the Associated Countries Norway (NO) ranks:

- 2nd in terms of number of applicants and
- 3rd in terms of requested EC contribution

### Success rates

- The NO applicant success rate of 24.7% is higher than the Associated Countries applicant success rate of 23.5%.
- The NO EC financial contribution success rate of 21.1% is similar to the Associated Countries rate of 21.7%.

Specifically, following evaluation and selection, a total of

- 812 proposals were retained for funding (23.6%)
- involving 1 184 (24.7%) successful applicants from Norway and
- requesting EUR 378.98m (21.1%) of EC financial contribution

Among the Associated Countries, Norway (NO) ranks:

- 3rd in terms of applicants success rate and
- 3rd in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Norway (NO) participates in

- 656 signed grant agreements
- involving 8 933 participants of which 951 (10.65%) are from Norway
- benefiting from a total of EUR 2 451.21m of EC financial contribution of which EUR 303.28m (12.37%) is dedicated to participants from Norway.

Among the Associated Countries in all FP7 signed grant agreements, Norway (NO) ranks:

- 2nd in number of participations and
- 3rd in budget share

### SME performance and participation

- The NO SME applicant success rate of 23.31% is higher than the Associated Countries SME applicant success rate of 20.42%.
- The NO SME EC financial contribution success rate of 21.48% is higher than the corresponding Associated Countries rate of 18.51%.

Specifically,

- 1 437 NO SME applicants requesting EUR 415.20m
- 335 (23.31%) successful SMEs requesting EUR 89.19m (21.48%)

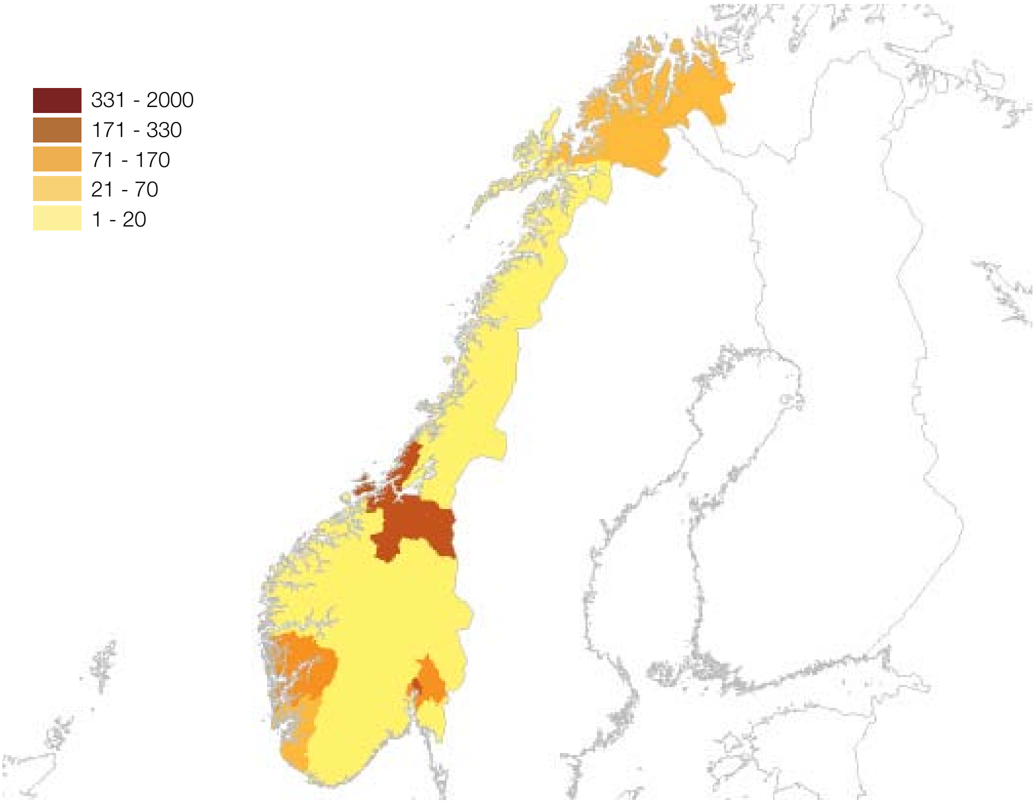
In signed grant agreements, as of 2011/03/16,

- 182 NO SME grant holders, i.e., 19.14% of total NO participation
- EUR 43.19m, i.e., 14.24% of total NO budget share

### Top 3 collaborative links with

- UK - United Kingdom (1 012)
- DE - Germany (985)
- FR - France (692)

| | | |
|---|---|---|
| Nr. of FP7 applicants | | |
| (% Associated Countries) | 4 801 | |
| (23.74%) | 20 227 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% Associated Countries) | 1 799.61 | |
| (22.83%) | 7 884 | |
| Nr. of successful FP7 applicants | | |
| (% Associated Countries) | 1 184 | |
| (24.66%) | 4 802 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% Associated Countries) | 378.98 | |
| (22.15%) | 1 711.27 | |
| Success rate FP7 applicants | 24.7% | 23.5% |
| Success rate | | |
| FP7 EC contribution | 21.1% | 21.7% |
| Nr. of FP7 grant holders | | |
| (% Associated Countries) | 951 | |
| (23.24%) | 4 092 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% Associated Countries) | 303.28 | |
| (19.76%) | 1 535.13 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 155 | |
| (16.30%) | 915 | |
| (22.36%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 182 | |
| (19.14%) | 634 | |
| (15.49%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 43.19 | |
| (14.24%) | 175.41 | |
| (11.43%) | | |



## TABLE 1

## NO - Norway - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 822 | 417.83 | 111 | 13.50% | 51.48 | 12.32% |
| Research for the benefit of SMEs | 793 | 127.43 | 216 | 27.24% | 36.03 | 28.27% |
| Environment (including Climate Change) | 465 | 160.54 | 136 | 29.25% | 48.24 | 30.05% |
| Marie-Curie Actions | 456 | n/a | 97 | 21.27% | n/a | n/a |
| Food, Agriculture and Fisheries, and Biotechnology | 335 | 111.53 | 60 | 17.91% | 19.04 | 17.07% |
| Health | 284 | 136.69 | 75 | 26.41% | 30.30 | 22.17% |

## TABLE 2

## NO - Norway - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all NO grant holders | EC contribution (EUR million) | % of total EC contribution to NO |
|---|---|---|---|---|
| Information and Communication Technologies | 106 | 11.15% | 46.19 | 15.23% |
| Environment (including Climate Change) | 107 | 11.25% | 35.19 | 11.60% |
| Energy | 82 | 8.62% | 31.34 | 10.33% |
| Health | 71 | 7.47% | 28.36 | 9.35% |
| ERC | 14 | 1.47% | 26.72 | 8.81% |
| Research for the benefit of SMEs | 157 | 16.51% | 25.60 | 8.44% |

*Notes :* Report generated on: 2011/03/28.11:37 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## NO - Norway - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| REC | 1 539 | 577.98 | 433 | 28.14% | 154.81 | 26.78% | 371 | 129.68 | 42.76% |
| HES | 1 409 | 443.51 | 279 | 19.80% | 78.47 | 17.69% | 242 | 99.27 | 32.73% |
| PRC | 1 187 | 350.68 | 301 | 25.36% | 81.97 | 23.37% | 253 | 62.92 | 20.75% |
| OTH | 267 | 73.34 | 56 | 20.97% | 14.47 | 19.73% | 14 | 3.29 | 1.09% |
| PUB | 227 | 44.44 | 99 | 43.61% | 15.03 | 33.83% | 71 | 8.12 | 2.68% |
| | | | | | | | | | |
| SME | 1 437 | 415.20 | 335 | 23.31% | 89.19 | 21.48% | 182 | 43.19 | 14.24% |

REC - Research organisations, HES - Higher or secondary education, PRC - Private for profit (excl. education), OTH - Others, PUB - Public body (excl. research and education

## TABLE 4

## NO - Norway - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| NO - Norway region | Number of grant holders | % of all NO - Norway grant holders | EC contribution (M euro) | % of total EC contribution to NO |
|---|---|---|---|---|
| Oslo (NO011) | 324 | 34.07% | 85.12 | 28.07% |
| Sør-Trøndelag (NO061) | 204 | 21.45% | 94.75 | 31.24% |
| Akershus (NO012) | 132 | 13.88% | 30.04 | 9.91% |
| Hordaland (NO051) | 121 | 12.72% | 50.22 | 16.56% |
| Troms (NO072) | 50 | 5.26% | 15.15 | 5.00% |

## TABLE 5

## NO - Norway - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all NO grant holders | EC contribution (M euro) | % of total EC contribution to NO grant holders |
|---|---|---|---|---|
| Stiftelsen Sintef (Sintef) | 81 | 8.52% | 47.84 | 15.77% |
| Universitetet i Oslo | 64 | 6.73% | 29.06 | 9.58% |
| Universitetet i Bergen | 55 | 5.78% | 26.15 | 8.62% |
| Norges Teknisk-Naturvitenskapelige Universitet Ntnu (NTNU) | 50 | 5.26% | 22.86 | 7.54% |
| Universitetet i Tromsoe | 20 | 2.10% | 7.57 | 2.49% |

# COUNTRY PROFILE

# PL - Poland

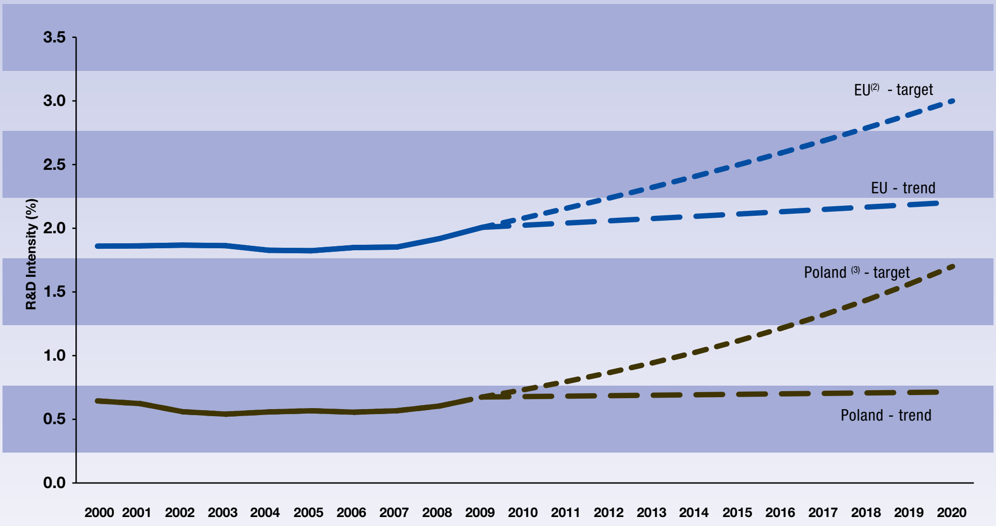
## Progress to meet the Europe 2020 R&D intensity target

In the last decade, R&D intensity in Poland has stayed below 0.7%, passing from 0.64% in 2000 to 0.68% in 2009. As a result, despite a small increase over the last decade, Poland scores one of the lowest R&D intensities in the European Union. In order to maintain and increase its economic competitiveness and secure high-quality jobs, in addition to keep improving factors such as primary and secondary education, production facilities or infrastructures, Poland will have to sharply increase its investments in Research and Innovation.

Polish authorities have recognised this challenge and have set an ambitious, albeit realistic[11] national R&D target for 2020: R&D intensity in Poland should account for 1.7% of the national GDP in 2020. This net increase of around 1.1% would be similar to the one needed for the EU to reach the 3% R&D target.

**POLAND**

**R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation **Innovation Union Competitiveness Report 2011**
*Data:* DG Research and Innovation, Eurostat
*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) PL: This projection is based on a tentative R&D Intensity target of 1.7% for 2020.

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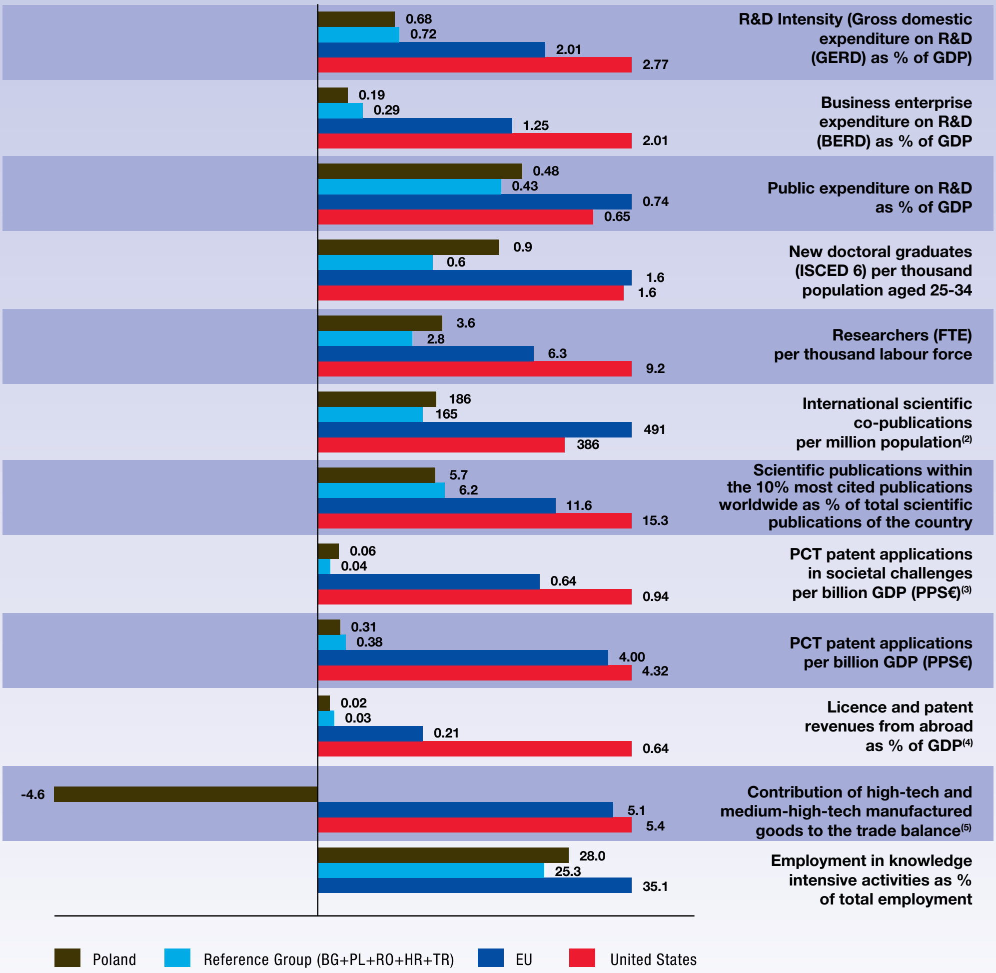
[11] Based on the current economic structure of Poland and the existing R&D intensity gap in most sectors of the economy vis-à-vis more developed countries, Poland could significantly increase its R&D intensity in order to start a scientific and technological convergence process.

## POLAND

## R&D profile, 2009[1]



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) (i) HR and TR are not included in the Reference Group; (ii) The EU value refers to the median rather than to the average.
(3) HR is not included in the Reference Group.
(4) EU refers to extra-EU.
(5) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU; (iii) Data are not available for the Reference Group.
(6) Elements of estimation were involved in the compilation of the data.

**Innovation Union Competitiveness Report 2011**

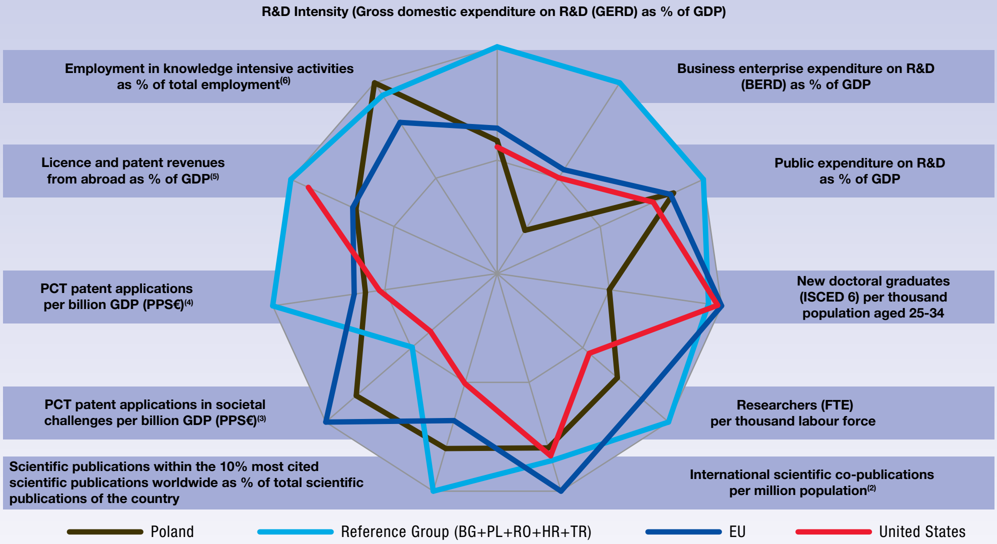
### Research and Innovation Performance

The Polish research and innovation system is characterised by its need to reform in order to enhance both its scientific and technological capacity and facilitate the uptake of new ideas by the business sector. At present, the low level of R&D expenditure, especially by the private sector, coupled with insufficiently favourable framework conditions, reflects in a poor scientific and technological performance. Poland scores low both in terms of high-impact scientific publications and patent applications, where the gap with the EU average is particularly large. Inevitably, the low levels of scientific and technological investment and performance also have consequences on the transition of Poland towards a knowledge based economy. Employment in knowledge intensive activities is one of the lowest in the EU as so is the international competitiveness of the high-technology and medium-high technology sectors, despite the overall relative importance of the manufacturing sector in the economy.

In dynamic terms, in general Poland has been progressing but at a lower pace than the average for those countries that count on a similar scientific

## POLAND

## Average annual growth (%), 2000-2009(1)



*Source:* DG Research and Innovation

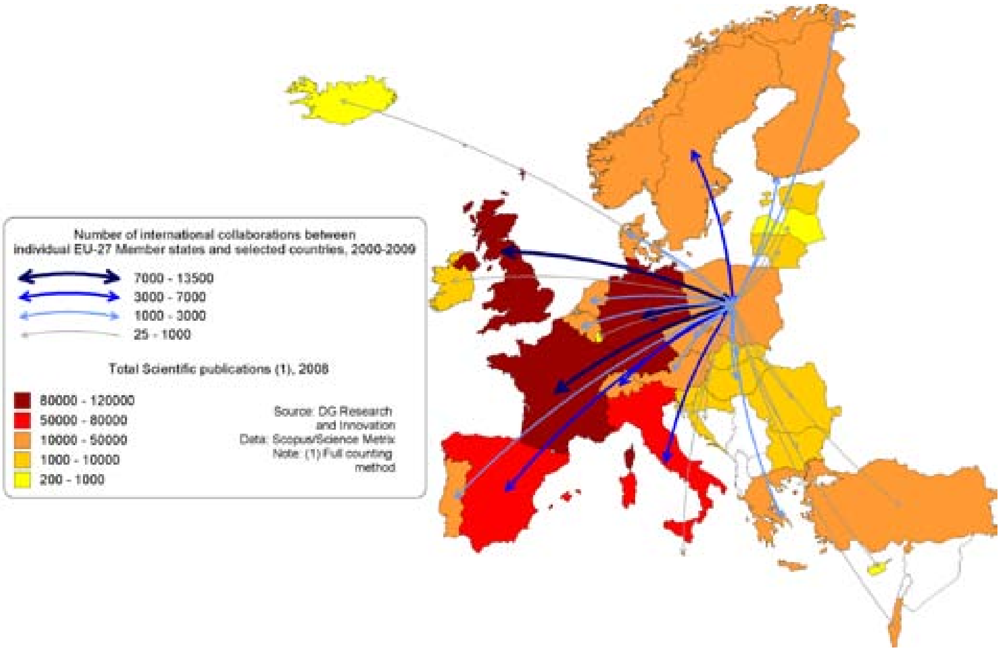
**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) (i) HR and TR are not included in the Reference Group; (ii) EU refers to the median rather than to the average.
(3) HR is not included in the Reference Group; Average annual growth refers to real growth.
(4) Average annual growth refers to real growth.
(5) EU refers to extra-EU.
(6) TR is not included in the Reference Group.
(7) Elements of estimation were involved in the compilation of the data.

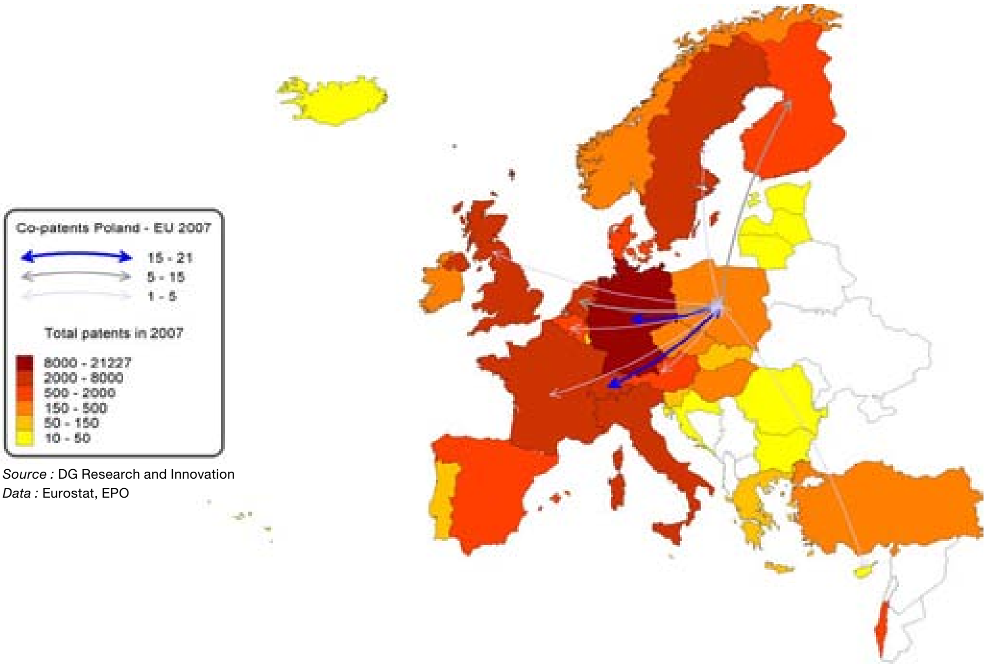
## POLAND

## Co-publications between Poland and European Countries in 2000-2009



Source: DG Research and Innovation
Data: Scopus/Science Metrix
Note: (1) Full counting method

## Co-invented patent applications between Poland and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

and technological profile. If this trend continued, it could have important consequences for the future international economic competitiveness of Poland and its scientific and technological convergence with the rest of the EU.

### Participation in the European Research Area : Scientific and Technological collaborations

As indicated in the table above, Poland is one of the European countries with the lowest rates of overall co-publications per million population. This suggests that the country is not actively participating and benefiting from the international scientific knowledge flows favoured by the construction of the European Research Area. In terms of scientific partners, the closest linkages are created with Germany, mainly due to its overall scientific and technological leadership in Europe and the geographical proximity between the two countries.

In terms of co-patenting, Poland scores overall very low levels of co-patenting activity. As for co-publications, Germany is the biggest partner of Polish technological actors. Switzerland is the second largest technological partner while the connections with all the other countries are relatively low.

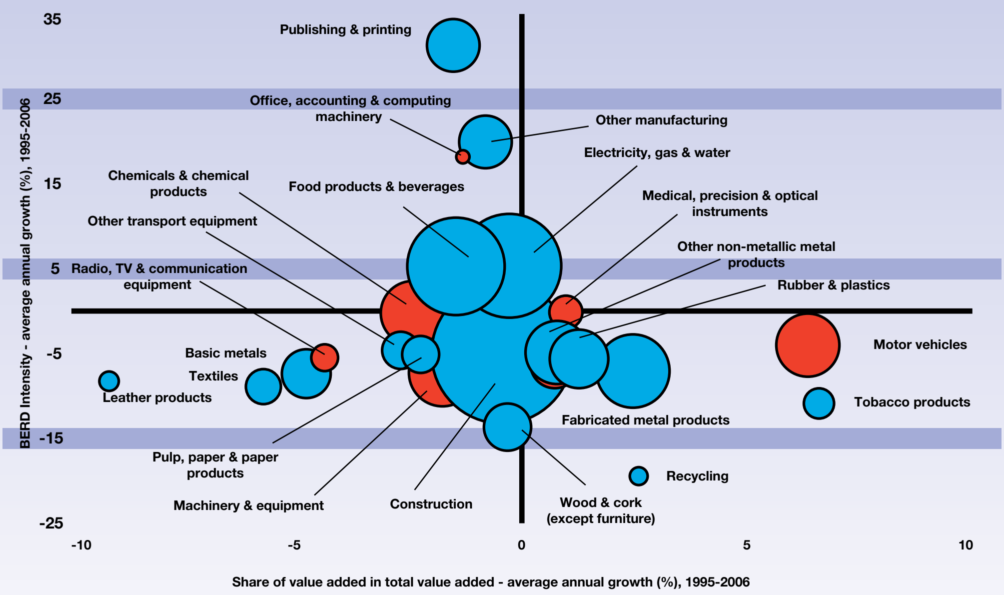
### Structural change towards more research-intensive economy

The fall of private R&D intensity in Poland in the last decade is mainly due to a stagnation of the relative research intensity in high technology sectors and the shift of the economic structure towards less research intensive activities, with the exception of the motor vehicle sector, which has gained relative importance in the total Polish production in the last decade.

Three of the most research intensive sectors, i.e. the machinery and equipment sector, the radio, TV and communication equipment sector, and the motor vehicle sector, have suffered from a drop in their relative R&D investments over the value of their production. This finding suggests that there has not been a move towards more research intensive, higher value added products in these industries. The relative stable sectoral composition of Polish industry around low research intensive sectors reflects the comparative weaknesses in terms of research and innovation performance.

# POLAND

## Share of value added versus BERD intensity - Average annual growth, 1995-2006



*Source:* DG Research and Innovation **Innovation Union Competitiveness Report 2011**
*Data:* OECD
*Notes:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.
(2) 'Wearing apparel and fur' is not included on the graph.
(3) 'Coke, refined petroleum, nuclear fuel' and 'Electrical machinery and apparatus' are not visible on the graph.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 5 248 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 6 741 applicants from Poland (2.53% of EU-27*) and
- requesting EUR 1 643.72m of EC contribution (1.86% of EU-27*)

Among the EU-27* Poland (PL) ranks:

- 11th in terms of number of applicants and
- 13th in terms of requested EC contribution

### Success rates

- The PL applicant success rate of 19.2% is lower than the EU-27* applicant success rate of 21.6%.
- The PL EC financial contribution success rate of 13.7% is lower than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 1 010 proposals were retained for funding (19.2%)
- involving 1 297 (19.2%) successful applicants from Poland and
- requesting EUR 225.15m (13.7%) of EC financial contribution

Among the EU-27*, Poland (PL) ranks:

- 19th in terms of applicants success rate and
- 18th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Poland (PL) participates in

- 867 signed grant agreements
- involving 11 615 participants of which 1 078 (9.28%) are from Poland
- benefiting from a total of EUR 3 056.88m of EC financial contribution of which EUR 201.18m (6.58%) is dedicated to participants from Poland.

Among the EU-27* in all FP7 signed grant agreements, Poland (PL) ranks:

- 13th in number of participations and
- 15th in budget share

**SME performance and participation**

- The PL SME applicant success rate of 17.98% is lower than the EU-27* SME applicant success rate of 19.33%.
- The PL SME EC financial contribution success rate of 15.30% is lower than the corresponding EU-27* rate of 18.26%.

Specifically,

- 1 819 PL SME applicants requesting EUR 350.12m
- 327 (17.98%) successful SMEs requesting EUR 53.57m (15.30%)

In signed grant agreements, as of 2011/03/16,

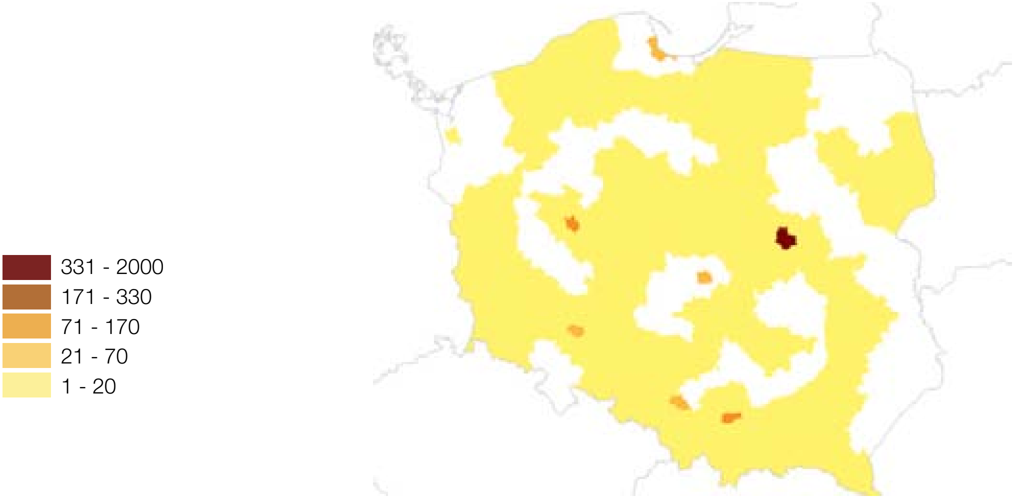
- 168 PL SME grant holders, i.e., 15.58% of total PL participation
- EUR 29.02m, i.e., 14.42% of total PL budget share

**Top 3 collaborative links with**

- DE - Germany (1 462)
- UK - United Kingdom (1 141)
- IT - Italy (1 012)

| | | |
|---|---|---|
| **Nr. of Researchers as% of population | N/A | 0.40% |
| Rank in EU-27* Innovation scoreboard (2008) | - 23th | |
| - Below EU-27 average | | |
| - Moderate Innovator | | |

| | | |
|---|---|---|
| Nr. of FP7 applicants | | |
| (% EU-27*) | 6 741 | |
| (2.53%) | 266 507 | |
| Req. EC contribution by FP7 applicants in EUR million | | |
| (% EU-27*) | 1 643.72 | |
| (1.86%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 1 297 | |
| (2.19%) | 59 199 | |
| Req. EC contribution by successful FP7 applicants in EUR million | | |
| (% EU-27*) | 225.15 | |
| (1.23%) | 18 262.02 | |
| Success rate FP7 applicants | 19.2% | 21.6% |
| Success rate FP7 EC contribution | 13.7% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 1 078 | |
| (2.10%) | 51 279 | |
| EC contribution to FP7 grant holders in EUR million | | |
| (% EU-27*) | 201.18 | |
| (1.21%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 114 | |
| (10.58%) | 9383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 168 | |
| (15.58%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME grant holders in EUR million | | |
| (% of grant holders) | 29.02 | |
| (14.42%) | 2 207.73 | |
| (13.32%) | | |



## TABLE 1

## PL - Poland - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 1 145 | 306.99 | 151 | 13.19% | 34.80 | 11.33% |
| Marie-Curie Actions | 776 | n/a | 210 | 27.06% | n/a | n/a |
| Research for the benefit of SMEs | 766 | 91.58 | 125 | 16.32% | 14.30 | 15.61% |
| Transport (including Aeronautics) | 609 | 122.32 | 144 | 23.65% | 24.13 | 19.73% |
| Socio-economic sciences and Humanities | 518 | 84.58 | 41 | 7.92% | 4.76 | 5.62% |
| Health | 473 | 128.07 | 76 | 16.07% | 16.32 | 12.74% |

## TABLE 2

## PL - Poland - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all PL grant holders | EC contribution (EUR million) | % of total EC contribution to PL |
|---|---|---|---|---|
| Information and Communication Technologies | 148 | 13.73% | 29.97 | 14.90% |
| Marie-Curie Actions | 155 | 14.38% | 19.26 | 9.57% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 85 | 7.88% | 17.64 | 8.77% |
| Research Infrastructures | 89 | 8.26% | 17.58 | 8.74% |
| Research Potential | 11 | 1.02% | 15.78 | 7.84% |
| Health | 81 | 7.51% | 15.30 | 7.61% |

*Notes :* Report generated on: 2011/03/28.10:47 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## PL - Poland - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 2.736 | 589,72 | 478 | 17,47% | 73,61 | 12,48% | 410 | 78,25 | 38,89% |
| PRC | 1.615 | 308,48 | 308 | 19,07% | 53,99 | 17,50% | 270 | 45,43 | 22,58% |
| REC | 1.295 | 305,45 | 316 | 24,40% | 55,24 | 18,08% | 314 | 65,05 | 32,34% |
| OTH | 518 | 107,96 | 101 | 19,50% | 14,03 | 13,00% | 6 | 1,04 | 0,52% |
| PUB | 349 | 67,23 | 86 | 24,64% | 16,93 | 25,18% | 78 | 11,41 | 5,67% |
| | | | | | | | | | |
| SME | 1.819 | 350,12 | 327 | 17,98% | 53,57 | 15,30% | 168 | 29,02 | 14,42% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education

## TABLE 4

## PL - Poland - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| PL - Poland region | Number of grant holders | % of all PL - Poland grant holders | EC contribution (M euro) | % of total EC contribution to PL |
|---|---|---|---|---|
| Miasto Warszawa (PL127) | 445 | 41.28% | 79.57 | 39.55% |
| Miasto Krakow (PL213) | 125 | 11.60% | 25.05 | 12.45% |
| Miasto Poznan (PL415) | 109 | 10.11% | 22.85 | 11.36% |
| Miasto Wroclaw (PL514) | 69 | 6.40% | 11.31 | 5.62% |
| Trojmiejski (PL633) | 63 | 5.84% | 11.29 | 5.61% |

## TABLE 5

## PL - Poland - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all PL grant holders | EC contribution (M euro) | % of total EC contribution to PL grant holders |
|---|---|---|---|---|
| Uniwersytet Warszawski (Uniwarsaw) | 52 | 4.82% | 13.72 | 6.82% |
| Akademia Gorniczo-Hutnicza Im. Stanislawa Staszica W Krakowie (AGH / AGH-UST) | 28 | 2.60% | 10.56 | 5.25% |
| Instytut Chemii Bioorganicznej Pan | 24 | 2.23% | 10.01 | 4.98% |
| Politechnika Warszawska (WUT) | 40 | 3.71% | 9.17 | 4.56% |
| Instytut Biologii Doswiadczalnej Im. M. Nenckiego Polskiej Akademii Nauk (IBD PAN) | 12 | 1.11% | 4.75 | 2.36% |

# COUNTRY PROFILE

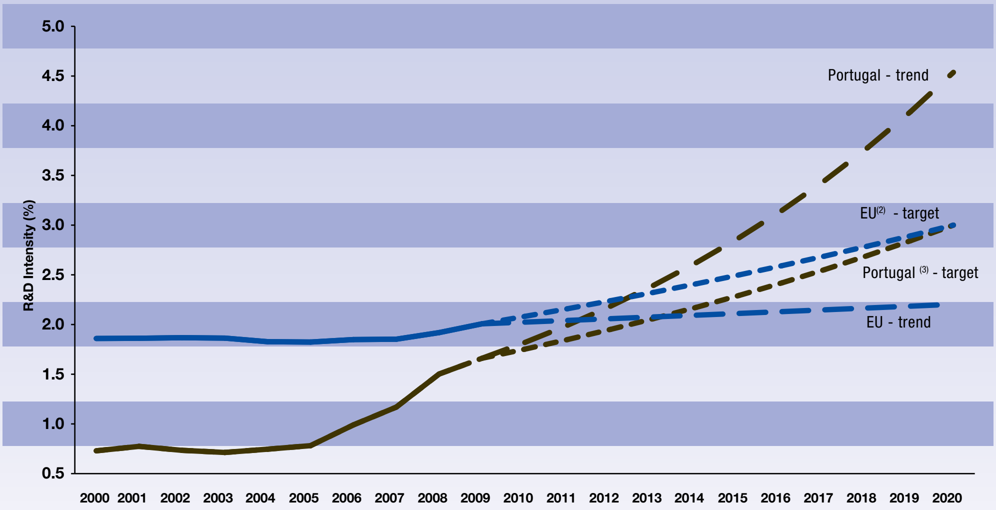
# PT - Portugal

## Progress towards meeting the Europe 2020 R&D intensity target

The figure for Portugal on R&D intensity (GERD/GDP) is 1.66% in 2009 (0.71% public + 0.96% private). This compares to 0.73% in 2000, having had a very high average growth rate of 10.2% for the period 2000-2009. The main feature for this period is the strong growth of private expenditure (0.28% of GDP in 2000) becoming higher than public expenditure from 2006 onwards. Despite the crisis, government spending on R&D increased in 2009 to 205 million Euro. In order to increase its economic competitiveness by raising its productivity and changing the structure of exporting enterprises, Portugal will have to maintain its efforts in increasing its investments in Research and Innovation.

Portuguese authorities have recognised this and have set an ambitious, albeit realistic set of R&D targets for 2020: R&D intensity should account for 2.7% - 3.3%, of which 1.0% - 1.2% in the public sector and 1.7% - 2.1% in the private sector.

**PORTUGAL** **R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* DG Research and Innovation, Eurostat

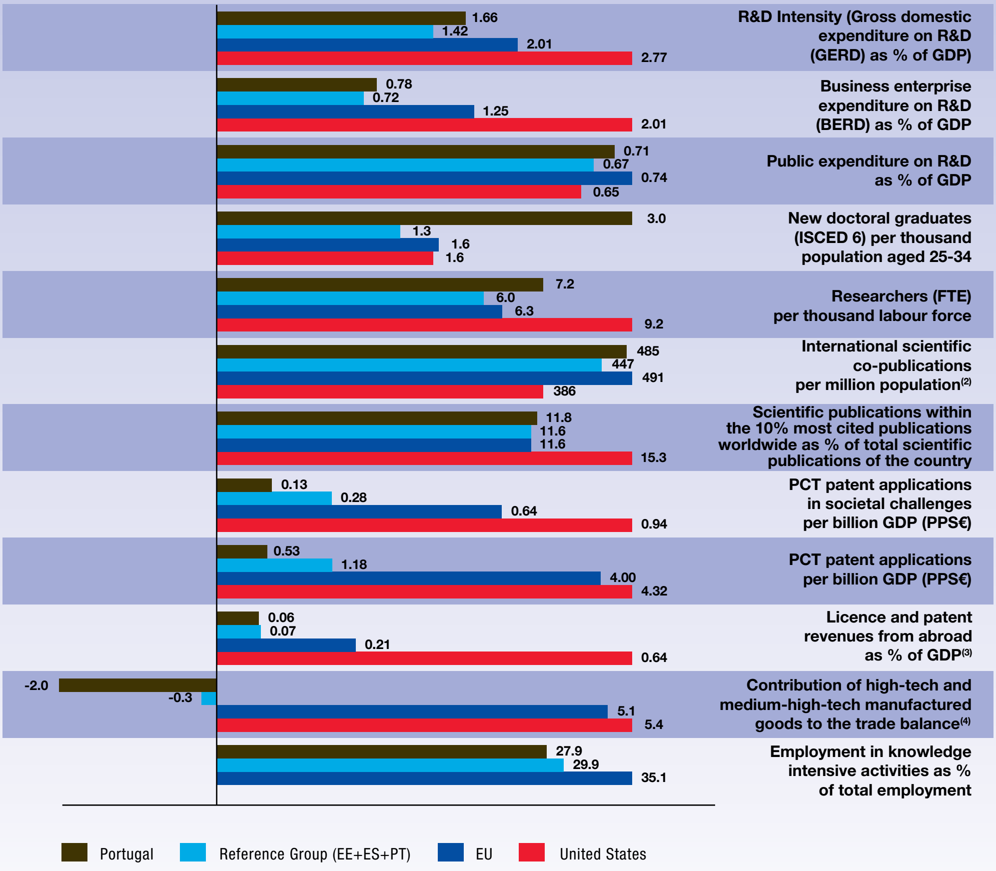
*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) PT: This projection is based on a tentative R&D Intensity target of 3.0% for 2020.

## Research and Innovation Performance

The Portuguese research and innovation system is characterised by a growing private sector share in both financing and performance, although enterprises are still investing about 2/3 of the EU average on R&D. Portugal is outperforming in doctoral graduates and employed researchers, as a result of the important resources provided by the State, having exceeded the EU average on these resources. However, tertiary and upper secondary education attainment is still low,

# PORTUGAL

## R&D profile, 2009[1]



*Source:* DG Research and Innovation

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

**Innovation Union Competitiveness Report 2011**

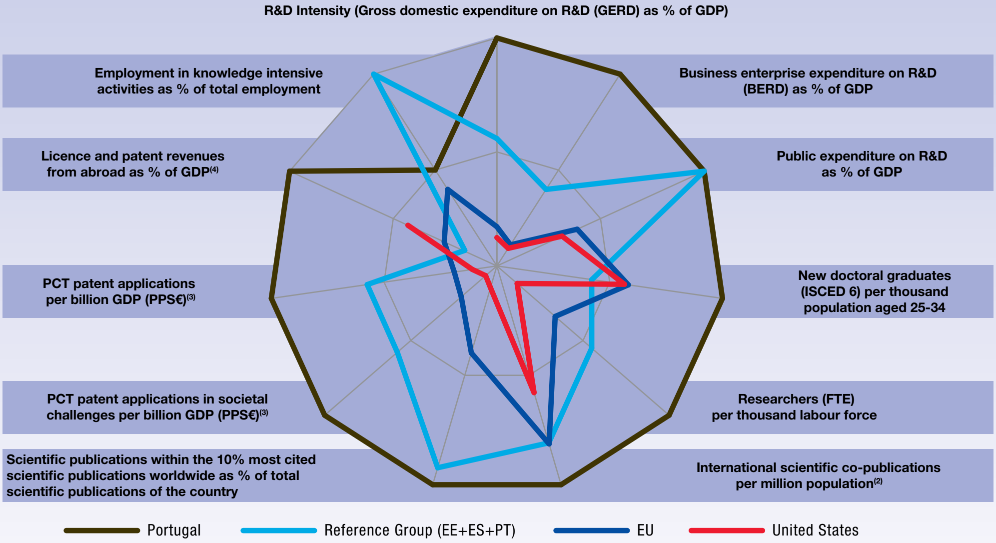
although improving. On the international scientific co-publications and their citation worldwide, Portugal has also progressed well and reached about the EU average – although remaining at less than 1/8 of the EU level in patent applications. Employment in knowledge-intensive activities remains weak which, in conjunction with the general industrial structure of the country, leads to a negative contribution of high-tech and medium-high-tech manufactured goods to the trade balance.

The Portuguese innovation framework presents some strengths and more weaknesses. Under macroeconomic imbalances, public budget austerity and a large rate of unemployment, improving the competitiveness of national enterprises is one of the key challenges.

All indicators but one improved significantly in the period 2000-2009. Portugal ranks well in international scientific co-publications, high-speed broadband lines and SMEs introducing innovations. However, notably, business enterprise expenditure in R&D, enterprise survival rate after two years and PCT patent applications remain well under the EU average. Employment in knowledge-intensive activities remains low, under other European countries and the EU average. This type of employment has not much improved over the period under analysis. This, in conjunction with the negative contribution of high-tech and medium-high-tech manufactured goods to the trade balance, shows the need of more high-tech and medium-tech innovative enterprises, notably in emerging domains.

## PORTUGAL

## Average annual growth (%), 2000-2009[1]



*Source:* DG Research and Innovation

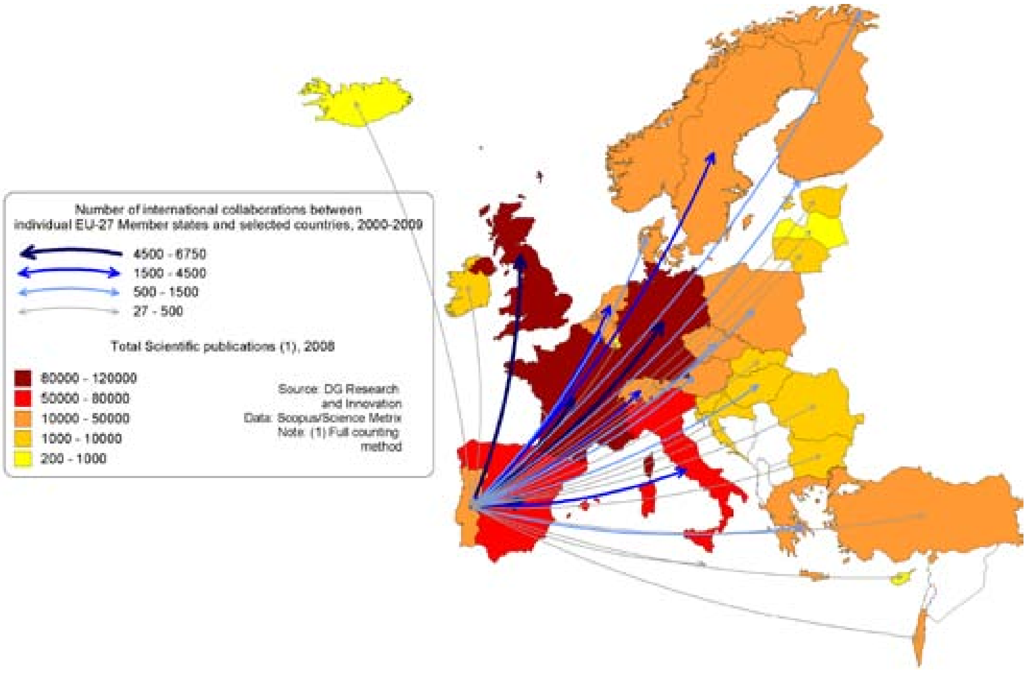
**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average.
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

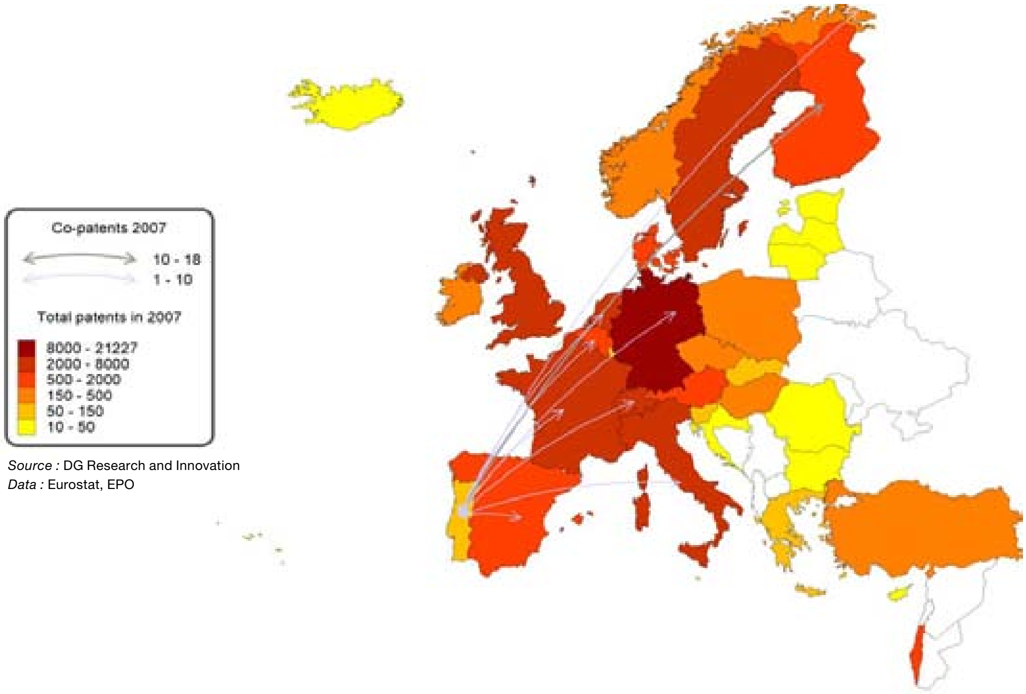
## PORTUGAL

## Co-publications between Portugal and European Countries in 2000-2009



PORTUGAL

## Co-invented patent applications between Portugal and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

### Participation in the European Research Area : Scientific and Technological collaborations

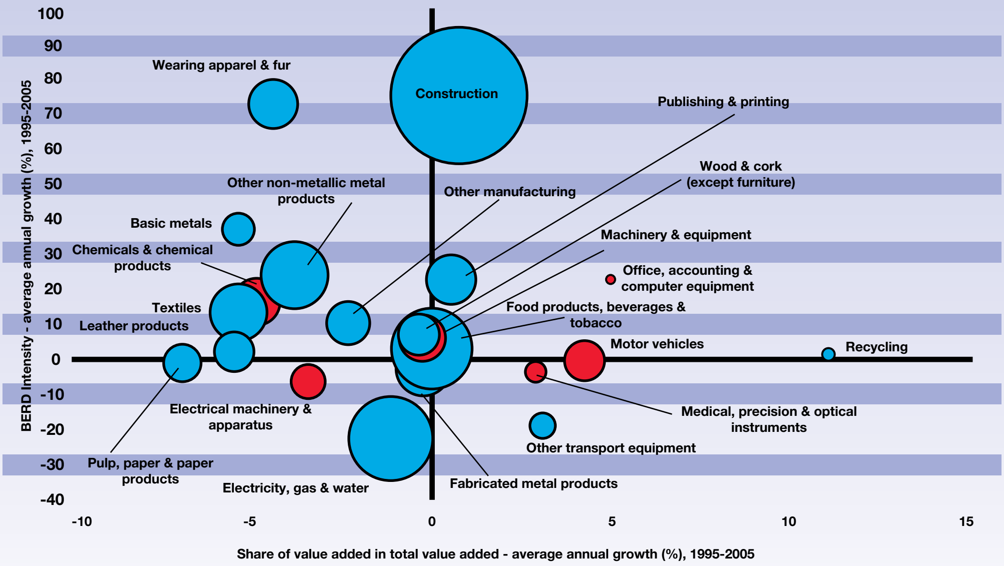
Portugal is a small and open country. The research system has a tradition of hosting researchers of other countries and promoting the participation of young researchers in other countries through bi- and multilateral agreements with other European countries. The International Iberian Nanotechnology Laboratory, jointly launched with Spain, is an example of such openness. A joint programme with Spain was launched promoting research projects in nanosciences and nanotechnologies and a cooperation agreement with Spain and France was concluded to launch a call for joint projects in knowledge-based bio-economy. Portugal is integrated in enlarging networks of scientific and technological cooperation, particularly with Spain, the United Kingdom, France, Germany and Italy. However, the absolute level of technological cooperation remains low as compared with scientific cooperation, pleading for scientific policies to further encourage its development.

### Structural change towards more knowledge-intensive economy

Portugal has a low dynamics of knowledge-intensive firms which has not contributed to the expected growth of value added to the economy. High-tech and medium-high-tech sectors that have moderately increased their share in the total value-added are: Office, accounting and computing machinery, Motor vehicles, and Medical, precision and optical instruments. Other sectors have reduced their share of value added, like the Chemicals and chemical products sector, the Electrical machinery and apparatus, and the Radio, TV and communication equipment sector. Recycling has had a greater growth in the share of value added. The strong increase in BERD intensity for Construction and Wearing apparel and fur sectors demonstrates the potential of progress in traditional sectors. The highest decrease in BERD intensity occurs in Electricity, gas and water.

# PORTUGAL

## Share of value added versus BERD intensity - Average annual growth, 1995-2005



*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* OECD

*Notes:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.
(2) 'Wearing apparel and fur': average annual growth refers to 1996-2005.
(3) 'Coke, refined petroleum, nuclear fuel' and 'Rubber and plastics' are not included on the graph.
(4) 'Radio, TV and communication equipment ' is not visible on the graph.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 4 280 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 5 764 applicants from Portugal (2.16% of EU-27*) and
- requesting EUR 1 426.35m of EC contribution (1.62% of EU-27*)

Among the EU-27* Portugal (PT) ranks:

- 13th in terms of number of applicants and
- 14th in terms of requested EC contribution

### Success rates

- The PT applicant success rate of 19.7% is lower than the EU-27* applicant success rate of 21.6%.
- The PT EC financial contribution success rate of 15.9% is lower than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 853 proposals were retained for funding (19.9%)
- involving 1 138 (19.7%) successful applicants from Portugal and
- requesting EUR 226.77m (15.9%) of EC financial contribution

Among the EU-27*, Portugal (PT) ranks:

- 18th in terms of applicants success rate and
- 15th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Portugal (PT) participates in

- 716 signed grant agreements
- involving 9 309 participants of which 960 (10.31%) are from Portugal
- benefiting from a total of EUR 2 502.09m of EC financial contribution of which EUR 205.65m (8.22%) is dedicated to participants from Portugal.

Among the EU-27* in all FP7 signed grant agreements, Portugal (PT) ranks:

- 14th in number of participations and
- 14th in budget share

**SME performance and participation**

- The PT SME applicant success rate of 16.61% is lower than the EU-27* SME applicant success rate of 19.33%.
- The PT SME EC financial contribution success rate of 14.12% is lower than the corresponding EU-27* rate of 18.26%.

Specifically,

- 1 764 PT SME applicants requesting EUR 384.02m
- 293 (16.61%) successful SMEs requesting EUR 54.21m (14.12%)

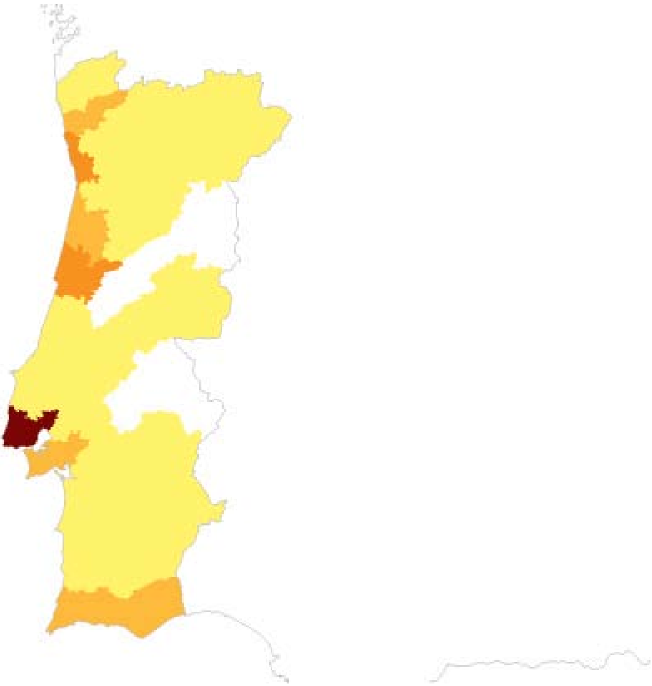
In signed grant agreements, as of 2011/03/16,

- 204 PT SME grant holders, i.e., 21.25% of total PT participation
- EUR 43.23m, i.e., 21.02% of total PT budget share

**Top 3 collaborative links with**

- DE - Germany (973)
- UK - United Kingdom (863)
- IT - Italy (806)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 16th | |
| - Below EU-27 average | | |
| - Moderate Innovator | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 5 764 | |
| (2.16%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 1 426.35 | |
| (1.62%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 1 138 | |
| (1.92%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 226.77 | |
| (1.24%) | 18 262.02 | |
| Success rate FP7 applicants | 19.7% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 15.9% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 960 | |
| (1.87%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 205.65 | |
| (1.24%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 139 | |
| (14.48%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 204 | |
| (21.25%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 43.23 | |
| (21.02%) | 2 207.73 | |
| (13.32%) | | |



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| 🟥 | 331 - 2000 |
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## TABLE 1

## PT - Portugal - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 1 228 | 410.63 | 181 | 14.74% | 63.51 | 15.47% |
| Marie-Curie Actions | 766 | n/a | 195 | 25.46% | n/a | n/a |
| Research for the benefit of SMEs | 626 | 77.29 | 111 | 17.73% | 12.78 | 16.54% |
| Environment (including Climate Change) | 454 | 104.86 | 70 | 15.42% | 14.60 | 13.92% |
| Transport (including Aeronautics) | 424 | 89.06 | 114 | 26.89% | 21.93 | 24.62% |
| Food, Agriculture and Fisheries, and Biotechnology | 334 | 82.16 | 58 | 17.37% | 10.42 | 12.68% |

## TABLE 2

## PT - Portugal - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all PT grant holders | EC contribution (EUR million) | % of total EC contribution to PT |
|---|---|---|---|---|
| Information and Communication Technologies | 182 | 18.96% | 56.88 | 27.66% |
| Marie-Curie Actions | 149 | 15.52% | 23.40 | 11.38% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 75 | 7.81% | 19.38 | 9.42% |
| ERC | 13 | 1.35% | 19.00 | 9.24% |
| Transport (including Aeronautics) | 86 | 8.96% | 16.43 | 7.99% |
| Health | 48 | 5.00% | 11.49 | 5.59% |

*Notes :* Report generated on: 2011/03/28.10:48 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## PT - Portugal - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 1 961 | 458.33 | 343 | 17.49% | 64.69 | 14.12% | 276 | 57.71 | 28.06% |
| PRC | 1 639 | 385.03 | 304 | 18.55% | 60.99 | 15.84% | 265 | 49.18 | 23.91% |
| REC | 1 397 | 312.10 | 316 | 22.62% | 59.45 | 19.05% | 306 | 79.13 | 38.48% |
| OTH | 353 | 56.51 | 67 | 18.98% | 7.70 | 13.63% | 50 | 5.74 | 2.79% |
| PUB | 268 | 34.25 | 92 | 34.33% | 10.94 | 31.93% | 63 | 13.89 | 6.75% |
| | | | | | | | | | |
| SME | 1 764 | 384.02 | 293 | 16.61% | 54.21 | 14.12% | 204 | 43.23 | 21.02% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education

## TABLE 4

## PT - Portugal - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| FI - Finland region | Number of grant holders | % of all PT - Portugal grant holders | EC contribution (M euro) | % of total EC contribution to PT |
|---|---|---|---|---|
| Grande Lisboa (PT171) | 469 | 48.85% | 105.41 | 51.26% |
| Grande Porto (PT114) | 165 | 17.19% | 31.98 | 15.55% |
| Baixo Mondego (PT162) | 86 | 8.96% | 17.88 | 8.70% |
| Baixo Vouga (PT161) | 46 | 4.79% | 10.81 | 5.26% |
| Península de Setúbal (PT172) | 43 | 4.48% | 11.03 | 5.36% |

## TABLE 5

## PT - Portugal - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all PT grant holders | EC contribution (M euro) | % of total EC contribution to PT grant holders |
|---|---|---|---|---|
| Instituto Superior Tecnico (IST) | 57 | 5.94% | 13.56 | 6.60% |
| Fundacao Calouste Gulbenkian | 29 | 3.02% | 11.88 | 5.78% |
| Instituto de Telecomunicacoes (IT) | 28 | 2.92% | 9.74 | 4.74% |
| Universidade do Minho | 32 | 3.33% | 8.46 | 4.12% |
| Universidade do Porto (UPORTO) | 35 | 3.65% | 7.78 | 3.78% |

# COUNTRY PROFILE

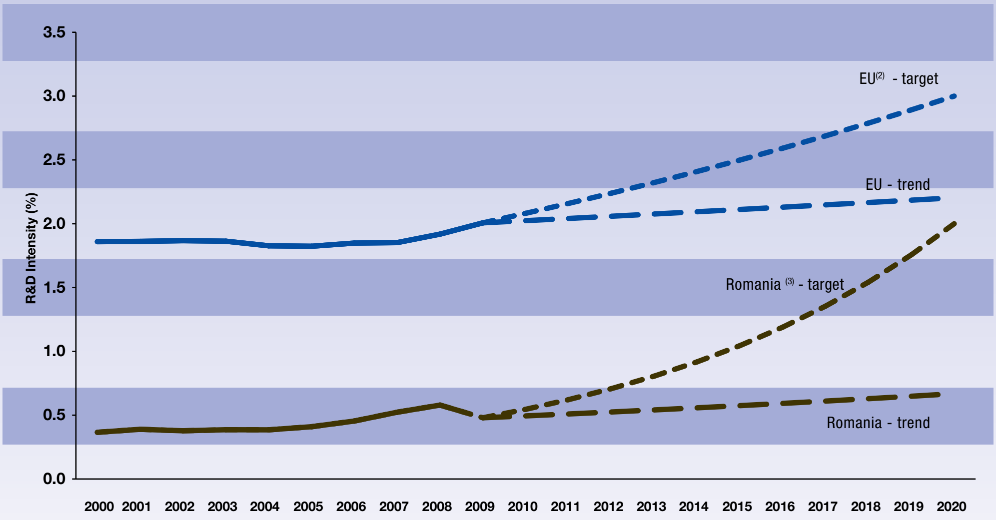
# RO - Romania

## Progress towards meeting the Europe 2020 R&D intensity target

In the last decade, the R&D intensity in Romania increased from 0.37% in 2000 to 0.48% in 2009. Despite this moderate positive trend, Romania still scores one of the lowest R&D intensities in the European Union. Using a multiannual perspective, the Romanian 2007-2013 Strategy for Research, Development and Innovation has foreseen a gradual increase of the R&D public budget. However, the further planned increase of the R&D public budget in 2009 did not take place, mainly due to the economic crisis. A substantial increase of the R&D spending, both in absolute and relative terms, will be instrumental for Romania in order to raise the economic competitiveness and secure high-quality jobs.

Romanian authorities have recognised this and have set an ambitious but achievable target for 2020: R&D intensity is expected to account for 2.0% of the national GDP in 2020.

**ROMANIA** **R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation

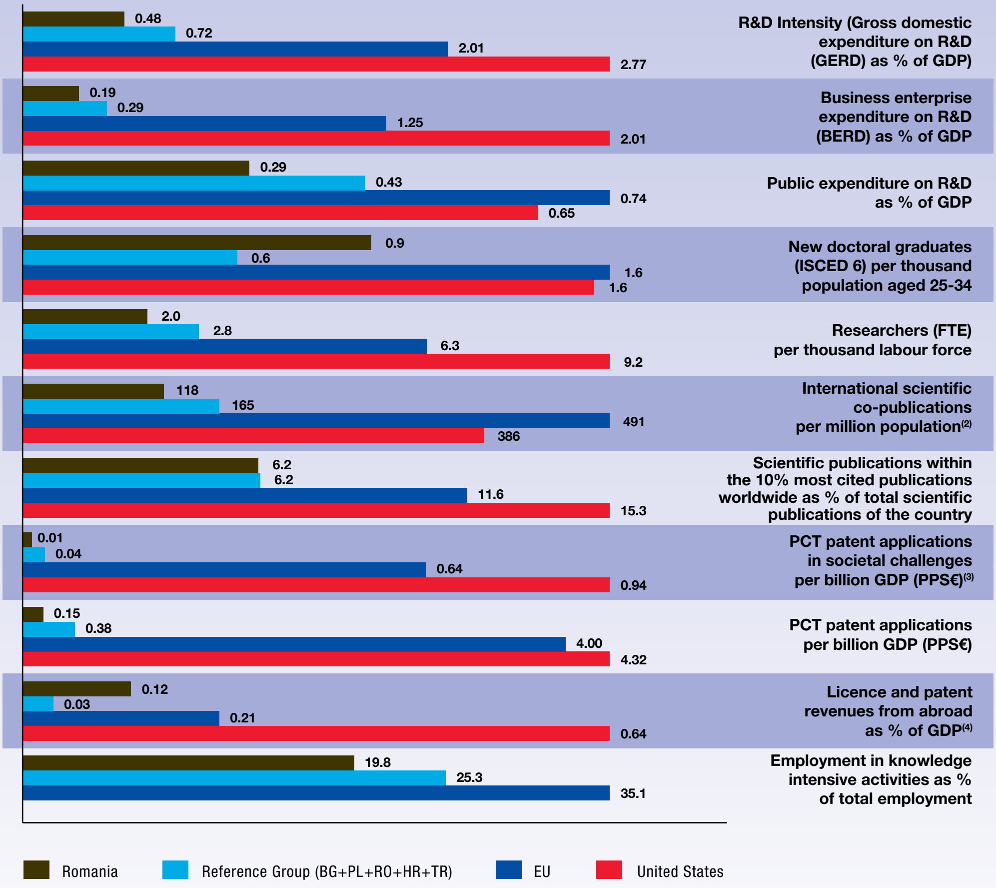
**Innovation Union Competitiveness Report 2011**

*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) RO: This projection is based on a tentative R&D Intensity target of 2.0% for 2020.

## ROMANIA

**R&D profile, 2009(1)**



*Source:* DG Research and Innovation

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

**Innovation Union Competitiveness Report 2011**

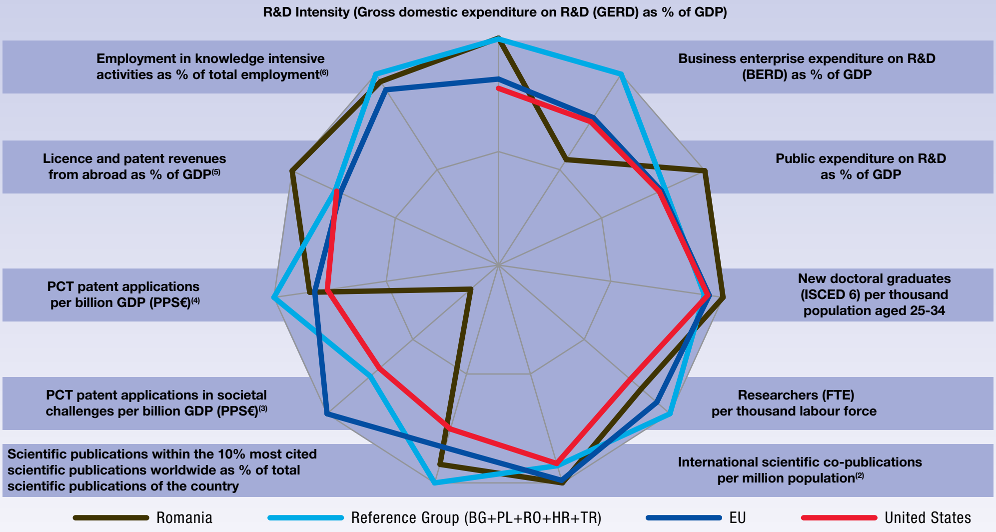
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) (i) HR and TR are not included in the Reference Group; (ii) The EU value refers to the median rather than to the average.
(3) HR is not included in the Reference Group.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## Research and Innovation Performance

An important challenge is the overall fragmentation of the Romanian Research and Innovation system, as reflected by the large number of research performers (universities, research institutes and institutes of the Romanian Academy) combined with a lack of critical mass of the quality of research results. Romania scores low both in terms of high-impact scientific publications and patent applications. The weak scientific and technological performance is combined with rather unfavourable framework conditions for business R&D, as reflected by the low figures of business enterprise expenditure on R&D. As expected in this context, the employment in knowledge intensive activities appears to be one of the lowest in the EU.

## ROMANIA

**Average annual growth (%), 2000-2009[1]**



*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) (i) HR and TR are not included in the Reference Group; (ii) EU refers to the median rather than to the average.
(3) HR is not included in the Reference Group; Average annual growth refers to real growth.
(4) Average annual growth refers to real growth.
(5) EU refers to extra-EU.
(6) TR is not included in the Reference Group.
(7) Elements of estimation were involved in the compilation of the data.

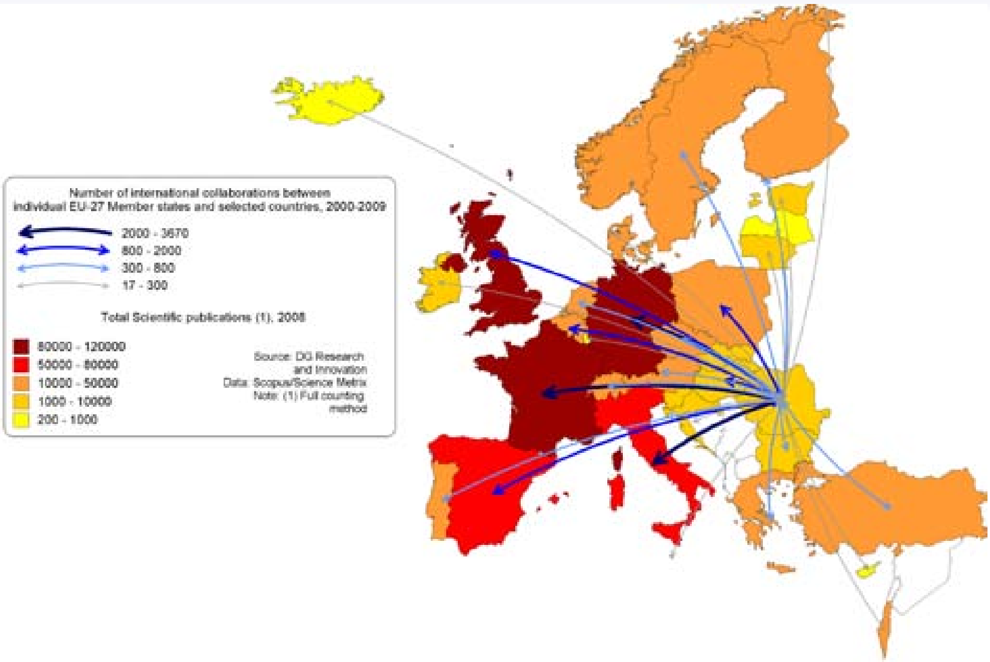
In comparison with similar countries both in terms of industrial structure and R&D performance, as well as with the EU as a whole, Romania appears particularly weak as regards the dynamics of private sector R&D and implicitly the framework conditions for business R&D put in place by the national authorities. This is reflected both by the yet again overall decrease of business enterprise expenditure on R&D between 2000 and 2009 and the number of patent applications in societal challenges. At the contrary, Romania is improving beyond the EU average and the reference group of countries in public R&D expenditure and new doctoral graduates.

### Participation in the European Research Area : Scientific and Technological collaborations

As indicated above, the rate of overall number of co-publications between Romanian researchers and colleagues from other European countries is one of the lowest in Europe. This suggests that the country does not sufficiently benefit from the international knowledge flows favoured by the European Research Area architecture. However, the scientific and technological cooperation is well distributed across Europe. Main partners in terms of co-publications are France, Germany, Italy, the United Kingdom, and Spain. As regards co-patenting, Germany and Ireland appear to be among the main partners of Romanian technological actors.

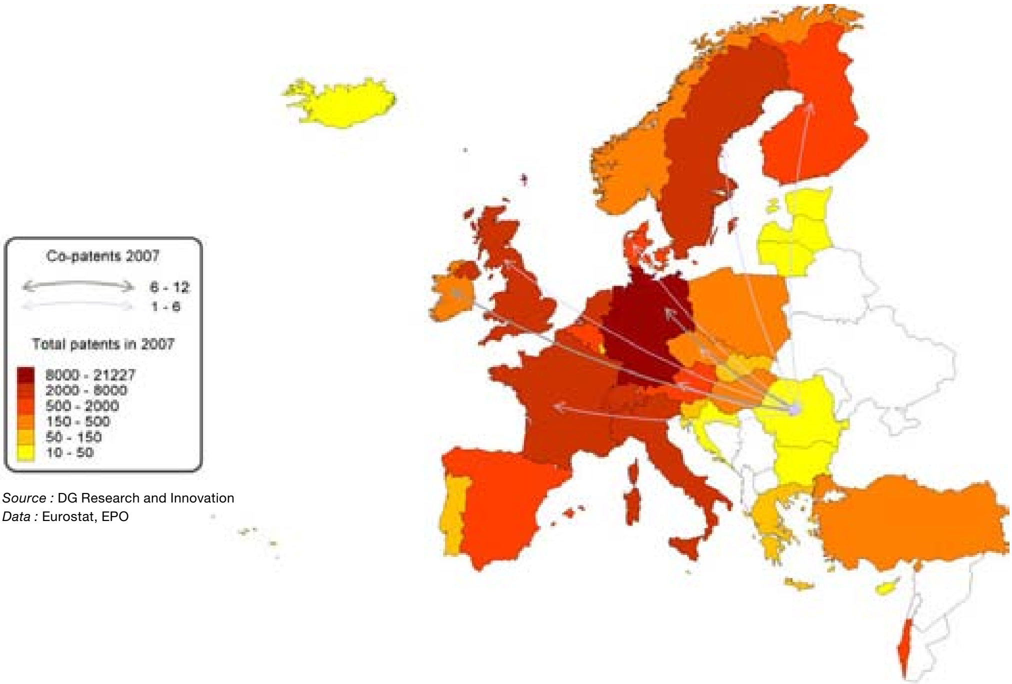
## ROMANIA

## Co-publications between Romania and European Countries in 2000-2009



## ROMANIA

## Co-invented patent applications between Romania and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 3 163 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 4 172 applicants from Romania (1.57 % of EU-27*) and
- requesting EUR 916.01m of EC contribution (1.04 % of EU-27*)

Among the EU-27* Romania (RO) ranks:

- 16th in terms of number of applicants and
- 17th in terms of requested EC contribution

### Success rates

- The RO applicant success rate of 14.5 % is lower than the EU-27* applicant success rate of 21.6 %.
- The RO EC financial contribution success rate of 9.1 % is lower than the EU-27* rate of 20.7 %.

Specifically, following evaluation and selection, a total of

- 494 proposals were retained for funding (15.6 %)
- involving 606 (14.5 %) successful applicants from Romania and
- requesting EUR 83.28m (9.1 %) of EC financial contribution

Among the EU-27*, Romania (RO) ranks:

- 27th in terms of applicants success rate and
- 27th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Romania (RO) participates in

- 429 signed grant agreements
- involving 6 753 participants of which 538 (7.97 %) are from Romania
- benefiting from a total of EUR 1 635.88m of EC financial contribution of which EUR 72.35m (4.42 %) is dedicated to participants from Romania.

Among the EU-27* in all FP7 signed grant agreements, Romania (RO) ranks:

- 18th in number of participations and
- 19th in budget share

### SME performance and participation

- The RO SME applicant success rate of 13.79 % is lower than the EU-27* SME applicant success rate of 19.33 %.
- The RO SME EC financial contribution success rate of 8.35 % is lower than the corresponding EU-27* rate of 18.26 %.

Specifically,

- 1 487 RO SME applicants requesting EUR 299.16m
- 205 (13.79 %) successful SMEs requesting EUR 24.99m (8.35 %)

In signed grant agreements, as of 2011/03/16,

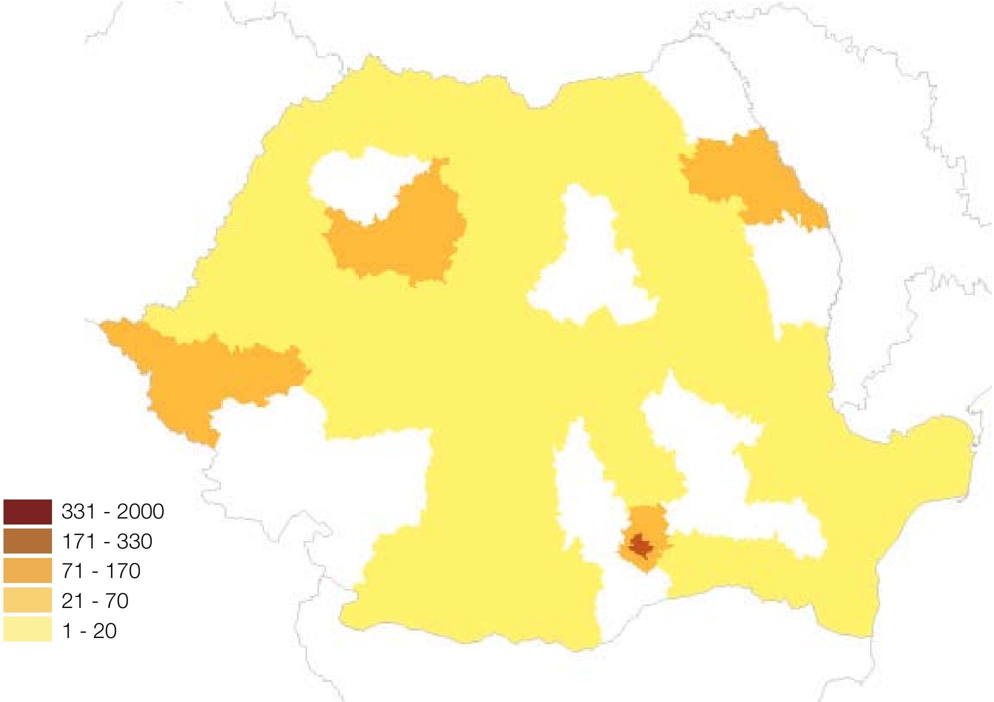
- 115 RO SME grant holders, i.e., 21.38 % of total RO participation
- EUR 15.65m, i.e., 21.63 % of total RO budget share

### Top 3 collaborative links with

- DE - Germany (702)
- IT - Italy (574)
- FR - France (557)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 25th | |
| - Below EU-27 average | | |
| - Catching-up Country | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 4 172 | |
| (1.57%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 916.01 | |
| (1.04%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 606 | |
| (1.02%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 83.28 | |
| (0.46%) | 18 262.02 | |
| Success rate FP7 applicants | 14.5% | 21.6% |

| | | |
|---|---|---|
| Success rate | | |
| FP7 EC contribution | 9.1% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 538 | |
| (1.05%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 72.35 | |
| (0.44%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 32 | |
| (5.95%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 115 | |
| (21.38%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 15.65 | |
| (21.63%) | 2 207.73 | |
| (13.32%) | | |



## TABLE 1

## RO - Romania - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 820 | 176.93 | 67 | 8.17% | 14.37 | 8.12% |
| Research for the benefit of SMEs | 419 | 49.25 | 59 | 14.08% | 8.46 | 17.19% |
| Environment (including Climate Change) | 352 | 62.26 | 56 | 15.91% | 6.78 | 10.89% |
| Transport (including Aeronautics) | 322 | 72.78 | 58 | 18.01% | 10.21 | 14.03% |
| Socio-economic sciences and Humanities | 280 | 35.39 | 16 | 5.71% | 1.20 | 3.40% |
| Marie-Curie Actions | 274 | n/a | 53 | 19.34% | n/a | n/a |

## TABLE 2

## RO - Romania - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all RO grant holders | EC contribution (EUR million) | % of total EC contribution to RO |
|---|---|---|---|---|
| Information and Communication Technologies | 67 | 12.45% | 12.97 | 17.92% |
| Transport (including Aeronautics) | 49 | 9.11% | 8.72 | 12.06% |
| Research Potential | 9 | 1.67% | 8.69 | 12.01% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 45 | 8.36% | 7.54 | 10.43% |
| Environment (including Climate Change) | 47 | 8.74% | 5.79 | 8.01% |
| Research for the benefit of SMEs | 45 | 8.36% | 5.13 | 7.09% |

*Notes :* Report generated on: 2011/03/28.10:49 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## RO - Romania - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 1 487 | 283.97 | 185 | 12.44% | 26.04 | 9.17% | 155 | 23.14 | 31.99% |
| PRC | 991 | 174.97 | 138 | 13.93% | 18.50 | 10.58% | 139 | 19.14 | 26.46% |
| REC | 710 | 150.19 | 132 | 18.59% | 18.42 | 12.27% | 149 | 21.98 | 30.38% |
| OTH | 527 | 110.23 | 76 | 14.42% | 10.03 | 9.10% | 15 | 0.86 | 1.19% |
| PUB | 295 | 42.03 | 73 | 24.75% | 9.35 | 22.23% | 80 | 7.22 | 9.98% |
| | | | | | | | | | |
| SME | 1 487 | 299.16 | 205 | 13.79% | 24.99 | 8.35% | 115 | 15.65 | 21.63% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education

## TABLE 4

## RO - Romania - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| RO - Romania region | Number of grant holders | % of all RO - Romania grant holders | EC contribution (M euro) | % of total EC contribution to RO |
|---|---|---|---|---|
| Bucuresti (RO321) | 262 | 48.70% | 32.79 | 45.32% |
| Cluj (RO113) | 51 | 9.48% | 6.80 | 9.40% |
| Ilfov (RO322) | 39 | 7.25% | 5.24 | 7.25% |
| Iasi (RO213) | 36 | 6.69% | 6.96 | 9.62% |
| Timis (RO424) | 26 | 4.83% | 3.56 | 4.93% |

## TABLE 5

## RO - Romania - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all RO grant holders | EC contribution (M euro) | % of total EC contribution to RO grant holders |
|---|---|---|---|---|
| Universitatea Politehnica Din Bucuresti (UPB) | 30 | 5.58% | 6.93 | 9.58% |
| Institutul de Chimie Macromoleculara Petru Poni (ICMPP) | 7 | 1.30% | 3.54 | 4.89% |
| Universitatea Tehnica Cluj-Napoca (UTC) | 16 | 2.97% | 2.77 | 3.82% |
| Primaria Municipiului Iasi (IASI) | 1 | 0.19% | 2.38 | 3.29% |
| Institutul National de Cercetaredezvoltare Pentru Microtehnologie (IMT) | 6 | 1.12% | 1.98 | 2.73% |

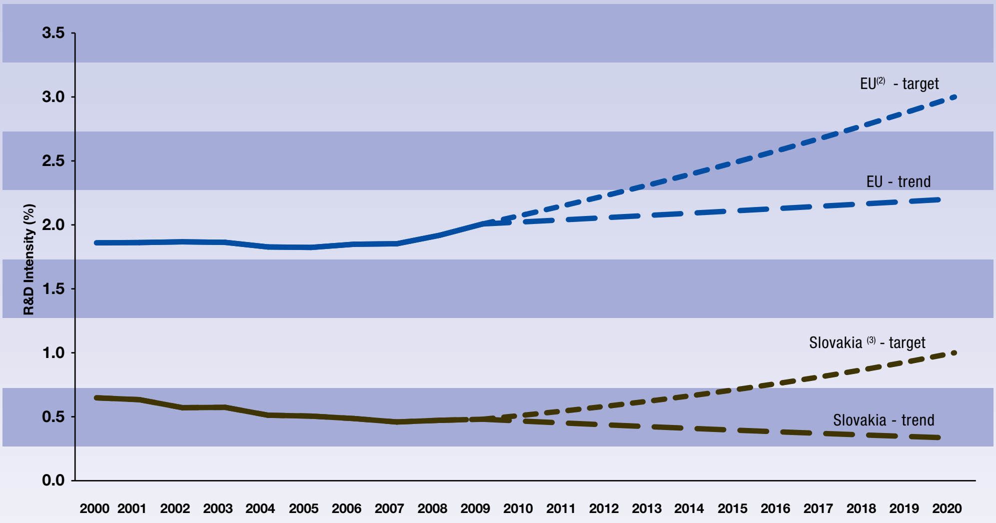
# COUNTRY PROFILE

# SK - Slovakia

## Progress towards meeting the Europe 2020 R&D intensity target

Since the early 1990s, the Slovak Republic has undertaken a radical transformation of its economic and social structures that also affected its research and innovation system. The rise of a dual economy comprising branches of multinational companies with high productivity level and some 60 000 SMEs and few large domestic companies has favoured a system dominated by technology imports and a sharp fall in traditional in-house R&D. As a result, R&D intensity has steadily declined from a peak of 3.88% in 1989 to 0.48% in 2009. This sharp fall shows a scientific and technological dependency which may jeopardise the long-term growth perspectives of the Slovak economy, particularly once efficiency gains through capital investment are exhausted. In order to correct this situation, the Slovak Republic has set an R&D intensity target of 1% for 2020 which would reverse the last 20-year negative trend.

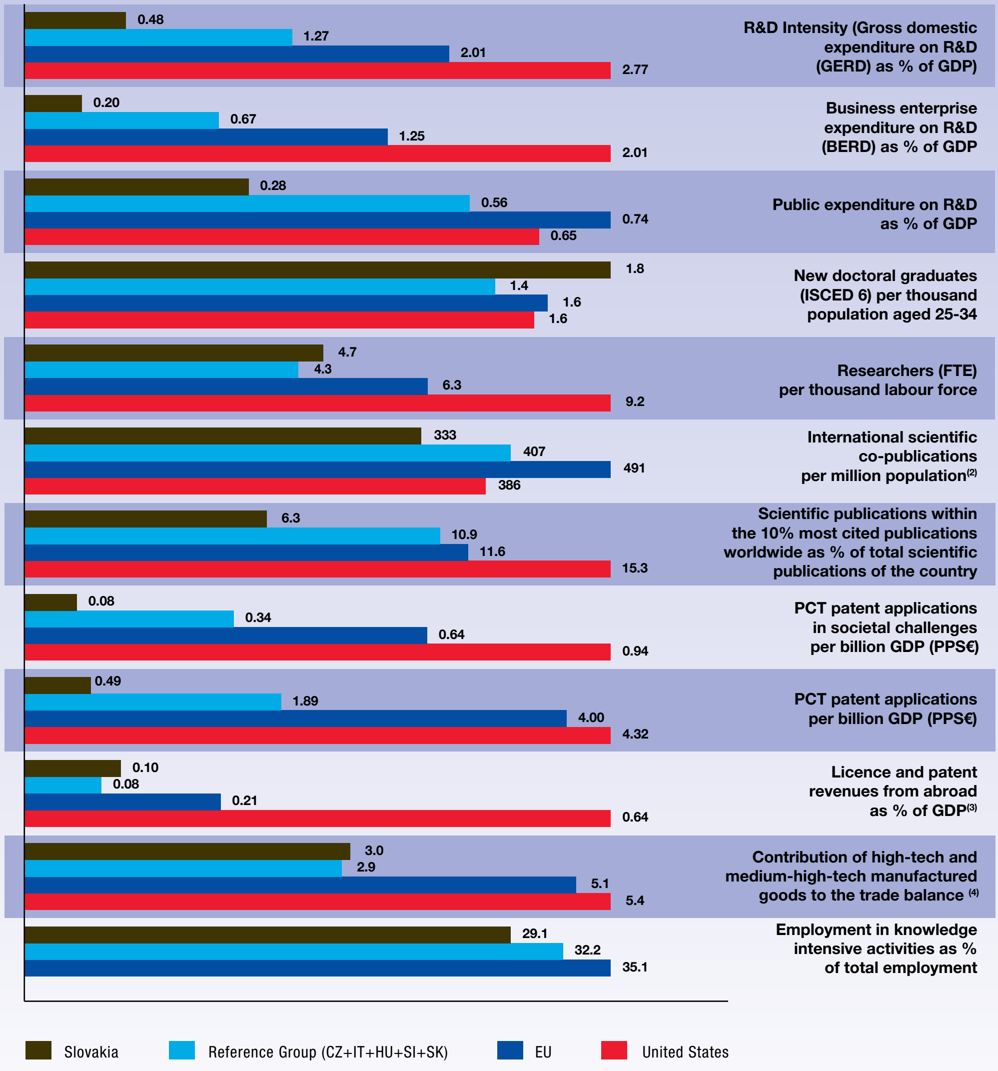
**SLOVAKIA** **R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation **Innovation Union Competitiveness Report 2011**
*Data:* DG Research and Innovation, Eurostat
*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) SK: This projection is based on a tentative R&D Intensity target of 1.0% for 2020.

# SLOVAKIA

## R&D profile, 2009(1)



*Source:* DG Research and Innovation

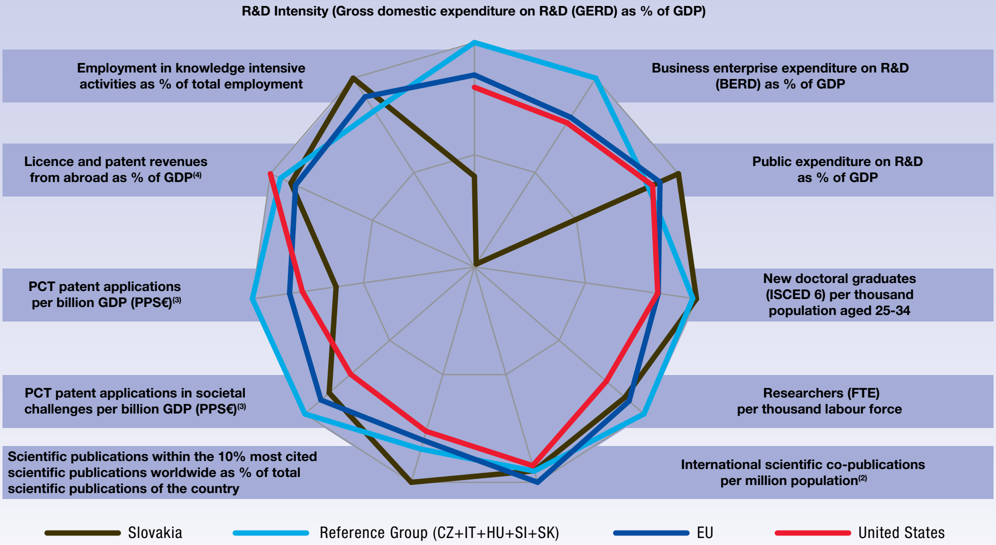
Innovation Union Competitiveness Report 2011

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## SLOVAKIA

### Average annual growth (%), 2000-2009(1)



*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average.
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## Research and Innovation Performance

The Slovak research and innovation system is characterised by the sharp effects of the economic and social transformations that took place in the 1990s and early 2000s and that radically downsized the system due to falling public and private R&D investments and the associated brain drain of scientists from the public sector. At present, the very low R&D investment, both in the public and private sectors, results in poor scientific and technological production that reinforces the international dependency of the system and hinders its ability to create, use and diffuse knowledge. As a consequence, the transition to a knowledge-based economy may be at stake, as evidenced by the relatively low percentage of people employed in knowledge-intensive activities.

In dynamic terms, the most striking feature is the sharp fall in private R&D investments, in comparison with other countries that may be closer technological and economic competitors, such as the Czech Republic or, to a lesser extent, Slovenia and Hungary. In the longer run, a sustained underinvestment in R&D may endanger not only the scientific and technological convergence with the EU average, but also Slovakia's long-term competitiveness. There are positive signs, such as dynamic improvement of public expenditure on R&D, scientific quality and new doctoral graduates.

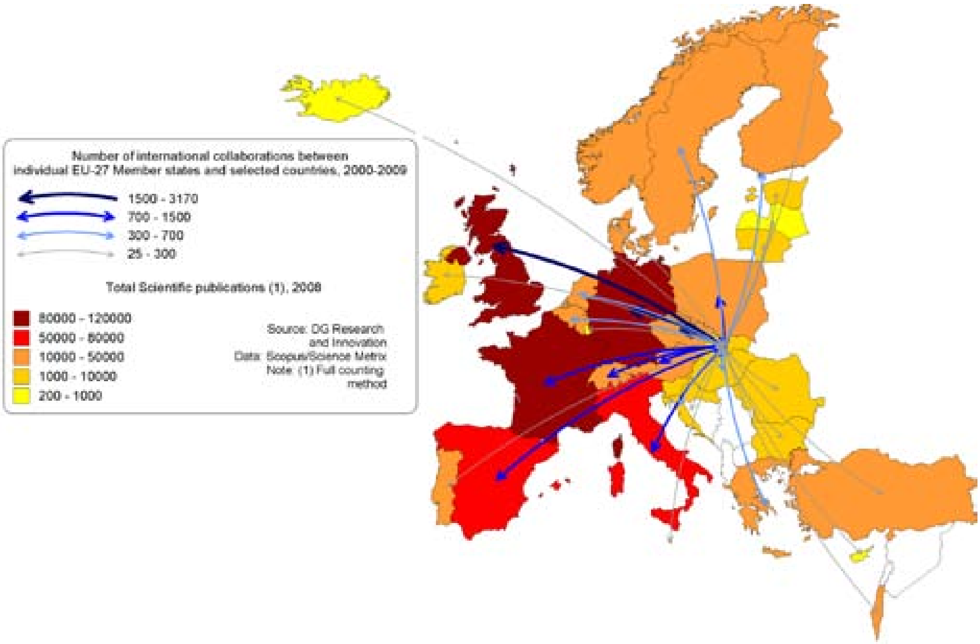
## Participation in the European Research Area : Scientific and Technological collaborations

As indicated in the table above, Slovakia is one of the countries with the lowest rates of overall scientific co-publications per million population. This suggests that the country is not actively participating in and benefiting from the international scientific knowledge flows favoured by the construction of the European Research Area. As it could be expected due to the geographical and historical ties, the Czech Republic is one of its main scientific partners.

In terms of co-patenting, the Slovak Republic has a low activity level, but with cooperation also with Germany, France, Switzerland and Finland.

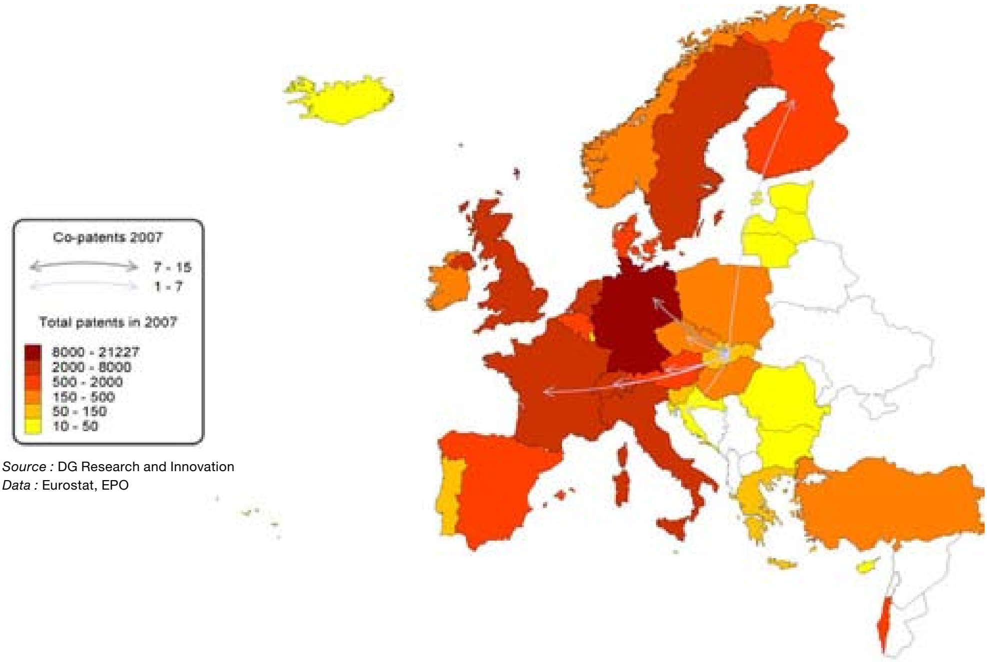
## SLOVAKIA

## Co-publications between Slovakia and European Countries in 2000-2009



## SLOVAKIA

## Co-invented patent applications between Slovakia and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 1 177 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 1 479 applicants from Slovakia (0.55% of EU-27*) and
- requesting EUR 301.74m of EC contribution (0.34% of EU-27*)

Among the EU-27* Slovakia (SK) ranks:

- 21st in terms of number of applicants and
- 22nd in terms of requested EC contribution

### Success rates

- The SK applicant success rate of 19.9% is lower than the EU-27* applicant success rate of 21.6%.
- The SK EC financial contribution success rate of 12.8% is lower than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 230 proposals were retained for funding (19.5%)
- involving 295 (19.9%) successful applicants from Slovakia and
- requesting EUR 38.77m (12.8%) of EC financial contribution

Among the EU-27*, Slovakia (SK) ranks:

- 17th in terms of applicants success rate and
- 20th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Slovakia (SK) participates in

- 205 signed grant agreements
- involving 3 155 participants of which 260 (8.24%) are from Slovakia
- benefiting from a total of EUR 797.01m of EC financial contribution of which EUR 33.24m (4.17%) is dedicated to participants from Slovakia.

Among the EU-27* in all FP7 signed grant agreements, Slovakia (SK) ranks:

- 22nd in number of participations and
- 24th in budget share

### SME performance and participation

- The SK SME applicant success rate of 18.26% is lower than the EU-27* SME applicant success rate of 19.33%.
- The SK SME EC financial contribution success rate of 13.46% is lower than the corresponding EU-27* rate of 18.26%.

Specifically,

- 493 SK SME applicants requesting EUR 116.68m
- 90 (18.26%) successful SMEs requesting EUR 15.71m (13.46%)

In signed grant agreements, as of 2011/03/16,

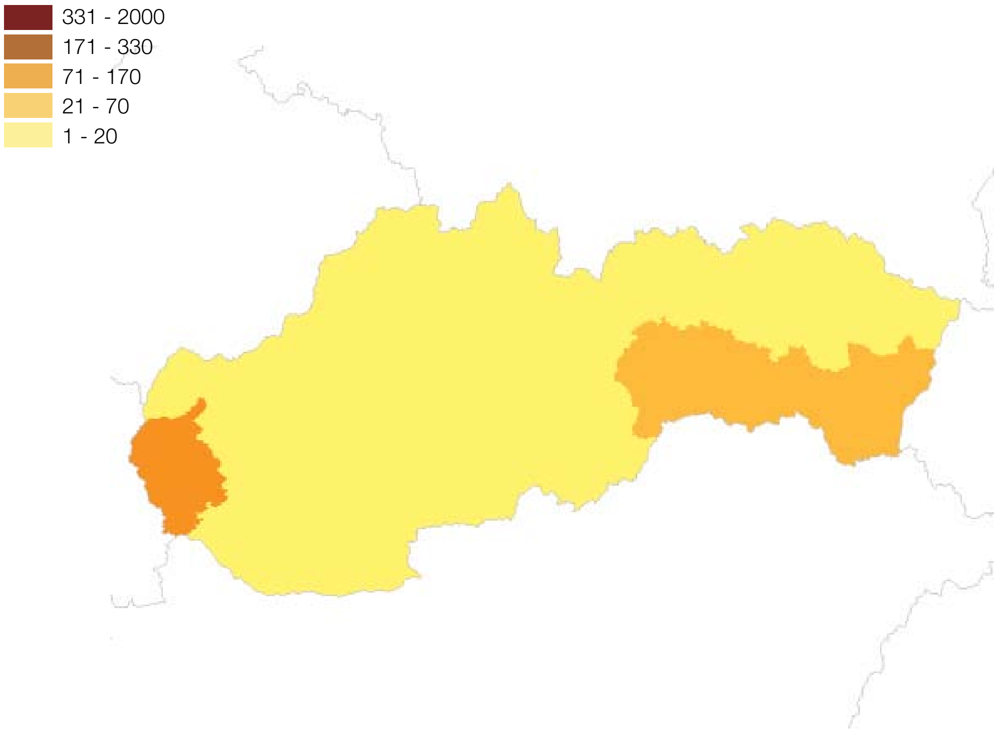
- 49 SK SME grant holders, i.e., 18.85% of total SK participation
- EUR 9.68m, i.e., 29.12% of total SK budget share

### Top 3 collaborative links with

- DE - Germany (336)
- UK - United Kingdom (273)
- IT - Italy (228)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | 0.36% | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 21st | |
| - Below EU-27 average | | |
| - Moderate Innovator | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 1 479 | |
| (0.55%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 301.74 | |
| (0.34%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 295 | |
| (0.50%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 38.77 | |
| (0.21%) | 18 262.02 | |
| Success rate FP7 applicants | 19.9% | 21.6% |

| | | |
|---|---|---|
| Success rate | | |
| FP7 EC contribution | 12.8% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 260 | |
| (0.51%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 33.24 | |
| (0.20%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 20 | |
| (7.69%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 49 | |
| (18.85%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 9.68 | |
| (29.12%) | 2 207.73 | |
| (13.32%) | | |



## TABLE 1

## SK - Slovakia - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 219 | 71.42 | 36 | 16.44% | 8.15 | 11.41% |
| Research for the benefit of SMEs | 141 | 17.62 | 22 | 15.60% | 2.82 | 16.02% |
| Marie-Curie Actions | 140 | n/a | 36 | 25.71% | n/a | n/a |
| Socio-economic sciences and Humanities | 128 | 17.87 | 11 | 8.59% | 1.64 | 9.19% |
| Environment (including Climate Change) | 120 | 23.82 | 15 | 12.50% | 1.97 | 8.25% |
| Health | 101 | 23.79 | 14 | 13.86% | 2.70 | 11.35% |

## TABLE 2

## SK - Slovakia - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all SK grant holders | EC contribution (EUR million) | % of total EC contribution to SK |
|---|---|---|---|---|
| Information and Communication Technologies | 33 | 12.69% | 5.96 | 17.92% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 19 | 7.31% | 3.51 | 10.57% |
| Security | 8 | 3.08% | 3.41 | 10.27% |
| Marie-Curie Actions | 32 | 12.31% | 3.30 | 9.92% |
| Health | 13 | 5.00% | 2.23 | 6.71% |
| Research for the benefit of SMEs | 18 | 6.92% | 2.20 | 6.61% |

*Notes :* Report generated on: 2011/03/28.10:50 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## SK - Slovakia - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 574 | 96.22 | 102 | 17.77% | 11.04 | 11.47% | 82 | 9.49 | 28.57% |
| PRC | 352 | 86.97 | 73 | 20.74% | 14.14 | 16.26% | 76 | 11.76 | 35.38% |
| REC | 277 | 50.53 | 59 | 21.30% | 8.50 | 16.83% | 63 | 9.43 | 28.38% |
| OTH | 144 | 30.34 | 28 | 19.44% | 2.18 | 7.19% | 10 | 0.29 | 0.88% |
| PUB | 102 | 13.39 | 32 | 31.37% | 2.82 | 21.04% | 29 | 2.26 | 6.80% |
| | | | | | | | | | |
| SME | 493 | 116.68 | 90 | 18.26% | 15.71 | 13.46% | 49 | 9.68 | 29.12% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education

## TABLE 4

## SK - Slovakia - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| SK - Slovakia region | Number of grant holders | % of all SK - Slovakia grant holders | EC contribution (M euro) | % of total EC contribution to SK |
|---|---|---|---|---|
| Bratislavsky kraj (SK010) | 137 | 52.69% | 18.43 | 55.44% |
| Kosicky kraj (SK042) | 39 | 15.00% | 6.00 | 18.05% |
| Zilinsky kraj (SK031) | 21 | 8.08% | 1.79 | 5.39% |
| Trnavsky kraj (SK021) | 17 | 6.54% | 1.69 | 5.08% |
| Banskobystricky kraj (SK032) | 10 | 3.85% | 0.75 | 2.24% |

## TABLE 5

## SK - Slovakia - Most active organisations in terms of EC contribution granted to the FP7 research projects

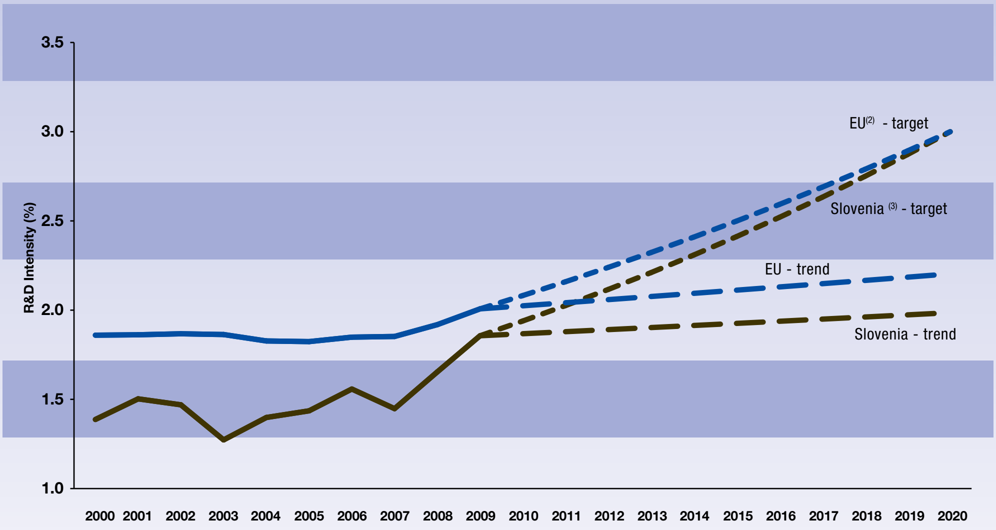
| Legal Name | Number of Participations | % of all SK grant holders | EC contribution (M euro) | % of total EC contribution to SK grant holders |
|---|---|---|---|---|
| Technical University Kosice (TUK) | 11 | 4.23% | 2.29 | 6.90% |
| Ardaco, A.S. (ADO) | 5 | 1.92% | 2.23 | 6.70% |
| Univerzita Komenskeho v Bratislave (Univerzita Komenskeh) | 15 | 5.77% | 1.99 | 5.99% |
| Ustav Informatiky, Slovenska Akademia Vied (UI SAV) | 5 | 1.92% | 1.76 | 5.29% |
| Virologicky Ustav Slovenskej Akademie Vied | 5 | 1.92% | 1.54 | 4.64% |

# SI - Slovenia

## Progress towards meeting the Europe 2020 R&D intensity target

R&D intensity in Slovenia has fluctuated over the last decade. More precisely, it decreased from 1.50% in 2001 to 1.27% in 2003, increased to 1.56% in 2006 and slightly decreased to 1.45% in 2007, before increasing to 1.86% in 2009. These fluctuations are mirrored by fluctuations in the R&D intensity of both private and public sectors over the same period, with the exception of the decrease in 2007, which is attributed mainly to the large increase in GDP. In 2009 business enterprise expenditure on R&D as a % of GDP was 1.2% and public sector expenditure was 0.66%, these values being above those in countries with a similar industrial structure and knowledge capacity. In nominal terms in 2009, Business expenditure and government funding on R&D increased in Slovenia, which proves that Slovenia regards R&D as a priority for ensuring better and more economic growth in the longer term. Given the trend scenario presented below, Slovenia would still be slightly below the EU average in 2020, at an R&D intensity level of 1.99%. In this context Slovenia has set an ambitious, albeit realistic R&D intensity target of 3% of GDP for 2020.

**SLOVENIA** **R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation

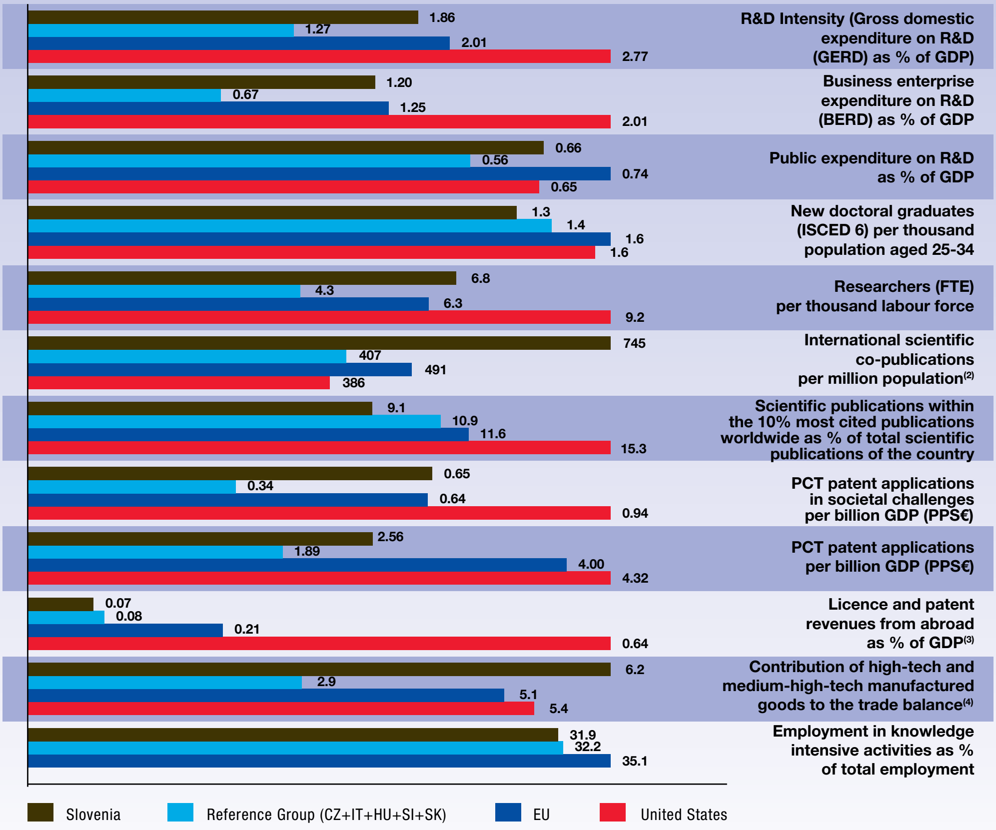
*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009 in the case of the EU and for 2000-2007 in the case of Slovenia.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) SI: This projection is based on a tentative R&D Intensity target of 3.0% for 2020.
(4) SI: There is a break in series between 2008 and the previous years.

**Innovation Union Competitiveness Report 2011**

## SLOVENIA

**R&D profile, 2009**(1)



*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

## Research and Innovation Performance

Slovenia is making continuous progress in its innovation performance. Based on its average innovation performance, it is one of the moderate innovators with several indicators close or above to the EU average[12]. The country's research and innovation performance shows strengths and weaknesses. In terms of strengths, Slovenia scores higher than the EU average in the share of international scientific co-publications, the contribution of high-tech and medium-high-tech manufactured goods to the trade balance and PCT patent applications in societal challenges. Slovenia is above EU average in the number of researchers in the labour force. Besides, Slovenia is making progress in certain indicators, particularly in the area of employment in knowledge intensive activities. However, there are also some weaknesses in the research and innovation system. Slovenia scores lower than the EU average in scientific quality, new doctoral graduates and in the field of licence and patent revenues from abroad as percentage of GDP. In spite of a good dynamics towards a higher scientific excellence, there is still progress to be made.

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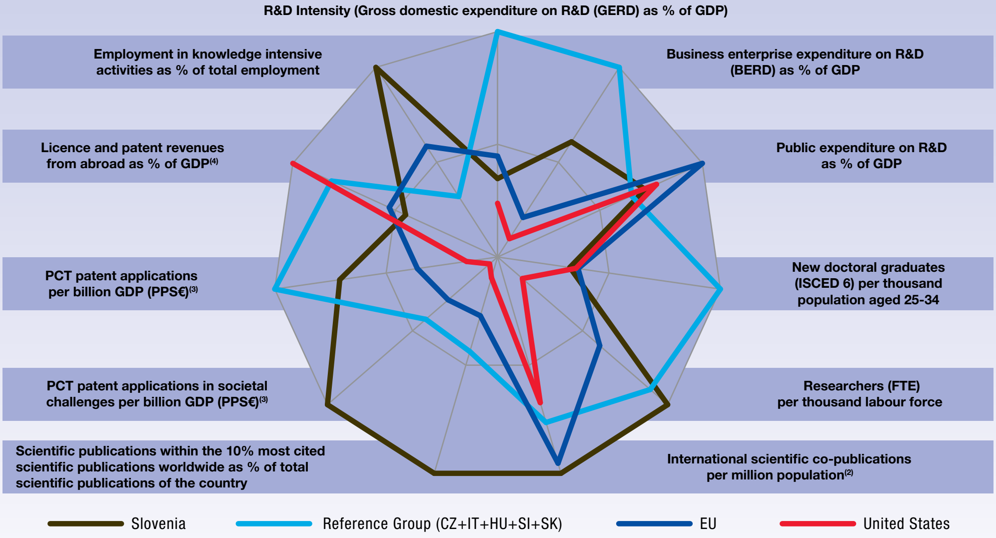
[12] Innovation Union Scoreboard 2010, The Innovation Union's performance scoreboard for Research and Innovation, http://www.proinno-europe.eu/inno-metrics/page/innovation-union-scoreboard-2010

## SLOVENIA

## Average annual growth (%), 2000-2009$^{(1)}$

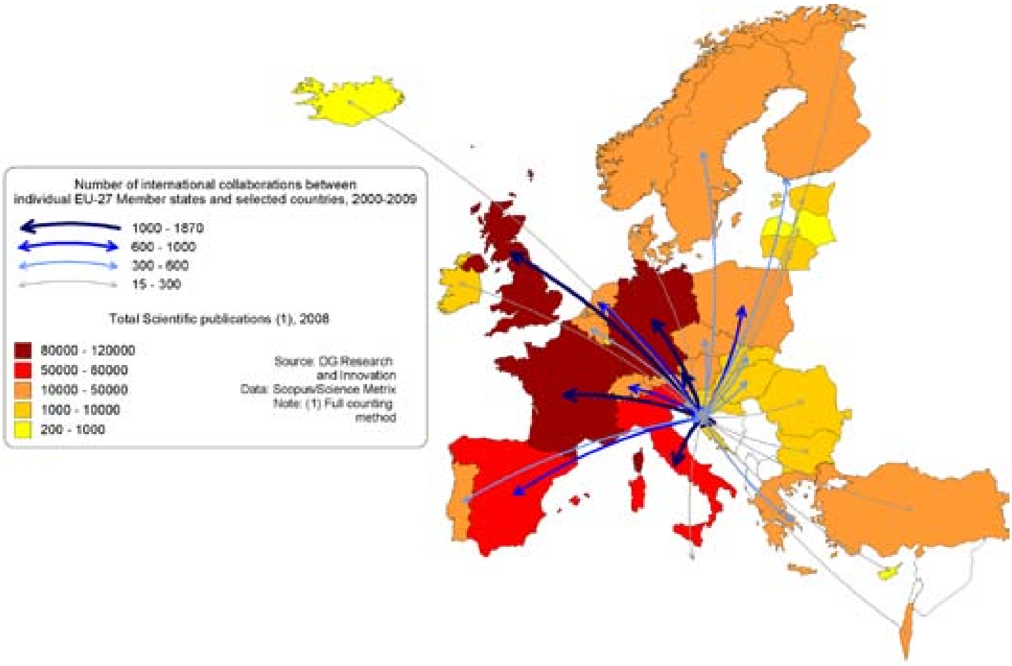


*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average.
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

**Innovation Union Competitiveness Report 2011**

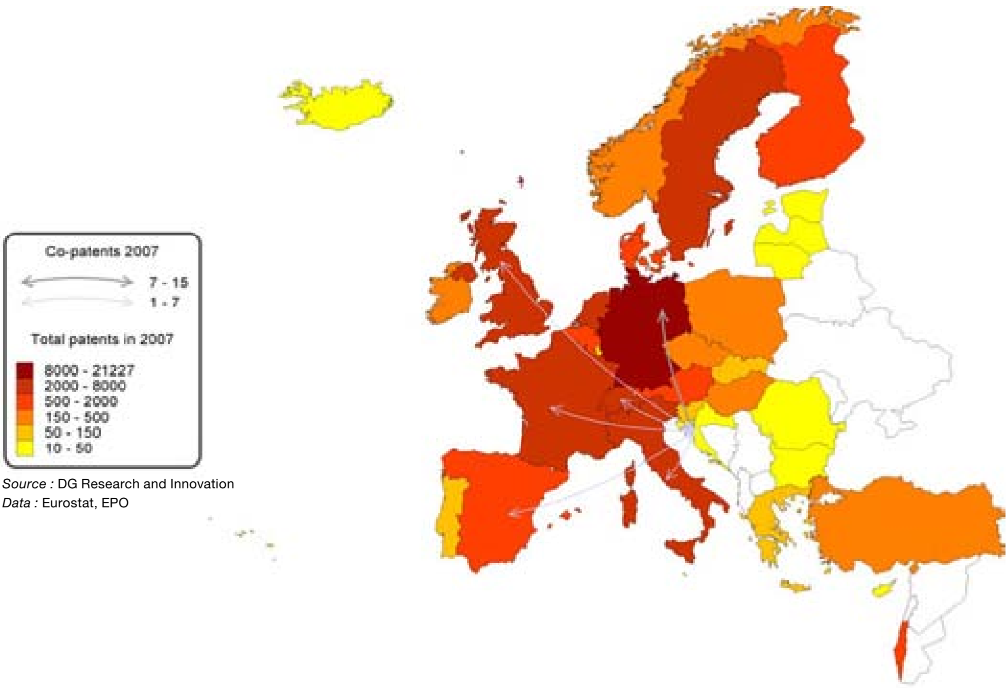
## SLOVENIA

## Co-publications between Slovenia and European Countries in 2000-2009



SLOVENIA

## Co-invented patent applications between Slovenia and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

In dynamic terms, relative strengths and increases in the Slovenian science and innovation system, comparative to EU and reference group country average, are in employment in knowledge intensive activities, most cited scientific publications, patenting intensity for societal challenges in which Slovenia consolidates its strong position. Relative lower dynamics are in licence and patents revenues from abroad and new doctoral graduates. It is noticeable the dynamics for improving scientific quality, where Slovenia is behind the EU average in absolute terms.

### Participation in the European Research Area : Scientific and Technological collaborations

The partner countries reflect particular geographical, cultural and/or linguistic ties between certain countries (e.g. Slovenia-Italy).

Slovenia's scientific cooperation (measured by co-publications) with other European countries is particularly intense. It is also broader and more intense than its technological cooperation (measured by co-patents), providing potential for growing internationalisation of the technology development. The main scientific partner countries are Germany, France, Italy, Spain, Austria and the United Kingdom, followed by countries such as Spain, Belgium, Switzerland and Poland.

Co-patenting collaboration of inventors in Slovenia with inventors in other European countries is intensive with France, Italy, the United Kingdom, Spain, Germany and Switzerland.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 2 317 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 3 042 applicants from Slovenia (1.14% of EU-27*) and
- requesting EUR 694.27m of EC contribution (0.79% of EU-27*)

Among the EU-27* Slovenia (SI) ranks:

- 19th in terms of number of applicants and
- 19th in terms of requested EC contribution

### Success rates

- The SI applicant success rate of 16.1% is lower than the EU-27* applicant success rate of 21.6%.
- The SI EC financial contribution success rate of 11.2% is lower than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 406 proposals were retained for funding (17.5%)
- involving 491 (16.1%) successful applicants from Slovenia and
- requesting EUR 77.93m (11.2%) of EC financial contribution

Among the EU-27*, Slovenia (SI) ranks:

- 26th in terms of applicants success rate and
- 23rd in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Slovenia (SI) participates in

- 366 signed grant agreements
- involving 5 201 participants of which 443 (8.52%) are from Slovenia
- benefiting from a total of EUR 1 328.06m of EC financial contribution of which EUR 73.30m (5.52%) is dedicated to participants from Slovenia.

Among the EU-27* in all FP7 signed grant agreements, Slovenia (SI) ranks:

- 19th in number of participations and
- 18th in budget share

### SME performance and participation

- The SI SME applicant success rate of 13.51% is lower than the EU-27* SME applicant success rate of 19.33%.
- The SI SME EC financial contribution success rate of 11.70% is lower than the corresponding EU-27* rate of 18.26%.

Specifically,

- 1 140 SI SME applicants requesting EUR 213.39m
- 154 (13.51%) successful SMEs requesting EUR 24.98m (11.70%)

In signed grant agreements, as of 2011/03/16,

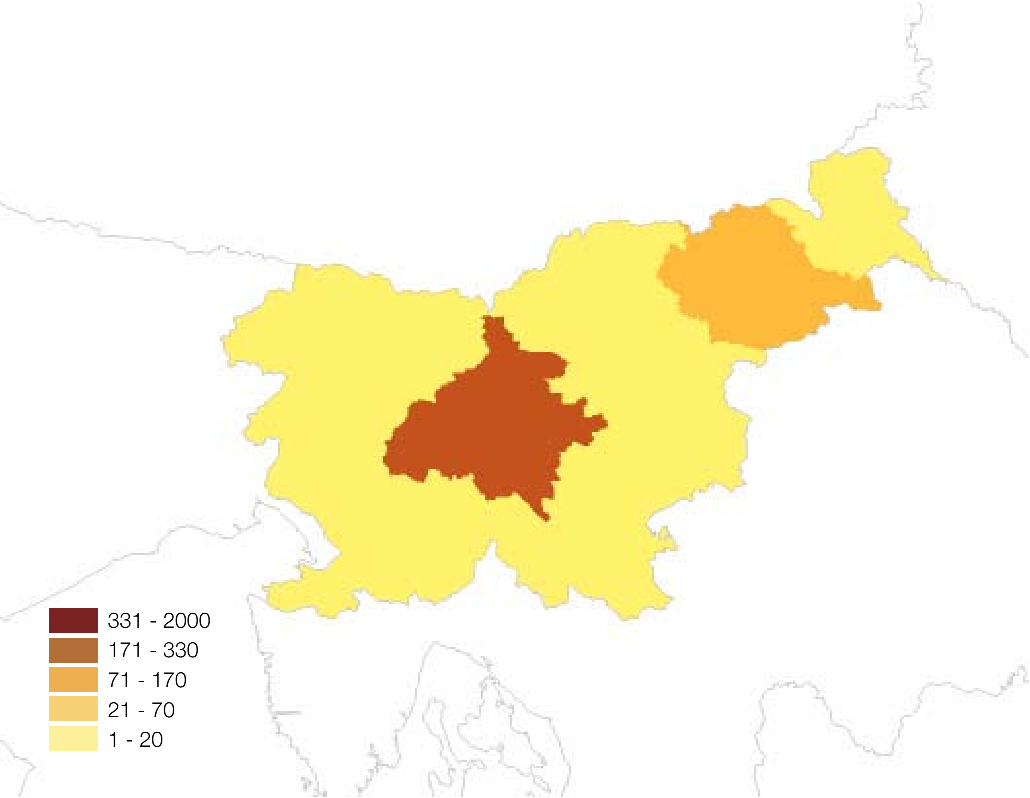
- 92 SI SME grant holders, i.e., 20.77% of total SI participation
- EUR 16.71m, i.e., 22.80% of total SI budget share

### Top 3 collaborative links with

- DE - Germany (570)
- IT - Italy (443)
- UK - United Kingdom (426)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 14th | |
| - Below EU-27 average | | |
| - Innovation Follower | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 3042 | |
| (1.14%) | 266507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 694.27 | |
| (0.79%) | 88295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 491 | |
| (0.83%) | 59199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 77.93 | |
| (0.43%) | 18262.02 | |
| Success rate FP7 applicants | 16.1% | 21.6% |

| | | |
|---|---|---|
| Success rate | | |
| FP7 EC contribution | 11.2% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 443 | |
| (0.86%) | 51279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 73.30 | |
| (0.44%) | 16578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 23 | |
| (5.19%) | 9383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 92 | |
| (20.77%) | 8845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 16.71 | |
| (22.80%) | 2207.73 | |
| (13.32%) | | |



## TABLE 1

## SI - Slovenia - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 561 | 159.67 | 60 | 10.70% | 17.13 | 10.73% |
| Research for the benefit of SMEs | 366 | 51.06 | 44 | 12.02% | 5.94 | 11.63% |
| Socio-economic sciences and Humanities | 292 | 50.89 | 18 | 6.16% | 1.70 | 3.35% |
| Marie-Curie Actions | 247 | n/a | 55 | 22.27% | n/a | n/a |
| Environment (including Climate Change) | 241 | 43.47 | 55 | 22.82% | 9.99 | 22.99% |
| Health | 210 | 57.19 | 34 | 16.19% | 5.64 | 9.86% |

## TABLE 2

## SI - Slovenia - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all SI grant holders | EC contribution (EUR million) | % of total EC contribution to SI |
|---|---|---|---|---|
| Information and Communication Technologies | 63 | 14.22% | 16.93 | 23.10% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 38 | 8.58% | 8.56 | 11.68% |
| Transport (including Aeronautics) | 33 | 7.45% | 7.49 | 10.22% |
| Marie-Curie Actions | 47 | 10.61% | 7.34 | 10.01% |
| Environment (including Climate Change) | 45 | 10.16% | 7.26 | 9.91% |
| Research for the benefit of SMEs | 42 | 9.48% | 5.42 | 7.40% |

*Notes :* Report generated on: 2011/03/28.10:50 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## SI - Slovenia - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 994 | 204.27 | 146 | 14.69% | 19.45 | 9.52% | 127 | 19.59 | 26.72% |
| PRC | 788 | 155.07 | 94 | 11.93% | 18.45 | 11.90% | 103 | 19.32 | 26.36% |
| REC | 689 | 152.71 | 147 | 21.34% | 26.33 | 17.24% | 133 | 26.60 | 36.29% |
| OTH | 258 | 42.52 | 39 | 15.12% | 6.57 | 15.45% | 13 | 0.99 | 1.34% |
| PUB | 212 | 29.33 | 65 | 30.66% | 7.13 | 24.32% | 67 | 6.81 | 9.28% |
| | | | | | | | | | |
| SME | 1 140 | 213.39 | 154 | 13.51% | 24.98 | 11.70% | 92 | 16.71 | 22.80% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education)

## TABLE 4

## SI - Slovenia - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| SI - Slovenia region | Number of grant holders | % of all SI - Slovenia grant holders | EC contribution (M euro) | % of total EC contribution to SI |
|---|---|---|---|---|
| Osrednjeslovenska (SI021) | 357 | 80.59% | 61.37 | 83.72% |
| Podravska (SI012) | 33 | 7.45% | 4.71 | 6.42% |
| Savinjska (SI014) | 13 | 2.93% | 2.16 | 2.94% |
| Obalno-kraska (SI024) | 10 | 2.26% | 0.79 | 1.07% |
| Goriska (SI023) | 8 | 1.81% | 1.53 | 2.08% |

## TABLE 5

## SI - Slovenia - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all SI grant holders | EC contribution (M euro) | % of total EC contribution to SI grant holders |
|---|---|---|---|---|
| Institut Jozef Stefan (JSI) | 72 | 16.25% | 17.76 | 24.23% |
| Univerza v Ljubljani (UL) | 89 | 20.09% | 15.08 | 20.57% |
| Univerza v Mariboru (UM) | 17 | 3.84% | 2.33 | 3.18% |
| Xlab Razvoj Programske Opreme in Svetovanje D.O.O. | 6 | 1.35% | 2.18 | 2.97% |
| Kemijski Institut (KI) | 10 | 2.26% | 2.00 | 2.73% |

# COUNTRY PROFILE

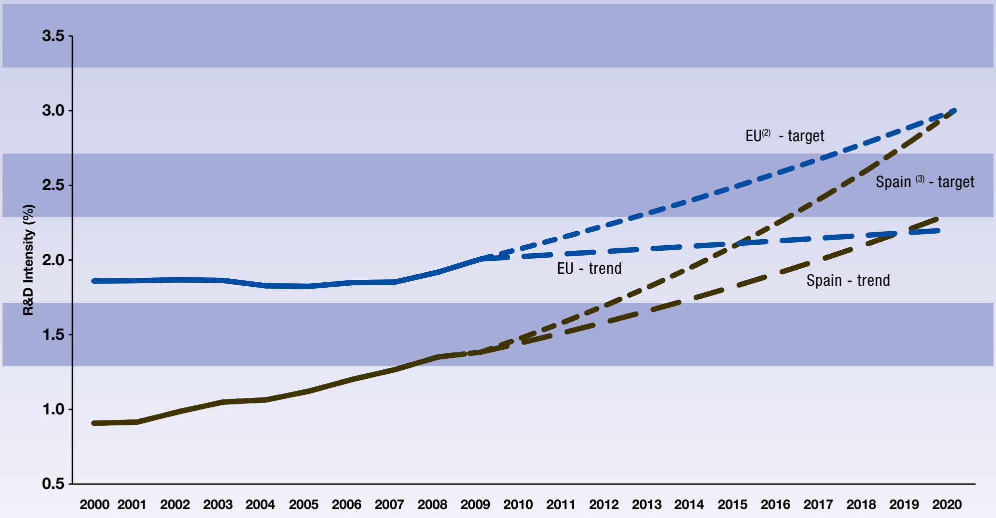
# ES - Spain

## Progress towards meeting the Europe 2020 R&D intensity target

Spain's R&D intensity has grown from 0.91% in 2000 to 1.38% in 2009, which is one of the highest increases of all EU Member States. This positive trend is due to an increase of both government and business enterprise funding to R&D. Spanish GBAORD (Government Budget Appropriations or Outlays on R&D) has increased steadily with an average annual growth rate of 14.1% between 2004 and 2009. Public funding to research and innovation decreased slightly in the 2010 national budget, but in 2011 the country protected R&I investment as compared to the rest of the budgetary expenses. For 2020, Spain has set a national R&D intensity target of 3%, which is achievable but would require an increase of the average annual growth rate, mainly of business R&D investment. Given the structure of the Spanish economy, reforms for a structural change would be needed towards a more knowledge-intensive economy. Compared to other countries, Spain has scope to increase both the R&D intensity in existing high-tech and medium-high-tech sectors (moving closer to the technology frontier) and to increase knowledge intensity in more traditional sectors of the economy. Efforts already made in this direction are reflected in some figures, such as the number of employees in the high and medium-high technology manufacturing sector, where Spain is the sixth country in the EU.

SPAIN

**R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation

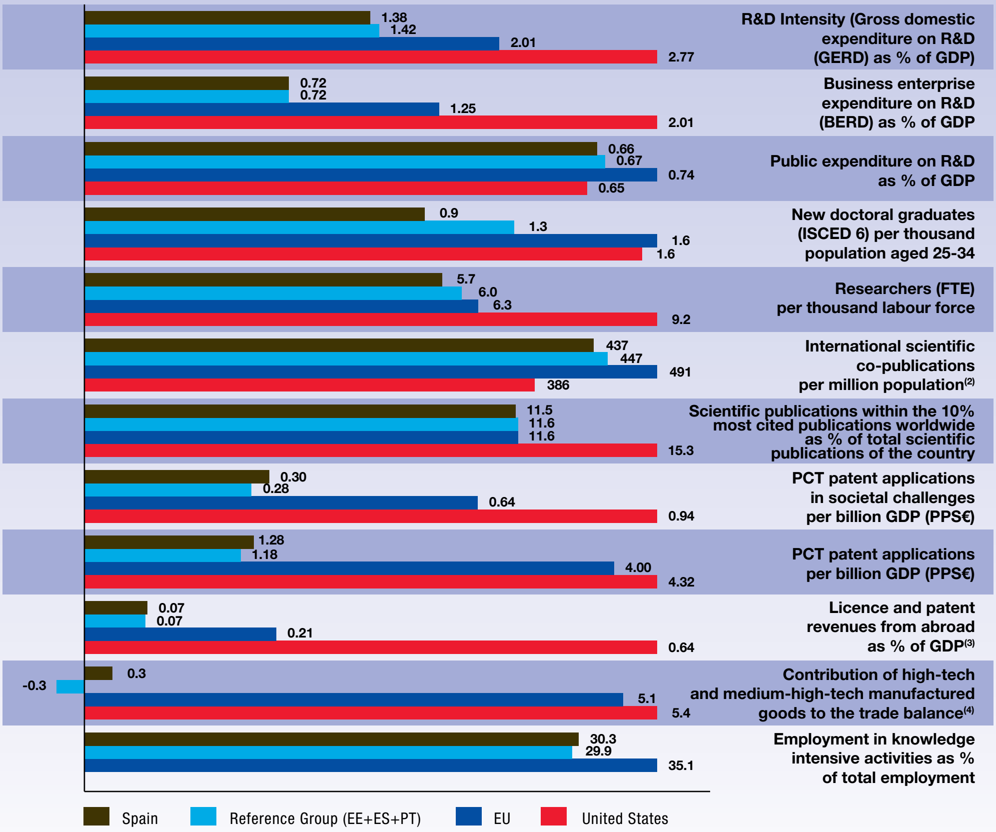
**Innovation Union Competitiveness Report 2011**

*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) ES: This projection is based on a tentative R&D Intensity target of 3.0% for 2020.

# SPAIN

## R&D profile, 2009(1)



*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

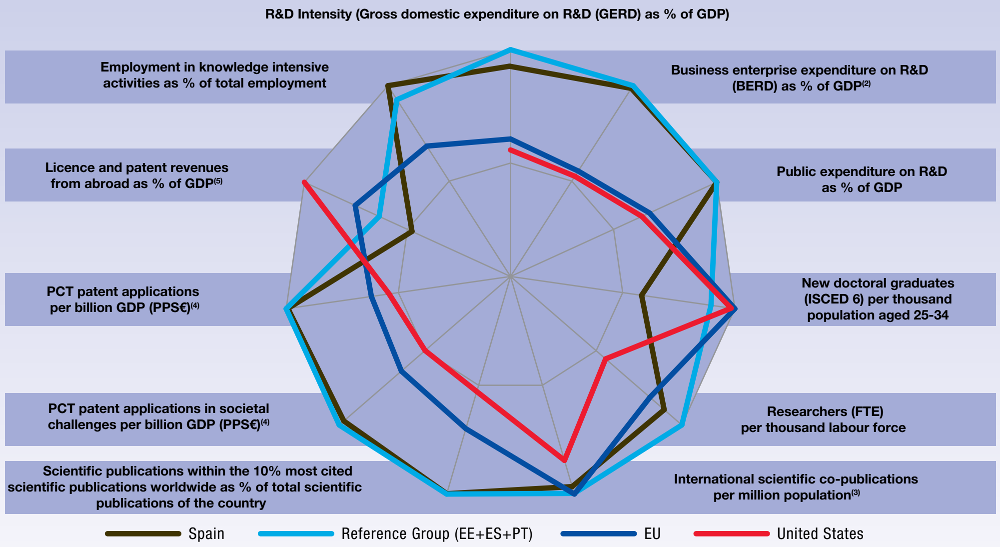
## Research and Innovation Performance

The main challenge in the Spanish R&I system is to increase business expenditure on R&D, which in 2009 only amounted to 0.72% of GDP, under the EU average of 1.25%, and represented 52% of GERD, well below the figure of 65-70% of the top performing countries in Europe and the world (Germany, the Nordic countries, Switzerland, Japan and the United States). However, since 2000, business enterprises have increased their expenditure on R&D, which has grown as a share of GDP by almost 45% over the period 2000-2009. Also venture capital intensity has risen substantially to 0.13% of GDP in 2008. The still low level of business expenditure on R&D has a negative impact on Spain's technology and innovation performance, and its capacity to produce world competitive technologies and new knowledge-intensive products.

Spain is a dynamic country with a growing research and innovation system. Over the period 2000-2008, Spain increased not only its domestic expenditure on R&D but also its international scientific cooperation, the quality of the scientific production, its technological development and the knowledge-intensity of its economy. Although the growth in new doctoral graduates is lower than in the EU, Spain has one of the world's highest rates in science and engineering degrees as a percentage of all new degrees. Moreover, the number of researchers as % of total employment has been constantly growing since 2000, at an average annual growth rate of 3.60%, more than the EU average. Regarding licence and patent revenues from abroad, Spain has grown more than the EU. However, the share of doctoral degrees in the active population is still far below the EU average, and the unemployment rate of researchers is one of the highest in the EU.

## SPAIN

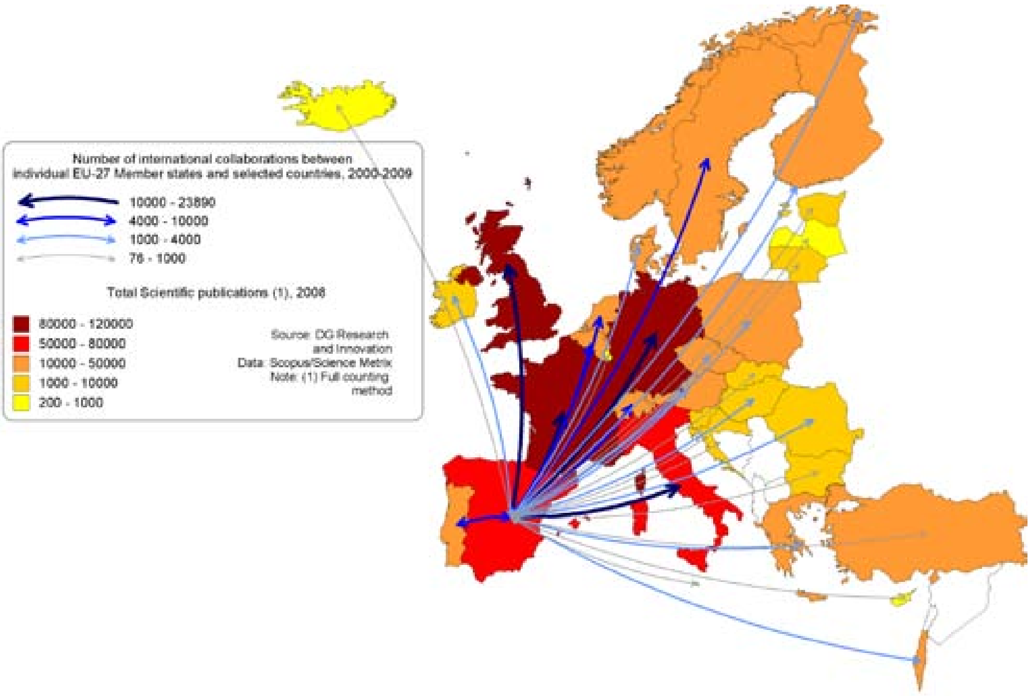
## Average annual growth (%), 2000-2009(1)



*Source:* DG Research and Innovation **Innovation Union Competitiveness Report 2011**
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) Average annual growth for Spain refers to 2002-2007 - there are breaks in series between 2002 and the previous years and 2008 and the previous years.
(3) The EU value refers to the median rather than to the average.
(4) Average annual growth refers to real growth.
(5) EU refers to extra-EU.
(6) Elements of estimation were involved in the compilation of the data.

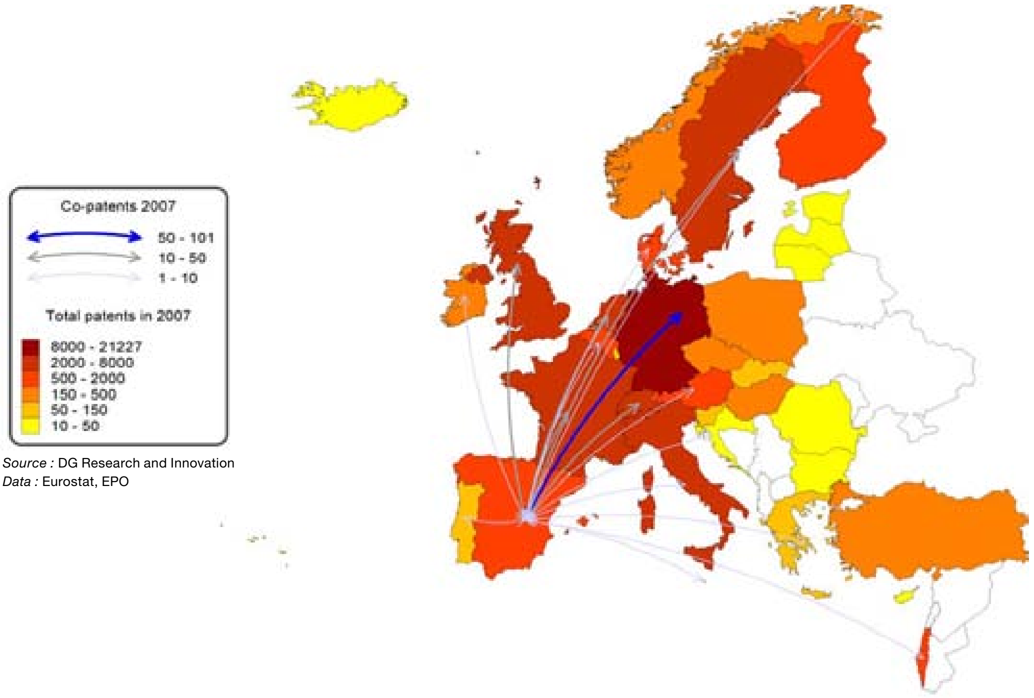
## SPAIN

## Co-publications between Spain and European Countries in 2000-2009



SPAIN

## Co-invented patent applications between Spain and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

### Participation in the European Research Area : Scientific and Technological collaborations

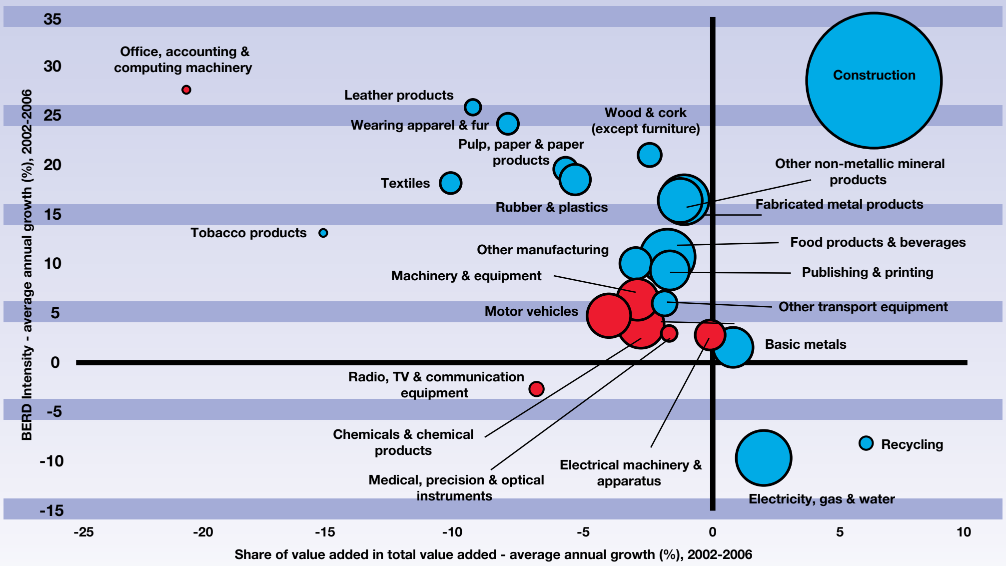
Internationalisation and connection to the major European research and innovation networks remain a major challenge for the Spanish R&I system. Spain has increased its international cooperation (as measured by co-publications and co-patents) and is building up cooperation with the major research-intensive countries in Europe - although more in scientific than in technological cooperation. However, despite progress, Spanish researchers and firms still hold a marginal position in the major S&T cooperation networks in Europe, as illustrated in the overall cooperation maps presented in part II of this report. Moreover, in the EU Research and Development Framework Programme, Spanish researchers have relatively less collaborative links with colleagues from other countries per thousand researchers. Signs of change are the better international connectivity of upcoming generations, as visible in networking maps of students for Erasmus and Marie Curie grant holders. In 2009, Spain was the 4th country concerning the number of Marie Curie Grant Agreements. Spain also has an important success rate in the grants of the European Research Council, with 13 Advanced Grants and 23 Starting Grants in 2010. The report shows a potential for Spain to attract more top researchers, if research institutions would further improve their international excellence.

### Structural change towards more knowledge-intensive economy

The figure below illustrates two trends in the Spanish economy: a) the economic expansion over the period 2002-2006 was mainly related to low-tech sectors or large consumer goods and services; b) there has been a general increase of research and innovation expenditure in most sectors of the Spanish economy, and in particular in the low-tech and traditional sectors. However, this knowledge injection has not been directly translated into an increasing share of the value added in the overall economy. Despite the harsh effects of the financial and economic crisis on the Spanish economy (a severe rise of unemployment from 8.3% in 2007 to 20.7% at the end of 2010), there is an upgrading of knowledge in traditional sectors, which still dominate the Spanish economy, matching Spain's increasingly skilled human resources. The increase of R&D expenditures is also visible in the high- and medium-high-tech sectors (red in the graph), and if this trend continues (the overall Spanish R&D investments increased on average by 8.4% over

## SPAIN

### Share of value added versus BERD Intensity - Average annual growth, 2002-2006



*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* OECD

*Notes:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.
(2) 'Coke, refined petroleum, nuclear fuel' is not visible on the graph.

the period 2000-2008) positive economic effects may be expected in the medium-term. To this aim, the new Law for Science, Technology and Innovation establishes a general framework to strengthen and coordinate research contributing to sustainable development and social welfare. Also, the State Innovation Strategy, approved in 2010, is developing several measures to increase private R&D investment, the number of innovative enterprises, and employment in the high- and medium-tech sectors.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 15 512 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 25 257 applicants from Spain (9.48% of EU-27*) and
- requesting EUR 7 463.68m of EC contribution (8.45% of EU-27*)

Among the EU-27* Spain (ES) ranks:

- 4th in terms of number of applicants and
- 5th in terms of requested EC contribution

### Success rates

- The ES applicant success rate of 20.3% is lower than the EU-27* applicant success rate of 21.6%.
- The ES EC financial contribution success rate of 18.0% is lower than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 3 152 proposals were retained for funding (20.3%)
- involving 5 118 (20.3%) successful applicants from Spain and
- requesting EUR 1 342.32m (18.0%) of EC financial contribution

Among the EU-27*, Spain (ES) ranks:

- 15th in terms of applicants success rate and
- 11th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Spain (ES) participates in

- 2 646 signed grant agreements
- involving 28 295 participants of which 4 282 (15.13%) are from Spain
- benefiting from a total of EUR 7 908.95m of EC financial contribution of which EUR 1 198.25m

(15.15%) is dedicated to participants from Spain.

Among the EU-27* in all FP7 signed grant agreements, Spain (ES) ranks:

- 5th in number of participations and
- 6th in budget share

### SME performance and participation

- The ES SME applicant success rate of 17.65% is lower than the EU-27* SME applicant success rate of 19.33%.
- The ES SME EC financial contribution success rate of 16.47% is lower than the corresponding EU-27* rate of 18.26%.

Specifically,

- 7987 ES SME applicants requesting EUR 1965.05m
- 1410 (17.65%) successful SMEs requesting EUR 323.66m (16.47%)

In signed grant agreements, as of 2011/03/16,

- 854 ES SME grant holders, i.e., 19.94% of total ES participation
- EUR 184.07m, i.e., 15.36% of total ES budget share

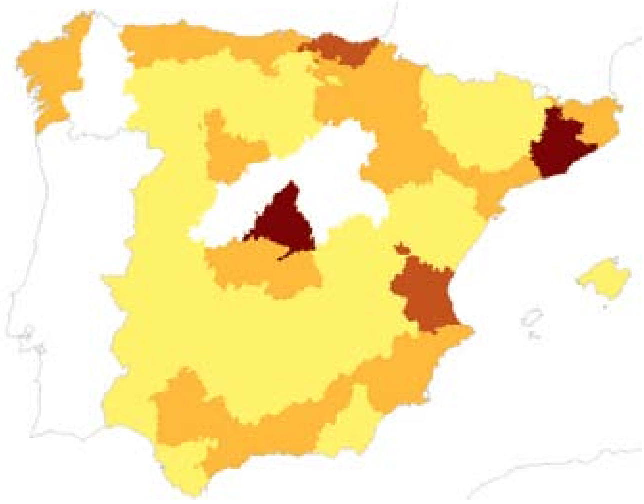
### Top 3 collaborative links with

- DE - Germany (3487)
- UK - United Kingdom (2923)
- FR - France (2654)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 17th | |
| - Below EU-27 average | | |
| - Moderate Innovator | | |

| | | |
|---|---|---|
| Nr. of FP7 applicants | | |
| (% EU-27*) | 25257 | |
| (9.48%) | 266507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 7463.68 | |
| (8.45%) | 88295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 5118 | |
| (8.65%) | 59199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 1342.32 | |
| (7.35%) | 18262.02 | |
| Success rate FP7 applicants | 20.3% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 18.0% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 4282 | |
| (8.35%) | 51279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 1198.25 | |
| (7.23%) | 16578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 901 | |
| (21.04%) | 9383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 854 | |
| (19.94%) | 8845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 184.07 | |
| (15.36%) | 2207.73 | |
| (13.32%) | | |

| | |
|---|---|
| ■ | 331 - 2000 |
| ■ | 171 - 330 |
| ■ | 71 - 170 |
| ■ | 21 - 70 |
| ■ | 1 - 20 |



## TABLE 1

## ES - Spain - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 5838 | 2115.60 | 831 | 14.23% | 309.58 | 14.63% |
| Research for the benefit of SMEs | 3731 | 490.78 | 706 | 18.92% | 91.29 | 18.60% |
| Marie-Curie Actions | 3263 | n/a | 811 | 24.85% | n/a | n/a |
| Transport (including Aeronautics) | 1696 | 447.85 | 389 | 22.94% | 93.01 | 20.77% |
| Health | 1566 | 662.87 | 332 | 21.20% | 130.45 | 19.68% |
| Environment (including Climate Change) | 1534 | 397.77 | 262 | 17.08% | 59.50 | 14.96% |

## TABLE 2

## ES - Spain - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all ES grant holders | EC contribution (EUR million) | % of total EC contribution to ES |
|---|---|---|---|---|
| Information and Communication Technologies | 816 | 19.06% | 263.17 | 21.96% |
| ERC | 108 | 2.52% | 145.71 | 12.16% |
| Marie-Curie Actions | 604 | 14.11% | 122.24 | 10.20% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 372 | 8.69% | 120.30 | 10.04% |
| Health | 308 | 7.19% | 106.92 | 8.92% |
| Energy | 163 | 3.81% | 80.45 | 6.71% |

*Notes :* Report generated on: 2011/03/25.04:38 PM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## ES - Spain - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| PRC | 7651 | 2104.87 | 1512 | 19.76% | 445.80 | 21.18% | 1286 | 340.63 | 28.43% |
| HES | 7340 | 1798.97 | 1293 | 17.62% | 254.36 | 14.14% | 1122 | 317.98 | 26.54% |
| REC | 6479 | 1604.00 | 1564 | 24.14% | 367.79 | 22.93% | 1498 | 466.37 | 38.92% |
| OTH | 1631 | 350.79 | 320 | 19.62% | 58.64 | 16.72% | 123 | 20.07 | 1.67% |
| PUB | 1146 | 266.25 | 320 | 27.92% | 65.80 | 24.71% | 253 | 53.21 | 4.44% |
| SME | 7987 | 1965.05 | 1410 | 17.65% | 323.66 | 16.47% | 854 | 184.07 | 15.36% |

PRC - Private for profit (excl. education), HES - Higher or secondary education, REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education

## TABLE 4

## ES - Spain - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| ES - Spain region | Number of grant holders | % of all ES - Spain grant holders | EC contribution (M euro) | % of total EC contribution to ES |
|---|---|---|---|---|
| Madrid (ES300) | 1464 | 34.19% | 427.00 | 35.64% |
| Barcelona (ES511) | 974 | 22.75% | 311.35 | 25.98% |
| Vizcaya (ES213) | 306 | 7.15% | 89.07 | 7.43% |
| Valencia / Valooncia (ES523) | 246 | 5.74% | 60.07 | 5.01% |
| Guipoozcoa (ES212) | 162 | 3.78% | 44.99 | 3.75% |

## TABLE 5

## ES - Spain - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all ES grant holders | EC contribution (M euro) | % of total EC contribution to ES grant holders |
|---|---|---|---|---|
| Agencia Estatal Consejo Superior de Investigaciones Cientificas (CSIC) | 331 | 7.73% | 95.05 | 7.93% |
| Fundacion Tecnalia Research & Innovation (Tecnalia) | 134 | 3.13% | 39.29 | 3.28% |
| Universidad Politecnica De Madrid (UPM) | 119 | 2.78% | 33.45 | 2.79% |
| Telefonica Investigacion y Desarrollo sa (TID) | 74 | 1.73% | 31.52 | 2.63% |
| Universitat Pompeu Fabra (UPF) | 60 | 1.40% | 29.04 | 2.42% |

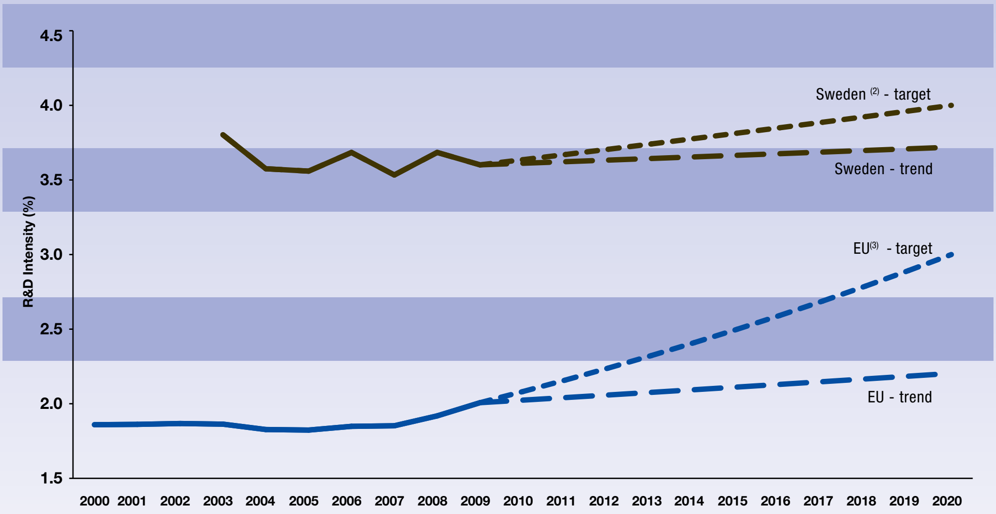
# COUNTRY PROFILE

# SE - Sweden

## Progress towards meeting the Europe 2020 R&D intensity target

The most recent figures for Sweden on R&D intensity are 3.6% (1.06% public + 2.54% private). This is still below its probable[13] peak level of 2001 (4.18% of GDP). The downward variation is mainly due to changes in private sector R&D investments. In view of 2020, Sweden is considering a preliminary national R&D target of 4% of GDP. Given the trend scenario presented below, a 4% R&D intensity target is realistic given that both public and private R&D investments are increasing. In its most recent research bill, for the period 2009–2012, the government substantially increased its R&D expenditures, despite the financial crisis at the time. In this research bill, public R&D expenditures identified 'strategic areas' for research and innovation in Sweden in the coming years, in particular medicine, technology and climate.

**SWEDEN** **R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation

*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009 in the case of the EU and for 2005-2009 in the case of Sweden.
(2) SE: This projection is based on a tentative R&D Intensity target of 4.0% for 2020.
(3) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(4) SE: There is a break in series between 2005 and the previous years.

**Innovation Union Competitiveness Report 2011**

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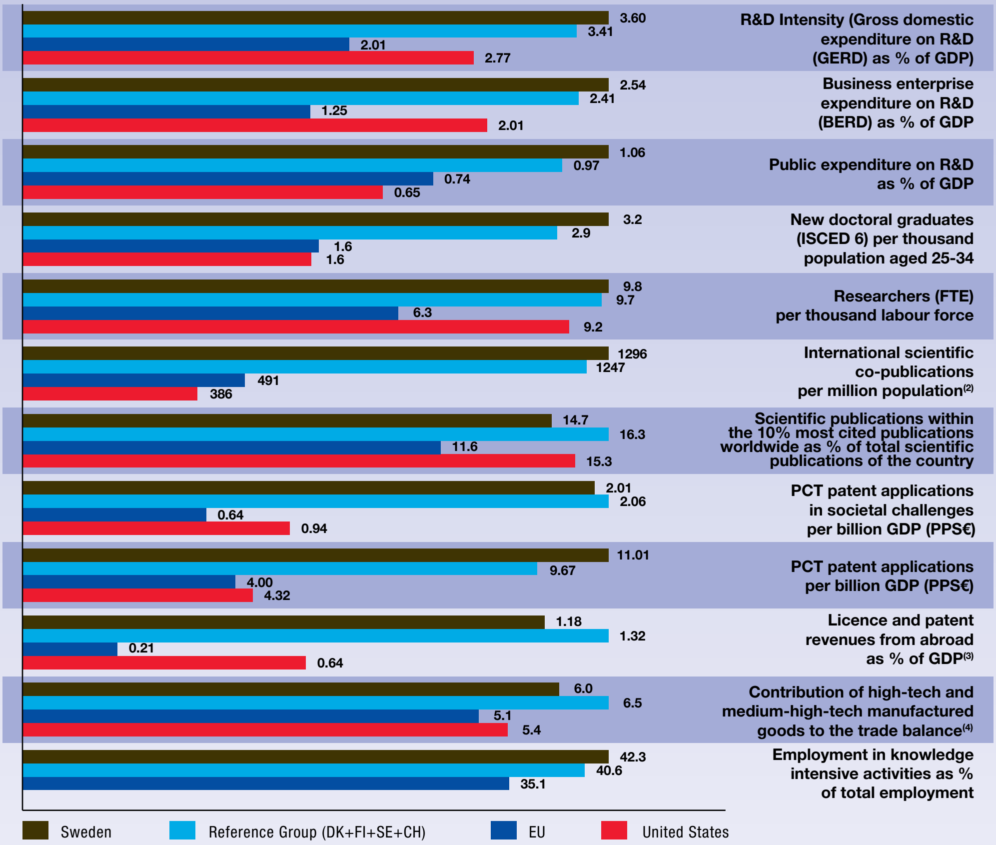
[13] There is a break in series of data over the period 2000–2009.

# SWEDEN

## R&D profile, 2009(1)



*Source:* DG Research and Innovation **Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) (i) The EU value refers to the median rather than to the average; (ii) CH is not included in the Reference Group.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU; (iii) CH is not included in the Reference Group.
(5) Elements of estimation were involved in the compilation of the data.

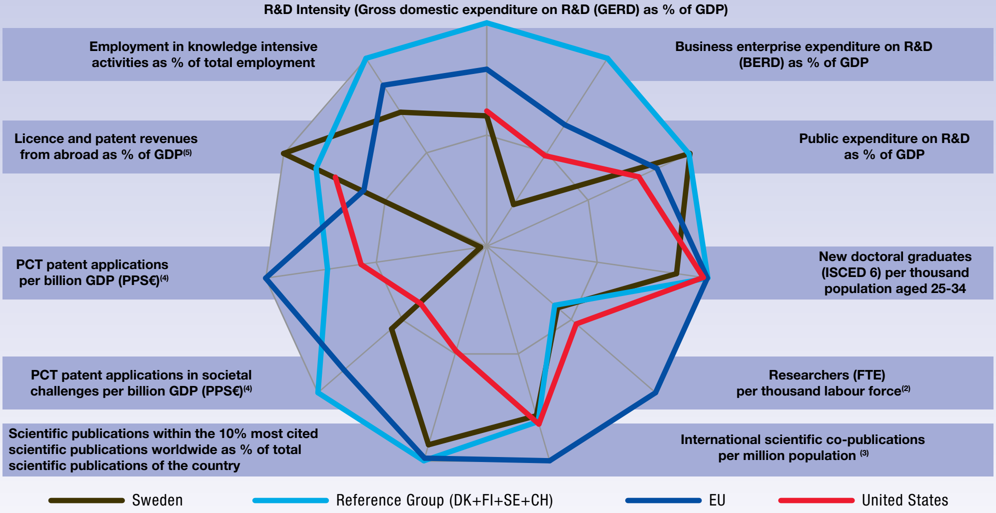
## Research and Innovation Performance

The Swedish research and innovation system is characterised by a dominating private sector combined with a public sector with a very high and expanding research and education investment rate. The leading performer of research in Sweden is the business enterprise sector (that accounted for around 74% of the R&D expenditure in the last five years). The second main performer is the higher education sector, with the universities as the main actors (around 20% of the total R&D expenditure). Sweden is among the most knowledge-intensive countries in the world, with over 42% of the work force employed in knowledge-intensive activities. It has among the highest R&D intensities, high shares of researchers and skilled human resources in the economy, low unemployment rates for researchers and high levels of new academic-oriented tertiary education degrees. These efforts have resulted in very high and increasing quality of its scientific production (a ratio of 14% of the Swedish scientific publications are among the 10% most cited in the world) - although here Sweden is below the scientific quality of its Nordic neighbours, Switzerland and the United States. Sweden has also achieved a high number of patent applications - as well as high-tech patent applications - to the European Patent Office per billion GDP.

As shown in the report, the Swedish national innovation framework conditions show clear strengths in several areas: a stable macroeconomic environment, a highly trained workforce, a handful of R&D-intensive multinational corporations, one of the highest levels of venture capital availability in the world (both for early stage and expansion capital), and a high rate

## SWEDEN

## Average annual growth (%), 2000-2009(1)



*Source:* DG Research and Innovation

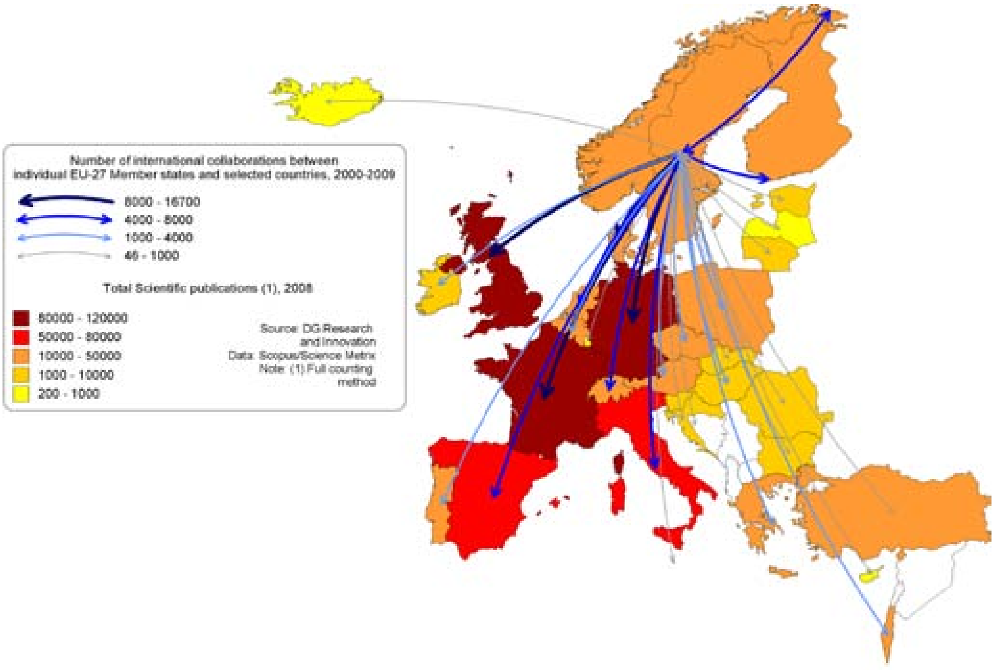
**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) Average annual growth for Sweden refers to 2007-2008 - there is a break in series between 2007 and the previous years.
(3) (i) The EU value refers to the median rather than to the average; (ii) CH is not included in the Reference Group.
(4) Average annual growth refers to real growth.
(5) EU refers to extra-EU.
(6) Elements of estimation were involved in the compilation of the data.

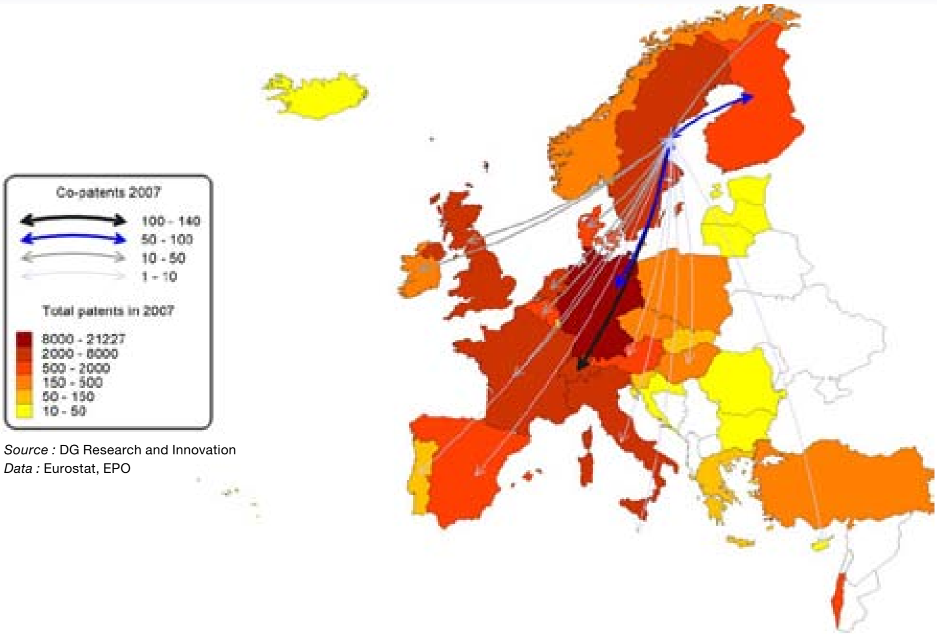
## SWEDEN

## Co-publications between Sweden and European Countries in 2000-2009



SWEDEN

## Co-invented patent applications between Sweden and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

of broadband access by firms. These strengths are reinforced by Sweden's integration into global markets.

The main vulnerability is business-sector knowledge intensity and dynamics, given its overall importance in the Swedish R&I system. Sweden benefits from expanding knowledge-based firm dynamics, with a high R&D investment rate and new-to-the-market products by SMEs. However, the firm-knowledge dynamics are less intensive than could be expected from the high level of S&T production and favourable framework conditions. Similar countries have higher private R&D investment growth and more dynamic patenting activity than in Sweden, both for PCT patents and for SME patenting. The overall birth rate of new firms in Sweden is also low compared to other European countries. More generally, since 2000 the patent application rate has grown faster in Denmark, Finland, and the United States than in Sweden.

### Participation in the European Research Area : Scientific and Technological collaborations

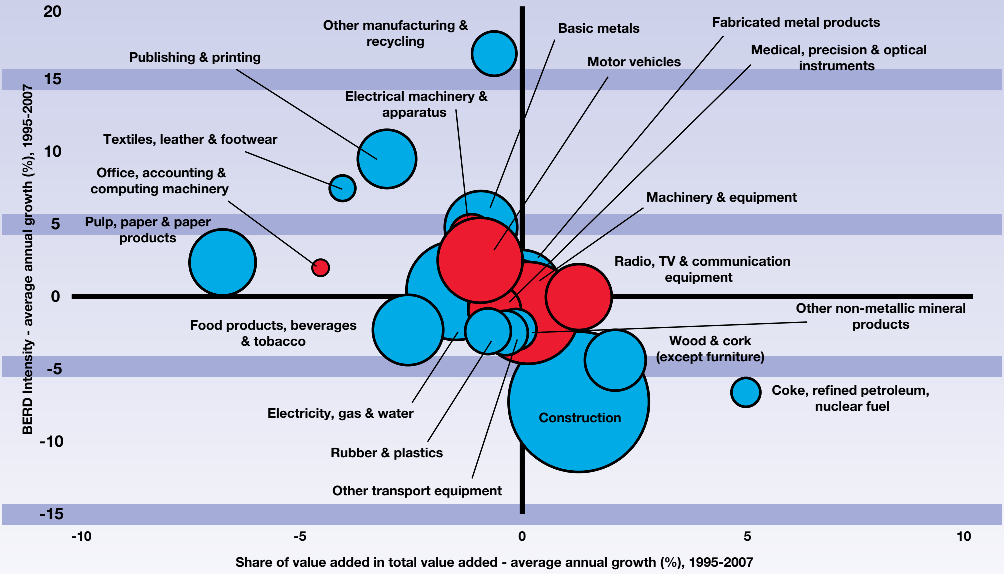
Sweden is a small and open country. The efficiency of the research system is being strengthened by an opening up to and integration into the European research system. In Sweden, openness towards other European organisations has increased, and its integration in European scientific networks is improving. The report illustrates several aspects of scientific and technological cooperation. Europe-wide maps in part II illustrate the manner in which Sweden is connected to the main nodes of the networks, which are located in the dominant research countries of Western and Central Europe. As also seen below, the strongest links of Swedish science and technology cooperation are with neighbouring countries, as well as Germany, France and the United Kingdom, but intensive cooperation is also visible with researchers from Southern and Central European countries. More generally, Swedish researchers have a high integration of international scientific knowledge flows, visible in international co-publications including cooperation with the United States and Asia. Given that Sweden is among Europe's scientific and technological leaders, it can be expected that the country is well-connected to international knowledge flows. In this sense, it is noticeable that Sweden is still not in the centre node of the intra-European science and technology networks, although factors of critical mass do play a role.

### Structural change towards more knowledge-intensive economy

The slightly lower dynamics of knowledge-intensive firms has contributed to a lack of major structural change in the Swedish knowledge economy over the period 1995-2007. Many of the large research-intensive

## SWEDEN

### Share of value added versus BERD Intensity - Average annual growth, 1995-2007



Innovation Union Competitiveness Report 2011

*Source:* DG Research and Innovation
*Data:* OECD
*Notes:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.
(2) 'Chemicals and chemical products' is not visible on the graph.

firms are close to the world technology frontier in their domains and, therefore, have small margins to increase their R&D intensity relative to international competitors. However, as shown in the figure below, the Swedish manufacturing sector is showing signs of diversification, with knowledge and R&D being injected into and invested in medium-and low-tech sectors, both more traditional (such as textiles or basic metals) and newer sectors (in particular recycling and publishing–printing).

The Swedish economy has not shifted towards a larger weight of knowledge-intensive manufacturing sectors in the economy. This stable sectoral composition of Sweden shows that the increases in R&D intensity inside sectors have not been enough to compensate some decreases. Sweden needs the emergence of new sectors.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 7 027 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 9 551 applicants from Sweden (3.58% of EU-27*) and
- requesting EUR 3 688.27m of EC contribution (4.18% of EU-27*)

Among the EU-27* Sweden (SE) ranks:

- 9th in terms of number of applicants and
- 8th in terms of requested EC contribution

### Success rates

- The SE applicant success rate of 24.9% is higher than the EU-27* applicant success rate of 21.6%.
- The SE EC financial contribution success rate of 21.9% is higher than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 1 678 proposals were retained for funding (23.9%)
- involving 2 380 (24.9%) successful applicants from Sweden and
- requesting EUR 806.37m (21.9%) of EC financial contribution

Among the EU-27*, Sweden (SE) ranks:

- 4th in terms of applicants success rate and
- 7th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Sweden (SE) participates in

- 1 458 signed grant agreements
- involving 18 247 participants of which 2 063

(11.31%) are from Sweden

- benefiting from a total of EUR 5453.14m of EC financial contribution of which EUR 746.01m (13.68%) is dedicated to participants from Sweden.

Among the EU-27* in all FP7 signed grant agreements, Sweden (SE) ranks:

- 8th in number of participations and
- 7th in budget share

**SME performance and participation**

- The SE SME applicant success rate of 22.20% is higher than the EU-27* SME applicant success rate of 19.33%.
- The SE SME EC financial contribution success rate of 19.91% is higher than the corresponding EU-27* rate of 18.26%.

Specifically,

- 1851 SE SME applicants requesting EUR 522.75m
- 411 (22.20%) successful SMEs requesting EUR 104.07m (19.91%)

In signed grant agreements, as of 2011/03/16,

- 268 SE SME grant holders, i.e., 12.99% of total SE participation
- EUR 75.90m, i.e., 10.17% of total SE budget share

**Top 3 collaborative links with**

- DE - Germany (2564)
- UK - United Kingdom (1954)
- FR - France (1694)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 1st | |
| - Above EU-27 average | | |
| - Innovation Leader | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 9551 | |
| (3.58%) | 266507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 3688.27 | |
| (4.18%) | 88295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 2380 | |
| (4.02%) | 59199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 806.37 | |
| (4.42%) | 18262.02 | |
| Success rate FP7 applicants | 24.9% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 21.9% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 2063 | |
| (4.02%) | 51279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 746.01 | |
| (4.50%) | 16578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 340 | |
| (16.48%) | 9383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 268 | |
| (12.99%) | 8845 | |
| (17.25%) | | |
| EC contribution to FP7 SME grant holders in EUR million | | |
| (% of grant holders) | 75.90 | |
| (10.17%) | 2207.73 | |
| (13.32%) | | |

■ 331 - 2000
■ 171 - 330
■ 71 - 170
■ 21 - 70
■ 1 - 20

## TABLE 1

## SE - Sweden - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 1 992 | 848.89 | 384 | 19.28% | 153.71 | 18.11% |
| Marie-Curie Actions | 1 324 | n/a | 305 | 23.04% | n/a | n/a |
| Health | 1 077 | 575.44 | 295 | 27.39% | 140.06 | 24.34% |
| Transport (including Aeronautics) | 804 | 250.86 | 273 | 33.96% | 80.08 | 31.92% |
| Environment (including Climate Change) | 637 | 196.11 | 135 | 21.19% | 34.65 | 17.67% |
| Research for the benefit of SMEs | 590 | 82.92 | 137 | 23.22% | 17.81 | 21.47% |

## TABLE 2

## SE - Sweden - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all SE grant holders | EC contribution (EUR million) | % of total EC contribution to SE |
|---|---|---|---|---|
| Information and Communication Technologies | 380 | 18.42% | 144.95 | 19.43% |
| Health | 275 | 13.33% | 134.25 | 18.00% |
| ERC | 69 | 3.34% | 116.31 | 15.59% |
| Marie-Curie Actions | 235 | 11.39% | 64.87 | 8.70% |
| Transport (including Aeronautics) | 218 | 10.57% | 59.55 | 7.98% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 163 | 7.90% | 54.81 | 7.35% |

*Notes :* Report generated on: 2011/03/28.10:49 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## SE - Sweden - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 4 951 | 1 635.88 | 1 167 | 23.57% | 360.22 | 22.02% | 1 122 | 483.59 | 64.82% |
| PRC | 2 174 | 641.77 | 555 | 25.53% | 163.97 | 25.55% | 513 | 145.47 | 19.50% |
| REC | 1 138 | 413.87 | 319 | 28.03% | 106.30 | 25.68% | 270 | 89.64 | 12.02% |
| PUB | 461 | 112.65 | 181 | 39.26% | 26.29 | 23.34% | 134 | 24.38 | 3.27% |
| OTH | 357 | 88.33 | 86 | 24.09% | 17.69 | 20.03% | 24 | 2.94 | 0.39% |
| | | | | | | | | | |
| SME | 1 851 | 522.75 | 411 | 22.20% | 104.07 | 19.91% | 268 | 75.90 | 10.17% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, PUB - Public body (excl. research and education), OTH - Others,

## TABLE 4

## SE - Sweden - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| SE - Sweden region | Number of grant holders | % of all SE - Sweden grant holders | EC contribution (M euro) | % of total EC contribution to SE |
|---|---|---|---|---|
| Stockholms län (SE110) | 802 | 38.88% | 320.99 | 43.03% |
| Västra Götalands län (SE232) | 443 | 21.47% | 161.25 | 21.61% |
| Skåne län (SE224) | 231 | 11.20% | 83.44 | 11.18% |
| Uppsala län (SE121) | 210 | 10.18% | 72.47 | 9.71% |
| Östergötlands län (SE123) | 114 | 5.53% | 43.82 | 5.87% |

## TABLE 5

## SE - Sweden - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all SE grant holders | EC contribution (M euro) | % of total EC contribution to SE grant holders |
|---|---|---|---|---|
| KAROLINSKA INSTITUTET (KI) | 179 | 8.68% | 102.66 | 13.76% |
| KUNGLIGA TEKNISKA HOEGSKOLAN | 150 | 7.27% | 67.93 | 9.11% |
| LUNDS UNIVERSITET | 163 | 7.90% | 66.72 | 8.94% |
| CHALMERS TEKNISKA HOEGSKOLA AB | 129 | 6.25% | 52.37 | 7.02% |
| UPPSALA UNIVERSITET | 113 | 5.48% | 46.52 | 6.24% |

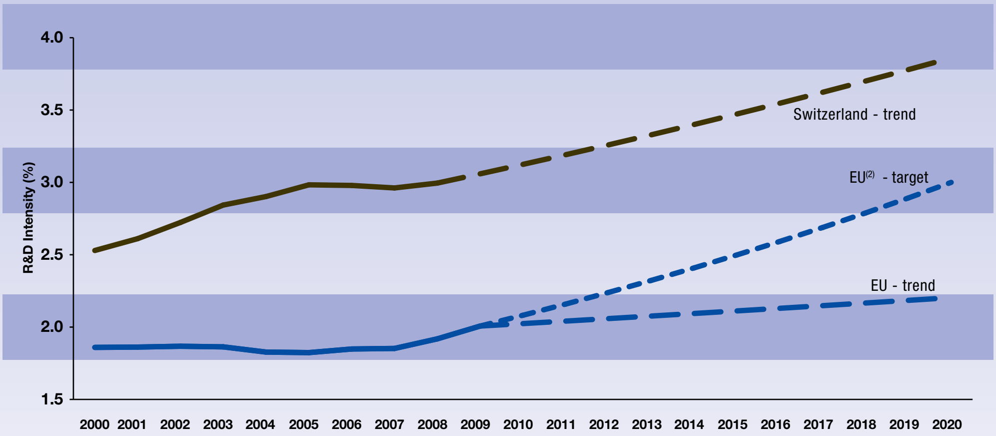
# COUNTRY PROFILE

# CH - Switzerland

## Progress towards increasing the R&D intensity

R&D intensity in Switzerland in 2009 was 3% of GDP, one of the highest in Europe and in the world. The private sector performed 74% of the total R&D and the higher education sector, 24%. In the last decade, R&D intensity grew at an average annual growth rate of 2.1%, well above the 0.9% of the EU, passing from 2.53% in the year 2000 to 3% in 2009. If this trend continued, Switzerland would reach a R&D intensity of 3.86% in 2020. Even if the associated countries to the European research cooperation do not form part of the Europe 2020 strategy of the European Union, certain countries do envisage fixing an objective for research investment and initiatives for fast growing innovative enterprises. This strategy could be justified if based on a consultation with the stakeholders in the country.

**SWITZERLAND** **R&D Intensity projections, 2000-2020[(1)]**



*Source:* DG Research and Innovation

*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009 in the case of the EU and for 2000-2008 in the case of Swizerland.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.
(3) CH: The values for 2001, 2002, 2003, 2005, 2006 and 2007 were interpolated by DG Research and Innovation.

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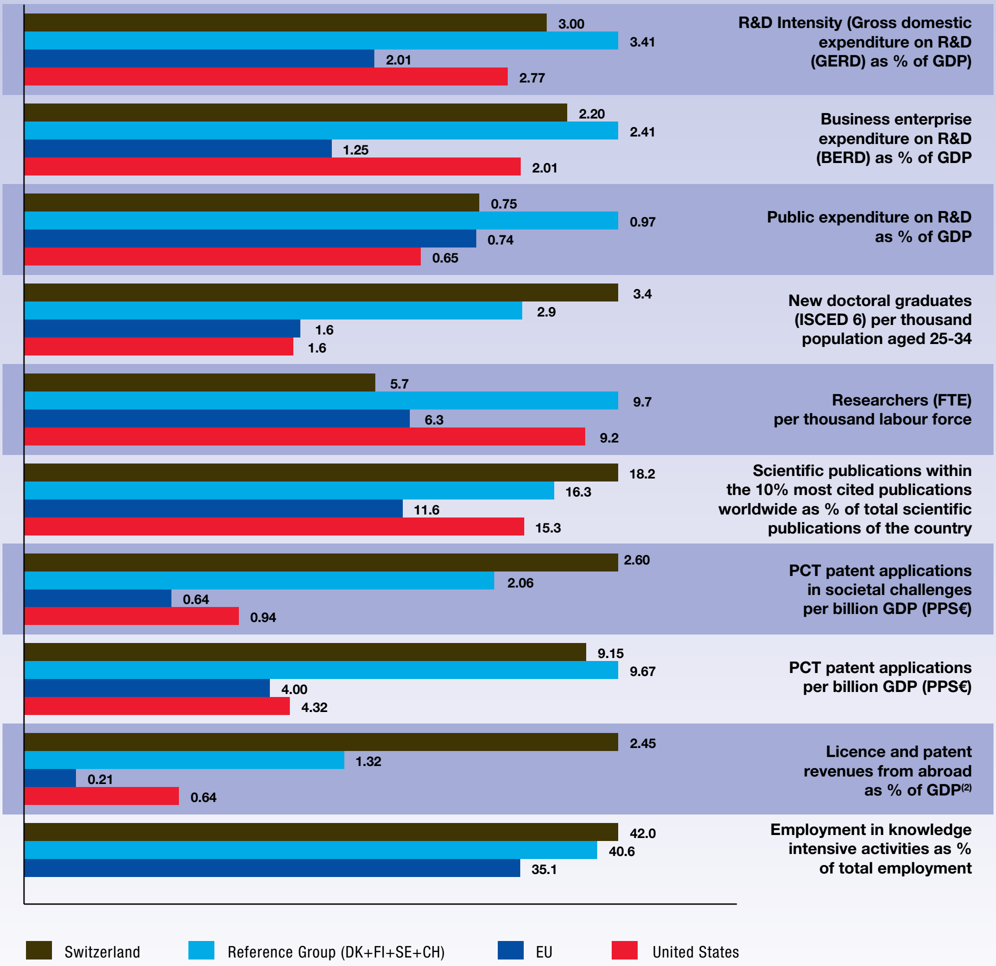
## SWITZERLAND

**R&D profile, 2009**(1)



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) EU refers to extra-EU.
(3) Elements of estimation were involved in the compilation of the data.

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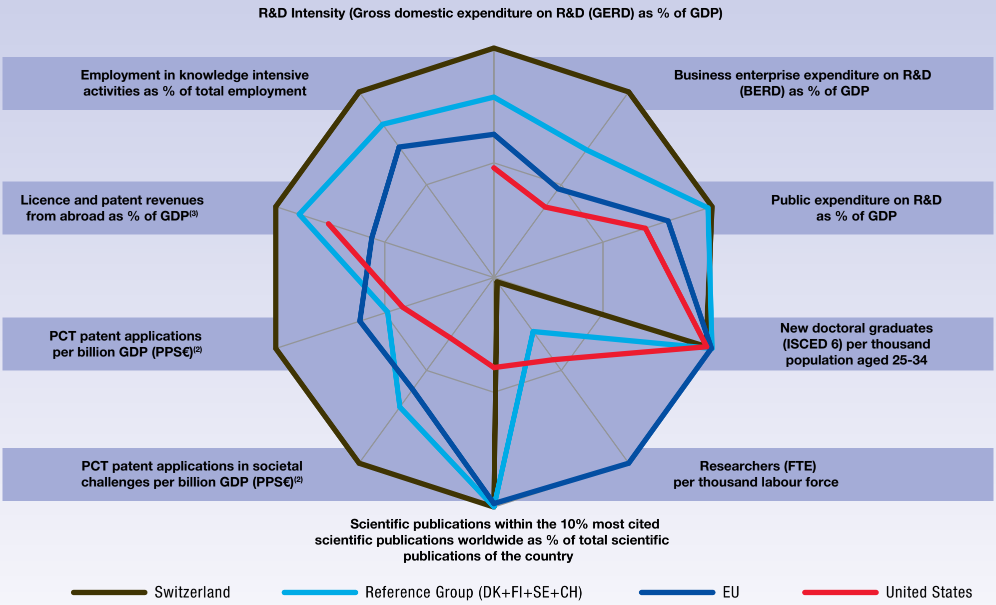
## Research and Innovation Performance

The Swiss research and innovation system is characterised by its very strong scientific and technological production that outperforms most countries in the world. A high level of R&D, alongside an overall excellent education system, investment coupled with an efficient allocation of both private and public R&D resources result in scientific and technological outcomes of ultimate quality. In this respect, Switzerland invests proportionally more resources than the EU and the United States. However, Switzerland outperforms not only the EU and the United States, but also this reference group in terms of high-quality scientific production and patents aimed at addressing societal challenges, and that can constitute important sources of new economic growth.

The development of strong competences in environmental and bio sciences is favoured by the strong linkages between a well performing scientific

## SWITZERLAND

## Average annual growth (%), 2000-2009(1)



*Source:* DG Research and Innovation

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) Average annual growth refers to real growth.
(3) EU refers to extra-EU.
(4) Elements of estimation were involved in the compilation of the data.

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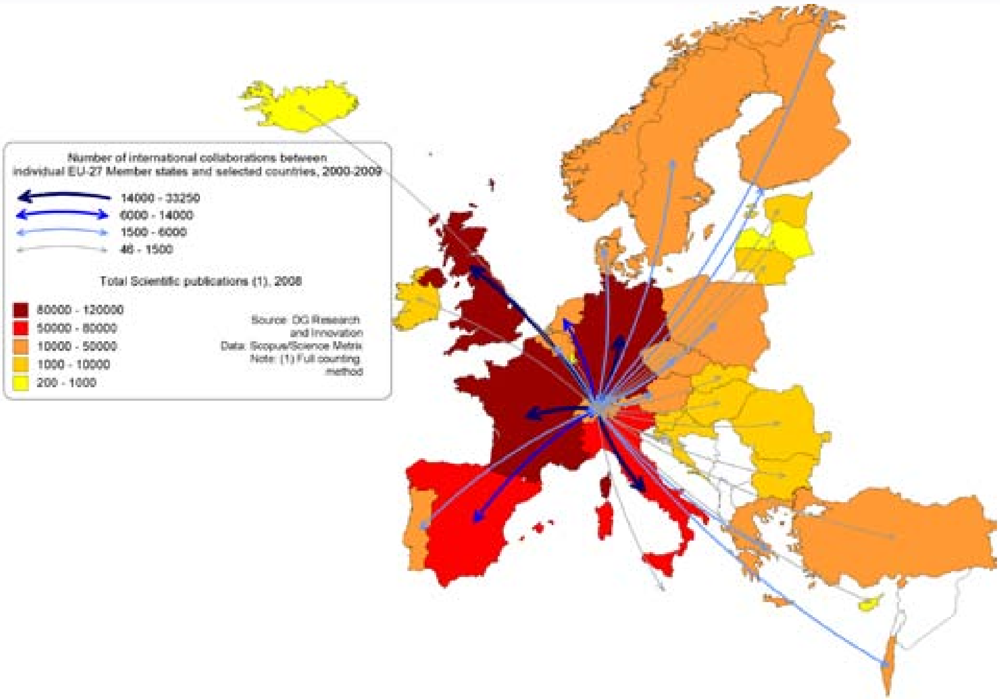
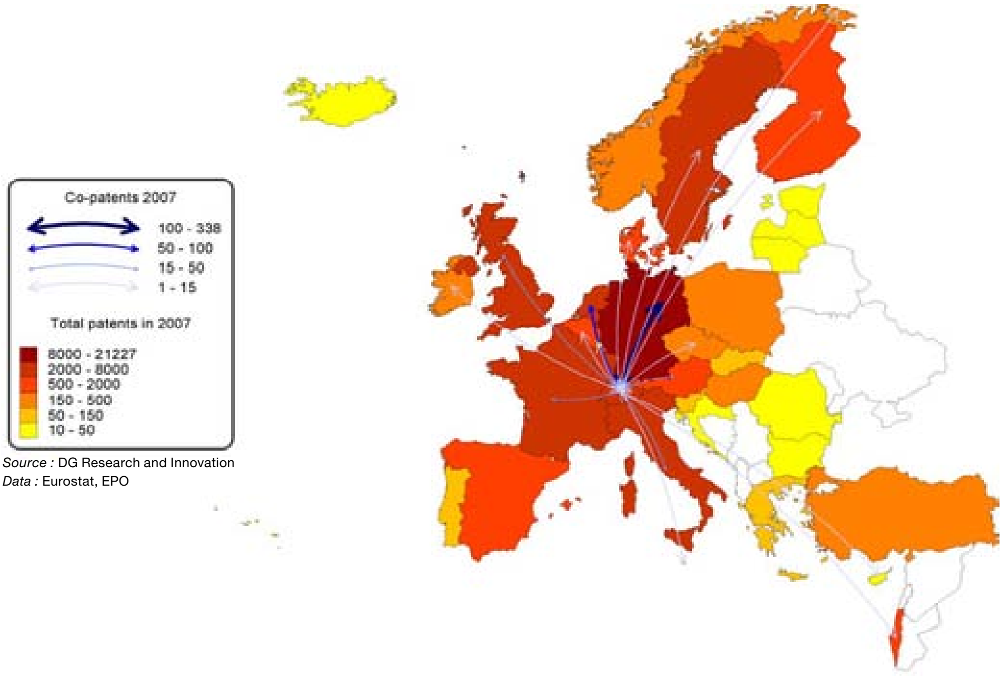
## SWITZERLAND

## Co-publications between Switzerland and European Countries in 2000-2009



SWITZERLAND

## Co-invented patent applications between Switzerland and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

system and a powerful pharmaceutical and rising environmental industry, which take up this knowledge, develop new technologies and in turn invest in higher knowledge production, generating a virtuous circle. In terms of the overall technological inventiveness of the economy, Switzerland more than doubles the EU and the United States, and comes close to the average of the reference group. The high quality of Swiss patents, as reflected by the licence and patent revenues from abroad, outperforms by far any other system. The relative low number of researchers employed in the economy, below the EU average, could constitute a potential threat to this good performance, especially if the system continues to expand as it may face a skill shortage.

In dynamic terms, Switzerland's scientific and technological performance has improved above the average of the EU, the United States and the reference group countries. The Swiss research and innovation system seems to have been able to absorb in an efficient manner the increasing R&D resources injected in the economy. It produces more and better scientific and technological outputs, which are then transferred into the economy.

### Participation in the European Research Area : Scientific and Technological collaborations

Switzerland is a small country with a very open research and innovation system. The very high quality of its scientific and technological production, its superior education system on all levels, coupled with its strategic geographical position and close historical, cultural and linguistic ties have allowed the Swiss research and innovation system to establish strong scientific and technological links with partners in other European systems. As an indication, 45% of the total Swiss patent applications count with a co-inventor located abroad, one of the highest percentages, if not the highest, in the world. Italy, France, the United Kingdom and especially Germany are the main scientific partners, while Germany remains the reference technological partner for Swiss enterprises and research centres.

This strong openness is allowing the system to tap into the main global knowledge networks, benefit from strong knowledge spillovers and leverage on their important R&D investments.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 7 111 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 8 998 applicants from Switzerland (44.49 % of Associated Countries) and
- requesting EUR 3 477.00m of EC contribution (44.10 % of Associated Countries)

Among the Associated Countries Switzerland (CH) ranks:

- 1st in terms of number of applicants and
- 1st in terms of requested EC contribution

### Success rates

- The CH applicant success rate of 26.1 % is higher than the Associated Countries applicant success rate of 23.5 %.
- The CH EC financial contribution success rate of 26.6 % is higher than the Associated Countries rate of 21.7 %.

Specifically, following evaluation and selection, a total of

- 1 834 proposals were retained for funding (25.8 %)
- involving 2 344 (26.1 %) successful applicants from Switzerland and
- requesting EUR 925.93m (26.6 %) of EC financial contribution

Among the Associated Countries, Switzerland (CH) ranks:

- 2nd in terms of applicants success rate and
- 2nd in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Switzerland (CH) participates in

- 1 553 signed grant agreements
- involving 16 711 participants of which 2 010 (12.03 %) are from Switzerland
- benefiting from a total of EUR 5 531.34m of EC financial contribution of which EUR 848.22m (15.33 %) is dedicated to participants from Switzerland.

Among the Associated Countries in all FP7 signed grant agreements, Switzerland (CH) ranks:

- 1st in number of participations and
- 1st in budget share

### SME performance and participation

- The CH SME applicant success rate of 23.04 % is higher than the Associated Countries SME applicant success rate of 20.42 %.
- The CH SME EC financial contribution success rate of 21.00 % is higher than the corresponding Associated Countries rate of 18.51 %.

Specifically,

- 2 092 CH SME applicants requesting EUR 618.01m
- 482 (23.04 %) successful SMEs requesting EUR 129.79m (21.00 %)

In signed grant agreements, as of 2011/03/16,

- 303 CH SME grant holders, i.e., 15.07 % of total CH participation
- EUR 86.62m, i.e., 10.21 % of total CH budget share

### Top 3 collaborative links with

- DE - Germany (2 529)
- UK - United Kingdom (1 687)
- FR - France (1 512)

| | | |
|---|---|---|
| Nr. of FP7 applicants | | |
| (% Associated Countries) | 8 998 | |
| (44.49%) | 20 227 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% Associated Countries) | 3 477.00 | |
| (44.10%) | 7 884 | |
| Nr. of successful FP7 applicants | | |
| (% Associated Countries) | 2 344 | |
| (48.81%) | 4 802 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% Associated Countries) | 925.93 | |
| (54.11%) | 1 711.27 | |
| Success rate FP7 applicants | 26.1% | 23.5% |
| Success rate | | |
| FP7 EC contribution | 26.6% | 21.7% |
| Nr. of FP7 grant holders | | |
| (% Associated Countries) | 2 010 | |
| (49.12%) | 4 092 | |

| | |
|---|---|
| EC contribution | |
| to FP7 grant holders | |
| in EUR million | |
| (% Associated Countries) | 848.22 |
| (55.25%) | 1 535.13 |
| Nr. of FP7 coordinators | |
| (% of grant holders) | 408 |
| (20.30%) | 915 |
| (22.36%) | |
| Nr. of FP7 SME grant holders | |
| (% of grant holders) | 303 |
| (15.07%) | 634 |
| (15.49%) | |
| EC contribution to FP7 SME | |
| grant holders in EUR million | |
| (% of grant holders) | 86.62 |
| (10.21%) | 175.41 |
| (11.43%) | |

## TABLE 1

## CH - Switzerland - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 2 413 | 1 040.35 | 460 | 19.06% | 188.97 | 18.16% |
| Marie-Curie Actions | 1 610 | n/a | 430 | 26.71% | n/a | n/a |
| Health | 1 088 | 497.54 | 277 | 25.46% | 114.38 | 22.99% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 527 | 216.66 | 230 | 43.64% | 93.23 | 43.03% |
| European Research Council | 488 | 871.92 | 136 | 27.87% | 264.43 | 30.33% |
| Environment (including Climate Change) | 487 | 136.12 | 139 | 28.54% | 35.06 | 25.75% |

## TABLE 2

## CH - Switzerland - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all CH grant holders | EC contribution (EUR million) | % of total EC contribution to CH |
|---|---|---|---|---|
| ERC | 126 | 6.27% | 205.47 | 24.22% |
| Information and Communication Technologies | 455 | 22.64% | 172.81 | 20.37% |
| Marie-Curie Actions | 323 | 16.07% | 103.06 | 12.15% |
| Health | 248 | 12.34% | 100.30 | 11.82% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 199 | 9.90% | 71.72 | 8.46% |
| Research Infrastructures | 108 | 5.37% | 52.14 | 6.15% |

*Notes :* Report generated on: 2011/03/28.11:36 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## CH - Switzerland - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 4354 | 1316.19 | 1083 | 24.87% | 310.94 | 23.62% | 1062 | 521.93 | 61.53% |
| PRC | 2244 | 661.85 | 556 | 24.78% | 160.37 | 24.23% | 493 | 139.60 | 16.46% |
| REC | 1169 | 445.30 | 349 | 29.85% | 140.90 | 31.64% | 332 | 159.62 | 18.82% |
| OTH | 420 | 99.93 | 99 | 23.57% | 23.15 | 23.17% | 51 | 10.50 | 1.24% |
| PUB | 326 | 82.00 | 122 | 37.42% | 26.18 | 31.92% | 72 | 16.59 | 1.96% |
| | | | | | | | | | |
| SME | 2092 | 618.01 | 482 | 23.04% | 129.79 | 21.00% | 303 | 86.62 | 10.21% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education

## TABLE 4

## CH - Switzerland - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| CH - Switzerland region | Number of grant holders | % of all CH - Switzerland grant holders | EC contribution (M euro) | % of total EC contribution to CH |
|---|---|---|---|---|
| Zürich (CH040) | 590 | 29.35% | 268.19 | 31.62% |
| Vaud (CH011) | 402 | 20.00% | 196.80 | 23.20% |
| Genève (CH013) | 256 | 12.74% | 133.76 | 15.77% |
| Bern (CH021) | 178 | 8.86% | 49.32 | 5.81% |
| Basel-Stadt (CH031) | 152 | 7.56% | 56.81 | 6.70% |

## TABLE 5

## CH - Switzerland - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all CH grant holders | EC contribution (M euro) | % of total EC contribution to CH grant holders |
|---|---|---|---|---|
| Ecole Polytechnique Federale de Lausanne (EPFL) | 258 | 12.84% | 145.35 | 17.14% |
| Eidgenössische Technische Hochschule Zürich (ETH Zurich) | 264 | 13.13% | 137.04 | 16.16% |
| Universitaet Zuerich (UZH) | 114 | 5.67% | 63.79 | 7.52% |
| European Organization for Nuclear Research (CERN) | 55 | 2.74% | 55.93 | 6.59% |
| Universite de Geneve | 104 | 5.17% | 52.32 | 6.17% |

# COUNTRY PROFILE

# TR - Turkey

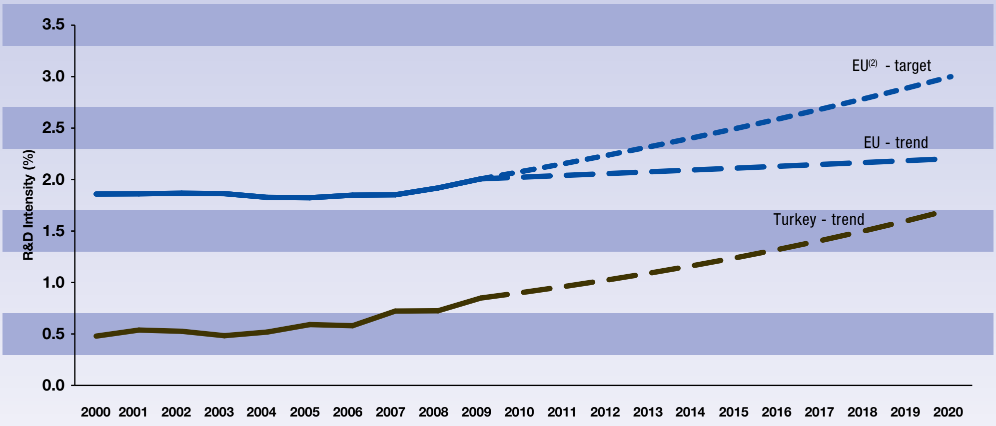
## Progress towards increasing the R&D intensity

The most recent figures for Turkey on R&D intensity are 0.85% for 2009, which represents a noticeable increase compared to the value in 2000. Over the period 2000-2009, the Gross Domestic Expenditure on R&D (GERD) in Turkey experienced an average annual real growth rate of 10.1%, which is the fourth highest growth rate in Europe. Although Turkey's R&D intensity is still far below the EU average, Turkey is in a positive catching-up process. In 2009, business expenditure on R&D in Turkey actually increased by 6.1%.

The National Science, Technology and Innovation Strategy 2011-2016 was adopted in December 2010 by the Supreme Council of Science and Technology. The strategy focuses on human resources development for science, technology and innovation, transformation of research outputs into products and services, enhancing interdisciplinary research, highlighting the role of SMEs, R&D infrastructures and international cooperation. Besides these horizontal aspects, automotive, machinery and production technologies, ICT, energy, water, food, security and space were determined as focus areas. In line with this, the strategy puts special emphasis on keeping the balance between focused areas and bottom-up research.

TURKEY

**R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation

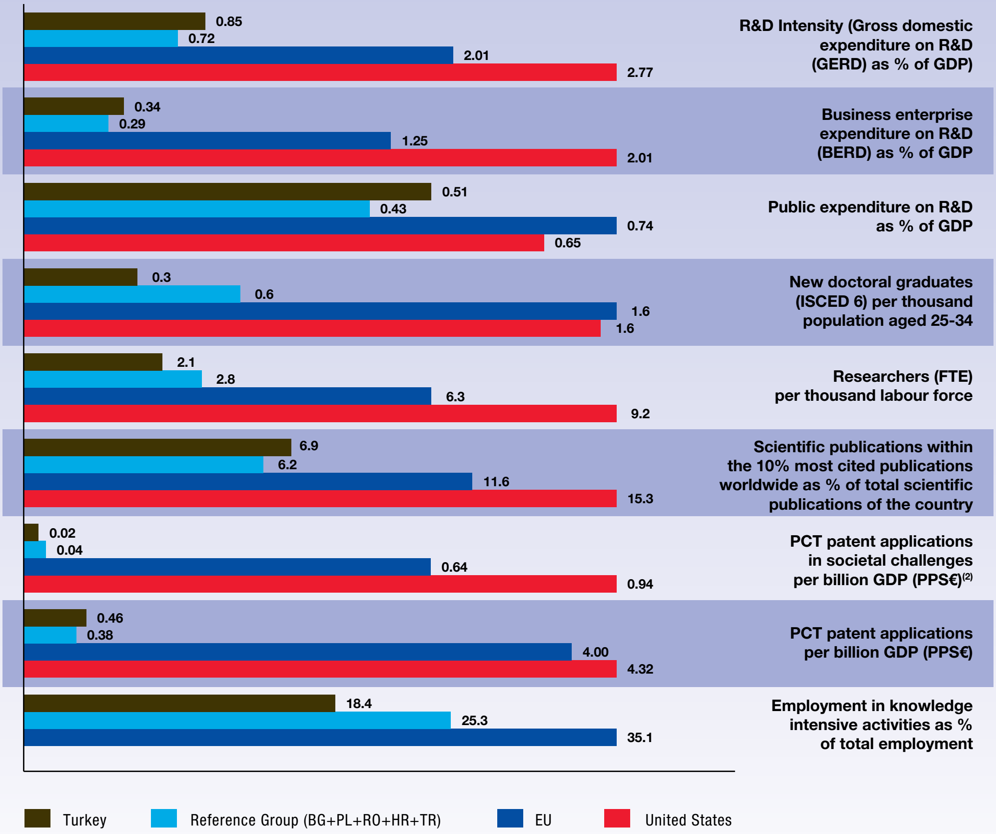
**Innovation Union Competitiveness Report 2011**

*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.

# TURKEY

## R&D profile, 2009(1)



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) HR is not included in the Reference Group.
(3) Elements of estimation were involved in the compilation of the data.

**Innovation Union Competitiveness Report 2011**

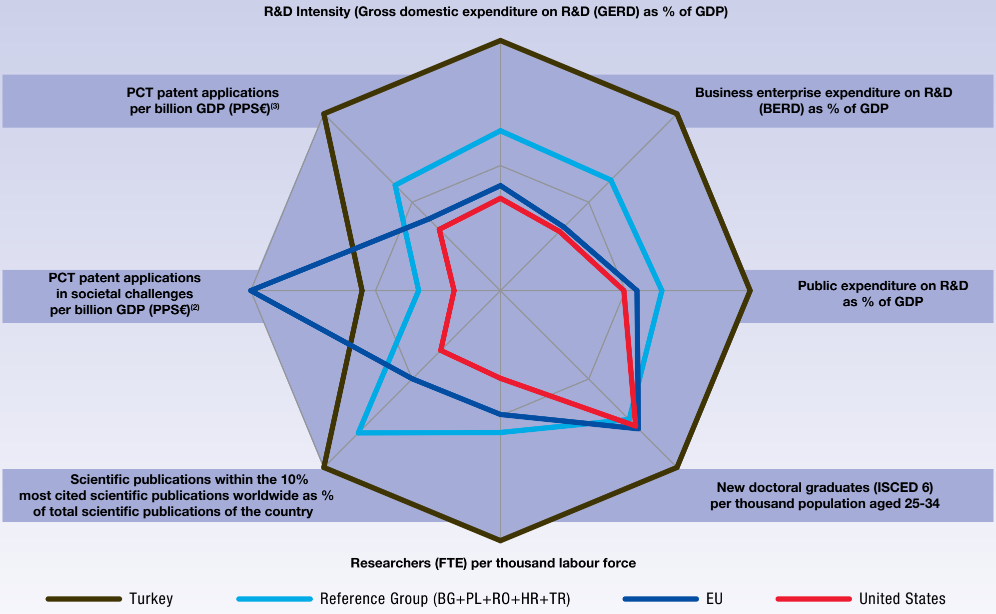
## Research and Innovation Performance

Turkey's R&D profile is weaker than that of the EU average, in particular new doctoral graduates and patenting activity. Given this structural base, Turkey has a specific relative strength in the quality of its scientific production, with 6.9% of its scientific publications among the top 10% most cited worldwide. On the other hand, Turkey is behind countries with similar industrial structure and knowledge capacity in what respect human resources intensity, and on the knowledge-intensity of its economy (reflecting both manufacturing and services). Concerning PCT patent applications in societal challenges defined as climate change mitigation and health, it should be noted that these areas are not primary S&T priority areas in Turkey. Therefore, PCT patent applications in societal challenges may not reflect the patenting dynamics of Turkey.

The growth of the Turkish research and innovation system is evidenced in all the main indicators (see graph below), except for patent activity in societal challenges. Turkey improved at a higher rate than the other countries with a comparable industrial structure and knowledge capacity, in particular in human resources for research and innovation. In the report, chapter 2 in part II, it is also visible that over the period 2000-2008 Turkey considerably improved knowledge transfer from public research to business enterprise, as measured by the public sector expenditure on R&D financed by business enterprise as % of GDP. This is particularly important given the relatively good performance of Turkey in scientific quality output.

## TURKEY

### Average annual growth (%), 2000-2009[1]



*Source:* DG Research and Innovation

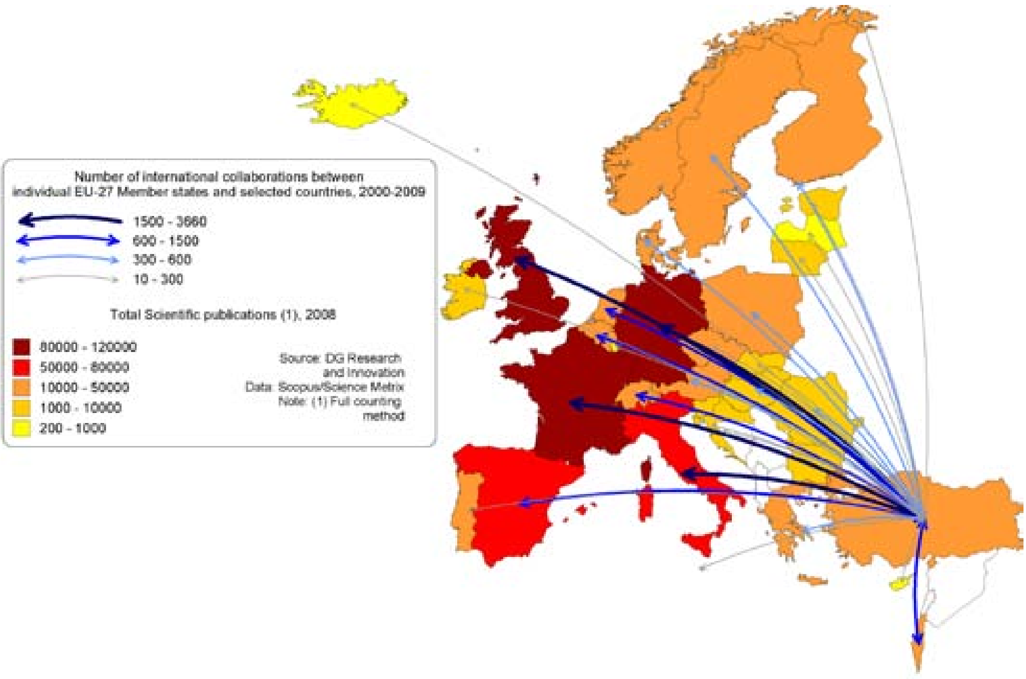
**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) HR is not included in the Reference Group; Average annual growth refers to real growth.
(3) Average annual growth refers to real growth.
(4) Elements of estimation were involved in the compilation of the data.

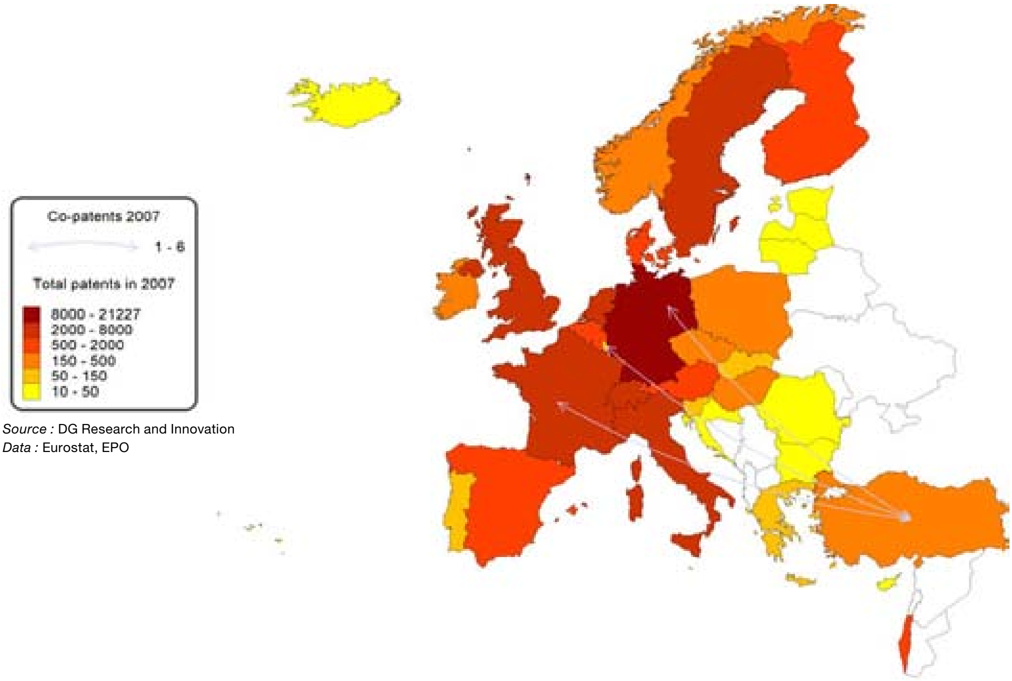
## TURKEY

### Co-publications between Turkey and European Countries in 2000-2009



# TURKEY

## Co-invented patent applications between Turkey and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

## Participation in the European Research Area : Scientific and Technological collaborations

The report shows in Part II that Turkey is modestly integrated in the European scientific co-publication networks and it holds a very marginal position in the main technological cooperation networks (as measured by co-patenting).

As seen from the figures below, the main scientific partner countries are the larger European countries in terms of research investments, i.e. Italy, France, the United Kingdom and Germany. As a difference from the technological cooperation, co-publications are intensive with almost all EU Member States and with some other Associated countries. However, the integration of Turkey in European S&T networks may improve in the coming years given the relatively high trans-European mobility of Turkish students, and in particular in their participation in European mobility instruments such as the ERASMUS student mobility scheme.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 3 001 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 3 847 applicants from Turkey (62.44% of Candidate Countries) and
- requesting EUR 1 501.15m of EC contribution (72.19% of Candidate Countries)

Among the Candidate Countries Turkey (TR) ranks:

- 1st in terms of number of applicants and
- 1st in terms of requested EC contribution

### Success rates

- The TR applicant success rate of 16.2% is lower than the Candidate Countries applicant success rate of 17.9%.
- The TR EC financial contribution success rate of 5.5% is lower than the Candidate Countries rate of 7.3%.

Specifically, following evaluation and selection, a total of

- 508 proposals were retained for funding (16.9%)
- involving 625 (16.2%) successful applicants from Turkey and
- requesting EUR 82.14m (5.5%) of EC financial contribution

Among the Candidate Countries, Turkey (TR) ranks:

- 5th in terms of applicants success rate and
- 5th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, Turkey (TR) participates in

- 437 signed grant agreements
- involving 5012 participants of which 511 (10.20%) are from Turkey
- benefiting from a total of EUR 1111.10m of EC financial contribution of which EUR 75.23m (6.77%) is dedicated to participants from Turkey.

Among the Candidate Countries in all FP7 signed grant agreements, Turkey (TR) ranks:

- 1st in number of participations and
- 1st in budget share

### SME performance and participation

- The TR SME applicant success rate of 13.74% is lower than the Candidate Countries SME applicant success rate of 15.12%.
- The TR SME EC financial contribution success rate of 8.53% is lower than the corresponding Candidate Countries rate of 10.71%.

Specifically,

- 1070 TR SME applicants requesting EUR 293.23m
- 147 (13.74%) successful SMEs requesting EUR 25.00m (8.53%)

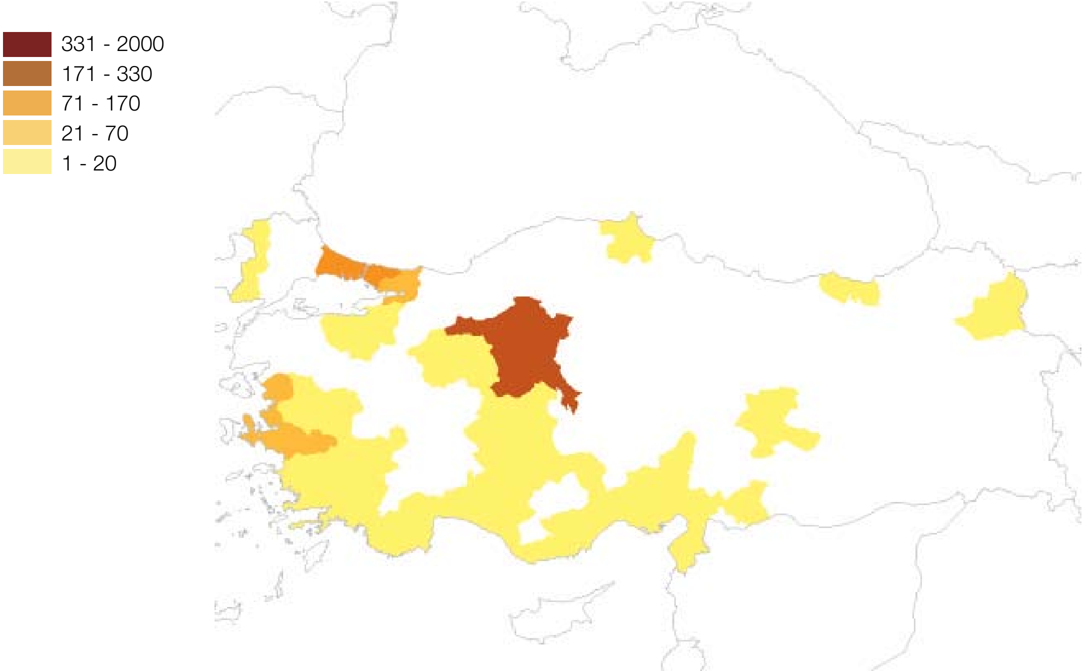
In signed grant agreements, as of 2011/03/16,

- 81 TR SME grant holders, i.e., 15.85% of total TR participation
- EUR 15.24m, i.e., 20.26% of total TR budget share

### Top 3 collaborative links with

- DE - Germany (429)
- IT - Italy (373)
- UK - United Kingdom (364)

| | | |
|---|---|---|
| Nr. of FP7 applicants | | |
| (% Candidate Countries) | 3 847 | |
| (62.44%) | 6 161 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% Candidate Countries) | 1 501.15 | |
| (72.19%) | 2 079 | |
| Nr. of successful FP7 applicants | | |
| (% Candidate Countries) | 625 | |
| (58.30%) | 1 072 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% Candidate Countries) | 82.14 | |
| (53.84%) | 152.58 | |
| Success rate FP7 applicants | 16.2% | 17.9% |
| Success rate | | |
| FP7 EC contribution | 5.5% | 7.3% |
| Nr. of FP7 grant holders | | |
| (% Candidate Countries) | 511 | |
| (58.53%) | 873 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% Candidate Countries) | 75.23 | |
| (55.61%) | 135.27 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 144 | |
| (28.18%) | 195 | |
| (22.34%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 81 | |
| (15.85%) | 131 | |
| (15.01%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 15.24 | |
| (20.26%) | 30.20 | |
| (22.32%) | | |



## TABLE 1

## TR - Turkey - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Marie-Curie Actions | 565 | n/a | 163 | 28.85% | n/a | n/a |
| Information and Communication Technologies | 518 | 150.92 | 46 | 8.88% | 11.15 | 7.38% |
| Research for the benefit of SMEs | 419 | 62.59 | 73 | 17.42% | 11.76 | 18.79% |
| Research Potential | 367 | 722.71 | 12 | 3.27% | 11.49 | 1.59% |
| Food, Agriculture and Fisheries, and Biotechnology | 251 | 53.51 | 42 | 16.73% | 5.24 | 9.80% |
| Socio-economic sciences and Humanities | 245 | 39.06 | 16 | 6.53% | 1.66 | 4.25% |

## TABLE 2

## TR - Turkey - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all TR grant holders | EC contribution (EUR million) | % of total EC contribution to TR |
|---|---|---|---|---|
| Marie-Curie Actions | 138 | 27.01% | 13.70 | 18.22% |
| Information and Communication Technologies | 40 | 7.83% | 9.93 | 13.20% |
| Research Potential | 12 | 2.35% | 9.29 | 12.35% |
| Research for the benefit of SMEs | 57 | 11.15% | 8.35 | 11.11% |
| Research Infrastructures | 36 | 7.05% | 6.05 | 8.04% |
| Environment (including Climate Change) | 38 | 7.44% | 4.45 | 5.91% |

*Notes :* Report generated on: 2011/03/28.11:34 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## TR - Turkey - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 1 761 | 559.65 | 293 | 16.64% | 32.57 | 5.82% | 267 | 38.83 | 51.62% |
| PRC | 956 | 238.06 | 140 | 14.64% | 23.58 | 9.91% | 105 | 20.12 | 26.74% |
| REC | 470 | 421.92 | 106 | 22.55% | 14.03 | 3.33% | 103 | 13.32 | 17.71% |
| PUB | 236 | 46.31 | 53 | 22.46% | 4.90 | 10.58% | 29 | 2.04 | 2.72% |
| OTH | 233 | 57.58 | 32 | 13.73% | 5.11 | 8.88% | 7 | 0.91 | 1.22% |
| | | | | | | | | | |
| SME | 1 070 | 293.23 | 147 | 13.74% | 25.00 | 8.53% | 81 | 15.24 | 20.26% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, PUB - Public body (excl. research and education), OTH - Others,

## TABLE 4

## TR - Turkey - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| TR - Turkey region | Number of grant holders | % of all TR - Turkey grant holders | EC contribution (M euro) | % of total EC contribution to TR |
|---|---|---|---|---|
| Ankara (TR510) | 212 | 41.49% | 36.42 | 48.42% |
| Istanbul (TR100) | 171 | 33.46% | 21.89 | 29.10% |
| Izmir (TR310) | 33 | 6.46% | 4.42 | 5.88% |
| Kocaeli (TR421) | 29 | 5.68% | 5.61 | 7.46% |
| Malatya (TRB11) | 9 | 1.76% | 0.39 | 0.51% |

## TABLE 5

## TR - Turkey - most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all TR grant holders | EC contribution (M euro) | % of total EC contribution to TR grant holders |
|---|---|---|---|---|
| Middle East Technical University (METU) | 38 | 7.44% | 8.65 | 11.50% |
| Turkiye Bilimsel ve Teknolojik Arastirma Kurumu (TUBITAK) | 67 | 13.11% | 7.02 | 9.33% |
| Bilkent Universitesi (Bilkent) | 30 | 5.87% | 5.64 | 7.50% |
| Koc University (KU) | 25 | 4.89% | 3.95 | 5.25% |
| Sabanci University | 32 | 6.26% | 3.65 | 4.85% |

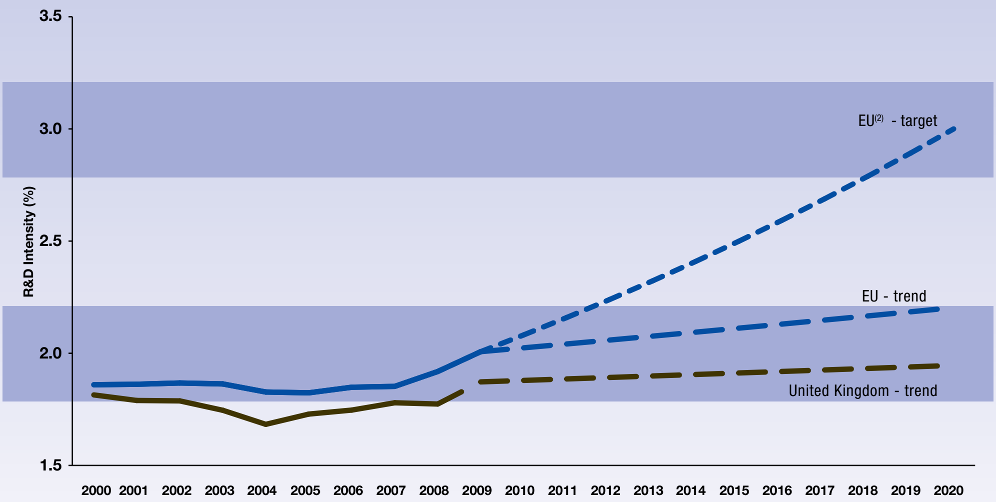
# UK - United Kingdom

## Progress towards meeting the Europe 2020 R&D intensity target

In the last decade, R&D intensity in the United Kingdom averaged around 1.8%, the latest figure being 1.87% in 2009[14]. The trend over the reference period showed an initial fall followed by a mild recovery since 2005. At present, R&D intensity in the United Kingdom falls below the EU average. Although the recent cutbacks in public expenditure have not severely hit research budgets, further measures to boost both public and private R&D may be needed to bridge the R&D gap with the EU average and, especially, with other trading competitors.

**UNITED KINGDOM**

**R&D Intensity projections, 2000-2020(1)**



*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* DG Research and Innovation, Eurostat

*Notes:* (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009.
(2) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.

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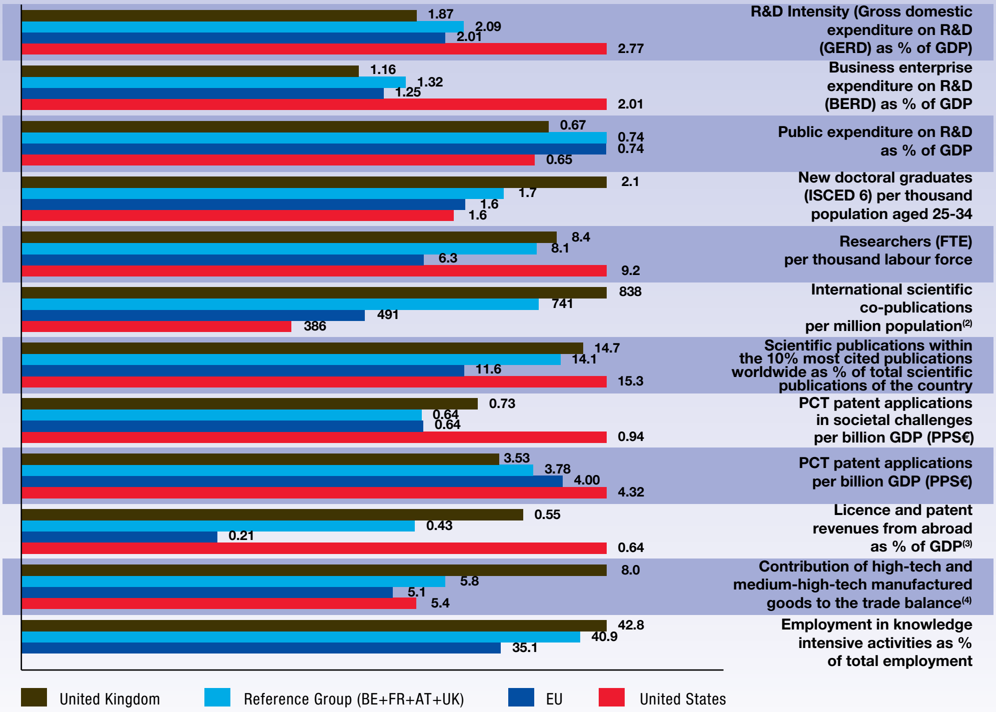
[14] 2009 figures are provisional

# UNITED KINGDOM

## R&D profile, 2009(1)



*Source:* DG Research and Innovation
*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)
*Notes:* (1) The values refer to 2009 or to the latest available year.
(2) The EU value refers to the median rather than to the average.
(3) EU refers to extra-EU.
(4) (i) EU does not include BG, CY, LV, LT, MT, RO; (ii) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

**Innovation Union Competitiveness Report 2011**

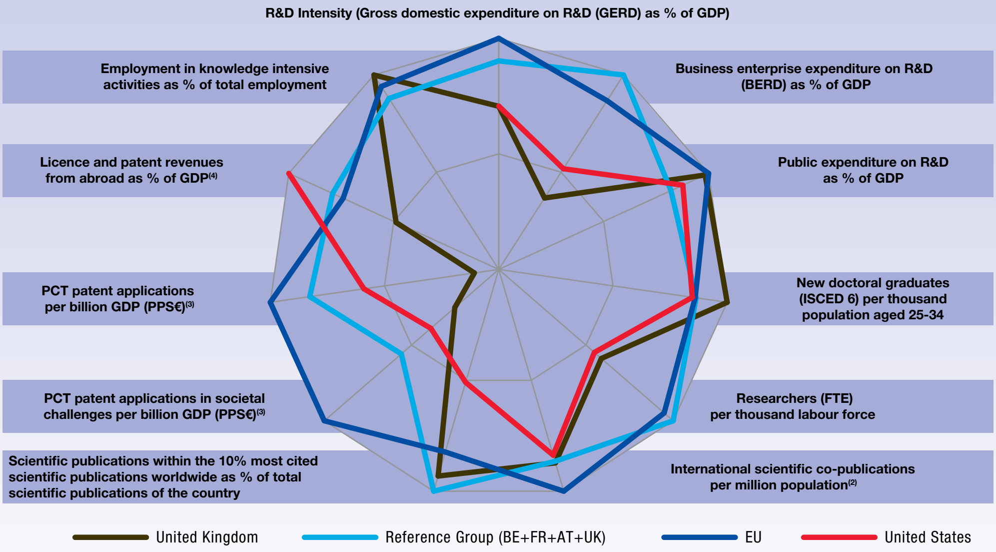
## Research and Innovation Performance

The British research and innovation system is characterised by strong performance over a range of research and innovation indicators, such as high quality publications, high quality patents for which it obtains high licence and patent revenues from abroad or the high share of the population working in knowledge intensive activities. In all these key indicators, the United Kingdom outperforms both the EU average and a group of similar countries and nears the United States. A number of world class Universities, a large share of young doctoral graduates and competitive strengths in some high-tech and medium-high tech sectors such as the pharmaceutical sector can account for this strong performance. On the other hand, the system underperforms in terms of public and private R&D investment and technological performance as measured by the importance of PCT patents in the economy. These lower values can be justified to some extent by the nature of the economic structure of the United Kingdom: when adjusting for the sectoral mix, the United Kingdom investment intensity gap is for instance only 0.25 points of GDP as compared with Germany and 0.5% points as compared with France. R&D underinvestment could potentially affect the United Kingdom's future scientific and technological competitiveness, although it is important to note the contribution of other forms of innovative activity to these outcomes.

Looked at in a longer perspective, in the last decade the United Kingdom public and especially private R&D investments lagged behind the EU and the United States. High quality scientific output grew at a similar rate as the reference group and the EU despite relatively lower growth of public R&D investments. It is welcome that, in a context where most UK Government Departments are facing significant expenditure cuts,

## UNITED KINGDOM

## Average annual growth (%), 2000-2009(1)



*Source:* DG Research and Innovation

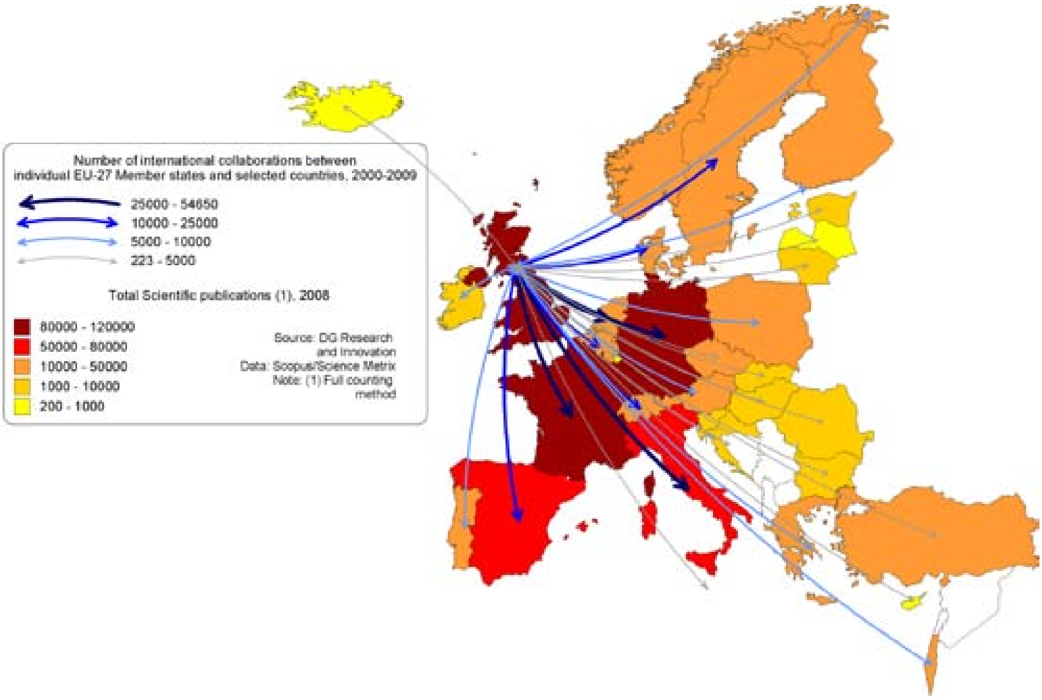
**Innovation Union Competitiveness Report 2011**

*Data:* Eurostat, OECD, Science Metrix / Scopus (Elsevier)

*Notes:* (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010.
(2) The EU value refers to the median rather than to the average
(3) Average annual growth refers to real growth.
(4) EU refers to extra-EU.
(5) Elements of estimation were involved in the compilation of the data.

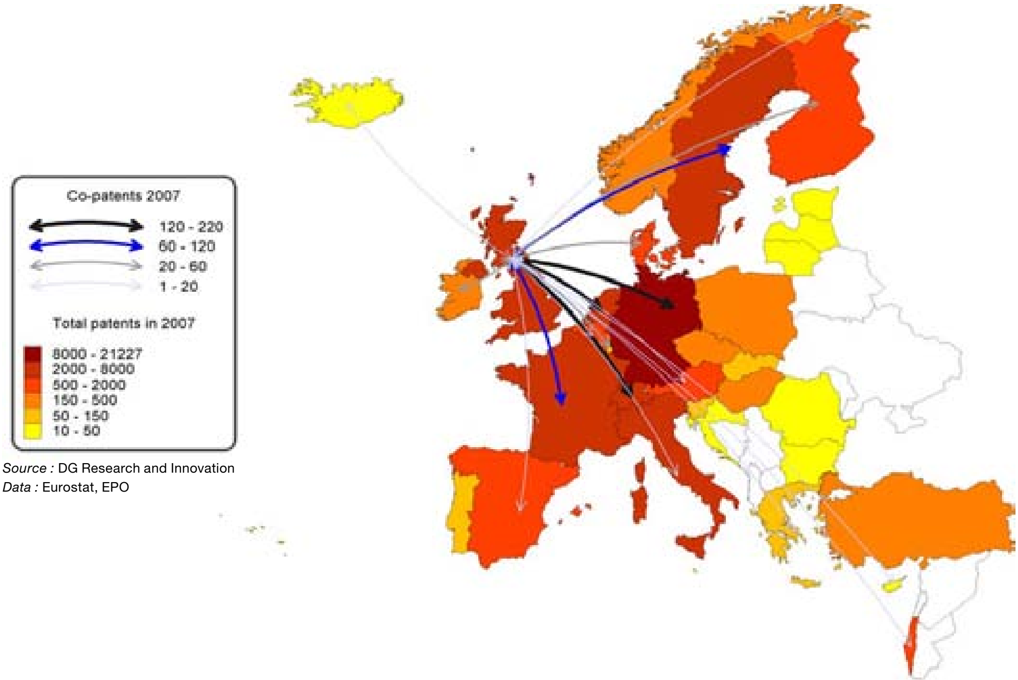
## UNITED KINGDOM

## Co-publications between the United Kingdom and European Countries in 2000-2009



**UNITED KINGDOM**

## Co-invented patent applications between the United Kingdom and European Countries, 2007



*Source :* DG Research and Innovation
*Data :* Eurostat, EPO

the UK Government has announced a Settlement for Science and Research programme of £ 4.6 billion per year for the next four years (2011-2015). This is ring fenced across the four year period. Furthermore, the UK announced that it will target its support for business towards areas with high impact on growth and leverage additional private sector investment[15].

### Participation in the European Research Area : Scientific and Technological collaborations

The United Kingdom is a very open scientific system as evidenced by the high level of co-publications. This allows tapping into international knowledge, enhancing excellence and rendering the system more efficient. The main research partners in the European Research Area are Germany, France, Italy and the Netherlands, which reflects the size of the research systems of these countries.

A similar structure is replicated in terms of co-registration of patents, where Germany or the Netherlands become the main technological partners. It is important to note that Switzerland also ranks high in this list of technological partners and this is due to the closer linkages between the countries in key industries such as pharmaceuticals.

### Structural change towards a more research-intensive economy

In the last decade, private R&D intensity remained static around 1.2%. To a large extent, this performance was due to the loss in importance in the economy of some high-technology and medium-high technology sectors such as chemical and chemical products, machinery and equipment and office, machinery and computing equipment. In addition, the research intensity, measured as the investment in R&D as a percentage of total value added, of most sectors stagnated, or in same cases fell. This stagnation, in an increasingly globalised economy with countries sharply raising their R&D investments, could endanger the long-term competitiveness of these sectors[16].

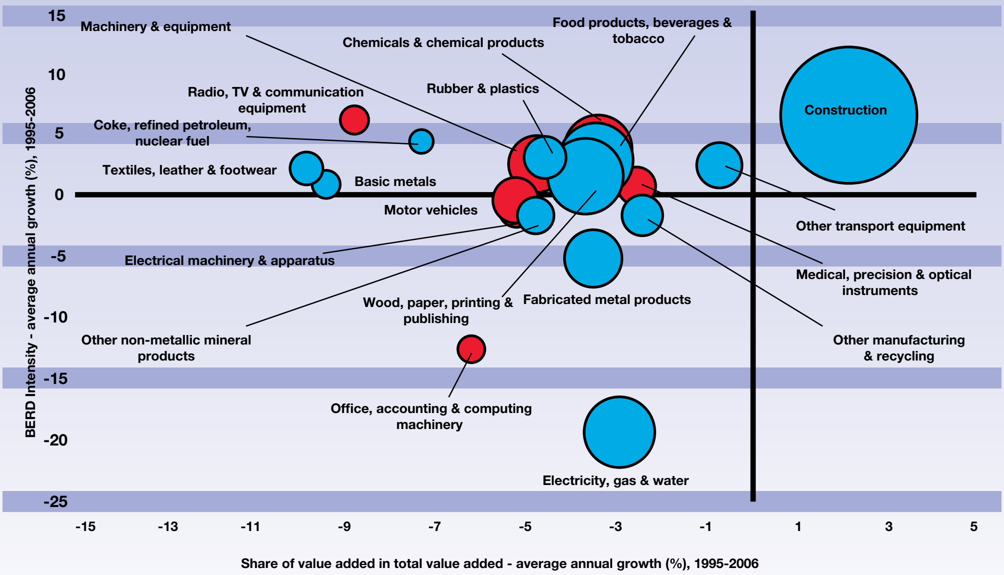
---

[15] The Technology Strategy Board will become the Government's prime channel to support business-led technology innovation and will be provided with additional funding of over £200m to establish a network of elite Technology and Innovation Centres.

[16] Of course, the dynamics of an economy depends also of many other factors. See for instance, NESTA's report *The Vital 6%* and *High Growth Enterprises: What Governments can do to make a difference* (OECD, 2010).

# UNITED KINGDOM

## Share of value added versus BERD intensity - Average annual growth, 1995-2006



*Source:* DG Research and Innovation

**Innovation Union Competitiveness Report 2011**

*Data:* OECD

*Note:* (1) High-Tech and Medium-High-Tech sectors are shown in red. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech.

## FP7 Key facts and figures

### Applications

As of 2011/03/16, a total of

- 22 871 eligible proposals were submitted in response to 248 FP7 calls for proposals
- involving 36 145 applicants from The United Kingdom (13.56% of EU-27*) and
- requesting EUR 13 071.00m of EC contribution (14.80% of EU-27*)

Among the EU-27* The United Kingdom (UK) ranks:

- 2nd in terms of number of applicants and
- 2nd in terms of requested EC contribution

### Success rates

- The UK applicant success rate of 24.1% is higher than the EU-27* applicant success rate of 21.6%.
- The UK EC financial contribution success rate of 22.1% is higher than the EU-27* rate of 20.7%.

Specifically, following evaluation and selection, a total of

- 5 272 proposals were retained for funding (23.1%)
- involving 8 721 (24.1%) successful applicants from The United Kingdom and
- requesting EUR 2 886.06m (22.1%) of EC financial contribution
- Among the EU-27*, The United Kingdom (UK) ranks:
- 6th in terms of applicants success rate and
- 6th in terms of EC financial contribution success rate

### Signed grant agreements

As of 2011/03/16, The United Kingdom (UK) participates in

- 4 372 signed grant agreements
- involving 38 289 participants of which 7 287 (19.03%) are from The United Kingdom
- benefiting from a total of EUR 11 621.96m of EC financial contribution of which EUR 2 698.98m (23.22%) is dedicated to participants from The United Kingdom.

Among the EU-27* in all FP7 signed grant agreements, The United Kingdom (UK) ranks:

- 2nd in number of participations and
- 2nd in budget share

**SME performance and participation**

- The UK SME applicant success rate of 21.88% is higher than the EU-27* SME applicant success rate of 19.33%.
- The UK SME EC financial contribution success rate of 21.26% is higher than the corresponding EU-27* rate of 18.26%.

Specifically,

- 7 582 UK SME applicants requesting EUR 2 174.16m
- 1 659 (21.88%) successful SMEs requesting EUR 462.16m (21.26%)

In signed grant agreements, as of 2011/03/16,

- 1 159 UK SME grant holders, i.e., 15.91% of total UK participation
- EUR 340.03m, i.e., 12.60% of total UK budget share

**Top 3 collaborative links with**

- DE - Germany (4 981)
- FR - France (3 525)
- IT - Italy (3 157)

| | | |
|---|---|---|
| **Nr. of Researchers | | |
| as% of population | N/A | 0.40% |
| Rank in EU-27* | | |
| Innovation scoreboard | | |
| (2008) | - 4th | |
| - Above EU-27 average | | |
| - Innovation Leader | | |
| Nr. of FP7 applicants | | |
| (% EU-27*) | 36 145 | |
| (13.56%) | 266 507 | |
| Req. EC contribution | | |
| by FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 13 071.00 | |
| (14.80%) | 88 295 | |
| Nr. of successful FP7 applicants | | |
| (% EU-27*) | 8 721 | |
| (14.73%) | 59 199 | |
| Req. EC contribution | | |
| by successful FP7 applicants | | |
| in EUR million | | |
| (% EU-27*) | 2 886.06 | |
| (15.80%) | 18 262.02 | |
| Success rate FP7 applicants | 24.1% | 21.6% |
| Success rate | | |
| FP7 EC contribution | 22.1% | 20.7% |
| Nr. of FP7 grant holders | | |
| (% EU-27*) | 7 287 | |
| (14.21%) | 51 279 | |
| EC contribution | | |
| to FP7 grant holders | | |
| in EUR million | | |
| (% EU-27*) | 2 698.98 | |
| (16.28%) | 16 578.15 | |
| Nr. of FP7 coordinators | | |
| (% of grant holders) | 1 903 | |
| (26.11%) | 9 383 | |
| (18.30%) | | |
| Nr. of FP7 SME grant holders | | |
| (% of grant holders) | 1 159 | |
| (15.91%) | 8 845 | |
| (17.25%) | | |
| EC contribution to FP7 SME | | |
| grant holders in EUR million | | |
| (% of grant holders) | 340.03 | |
| (12.60%) | 2 207.73 | |
| (13.32%) | | |

## TABLE 1

## UK - United Kingdom - Most active FP7 research priority areas by number of applicants applying for the research projects

| FP7 priority area | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success Rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success Rate (requested EC contribution) |
|---|---|---|---|---|---|---|
| Information and Communication Technologies | 7385 | 3109.15 | 1178 | 15.95% | 494.52 | 15.91% |
| Marie-Curie Actions | 7017 | n/a | 1954 | 27.85% | n/a | n/a |
| Health | 3490 | 1829.10 | 920 | 26.36% | 456.49 | 24.96% |
| Research for the benefit of SMEs | 3395 | 516.10 | 806 | 23.74% | 118.17 | 22.90% |
| Transport (including Aeronautics) | 2321 | 760.79 | 649 | 27.96% | 218.48 | 28.72% |
| European Research Council | 2127 | 3301.66 | 373 | 17.54% | 612.25 | 18.54% |

## TABLE 2

## UK - United Kingdom - Most active FP7 research priority areas by EC contribution granted to the research projects

| FP7 priority area | Number of grant holders | % of all UK grant holders | EC contribution (EUR million) | % of total EC contribution to UK |
|---|---|---|---|---|
| ERC | 341 | 4.68% | 492.00 | 18.23% |
| Information and Communication Technologies | 1150 | 15.78% | 460.37 | 17.06% |
| Health | 875 | 12.01% | 408.81 | 15.15% |
| Marie-Curie Actions | 1481 | 20.32% | 356.54 | 13.21% |
| Research Infrastructures | 359 | 4.93% | 178.52 | 6.61% |
| Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP | 440 | 6.04% | 145.03 | 5.37% |

*Notes :* Report generated on: 2011/03/28.10:50 AM
FP7 proposal and application figures are valid as of 2011/03/16
FP7 grant agreements and participation figures are valida as of 2011/03/16
*EU-27 includes the 27 country-members and JRC as a separate entity
**E-STAT Reference year: 2007
**European Innovation Scoreboard is available at the website of DG Enterprise and Industry

## TABLE 3

## UK - United Kingdom - Participation in the FP7 research projects by organisation activity type

| Activity Type | Nr. of applicants | Requested EC contribution by applicants (M euro) | Nr. of mainlisted applicants | Success rate (applicants) | Requested EC contribution by mainlisted applicants (M euro) | Success rate (requested contribution) | Nr. of grant holders | EC contribution to grant holders | % ot total EC contribution to grant holders |
|---|---|---|---|---|---|---|---|---|---|
| HES | 19973 | 5953.80 | 4744 | 23.75% | 1264.71 | 21.24% | 4391 | 1838.45 | 68.12% |
| PRC | 8273 | 2306.28 | 1983 | 23.97% | 577.40 | 25.04% | 1723 | 497.57 | 18.44% |
| REC | 3028 | 836.44 | 935 | 30.88% | 267.75 | 32.01% | 803 | 277.08 | 10.27% |
| OTH | 1697 | 404.88 | 400 | 23.57% | 93.66 | 23.13% | 121 | 22.38 | 0.83% |
| PUB | 1053 | 269.28 | 289 | 27.45% | 70.68 | 26.25% | 249 | 63.50 | 2.35% |
| SME | 7582 | 2174.16 | 1659 | 21.88% | 462.16 | 21.26% | 1159 | 340.03 | 12.60% |

HES - Higher or secondary education, PRC - Private for profit (excl. education), REC - Research organisations, OTH - Others, PUB - Public body (excl. research and education

## TABLE 4

## UK - United Kingdom - The most active NUTS3 regions, by EC contribution granted to the FP7 research projects

| UK - United Kingdom region | Number of grant holders | % of all UK - United Kingdom grant holders | EC contribution (M euro) | % of total EC contribution to UK |
|---|---|---|---|---|
| Inner London - West (UKI11) | 1362 | 18.69% | 561.72 | 20.81% |
| Oxfordshire (UKJ14) | 440 | 6.04% | 233.71 | 8.66% |
| Cambridgeshire CC (UKH12) | 417 | 5.72% | 179.91 | 6.67% |
| Edinburgh, City of (UKM25) | 256 | 3.51% | 110.65 | 4.10% |
| Inner London - East (UKI12) | 246 | 3.38% | 86.25 | 3.20% |

## TABLE 5

## UK - United Kingdom - Most active organisations in terms of EC contribution granted to the FP7 research projects

| Legal Name | Number of Participations | % of all UK grant holders | EC contribution (M euro) | % of total EC contribution to UK grant holders |
|---|---|---|---|---|
| The Chancellor, Masters and Scholars of the University of Cambridge | 331 | 4.54% | 157.07 | 5.82% |
| The Chancellor, Masters And Scholars of the University of Oxford (University of Oxford) | 278 | 3.82% | 146.92 | 5.44% |
| Imperial College of Science, Technology and Medicine (Imperial) | 283 | 3.88% | 127.48 | 4.72% |
| University College London | 240 | 3.29% | 127.41 | 4.72% |
| The University of Edinburgh | 177 | 2.43% | 89.12 | 3.30% |

# ANNEXES

## TABLE 1

## Index of Themes and Sectors

| Sector/Themes | ICT | Biotech | Nano/New Material | Health | Climate/ Environment | Industrial Sectors (Nace) | Educational/ Science fields | Framework Programme |
|---|---|---|---|---|---|---|---|---|
| Chapter | | | | | | | | |
| O.P.4.3. | X | X | X | | | | | |
| O.P. 4.4. | | | | X | X | | | |
| I.2.4. | X | | | | | X | | |
| I.4.2. | | | | | | | X | |
| I.4.3. | X | X | X | X | | X | | |
| I.5.3. | X | X | X | X | | X | | |
| I.5.4. | X | X | X | X | | X | | |
| I.5.5. | X | | | | | | | |
| II.2.2. | X | X | X | X | | X | | |
| II.3.2.4. | | | | | | | X | |
| II.4.2. | | | | | | | | X |
| II.4.3.1 | | | | | | | | X |
| II.4.3.2. | | | | | | | | X |
| II.4.3.3. | | | | | | | | X |
| II.5.1. | | | | | | | X | |
| III.2.2.3. | X | X | X | X | X | X | | |
| III.3.2.1. | X | X | | X | | X | | |
| III.3.2.2. | X | X | | X | | X | | |
| III.5.1.1 | | | | | X | | | |
| III.5.1.2. | | | | | X | | | |
| III.5.1.3. | | | | | X | | | |
| III.5.2.1. | | | | X | | | | |
| III.5.2.2. | | | | X | | | | |
| III.5.3. | | | | X | X | | | X |
| N.P.2.2. | X | X | | X | | X | X | |
| N.P.2.3. | | | | X | X | | | |
| N.P.2.4. | X | X | X | | | | | |
| N.P.3.2. | X | X | X | X | X | | | |
| C.P.all countries | | | | | | X | | X |

*Note:* O.P. : Overall Picture
I: Part I
II: Part II
III: Part III
N.P.: New Perspectives
C.P.: Country profiles

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## TABLE 2 Summary table of indicators, 2009 with average annual growth (%), 2000-2009

| | EU | | | |
|---|---|---|---|---|
| | 2009 | | AAGR(1) 2000-2009 | |
| Gross domestic expenditure on R&D (GERD) millions of euro | *236553* | | *2.5* | |
| R&D intensity | *2.01* | | *0.9* | |
| Business expenditure on R&D (BERD) millions of euro | *146905* | | *2.1* | |
| Business expenditure on R&D (BERD) as % of GDP (15) | *1.25* | | *0.3* | |
| Business expenditure by SMEs (0-249 employees), millions of euro (15) | *25235* | (3) | 6.6 | (11) |
| Business expenditure by SMEs (0-249 employees) as % of GDP | 0.25 | (3) | 3.2 | (11) |
| Inward R&D expenditure by foreign affiliates, millions of euro (16) | *38871* | (3) | *2.6* | (11) |
| Inward R&D expenditure as % of R&D expenditure by business enterprise (16) | *31.6* | (3) | *-0.4* | (11) |
| Public expenditure on R&D (GOVERD + HERD) millions of euro | *87275* | | *3.2* | |
| Public expenditure on R&D (GOVERD + HERD) as % of GDP | *0.74* | | *1.7* | |
| Investment in knowledge (R&D and Education), millions of euro | *822588* | (3) | *1.8* | (5) |
| Investment in knowledge (R&D and Education) as % of GDP | *6.6* | (3) | *-0.1* | (5) |
| New doctoral graduates (ISCED 6), total | 110073 | (2) | *3.7* | (4) |
| New doctoral graduates (ISCED 6) per thousand population aged 25-34 | 1.60 | (2) | *4.3* | (4) |
| Number of researchers (FTE) | *1504575* | (2) | *3.8* | (4) |
| Number of researchers (FTE), per thousand labour force | *6.3* | (2) | *2.9* | (4) |
| Number of researchers (FTE) working in the private sector | *707534* | (2) | *3.5* | (4) |
| Number of researchers (FTE) working in the public sector | *797040* | (2) | *4.0* | (4) |
| Human Resources in Science and Technology aged 25-64 | 91554 | | *2.9* | |
| Human Resources in Science and Technology aged 25-64 as % of labour force | 40.1 | | 1.9 | |
| New S&T graduates (ISCED 5A) with S&E orientation) | 586144 | (2) | 3.3 | (4) |
| License and patent revenues from abroad, millions of euro (17) | 25137 | | 2.3 | (8) |
| License and patent revenues from abroad as % GDP (17) | 0.21 | | 2.4 | (8) |
| Community trademarks | 60967 | (2) | 6.7 | (4) |
| Community trademarks per billion GDP (PPS€) | 4.88 | (2) | 4.5 | (4) |
| Total number of scientific publications (fractional counting method) | 469479 | (2) | 4.7 | (4) |
| Scientific publications in the 10% most cited scientific publications worldwide | 55557 | (3) | 5.9 | (5) |
| Scientific publications in the 10% most cited scientific publications worldwide as % of total scientific publications of the country | 11.6 | (3) | 1.4 | (5) |
| PCT patent applications, total number | 49545 | (3) | 4.3 | (5) |
| PCT patent applications per billion GDP (PPS€) | 4.0 | (3) | 1.9 | (5) |

*Source:* DG Research and Innovation

*Data:* See the other tables and graphs in the publication for details.

*Notes:* (1) AAGR (average annual growth rates) for financial indicators refer to real growth and were derived from data in PPS€2000.
(2) 2008.
(3) 2007.
(4) 2000-2008.
(5) 2000-2007.
(6) 2000-2006.
(7) 2002-2007.
(8) 2004-2009.
(9) 2008-2009.
(10) 2003-2008.
(11) 2003-2007.
(12) 2004-2008.
(13) 2002-2006.
(14) 2006-2008.
(15) EU does not include BE, IE, EL, IT, LU.
(16) EU does not include BG, DK, EE, EL, ES, CY, LV, LT, LU, MT, NL, RO, SI, FI.
(17) EU refers to extra-EU.
(18) EU does not include BG, EE, CY, LV, LT, LU, MT, SI, SK.
(19) Employment in the public sector is included.
(20) EU includes intra-EU exports.
(21) EU does not include BG, CY, LV, LT, MT, RO.
(22) Values in italics are estimated or provisional.
(23) See the other tables and graphs in the publication for more detailed footnotes.

| United States | | Japan | | China | | South Korea | |
|---|---|---|---|---|---|---|---|
| 2009 | AAGR(1) 2000-2009 | 2009 | AAGR(1) 2000-2009 | 2009 | AAGR(1) 2000-2009 | 2009 | AAGR(1) 2000-2009 |
| *270733* (2) | *2.4* (4) | 113986 (2) | 3.4 (5) | 45151 (2) | *17.7* (4) | 21480 (2) | 9.4 (6) |
| *2.77* (2) | *0.4* (4) | 3.44 (2) | 1.8 (5) | 1.54 (2) | 6.9 (4) | 3.37 (2) | 4.6 (6) |
| *196563* (2) | *2.1* (4) | 89436 (2) | 4.1 (4) | 33077 (2) | 20.7 (4) | 16188 (2) | 10.2 (6) |
| *2.01* (2) | *0.0* (4) | 2.70 (2) | 2.8 (4) | 1.12 (2) | 9.6 (4) | 2.54 (2) | 5.4 (6) |
| *30762* (3) | *5.8* (7) | 5496 (3) | 7.6 (7) | : | : | 4280 (3) | 5.3 (13) |
| *0.30* (3) | *2.9* (7) | 0.17 (3) | 5.4 (7) | : | : | 0.56 (3) | 1.1 (13) |
| *29892* (3) | *3.0* (4) | *4406* (3) | *10.2* (5) | : | : | : | : |
| *14.3* (2) | *1.2* (4) | *5.1* (3) | *5.2* (5) | : | : | : | : |
| *63495* (2) | *3.4* (4) | 12073 (2) | 0.7 (5) | 22758 (2) | 12.0 (4) | 4984 (2) | 7.0 (6) |
| *0.65* (2) | *1.3* (4) | 0.69 (2) | -0.8 (5) | 0.41 (2) | 1.6 (4) | 0.78 (2) | 2.3 (6) |
| 930935 (3) | 2.9 (5) | 240224 (3) | 1.9 (5) | : | : | 74444 (3) | 7.2 (6) |
| 9.1 (3) | 0.5 (5) | 7.5 (3) | 0.3 (5) | : | : | 9.7 (3) | 2.5 (6) |
| 63712 (2) | 4.5 (4) | 16296 (2) | 3.7 (4) | : | : | 9369 (2) | 5.4 (4) |
| 1.56 (2) | 4.1 (4) | 0.98 (2) | 5.2 (4) | : | : | 1.19 (2) | 6.6 (4) |
| *1412639* (3) | *1.3* (5) | 656676 (2) | 1.9 (7) | 1592420 (2) | 10.9 (4) | 236137 (2) | 10.8 (6) |
| 9.2 (3) | *0.3* (5) | 10.3 (2) | 1.2 (7) | 2.0 (2) | 9.9 (4) | 9.7 (2) | 9.3 (6) |
| *1130500* (3) | 1.2 (5) | 501077 (2) | 2.2 (7) | 1092213 (2) | 15.1 (4) | 185811 (2) | 13.6 (6) |
| *282139* (3) | *1.6* (5) | 155599 (2) | 1.2 (7) | 500207 (2) | 4.9 (4) | 50326 (2) | 3.1 (6) |
| : | : | : | : | : | : | : | : |
| : | : | : | : | : | : | : | : |
| 247147 (2) | 2.0 (4) | 114310 (2) | -0.7 (4) | : | : | : | : |
| 62279 (2) | 7.1 (4) | 17474 (2) | 13.0 (4) | : | : | : | : |
| 0.64 (2) | 4.9 (4) | 0.53 (2) | 11.6 (4) | : | : | : | : |
| 12877 (2) | -1.6 (4) | 2081 (2) | 7.6 (4) | 811 (2) | 49.2 (4) | : | : |
| 1.16 (2) | -3.6 (4) | 0.62 (2) | 6.3 (4) | 0.13 (2) | 35.4 (4) | : | : |
| 357837 (2) | 3.5 (4) | 92089 (2) | 1.2 (4) | 256495 (2) | 20.7 (4) | 39792 (2) | 13.3 (4) |
| 58319 (3) | 3.9 (5) | 8122 (3) | 2.2 (5) | 14499 (3) | 25.2 (5) | 3231 (3) | 13.9 (5) |
| 15.3 (3) | 0.0 (5) | 8.3 (3) | 0.7 (5) | 7.0 (3) | 4.7 (5) | 8.5 (3) | 0.6 (5) |
| 49282 (3) | 2.7 (5) | 28970 (3) | 15.0 (5) | 6416 (3) | 22.3 (5) | 7227 (3) | 20.5 (5) |
| 4.3 (3) | 0.3 (5) | 8.3 (3) | 13.2 (5) | 1.1 (3) | 10.8 (5) | 7.0 (3) | 15.1 (5) |

## TABLE 2
(Part 2)

## Summary table of indicators, 2009 with average annual growth (%), 2000-2009

| | EU | | | |
|---|---|---|---|---|
| | 2009 | | AAGR(1) 2000-2009 | |
| Female PhD / doctoral graduates, total number | 47741 | (2) | *4.9* | (12) |
| Share (%) of female PhD / doctoral graduates in total PhD / doctoral graduates | 45.3 | (2) | *1.2* | (12) |
| International scientific co-publications, total number | 132412 | (2) | 9.6 | (4) |
| International co-publications as % of total publications | 24.2 | (2) | 4.2 | (4) |
| PCT patent applications with co-inventor(s) located abroad | 4719 | (2) | 2.3 | (4) |
| PCT applications with co-inventors located abroad, as % of total PCT patent applications | 9.7 | (2) | -0.5 | (4) |
| Public-private co-publications per million population | 36.2 | (3) | 2.7 | (10) |
| Venture capital (early stage, expansion and replacement), millions of euro (18) | 10185 | | *-8.1* | |
| Venture capital (early stage, expansion and replacement) as % of GDP (18) | 0.09 | | *-9.7* | |
| Cost of patent application and maintenance for SMEs, PPS€ | 167798 | | : | |
| Cost of patent application and maintenance for SMEs, per billion GDP (PPS€) | 14.21 | | : | |
| Health technology patents (PCT) | 6798 | (3) | 4.1 | (5) |
| Health technology patents (PCT) per billion GDP (PPS€) | 0.55 | (3) | 1.7 | (5) |
| Climate change mitigation patents (PCT) | 1195 | (3) | 16.9 | (5) |
| Climate change mitigation patents (PCT) per billion GDP (PPS€) | 0.10 | (3) | 14.2 | (5) |
| Employment in knowledge intensive economic activities (19) as % of total employment | 35.1 | | 2.4 | (9) |
| Medium and high-tech manufacturing exports, millions of euro (20) | 781149 | (2) | 5.4 | (12) |
| Medium and high-tech manufacturing exports as % of total product exports (20) | 59.6 | (2) | -0.3 | (12) |
| Knowledge intensive service exports, millions of euro (20) | 608223 | (2) | 7.8 | (12) |
| Knowledge intensive service exports as %¨of total service exports (20) | 49.4 | (2) | 1.5 | (12) |
| Contribution of medium-high and high-tech exports to the manufacturing trade balance as % of total manufacturing (21) | 5.1 | (2) | : | |

*Source:* DG Research and Innovation
*Data:* See the other tables and graphs in the publication for details.
*Notes:* (1) AAGR (average annual growth rates) for financial indicators refer to real growth and were derived from data in PPS€2000.
(2) 2008.
(3) 2007.
(4) 2000-2008.
(5) 2000-2007.
(6) 2000-2006.
(7) 2002-2007.
(8) 2004-2009.
(9) 2008-2009.
(10) 2003-2008.
(11) 2003-2007.
(12) 2004-2008.
(13) 2002-2006.
(14) 2006-2008.
(15) EU does not include BE, IE, EL, IT, LU.
(16) EU does not include BG, DK, EE, EL, ES, CY, LV, LT, LU, MT, NL, RO, SI, FI.
(17) EU refers to extra-EU.
(18) EU does not include BG, EE, CY, LV, LT, LU, MT, SI, SK.
(19) Employment in the public sector is included.
(20) EU includes intra-EU exports.
(21) EU does not include BG, CY, LV, LT, MT, RO.
(22) Values in italics are estimated or provisional.
(23) See the other tables and graphs in the publication for more detailed footnotes.

| United States | | Japan | | China | | South Korea | |
|---|---|---|---|---|---|---|---|
| 2009 | AAGR(1) 2000-2009 | 2009 | AAGR(1) 2000-2009 | 2009 | AAGR(1) 2000-2009 | 2009 | AAGR(1) 2000-2009 |
| 32497 (2) | 9.0 (12) | 4499 (2) | 4.5 (12) | : | : | 2763 (2) | 9.4 (12) |
| 51.0 (2) | 1.7 (12) | 27.6 (2) | 2.6 (12) | : | : | 29.5 (2) | 5.0 (12) |
| 117794 (2) | 9.5 (4) | 24064 (2) | 7.4 (4) | 37524 (2) | 19.8 (4) | : | : |
| 27.4 (2) | 5.1 (4) | 22.6 (2) | 5.5 (4) | 13.5 (2) | -0.5 (4) | : | : |
| 5002 (2) | 2.3 (4) | 627 (2) | 1.6 (4) | 760 (2) | 20.3 (4) | 261 (2) | 14.9 (4) |
| 11.1 (2) | 1.7 (4) | 2.3 (2) | -9.2 (4) | 10.5 (2) | 0.2 (4) | 3.6 (2) | -2.0 (4) |
| 70.2 (3) | 0.9 (10) | 56.3 (3) | 0.3 (10) | 1.2 (3) | 24.6 (10) | : | : |
| 12954 | *-19.2* | : | : | : | : | : | : |
| 0.13 | *-20.5* | : | : | : | : | : | : |
| 4413 | : | 6953 | : | : | : | 5509 | : |
| 0.39 | : | 2.24 | : | : | : | 5.08 | : |
| 10154 (3) | 1.2 (5) | 2277 (3) | 8.0 (5) | 540 (3) | -2.8 (5) | 449 (3) | 11.6 (5) |
| 0.89 (3) | -1.1 (5) | 0.65 (3) | 6.4 (5) | 0.09 (3) | -11.9 (5) | 0.44 (3) | 6.6 (5) |
| 551 (3) | 16.9 (5) | 744 (3) | 28.7 (5) | 115 (3) | 35.6 (5) | 89 (3) | 30.3 (5) |
| 0.05 (3) | 14.2 (5) | 0.21 (3) | 26.7 (5) | 0.02 (3) | 22.8 (5) | 0.09 (3) | 24.4 (5) |
| : | : | : | : | : | : | : | : |
| 522413 (2) | 6.7 (12) | 396343 (2) | 7.7 (12) | 544786 (2) | 19.6 (12) | 204299 (2) | 11.1 (12) |
| 59.1 (2) | -2.2 (12) | 74.6 (2) | -1.6 (12) | 56.0 (2) | 1.2 (12) | 71.2 (2) | -0.8 (12) |
| 153865 (2) | 10.6 (14) | 34418 (2) | 12.8 (12) | 38841 (2) | 33.3 (12) | 35703 (2) | 24.2 (14) |
| 41.4 (2) | 0.6 (14) | 33.9 (2) | 0.4 (12) | 38.8 (2) | 13.5 (12) | 69.1 (2) | 3.2 (14) |
| 5.4 (2) | : | 12.2 (2) | : | : | : | 3.5 (2) | : |

European Commission

EUR 24211 — **Innovation Union Competitiveness report. 2011 edition**

Luxembourg: Publications Office of the European Union

2011 — 758 pp. — 17.6 x 25.0 cm

ISBN: 978-92-79-14541-4
doi 10.2777/87066

Price (excluding VAT) in Luxembourg: EUR 55

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KI-NA-24211-EN-C

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Publications Office

doi:10.2777/87066
ISBN 978-92-79-14541-4