INDEPENDENT ASSESSMENT OF PORTUGUESE COLLABORATION WITH US UNIVERSITIES IN RESEARCH AND EDUCATION

International programmes between Portuguese universities and Carnegie-Mellon, Massachusetts Institute of Technology (MIT) and University of Texas at Austin

Academy of Finland

CONTENTS

	Executive summary	**3**
1.	**Introduction**	**11**
1.1	The context	11
1.2	Introduction to the Portugal-US Programmes	12
1.3	Description of the task at hand, Terms of Reference and methodology	14
1.4	Methodological summary	14
1.5	Methodological challenges identified	16
2.	**Programmes and their outputs in brief**	**18**
2.1	Massachusetts Institute of Technology - Portugal collaboration	18
2.2	Carnegie-Mellon University - Portugal collaboration	19
2.3	University of Texas at Austin – Portugal collaboration	21
2.4	Summary	22
3.	**Results**	**23**
3.1	Relevance in international terms	23
3.2	Value added	25
3.3	Assessment of the scientific, technological and academic returns from the Programmes	30
3.3.1	Education, training, study visits	30
3.3.2	Collaboration in research projects	35
3.3.3	Innovation and entrepreneurship activities	37
3.3.4	Technology transfer, innovation and entrepreneurship, commercialisation	43
3.4	Portuguese benchmark perspectives	46
3.5	Future perspectives	48
4.	**Conclusions and implications for the future**	**52**
4.1	Main conclusions on the objectives	54
4.2	Recommendations	57
4.3	The evaluation and its recommendations in a nutshell	60
5.	**References**	**61**
6.	**Appendices**	**63**
Appendix 1. Fact sheets per Programme		63
Appendix 2. Summative assessment		67
Appendix 3. List of statistics		71
Appendix 4. SWOT analyses		83
Appendix 5. Survey summary		90
Appendix 6. List of interviewed persons		115
Appendix 7. Members of expert panels		118
Appendix 8. The Portuguese context		119
Appendix 9. List of key terms and acronyms		123
Appendix 10. Key information from the benchmarking programmes		125

Foreword

Promoting the internationalisation of the science, education and innovation system lies at the heart of all knowledge-based societies, both in Europe and globally. This goal can be approached from different perspectives covering a variety of issues: international cooperation of universities and research organisations; promotion of mobility and building a critical mass; supporting access to research infrastructure innovation and entrepreneurship, funding instruments and other incentives; undertaking more concerted coordination efforts etc. However, one of the main challenges is linked to the possibilities of achieving cultural change.

Internationalisation can create exciting new opportunities for researchers and universities, innovation actors and business enterprises, funding agencies and governments. At the same time, it highlights the challenges that need to be met in an informed and sustainable way. How do we balance and make the right choices between smart specialisation and broad collaboration? How do we set indicators and measure success? What is the best way to spread excellence and, on the other hand, support open innovation, for instance? And how do we assess value for investment?

Portuguese collaboration with US universities in research and education is a bold example of an international university-government programme with high-profile science and innovation policy objectives. These kinds of models are few and far between, and even globally, creating a governmental internationalisation programme with significant public funding is quite uncommon.

The present report is an independent assessment of Portuguese collaboration with US universities in research and education. The evaluation was commissioned by the Portuguese Ministry of Education and Science (*Ministério da Educação e da Ciência*) and carried out by the Academy of Finland. The evaluation covers international partnerships between Portugal and Massachusetts Institute for Technology, Carnegie-Mellon University and the University of Texas at Austin.

The main objectives of the Portuguese collaboration were fourfold: to contribute to the internationalisation of Portuguese universities and research organisations, to increase cooperation between Portuguese institutions, to increase access to high-tech R&D equipment, and to promote cultural change in the Portuguese R&D sector. Programme financing came from the Foundation for Science and Technology (*Fundação para a Ciência e a Tecnologia*), the main research funding organisation in Portugal.

The focus of the evaluation is on the analysis and the assessment of outputs and scientific, technological and academic returns from Portuguese collaboration programmes implemented in 2007–2011. In addition, the Academy of Finland was to advise on the eventual renewal of the programmes. The evaluation was undertaken in a period of four months and included documentary material, an e-survey, a benchmarking exercise and statistical analysis, as well as an extensive round of interviews and two independent evaluation panels.

The assessment clearly demonstrates the great potential of the funding model in the promotion of R&D&I and cultural change, and in setting an ambitious agenda reaching out to the next level of innovation activity. The Portuguese Government can be commended on its important strategic decision to launch the programmes. Based on this assessment, it is easy to conceive that this Portuguese collaboration with US universities can be developed further and that a second-generation programme can be built on the lessons from the current one. The main approach is to find those strategic choices that are most valuable to Portugal through broadly-based high-level dialogue and collaboration.

The evaluation steering group was chaired by Dr Riitta Mustonen (Vice President for Research, Academy of Finland) and the other members were Professor Arto Mustajoki (Chair of the Academy of Finland Board, University of Helsinki), Dr Leena Treuthardt (Director of Strategy, Academy of Finland), Ms Satu Huuha-Cissokho (Manager, EU Affairs, Academy of Finland), Mr Juha Latikka (Senior Science Adviser, Academy of Finland), Dr David Cristina (Liaison Officer,

Secretaries of State for Science and for Entrepreneurship and Innovation, Portuguese Ministry of Education and Science) and Dr Joana Mendonca (Head of Department of Science and Education Statistics, Portuguese Foundation for Science and Technology). In spite of the substantial scope and level of ambition of the project, the steering group made sure that sufficient information was obtained for a balanced and fair evaluation. The steering group is confident that its analyses and recommendations are well founded and hopes that the report will be viewed as a constructive basis for the improvement and development of future programme work in Portugal.

The Academy of Finland would like to thank the Portuguese Ministry of Education and Science for entrusting it with an interesting, important and challenging task. The data collection and analysis process was carried out by Rambøll Management Consulting Ltd. The steering group expresses its warmest gratitude to the consultants, especially to Dr Kaisa Lähteenmäki-Smith for her assiduous and devoted work. Sincere thanks are also due to a large number of experts from various organisations for their in-depth and interactive contribution.

Helsinki, 12th January 2012

Riitta Mustonen
Vice President (Research)
Academy of Finland

EXECUTIVE SUMMARY

In 2006, the Portuguese government launched a collaborative initiative bringing together a number of US and Portuguese universities and R&D institutions. The objectives of this collaboration[1] were fourfold: to contribute to the internationalisation of Portuguese universities and research organisations, to increase cooperation between Portuguese institutions, to increase access to high-tech R&D equipment and to promote cultural change in the Portuguese R&D sector. The initiative was organised by the Ministry of Science, Technology and Higher Education (*Ministério da Ciência, Tecnologia e Ensino Superior*, or MCTES) into four programmes, three of which are the object of the evaluation reported here, i.e. the partnerships between Portugal and the Massachusetts Institute for Technology (MIT-PT), Carnegie-Mellon (CMU-PT) and the University of Austin, Texas (UTA-PT). Programme funding, approx. 166.5 M€, came from the Foundation for Science and Technology (*Fundação para a Ciência e a Tecnologia* or FCT), the main research funding organisation in Portugal. The goals for the Research and Education Collaboration were defined as the following: Improving educational and training ability, increasing the number of national consortia, promoting internationalisation, strengthening the recruitment of professors and faculty, supporting economic growth through science-based innovation and improving attractiveness of and access to international markets. The Programmes made use of several means to achieve the set goals, including reinforcing scientific and advanced training capabilities, strengthening the recruitment of professors and researchers, and stimulating economic growth through science-based innovations.

The Programmes have developed activities in three main strands: education and training (focusing on traditional Master's and PhD programmes, as well as more targeted professional Master's programmes focusing on the needs of the industrial community), project-based research collaboration, and innovation and entrepreneurship activities (focusing on the commercialisation and technology transfer). The latter was specifically targeted through the University Technology Transfer Network (UTEN) instrument, institutionally under the auspices of the University of Texas at Austin Programme (also referred to as the UTA-PT Programme), but with close links with the other US-PT Programmes.

The process of selecting the partners was at the same time both a bottom-up and a top-down one. The US partners were selected by the Ministry of Science, Technology and Higher Education (MCTES) from among those universities where collaboration and networks already existed with the Portuguese research community and, crucially, where world-class expertise in selected scientific fields was found. The intention here was to give them the possibility of selecting the Portuguese partners with the greatest potential in the selected research fields based on statistical and empirical knowledge. Personal networks with the US partners clearly played an important role in the initial selection and contact process. The Portuguese universities were then selected by the US partners after a five-month assessment period. The Programmes have reached the end of their first five-year term.

The evaluation was undertaken between 23 September and 24 November 2011. The evaluation steering group led by Dr Riitta Mustonen, Vice President for Research (Academy of Finland), consisted of experts from the Academy of Finland and *Rambøll Management Consulting*.[2] The work was commissioned by the current Portuguese Ministry of Education and Science.

The main objectives of the evaluation were:

- *To establish the real outputs from the three Programmes and the UTEN network under evaluation, and their relevance in international terms*

[1] Note on the language used in this report: 'Programmes' refer to the programmes between Portuguese universities and CMU, AUT and MIT as well as to UTEN activity. When referring to the three programmes together i.e. the instrument as a whole, the term "Research and Education Collaboration" is used. The individual programmes are most often referred to by their name as CMU-PT Programme, MIT-PT Programme, PT-UTA Programme and UTEN.

[2] Data collection and analysis have been supported by the following persons: Riitta Mustonen, Leena Treuthardt, Juha Latikka, Satu Huuha-Cissokho and Anja Raatikainen from the Academy of Finland, Kaisa Lähteenmäki-Smith, Henri Lahtinen, Kimmo Halme and Katri Haila from Rambøll Management Consulting. The evaluation steering group was formed by the the Finnish expert team, Professor Arto Mustajoki (Chair of the Board of the Academy of Finland) and representatives of the responsible Portuguese ministry.

- *To determine whether the scientific, technological and academic returns from the Programmes represent "good value" for the investments made*
- *To advise on the eventual renewal of the Programmes, in the context of current budgetary restrictions, where investment in these Programmes represents a significant proportion of the funds available in the support of local groups and projects, through open, national competition.*

The main methods and data sources used in the evaluation included:

- *Documentary analysis (monitoring and reporting materials, future plans etc.)*
- *Interviews (list of interviewees attached to the final report)*
- *E-survey to Programme stakeholders (ranging from Master's and PhD students to faculty and Programme management, as well as external stakeholders such as industrial affiliates)*
- *Statistical analysis*
- *Evaluation panels: two panels, whose task was to assess initial results and need for further data, as well as to provide a meta-analysis of the findings and conclusions. By so doing they helped to provide both additional benchmarking perspectives and strengthen the comparative international context. By their important contribution they also helped validate the methodology used and clarify knowledge and information gaps. Experts are listed in Appendix 7.*

The analysis herein covers the individual to the national (innovation policy) level as the task was to identify the dynamic by which these partnership initiatives work, including the outputs and results that have emerged, as well as the effects and impacts they may have generated over time. The data was collected and analysed at four levels: individual level (students, faculty members etc.), research group/team/unit level, university level and the national level (policy/innovation system).

While the Academy of Finland has been responsible for the evaluation, the Finnish benchmark is only one among many. The indicators in the statistics section, for instance, have contrasted the Portuguese case with EU average, as well as with other small EU countries, including Finland. In some cases the evaluation has relied on Finnish benchmarks for monitoring and evaluating R&D. Some aspects of the Finnish experience in science and innovation policy also proved relevant for the Portuguese experience, e.g. the necessity for consistent and long-term commitment not dictated by short-term cyclical or political consideration. The commitment to a continuous structural reform and principles of transparency and accountability are importantly also integrated into the evaluation culture. In the case of Finland, this has implied regular evaluation of its own science policy on all levels, ranging from institutions, policy instruments and individual programmes to the system itself, as was the case with the international evaluation of the Finnish innovation system undertaken in 2009.[3] The need to adjust to the global conditions through international cooperation is among the examples of driving forces of Finnish science and innovation policies (Ylä-Anttila & Lemola 2006, p. 97; see also Andersson 2010, Lemola 2002 and 2003).

Comparative benchmarks have been used where appropriate, including other Portuguese doctoral programmes (described in Section 3.4), Finnish doctoral programmes, which were just recently evaluated (Niemi et al 2011), as well as external examples which the evaluation experts involved in the expert panels were familiar with.

The key conclusions are summarised below, together with recommendations, both overall and for each of the Programme objectives, which the evaluation was designed to assess.

[3] Veugelers et al. (2009): Evaluation of the Finnish National Innovation System. Electronic report available at: http://www.tem.fi/?s=3161.

OVERALL CONCLUSIONS: SUMMARY

CONCLUSIONS	RECOMMENDATIONS
1. Overall, the present instrument *Research and Education Collaboration* is seen as unique. It has great potential in promoting R&D&I, and cultural change, and contains an ambitious agenda for taking Portugal to the next level in innovation activity.	➔ Sustainability should be ensured. This is important on the policy level (as R&D&I necessarily involves a long-term commitment), but also in terms of the position of the students involved in the process, who should be allowed to complete their PhD project. The possibility of making this *Research and Education Collaboration* Programme accessible to universities other than the three current US collaboration partners should be explored. This could also help attract more external funding, including that from the private sector and EU sources. However, a one-year transitional period should be launched with a view to enabling the institutions involved in the Programmes to formulate an exit strategy and to ensure sustainability.
2. Internationalisation, increasing collaboration within Portugal, access to R&D infrastructure and equipment, and cultural change have all been positively influenced. 'The access to equipment' objective is least relevant, while the other three are all equally important.	
3. The present Portuguese *Research and Education Collaboration* can be regarded as a pilot instrument in which monitoring, assessment, financial management etc. systems have not been adequately developed. There is no systematic monitoring, neither are there any systematic plans for follow-up and assessment. The future development of the instrument has been left to the individual Programmes, rather than been promoted by a concerted coordinative effort.	➔ Good management practice and sound financial management must be incorporated into all FCT practice in all programme activity. This includes transparent selection criteria, monitoring indicators and reporting practices. ➔ *Research and Education Collaboration* and all similar instruments of pilot nature should be the target of particular attention. This means that monitoring and assessment are needed during the whole process to ensure the timeliness and relevance of decisions to be made and also to develop the optimal information flow and impeccable management practices. This should be a fundamental goal in order to gain trust, transparency, legitimacy and accountability when public funds are being used. This is equally important when aiming at evidence-based decision-making, i.e. ensuring that all relevant information is available to ground Programme-specific and broader policy decisions on an evidence base. To ensure commitment and anchoring of different science- and innovation-policy objectives and instruments, a broad strategic dialogue based on relevant information is needed between policy-level actors. In Finland, for instance, the Research and Innovation Council offers a functional system for such dialogue. A similar model has recently also been launched in Portugal. ➔ Furthermore, the universities' steering mechanisms could include incentives to support internationalisation. One possibility is to build the universities' funding model in a way that is predicated on supporting their internationalisation. The universities' funding should entail a component that supports and rewards internationalisation, not only in a specific programme context but across the activity.
4. The objectives require somewhat different timeframes, though they all demand a long-term perspective. Achieving cultural change in particular is a long process, perhaps the main goal under which the sub-headings fall, i.e. attaining a new quality level in research and teaching and promoting a new mindset in terms of more entrepreneurial thinking. Such ambitious goals can only be achieved after years of concerted efforts, maybe only after the next generation of leaders and teachers are working in Portuguese academia.	
5. All Programmes have aspects that are worth maintaining. MIT has been particularly successful in PhD training, while CMU and Austin have concentrated more on project collaboration and technology transfer, and CMU in particular is perceived to have been successful in them. UTEN activity is valuable and welcomed by stakeholders in the technology transfer sphere, though it could be implemented separately.	➔ UTEN activity should be extended to cover the whole Portuguese research and innovation system instead of being embedded in the University of Austin-PT Programme.
6. Positive international attention and visibility have been gained through the Programmes.	➔ Marketing the collaborative model developed is not only an important part of raising funding for the future but also making Portugal visible in terms of proactive science-policy initiatives. This should be used as a flagship in the EU context and used in a broader international context, in particular within the Portuguese-speaking world.
7. The overall Programme approach and model are well-thought-out and the focus areas (education and training,	➔ A more concerted effort should be made to build synergies across the three strands: in future Programmes,

	collaborative projects, innovation and entrepreneurship) complement each other very well. They need, however, to be systematically coordinated to ensure that the flow of information is maintained and the lessons learned are adequately disseminated.		the use of a monitoring system and a more systematically defined set of objectives, sub-objectives and targets could be a way of making these Programmes more efficient.
8.	The strategy of focusing Portuguese public funding so strongly on US universities was not supported by all of the stakeholders. In the European context, 'collaboration' and 'partnership' are terms that imply financial commitment from both parties.	➔	The *Research and Education Collaboration* Programme could be opened to universities other than the current three US partners and, indeed, to other than US parties. Co-funding should be ensured.
9.	The outputs from the Programmes, and their relevance in international terms, are significant, though in many cases it is too early to estimate their long-term impacts. Indeed, in some cases it is too early even to judge the impacts (e.g. academic publications, PhDs in training, etc.). When assessing the value for investment, we need to bear in mind that the effectiveness of programmes always relates to the selected goals and objectives in question. The doctoral programmes presented briefly as benchmarks have ambitious, though more limited goals than the Portugal-US programmes that were launched by the Portuguese Government, and had high-profile objectives in science and innovation policy. From the perspective of the funding organisations and sponsors, the key issue, however, is how Portuguese doctoral training can be most efficiently and comprehensively developed as a whole. This goal would benefit from more comprehensive metrics that would provide a means of assessing the value added and value for investment for the various beneficiaries in question: researchers and the scientific community, universities and research institutes, companies, and society as a whole. Essential in all cases is that the objectives, their indicators and monitoring should be planned and implemented carefully at an early stage. In addition, all choices made along the planning process should be aware, transparent and as articulated as possible, in order to ensure the commitment of key stakeholders.	➔	The logic model must be standardised and further clarified with a small number of Programme- and activity-specific targets set for progress monitoring.
10.	The scientific, technological and academic returns from the Programmes are significant, but the cost has been quite high if calculated per PhD, student, academic publication, etc. When calculating the cost per PhD, it is natural that the price for international excellence and quality is high. However, there may also be less tangible, more long-term benefits that are more difficult to measure, such as international recognition and visibility. The challenge in the benchmarking cases, as in the Portugal-US programmes, lies in identifying and assessing in a commensurable way the effects of a longer duration: when PhDs work in enterprises, perhaps as a result of the cultural changes that have gradually emerged, their contribution is only shown in the years to come.	➔	Co-funding should be ensured. The *Research and Education Collaboration* cannot be maintained by Portuguese funding alone.
11.	Financial inputs are significant and have enabled a broad system change in the fields selected for the Programmes. Cost-effectiveness is seen in a critical light, while return on investment cannot yet be assessed, as the goals are more long-term.	➔	The different temporal horizons of the societal objectives should be considered when making future decisions.

CONCLUSIONS PER OBJECTIVE

OBJECTIVE	CONCLUSIONS	RECOMMENDATIONS
Improving educational and training ability	1. The doctoral programmes have been successfully launched – joint degrees have not always been the rule. 2. The doctoral programmes themselves have been developed in a more focused and integrated way. 3. Effects have been achieved, though it is too early to fully quantify impacts at this stage. 4. Quality assurance systems, methods and practice have improved, though there is little standardised data available. 5. The US model of more structured supervision, training and student evaluation and feedback has been seen as an important part of developing the Portuguese higher education system. In some cases, however, supervision and training have not yet worked as expected.	➔ All doctoral programmes should be developed as joint/dual degrees. ➔ The candidates should have a defined topic at the PhD grant allocation stage to facilitate the smooth running of the process and to ensure good results for the institutions in terms of receiving and sending out students and faculty members. ➔ A set of appropriate indicators should be developed in order to monitor and assess the Programmes and their various activities. ➔ A quality assurance system should be developed for the FCT to ensure systematic standards applicable across all FCT programmes. ➔ See points 2 and 4.

OBJECTIVE	CONCLUSIONS	RECOMMENDATIONS
Increasing the number of national consortia	1. The willingness to work together has been positively impacted. Full systemic effects will, however, take time to emerge. 2. Thus far, cooperation and joint consortia within the Portugal-US Programme context have increased only to some extent. 3. The 'new' domestic consortia are not yet very active in applying for European funding.	➔ Joint applications should be set as a goal, if prioritised. ➔ Activities promoting networking within Portugal should be maintained (faculty exchange, student mobility). The community-building efforts associated with the Portugal-US Programmes should be maintained and provided coordination support by the FCT.
Promoting the internationalisation of universities and research organisations	1. Internationalisation has been one of the most positive impacts of the Programmes in the selected academic fields. 2. 'Value added' has been created in terms of more professional international standards in teaching, research collaboration and in attracting international students and faculty. 3. The drop-out rates reported are not unusually high, but higher than in the national doctoral programmes, where the drop-out rates are almost 0. The risk of brain drain is viewed as not having been realised. Brain gain remains more important. 4. Attractiveness has increased in many selected key areas, both in geographical and academic terms. 5. There is a significant risk of decreasing attractiveness of the institutions and scientific fields selected for the Programmes, if the Programmes are discontinued without a transitional period. The positive leverage effects of Portuguese R&D more generally could also be diminished.	➔ Quality standards should be set on the national level, benefitting from the lessons learned from the Programmes. This would also ensure that the benefits are promoted and taken into use across Portugal, including institutions not participating in the Programmes. ➔ National-level efforts to promote success stories from local innovation environments should be documented and actively communicated. ➔ Sustainability should be ensured, at least in the form of a transitional period. The potential to expand the positive methods and tested practices to other academic fields should also be systematically assessed.
Strengthening the recruitment of professors and faculty	1. The qualitative improvements required to strengthen PhD training are already well under way. 2. The Programmes have contributed to increasing the attractive career options available to young academic professionals in Portugal.	➔ Quality standards should be set for both the Programmes and R&D on the national level. ➔ Information on career path opportunities should be more actively communicated.

OBJECTIVE	CONCLUSIONS	RECOMMENDATIONS
Promoting economic growth through science-based innovation	1. There are still too few indications of anything yet having taken place in economic growth terms. It is difficult to assess the counterfactuals. 2. The number of venture capital interventions and spin-offs etc. remains modest. 3. The Programmes have made a difference in terms of supporting the preconditions for innovation, entrepreneurship and technology transfer, as well as in relation to working together across companies and academic environments in the selected academic fields. 4. Professionalism of the technology transfer process and personnel, as well as a more developed innovation ecosystem have, however, been promoted. UTA-Portugal and CMU-Portugal have been particularly important in this regard.	➔ Technology transfer, innovation and entrepreneurship should be maintained, while possible alternative sources of funding should also be investigated.
Improving attractiveness (new talent and high-value activities)	1. This *Research and Education Collaboration* has contributed to the positive visibility of Portugal. 2. Individual talent has been attracted and Portugal has been put on the map. However, it is too early to judge whether additional high-value activities have, or will, be undertaken. 3. Expertise in attracting and promoting high-value activities has been improved (e.g. public-private partnerships, entrepreneurship and fund-raising skills). 4. In addition to the general improvements in quality, entirely new research *niche* areas have been developed in previously relatively isolated locations such as Madeira.	➔ The US-Portugal community should be used as a source of peer-learning and information across the Portuguese and European R&D&I system. ➔ Lessons learned should be documented and promoted as soon as possible, with national coordination.

OBJECTIVE	CONCLUSIONS	RECOMMENDATIONS
Enabling access by Portuguese companies to international markets	1. At this stage, there is no discernible trend of progress in this area, and it is still too early to expect such effects to have emerged. 2. So far, there are, only a handful of spin-offs and start-ups resulting from Programme activities. 3. Company collaboration has developed in a positive way, but SMEs find it difficult to get involved, and there are very few large Portuguese companies. 4. The few companies that have become involved report positive benefits. They seem committed and could, in the long term, be significant and bring their sub-contractors and value chains with them to collaborative efforts.	➔ Spin-off and start-up competitions should be maintained. ➔ Company collaboration should be mainstreamed to all Portuguese universities. ➔ Companies should be involved in training, teaching and mentoring, as well as in project collaboration both through co-funding and steering group work.

1. INTRODUCTION

1.1 The context

In Portugal, the governance of the research system has always been under the responsibility of the Government, which manages the largest share of the national science and technology (S&T) budget. Important recent changes include the reform of the government labs and the establishment of new universities' governing law together with a new model for university career structure. These changes have sought to establish a more stable self-financing funding model and accentuated the need to mobilise external financing. At the same time, the tertiary education system has been reformed, the social basis for recruitment of students has been enlarged, and industry-science links have been strengthened. The system is, however, still dominated by a top-down approach, with few participatory mechanisms for the involvement of interest groups, business, NGOs and society at large.

Currently, the research and innovation system is characterised by a growing private sector share in both financing and performance. Portugal is outperforming in the number of graduated and employed doctoral researchers, having exceeded the EU average on these resources. Portugal has progressed well and reached about the EU average on the international scientific co-publications and their citation worldwide. Portugal also shows a remarkable growth rate in terms of publications (13.9%) and even higher with 10 % most cited publications (16.9%) between 2000 and 2008.

On the other hand, tertiary and upper secondary education still remains low. Additionally, there are problems related to the capacity of the existing business firms making use of their possibilities. This is further aggravated by the current economic climate, which inhibits firms of investing and adopting a more innovative behavioural posture. The very large firms, which usually have greater R&D intensity, are absent. The venture capital market is insufficiently developed. Moreover, the fraction of capital provided by business angels is residual.

Portugal has been a late-comer into the R&D development field, but has made considerable progress throughout the early 2000s. In 2009, per capita GDP expressed in purchasing power parities was 79% of the EU27 average. Real GDP growth has been very weak throughout the present decade, forecasts for 2010 and 2011 being rather low, according to Eurostat. In spite of Portugal's economic weaknesses and the current economic and financial crisis, both GERD (Gross Expenditure in Research and Development) and BERD (Business Expenditure in Research and Development) experienced significant growth rates. GERD reached 1.7% of GDP in 2009, as against 0.83% for 2003. BERD amounted to 0.8% of GDP, while the corresponding figure for 2003 was 0.2% only (GPEARI, 2010b, 2009b, cited in Godinho & Simões 2010, p. 3).

The structural and systemic problems of the innovation system are the very drivers behind the Programmes assessed in this evaluation. As argued in Godinho & Simões (op. cit.), the main barriers to private R&D investments are associated with the following five main features: (1) The structural characteristics of the economic fabric; (2) the size distribution of Portuguese firms, where very large firms, which typically have greater R&D intensity, are absent; (3) the nature of the domestic demand (intermediate and capital goods demand patterns are less sophisticated than European average, so hindering the local companies supplying advanced products); (4) average company absorptive capacity is relatively weak, not only in terms of purchasing advanced inputs but also in terms of integrating in their staff qualified human resources; and (5) the insufficient development of the venture capital market. Besides these barriers, reference is due to the insufficient applicability concerns that still dominate research policy. Despite a recent move to more targeted initiatives, the situation is still far from a healthy collaboration between academic research and potential end-users. This is a systemic problem, which is related to both the orientation of the policies and the weak absorptive capabilities of the economic fabric.

1.2 Introduction to the Portugal-US Programmes

The Programmes under evaluation

The Programmes under evaluation aimed to become an instrument to internationalise Portuguese universities and R&D institutions and to increase cooperation between them. Additional objectives include accessing high-tech R&D equipment and promoting cultural change in Portuguese R&D. These goals led to the initiation of the three partnerships (MIT-PT, CMU-PT, and UTA-PT) between Portugal and the US in 2006. The goals of the Programmes include reinforcing scientific and advanced training capabilities, strengthening the recruitment of professors and researchers, and stimulating economic growth through science-based innovation.

'Partnerships for the Future', as they were advertised at the time involve the US partners (**MIT, Carnegie-Mellon and University of Texas at Austin**), which were selected to collaborate with those Portuguese universities and research institutes that were considered to have greatest potential according to statistical and empirical knowledge. Personal contacts and networks with the chosen US partners played an important role especially at the beginning of the process. The participating Portuguese universities were selected after a five-month assessment by the US partners.

The cooperation with these US universities, including the Massachusetts Institute of Technology (MIT), Carnegie-Mellon (CMU), the University of Texas at Austin (UTA) and Harvard Medical School, was a central feature of the 'Commitment to Science' policy roadmap (for further details, see Godinho & Simões, 2009). The three Programmes were selected for comparison due to their similar development phase and the evaluation was targeted at them in the Terms of Reference.

These Programmes address several areas which have been identified in the EU as having European value added, namely *health, Information and Communication Technologies (ICT), energy, environment, transport and socio-economic sciences*. The International Collaboration for Emerging Technologies (CoLab), created in the context of the partnership with the University of Texas at Austin, has organised conferences to diffuse the results achieved by this partnership. In addition to other Programme activities in the form of training, collaborative research projects and innovation and entrepreneurship, a more focused technology transfer has been promoted, through the network of technology transfer UTEN, organised as part of the UTA collaboration, but with links to the other Programmes. UTEN activity has included a total of 15 universities, three institutes, a laboratory, six technology parks, six incubators, a polytechnic institute, three institutional partners (FCT, the INPI, CRUP), as well as four international partners (in addition to the three US universities involved in collaboration, the Fraunhofer Institute). Summaries of the Programmes are given below, as well as in the *fact sheets appended to this material*.

The total funding of the Programmes amounted to EUR 166,506,750. The budgets for the US and Portuguese institutions are illustrated in Table 1 below.

	2006–2011		Total budget	Percentage of Portuguese budget among Portuguese university partners
	Portugal	US	(2006–2012)	
MIT-PT	€32,600,000	€32,900,000	€77,579,210	75% IST, U. Minho and FEUP
CMU-PT	€27,870,000	€27,800,000	€65,507,540	70% IST, FCUL, U. Madeira, and U. Aveiro
UTA-PT	€10,250,000	€9,750,000	€23,420,000	75% U. Porto, U. Coimbra, IST
Total	€70,720,000	€70,450,000	€166,506,750	

Table 1. Budgets of the Programmes

The percentage of private funding was as follows: CMU Programme 17% of the total budget and 81 industrial affiliates; MIT-programme 2.7% and 59 industrial affiliates; UTA-PT programme 2.6% with 16 industrial affiliates. See Figure 1.

The funding model of the Programmes

The funding model of the Programmes has been channelled through two distinct ways, namely: i) international partners; and ii) national institutions involved. Each of these ways was formalised by contracts with the FCT (Portuguese Science Foundation), where the objectives, budgets, payment terms and conditions, as well as the respective management rules (incl. operation of the Boards of Directors, management and annual external international review), were defined.

The contracts were carried out in accordance with the proposals of each Programme's Board of Directors, based on the annual budget set by a resolution of the Council of Ministers and on the result of the annual external international review.

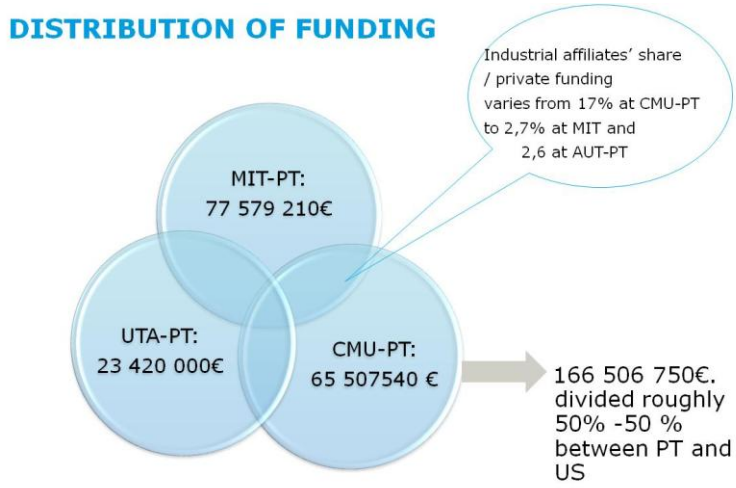


Figure 1. Funding of the Programmes. Source: Ministry of Education and Science, documented materials 2011.

Payments to national institutions, also in accordance with the referred contracts, are carried out taking into account the budgets and the changes decided by each Programme's Board of Directors. The payment process to international partners was performed according to the referred contracts, based on the invoices submitted semi-annually by international partners, after authorisation by the FCT President. In regards to the procedures, control and supervision of the financing of R&D activities and advanced training in Portugal, the usual procedures of the FCT were implemented, and there are therefore three types of contracts in progress: R&D projects, advanced training fellowships and institutional development projects.

- *R&D projects resulting from the open calls for research proposals: competitive research projects launched by open calls to consortia. The criteria set by the funding organisation FCT for the consortia required that at least two research groups from two national institutions were present, as well as a company and a research group of the corresponding international partner.[4] The budgets of these open calls were proposed to FCT by each Programme's Board of Directors.*
- *Advanced training fellowships resulting from competitive calls. These calls were open in accordance with the budget proposed by each Programme's Board of Directors to FCT.*
- *Institutional development projects to stimulate the scientific employment at postdoctoral training and to facilitate the exchange of researchers and teachers, as well as the specific coordination of doctoral and postgraduate programmes. The budgets of the respective contracts have been decided by each Programme's Board of Directors. These programme contracts were signed to promote scientific employment and mobility of teachers and researchers between national institutions and the international partner. (Source: Information received from the Ministry of Education and Science in October 2011, email correspondence.)*

[4] One exception: in contrast to the funding criteria, no company partner was included in one UTA-PT R&D project.

The Programmes have been an important part of the R&D effort of Portugal, in total covering an average 8% of the FCT annual funding since 2007. The funding has been at its highest in 2011, with 9.7% of the FCT budget targeted at the three Portugal-US Programmes.

1.3 Description of the task at hand, Terms of Reference and methodology

The evaluation was undertaken between 23 September and 24 November 2011. The evaluation steering group was led by Dr Riitta Mustonen, Vice President for Research (Academy of Finland) and the team consisted of experts from the Academy of Finland and Rambøll Management Consulting. Data collection and analysis were supported by the following persons: Riitta Mustonen, Leena Treuthardt, Juha Latikka, Satu Huuha-Cissokho and Anja Raatikainen from the Academy of Finland; Kaisa Lähteenmäki-Smith, Henri Lahtinen, Kimmo Halme and Katri Haila from Rambøll Management Consulting. Arto Mustajoki, Chair of the Board of the Academy of Finland was also member in the steering group, as were representatives of the Portuguese Ministry of Education and Science.

The main objectives of the evaluation given in the Terms of Reference were:

- *to establish the real outputs from the Programmes, and their relevance in international terms,*
- *to determine whether the scientific, technological and academic returns from the Programmes represent "good value" for the investments,*
- *to advise on the eventual renewal of the Programmes, in the context of current budgetary restrictions, when the investment in the Programmes represents a significant fraction of funds that are used in the support of local groups and projects through open, national competition.*

The levels of analysis and impacts have ranged from the individual to the national (innovation policy), as the task has consisted of identifying the dynamic by which these partnership initiatives work, the outputs and results that have emerged, and the effects and impacts it might have in the longer term. Thus, four levels were considered: individual (students, faculty members etc.), research group/team/unit, university as well as the national (policy/innovation system) level.

The methodology was tentatively planned in the kick-off meeting held in Lisbon on 23 September. Due to the relatively brief timeframe of the evaluation, some methodological choices were made, such as the e-survey intended to fill the gaps left after interviewing the key stakeholders in such a brief time, and the evaluation panels, which have been found to be a particularly useful additional method in large demanding evaluations.

1.4 Methodological summary

The following methods and data sources have been used in the evaluation of the Programmes and in the data collection:

- *documentary analysis (documents provided by the Portuguese Ministry)*
- *statistical analysis (list included as Appendix 3)*
- *interviews of stakeholders (list of interviewees as Appendix 6)*
- *e-survey to Programme stakeholders and innovation policy actors, ranging from Master's and PhD students to faculty and programme management, as well as external stakeholders such as industrial affiliates*
- *two panels of international experts not related to the Programmes (experts listed in Appendix 7)*
- *interviews and surveys with the External Review Committees of the Programmes*
- *Email contacts and additional data gathering were undertaken with the directors of the Portuguese PhD programmes. Students' views were included indirectly, i.e. through reports and documentation where available. Students and governing bodies of the benchmarking cases were not included in the interview round, however.*

A documentary analysis was conducted based on the materials (e.g. contracts, progress reports, annual reviews of the external review committee) received in the kick-off meeting held in Portugal on 23 September 2011. The evaluation was supported by **a statistical analysis** consisting of several indicators illustrating e.g. expenditure on R&D, education and human resources, tertiary education rates and venture capital investments. The statistics were acquired from the OECD and Eurostat databases and they were divided into themes according to output, relevance and effectiveness.

Interviews and an e-survey were used to recognise value added from various stakeholder perspectives (e.g. Portuguese Government, universities, research groups and teams, individual researchers and students) (Figure 2). External actors were also included, in both the survey and among those interviewed. More than a hundred persons were covered in face-to-face individual and focus-group interviews in Portugal. In addition, due to time constraints, some interviews were done on the phone and through video conferencing. The e-survey provided both quantitative and qualitative data on the stakeholder perceptions.

In addition to the stakeholders of the Programmes, external views and comparative perspectives were strengthened by including in the survey respondents who had no direct stake with the Programmes, but who can be considered as experts for "innovation ecosystem", i.e. they had a sufficient expertise and knowledge of the Portuguese innovation system and awareness of the Programmes and policy. Of the total number of respondents (717 persons), more than 60 represented the group "Other" (Figure 2).

This group "Other" consisted of innovation policy stakeholders from Portugal and abroad, as well as external experts such as consultants or university experts independent of the Programmes in question, Programme directors of the other doctoral schools, students and technology transfer officers not involved in Portugal-US Programmes etc. Of the entire group of respondents, 17% were Portuguese, 14% American and the rest represented a variety of nationalities from Europe and more broadly.

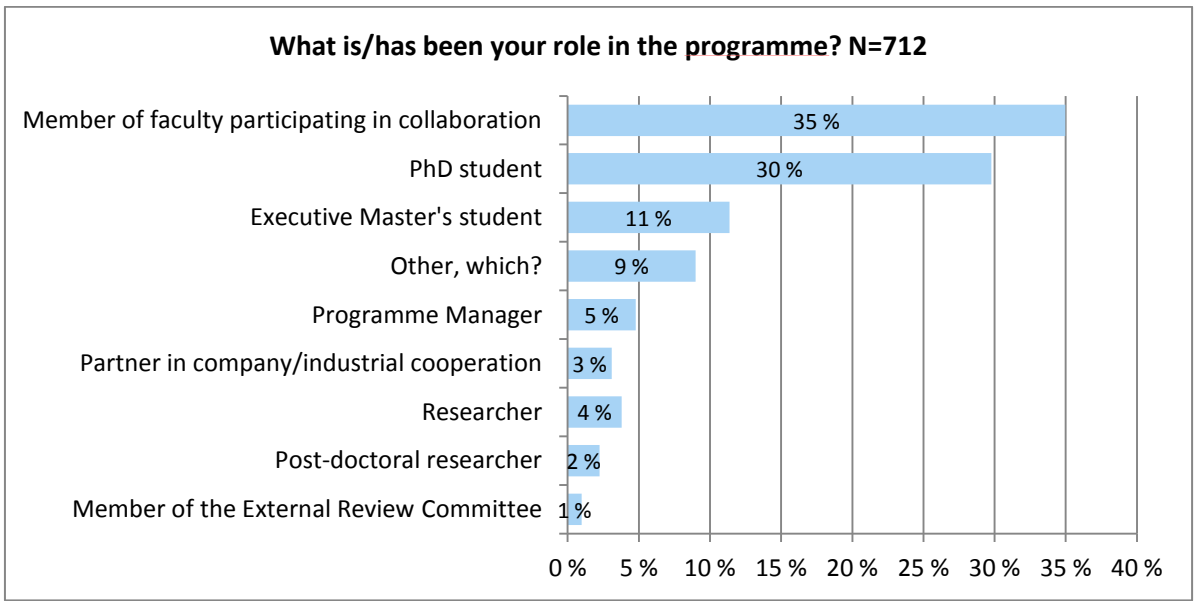


Figure 2. Respondents represented in the survey

Data gaps were addressed through individual interviews and email contacts with external experts in the final stages of the evaluation. One such gap was filled with the External Review Committees, who have a central role in the programme governance, but of whom only a total of seven respondents were accessed through the e-survey. Additional data gathering was done

within this group by personal interviews, as well as analysis of their written reports across the implementation of the Programme.

Wordle[5] was used to assess the perceived relevance of the areas of cooperation. The open question in the survey to be answered was "What disciplinary field or scientific area should have been included but was not?" In the Wordle analysis it had to be taken into account that, instead of answering to this question directly (i.e. simply mentioning the lacking fields), the respondents tended to also describe their general impressions of relevance of those fields already covered by the Programme. The question summarised related thus to the existing scientific fields of collaboration, their relevance as well as the possible need to further focus on particular areas that were not fully taken advantage of yet.

In addition to the Wordle illustration, quantitative analysis of the responses was also accompanied by "traffic lights" illustrating the state of affairs in terms of the relevance and perceived usefulness of the Programmes to date.

The evaluation panels were organised to help the investigation of the added value generated by this *Research and Education Collaboration* Programme to Portuguese society, its research and innovation system, universities, research teams and individual researchers. The independent panels were compiled amongst top experts in the R&D&I sector. The first panel of Finnish experts was held in Helsinki on 28 October 2011; the second panel that consisted of European experts was held in Copenhagen on 4 November 2011. Prior to the meeting, the panel members were provided with material complied by the evaluation steering group and background information.

The purpose of using two high-level panels was to seek a broader international perspective on the evaluation and the Programmes to be assessed. The task of the panels was not only to analyse the added value and value for money of the Programmes as such, but also to assess the appropriateness and validity of the analysis and the data provided. By using two panels it was possible to progressively deepen the analysis of the accumulated data and to identify possible data gaps to be filled in the final stages of the evaluation. The panellists were selected on the basis of their broad expertise in programme-based R&D&I development, the organisation and dynamics of R&D&I programmes, collaborative instruments for R&D, as well as evaluation and monitoring of R&D. The experts provided their independent view on the Programmes based on the compiled material.

1.5 Methodological challenges identified

The evaluation was implemented in a relatively tight timeframe. The provided time constraints were imposed by the new Portuguese Ministry of Education and Science for two main reasons. Firstly, there was a need to avoid irreversible damage to the Programmes, as the decision on their extension beyond 2012 had to be taken at the earliest time possible. Secondly, the Portuguese Government needed a basis for an informed decision, especially as no independent assessment has been carried out in the first five-year term.

The short timeframe available for the evaluation was, however, a source of some concern, as it was felt that it will be difficult to gather and access all the relevant stakeholders' views and data in time to provide a robust analysis and sufficiently encompassing conclusions for all the Programme activities involved. Also other more data-specific challenges ensued: the fact that while the Programmes were well documented and a rich material of the Programmes and their activities was in fact available, the Programmes – even though being financed almost totally through public funding – had not been expected to provide a logic model in the beginning, nor was there a systematic monitoring system with shared indicators available. This made the data collection and analysis more challenging and in fact provided the evaluation steering group with the challenge of mapping and charting the expected logic model of the Programmes themselves.

[5] Wordle is a software/illustration tool that provides a means of taking qualitative texts and putting them in a picture where the words used the most are most prominent and visible.

Another challenge was the financial data, which was not fully available. As one of the tasks was to determine the return on investment, this was very difficult to achieve without 100% of the financial data.

The e-survey faced some initial difficulties due to a lack of time to perform sufficient testing rounds. Only minor technical alterations were made, however, thereby ensuring the integrity and comparability of the data in the survey. Due to some respondents not receiving the initial invitation to participate in the survey, the deadline was subsequently extended and the survey period was from 18 October to 2 November. This is quite a standard length for a survey in the Finnish context (usually 7 to 10 days and subsequent reminder with 3 to 7 days to reply). It was, however, a relatively short time considering the size and diversity of the target group. This was due to the overall time pressure that the entire evaluation, and the Portuguese Government in this case faced.

The fact that easy access was seen important led to the survey being sent as an open link, which Programme stakeholders could send forward to their colleagues in case they so wished to ensure a good response rate. Naturally, this led to two potential difficulties: one cannot determine the exact response rate in percentage terms and there is a slight possibility of someone answering the survey twice. This, however, was seen as a strategy worth pursuing, given the importance of involving as many stakeholders as possible through a process as open and transparent as possible in the short timeframe.

Even if individual respondents would have responded more than once, the number of such responses would have had to been significant as the stakeholder group addressed was originally so large. With the number of respondents being 717, for this double response to be a real problem, the number of doubles should be considerable before it would make a statistical difference in the results. The low level of external respondents in the survey was not surprising and in fact, the questions were formulated in a way that required respondents to have some experience in the Programmes. External views were brought to the process through the involvement of the External Review Committees as survey respondents and interviewees and the two evaluation panels. A benchmarking comparison of selected indicators was also made on eight Portuguese doctoral programmes. The quantitative analysis is also accompanied by a large number of qualitative open responses, which provide us with important additional data despite all potential or actual problems with the survey's quantifiable data. Together with the other data sources, this provided the evaluation steering group with an important body of data to be analysed.

Interviews and stakeholder access was in the end less of a problem than expected. In fact, the evaluation steering group could speak with a large and representative sample of Programme stakeholders and the Ministry and FCT were very cooperative in organising the meetings. The stakeholders were very open and constructive when they were contacted and asked to contribute. Despite the time differences and calendar pressures, an important body of information was gathered from the stakeholders and Programme actors on both sides of the Atlantic, and their contribution was very highly appreciated.

Due to the tight timetable, recruiting high-level experts to the evaluation panels was challenging. The organisational issues were solved, and thanks to the flexibility of the experts contacted, two very good sessions with these two high-level experts were organised, one in Helsinki and one in Copenhagen.

2. PROGRAMMES AND THEIR OUTPUTS IN BRIEF

2.1 Massachusetts Institute of Technology - Portugal collaboration

The collaboration between Massachusetts Institute of Technology (MIT) and Portugal began in 2006 as a five-year programme (2006–2011). Renewed on 1 June 2001 until September 2012, the main goals of the Programme are the following:

- *to foster emerging concepts associated with complex engineering projects,*
- *to promote the design, test and implementation of new products worldwide,*
- *to train future leaders in cutting-edge areas of engineering,*
- *to facilitate, stimulate and reinforce the insertion of Portuguese academic research groups into international networks,*
- *to promote inter-institutional postgraduate training and opportunities,*
- *to develop a cadre of innovation leaders with an entrepreneurial bend, and*
- *to promote interaction between universities and companies.*

The scientific focus areas of the MIT-PT Programme consist of engineering systems (ES), bio-engineering systems (BIO), engineering design and advanced manufacturing (EDAM), sustainable energy systems (SES) and transportation. These have been translated into:

- *four doctoral degrees*
  - *BES*
  - *EDAM*
  - *SES*
  - *Transportation*
- *three Master's degrees*
  - *SES*
  - *Transportation*
  - *EDAM*

The structure of the Programme is built around three steps of financial support: institutional financing (first year), scholarships based on open call (second year) and R&D projects based on open call (third year). The activities within the MIT-PT Programme include teaching and training, research, exchange programmes, industry liaison as well as annual conferences and thematic workshops.

An additional activity was created in 2010. The innovation and entrepreneurship initiative was established with a view to creating a national venture competition that could act as a launching pad for early-stage, high-tech companies by offering seed funding and other capabilities. The structure of the initiative resembles traditional business plan competition with an award of EUR 100,000. The participating teams are expected to increase company value ten times within the first three years, to reach the minimum pre-money valuation of EUR 2 million, and be prepared to raise venture capital investment worth EUR 2–5 million.

The MIT-PT Programme is the largest of the three Programmes in terms of budget and students, attracting to date nearly 600 (586) students. The Programme has a budget of EUR 77,579,210 (Portugal: EUR 32,600,000; the US EUR 32,900,000), of which 75% of the funding remaining in Portugal has been allocated to the institutions of IST, the University of Minho and FEUP. Private funding covers a marginal share of the programme funding (2.7%, with 59 industrial affiliates having participated in the Programme).

The MIT-Portugal Programme – the largest of the three Programmes measured by outputs – has attracted a range of participating institutions consisting of six universities, eight schools that assign degrees, 13 universities participating in R&D, nine associated laboratories as well as a state laboratory in Portugal. Overseas (in the US), five schools covering 25 departments have taken part in the Programme. In terms of staff, 23 faculty teachers have been hired through the

Programme and 214 Portuguese university professors have been involved in the execution of the Programme, versus 62 MIT professors in the US. The private sector participation in Portugal has also been active, consisting of 59 companies.

The Master's students represent 44 and 16 nationalities, respectively. In the 2010/2011 academic year, 62% of the enrolled students were Portuguese and 38% foreign. Currently, there are 489 registered students, of which 369 are studying for a doctoral degree and 120 for a Master's degree; 89 students have obtained a Master's degree and 204 have been awarded a PhD scholarship.

During the Programme, 20 collaborative R&D projects (selected out of 72 applications) have been executed. The average duration of projects has been three years. The Programme has also resulted in four spin-offs (1 in 2008, 1 in 2010, and 2 in 2011):

- ***Biomode**: In 2008, the spin-off participated in the project DNAMIMics BioTeams initiative, and in December 2010, the company was established.*
- ***Cell2B**: established in 2011, a biotechnology company specialising in the development of cell therapies for medical application.*
- ***SilicoLife**: established in 2010, started as part of the MIT Portugal Programme, Bioteams 2010, developing computational tools and modelling to accelerate the optimisation of bioprocesses in the biotechnology industry.*
- ***Inside Building**: established in 2011, dedicated to energy certification activities and the quality of technical management of buildings.*

Additionally, the MIT-Portugal collaboration has resulted in two patents, one in 2009 and another more recently, in 2011.

2.2 Carnegie-Mellon University - Portugal collaboration

The Carnegie-Mellon–Portugal collaboration began in 2006 and was originally planned to end in 2011 but was renewed on 1 June 2001 until September 2012. The CMU-PT Programme aims at:

- *creating internationally recognised research and graduate education programmes,*
- *strengthening the connections among universities and academic research institutions with high-tech companies and start-ups,*
- *supporting the recruitment of outstanding talent to Portugal, and*
- *exchanging best practices and promoting a creative and entrepreneurial environment.*

The Programme focuses on Information and Communication Technologies and in order to meet the set goals, the Programme has been set up under the following scientific fields: security and critical infrastructure protection (SCIP), future internet services and technologies (FIT), services and technologies for interactive media (STIM), and software engineering (SEI). The scientific fields are reflected in the awarded degrees:

- *Dual PhD degrees*
    - *Computer Science (CS)*
    - *Electrical and Computer Engineering (ECE)*
    - *Engineering in Public Policy (EPP)*
    - *Human-Computer Interaction*
    - *Language Technology (LTI)*
    - *Applied Mathematics*
    - *Software Engineering in Technological Change and Entrepreneurship (TCE)*

- *Master's degrees*
    - *Entertainment Technology (MET)*
    - *Human-Computer Interaction (MHCI)*
    - *Information Technology – Information security (MSIT-IS)*
    - *Software Engineering (MSE)*

The Programmes have quite similar structures and activities. The CMU-PT structure consists of institutional financing (first year), scholarships based on open call (second year) and R&D projects based on open call (third year). The activities include teaching and training, research, exchange programmes, R&D networks, industry liaison as well as annual conferences and thematic workshops.

Under the initiative launched, a cooperation programme was set up as a joint initiative of FCT, UMIC and Fraunhofer-Gesellschaft. In contrast with the former partnerships, this one was established with an organisation from another European Research Area country, and it focuses exclusively on research activities.[6]

The CMU-PT Programme has the second largest budget, worth of EUR 65,507,540. More than two thirds of the Portuguese side of the budget has been distributed between the institutions of IST, FCUL, the University of Madeira, and the University of Aveiro. The share of private funding has been particularly important in the CMU Programme, with a total of 81 industrial affiliates contributing over 17% of the total budget. The Programme has attracted the smallest amount of students (273) consisting of 85 doctoral students, 183 Master's students, and five postdoctoral students. However, the figure of graduated students is the highest among the three Programmes (1 PhD, 101 Master's and 2 postdocs).

The Carnegie-Mellon University–Portugal Programme institutional participants in Portugal consist of nine universities, 14 schools that assign degrees, five associated laboratories and one institution of applied research as well as seven universities and nine research centres in the US. Teaching and training staff includes more than 150 professors and senior researchers involved in projects and educational programmes. Moreover, 56 faculty members have been hired through the programme. Thirty teachers from nine different Portuguese universities participated in the Faculty Exchange Programme, which stands for a period of stay at CMU to investigate and teach.

In terms of students, CMU-PT Programme is considerably smaller than MIT-PT. The percentages of Portuguese and foreign students are similar to the MIT-PT Programme (the former 66% and the latter 34%).

Additionally, there are 85 scholarships to be awarded for doctoral students and five for postdocs. Currently, 148 students are studying for 75 doctoral degrees, 70 Master's degrees, and three postdoc degrees. CMU-PT is the only Programme with a reference to students who have dropped out. There are 21 of them (nine PhD students, 12 Master's students). While the benchmark programmes analysed as part of the evaluation (chapter 3.4. of the final report) report lower figures for drop-out rates, the evaluation panels and their experts still considered the drop-out rates relatively low.

The private sector participation has been the most comprehensive in the CMU-PT Programme with 81 companies taking part. Altogether 25 R&D projects have been executed, and their average duration has been three years. The projects were chosen from among 43 applications, resulting in a rather high success rate.

Apart from the R&D projects, several other activities have also taken place, such as projects called Drive-In (Large-Scale Testbed for Intelligent Transportation Systems), Sinais (Human-Computer Interaction Systems for Sustainable Living), Vital Responder (Cyber-Physical Systems for First Responders in Emergency Scenarios), and Interfaces (Secure Software-Intensive Systems). No patents have been created so far. However, the following spin-offs have been established:

- ***Dognaedis**: a start-up established by Mário Zenha-Rela, faculty at Faculdade de Ciências e Tecnologia da Universidade de Coimbra (FCTUC) and Francisco Rente, PhD student. The main business focus of this company is on Information Security, in three major activity areas: Security Audit and Consultancy, Software Assurance and Business Continuity.*

[6] Godinho & Simões, 2009 and 2010.

- ***FeedZai****: a start-up created by Paulo Marques and Pedro Bizarro, two faculty members of the Faculdade de Ciências e Tecnologia da Universidade de Coimbra (FCTUC), and Nuno Sebastião, product manager at the European Space Agency (ESA), specialised in processing large volumes of data with low-latency producing actionable information in real-time.*
- ***GeoLink****: a start-up created by Michel Ferreira, at Faculdade de Ciências da Universidade do Porto (FCUP), focused on the management of geospatial information. This start-up is fully involved in the Carnegie Mellon Portugal partnership through the participation in the research project DRIVE-IN.*
- ***Mambu****: a start-up company established by two alumni of the Master in Human Computer Interaction, namely Eugene Danilkis and Frederick Pfisfered. This company was designed to support the unique needs of small- and medium-sized organisations (MFIs) providing microcredit services.*

2.3 University of Texas at Austin – Portugal collaboration

The five-year (2006–2011) cooperation between the University of Texas at Austin and Portugal has also been renewed until September 2012 and its main goals are:

- *to expand the presence of advanced digital media in Portugal through educational and research exchange*
- *to promote interaction between universities and companies*
- *to promote inter-institutional postgraduate training and opportunities.*

The Programme has been built around advanced digital media and mathematics. The focus areas in the latter are dynamical systems, financial mathematics, game theory, optimal control, viscosity solutions, number theory, and cryptography. These have been translated into:

- *Doctoral programmes*
    - *Digital Media*
    - *Advanced Computing*
    - *Mathematics*

- *Master's programme*
    - *Digital Media*

The structure of UTA-PT Programme follows the pattern of the other two Programmes: institutional financing (first year), scholarships based on open calls (second year) and R&D projects based on open calls (third year). There are small deviations in activities compared with MIT-PT and CMU-PT. The activities consist of teaching and training, research, exchange programmes, workshops and public exhibits (Future Places Festival, Monstra Short-Film Festival), industry liaison, as well as annual conferences and thematic workshops aimed at networking and community building. As part of the community building, the alumni are also seen as a significant resource, and this is an important lesson to be learnt across the Programmes.

The University Technology Enterprise Network (UTEN) separates UTA-PT from the other Programmes. The network of professional Technology Transfer Offices (TTOs) was established in 2009 and it operates under the UTA-PT Programme to promote the development of globally competitive and sustainable Portuguese technology commercialisation infrastructure. The activities of UTEN range from internships for international technology transfer professionals to more broad-based events specialising in technology transfer, as well as an international competition for technology-based companies "ISCTE Portugal-MIT Venture Competition" and a pilot programme "International Business Development". The evaluation of UTEN is undertaken as part of the UTA collaboration.

The budget of the UTA-PT Programme is considerably smaller than that of the other two, i.e. EUR 23,420,000. A slightly larger share of the budget stays in Portugal (EUR 10,250,000 vs. EUR 9,750,000). Three fourths of the Portuguese share of the budget has been allocated to three Portuguese institutions, namely the Universities of Porto and Coimbra, and IST. Private funding

plays only a marginal role in the Programme, covering 2.6% of the budget. The private sector funding is derived from 16 industrial affiliates.

The University of Texas at Austin–Portugal Programme has the highest number of participating Portuguese universities (14). Additional participants include 14 schools that assign degrees, three associated laboratories, and two public agencies. A total of 302 students have taken part in the Programme, of them 91 have been doctoral students and 211 Master's students. Currently, the number of registered students is 296 (85 doctoral students, 211 Master's students). So far no students have graduated, and the first ones are expected to complete their degree in 2012. The UTA-PT Programme has the highest rate of Portuguese students (76.5%) vs. international students (23.5%). This is also reflected in the low number of different nationalities (4) represented among the students compared to CMU (16) and especially MIT (44).

Under the Programme, 68 PhD and 11 postdoc scholarships have been awarded. A significant number of visits to the US have also been organised, altogether 256 (118 in mathematics, 97 in digital media and 41 in advanced computing). Organisation of workshops and courses has been active, especially in the area of digital media (87), followed by advanced computing (14) and mathematics (11).

The UTA-PT Programme has been public-sector driven. To date, 15 R&D projects have been executed with participation by 16 companies. Two of the projects were conducted jointly with CMU-Portugal. The projects were selected from among 46 applications. Additionally, support in the form of professional and research internships, including ZON prize winners, have been provided for 19 students.

Other activities (under UTEN collaboration) include:

- *events and workshops*
- *internships and faculty exchange events*
- *evaluation and development of technologies for commercialisation in international markets particularly in the US, originating from Portuguese universities*
    - *Evaluations consist of 64 reviews ('Rapid screen' assessments) and 19 assessments of market potential ('market look' assessments)*
    - *Development of technologies for commercialisation has resulted in more than 250 market contacts*
        - *These have led to 51 manifestations of interest and 13 negotiations.*
        - *Negotiations concern license technologies in three cases and potential on-shoring (via joint venture, IP bundling, and spin-off) in the US market in ten cases.*

2.4 Summary

In terms of figures, MIT-PT is to date the largest Programme, attracting nearly 600 (586) students. Corresponding figures for the other two Programmes are 310 (UTA-PT) and 245 (CMU-PT). MIT-PT also has the highest number of different nationalities represented (44), whereas the figure for CMU-PT is 16 and for UTA rather modest (4). Accordingly, the proportion of Portuguese students is also quite high in UTA-PT (76%). The figure for CMU-PT is 66% and for MIT-PT 62%. Both MIT-PT and CMU-PT have resulted in four spin-off companies and, additionally, MIT-PT has produced two patents. MIT-PT and CMU-PT are also more successful in terms of publications. The number for the former is 291 and for the latter 290. Simultaneously, UTA-PT has produced 229 publications. Not all of these were in peer-reviewed journals, however. The input-output ratio of UTA-PT, however, is better than that of the other two Programmes, because the budget of UTA-PT (2006–2012) is lower (EUR 23,420,000). Corresponding budgets for the two other Programmes are EUR 77,579,210 (MIT-PT) and EUR 65,507,540 (CMU-PT).

3. RESULTS

3.1 Relevance in international terms

When the survey respondents were asked to choose the most significant of the drivers behind the Programme they were familiar with, the answers were divided quite evenly between the options, also independently of the type of respondent (Figure 2). On average, internationalisation was seen as the main driver by 27% to 41% of respondents, clearly the highest rated amongst all Programmes. Closer collaboration between universities within Portugal and cultural change were both selected by about a third of respondents, while access to high-quality research infrastructure not available in Portugal was the least often selected option (8% to 15% of respondents). This estimation was largely confirmed by the evaluation interviews, where the three most often selected options were all seen largely equally important and access to research infrastructure was of secondary importance.

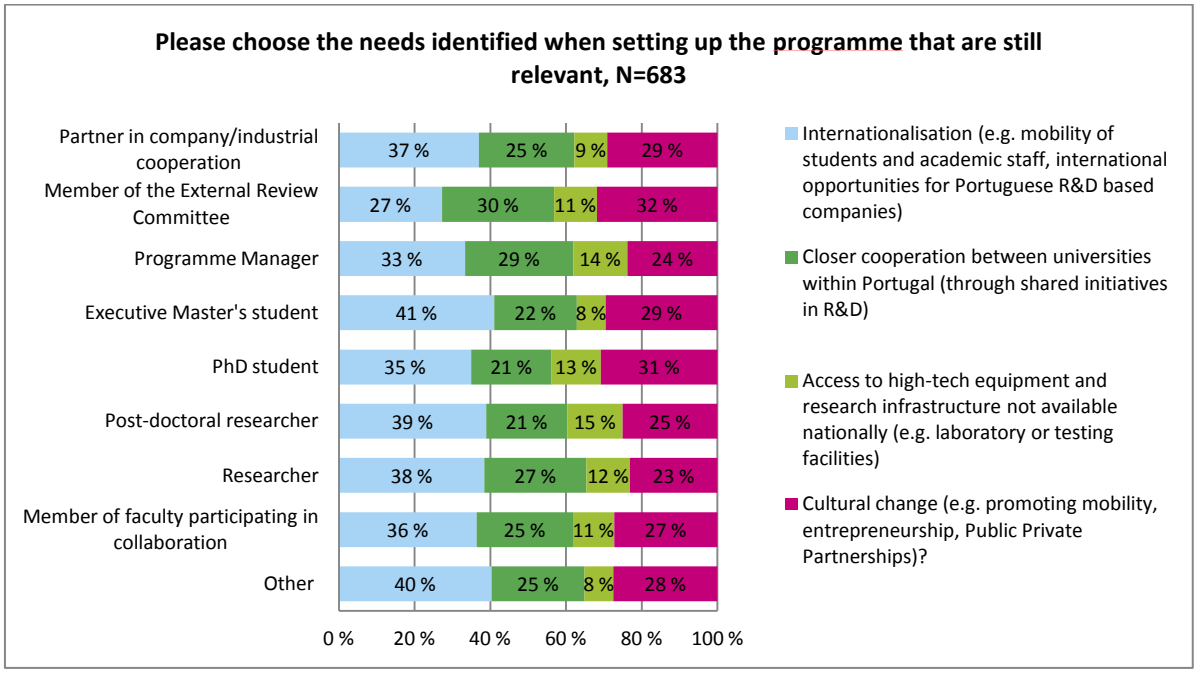


Figure 3. The relevance of needs behind the Programme: stakeholder perceptions

The figures summarise the picture of the respondents across the Programmes per respondent type. While the data was analysed across and between the Programmes, in many cases the results provided most differences when analysed across the responded types, though even here in many cases the statistically significant differences remained small. In the report, the name of the Programme is always referred to in the title of the figure in question, if the result is Programme-specific. In this case, the original needs motivating the Programme and its strategy were seen as relevant across the different types of respondents.

The interviews supported in general the above findings. There were only few cases in which access to R&D infrastructure emerged as an important reason: stem cell research in MIT or large-scale databases used in innovation and entrepreneurship programme (CMU) were mentioned as such examples. Some interviewees approached the issue of access to R&D infrastructure more broadly and then access to research infrastructure could also, for example, be seen as encompassing a fully developed innovation ecosystem (with access to fund-raising, Venture Capital, Living Labs etc.). This kind of positive leverage effect was referred to all three Programmes, but perhaps most often to UTA and CMU. UTA, for instance, was sometimes referred to as a "mini Silicon Valley", where participation in the Programme gave access to the

innovation ecosystem and offered an opportunity of being part of a referral system and innovation community.

The open questions of the survey were analysed to assess the perceived relevance of the areas of cooperation. In many cases comments related to the need to focus further, i.e. to limit the areas of cooperation. An interesting picture emerged when the data from open questions on most relevant scientific fields of collaboration was analysed with the help of Wordle. The question to be answered was "What disciplinary field or scientific area should have been included but was not?" Many respondents first cited the field which they felt was most central or relevant. These were both then listed as relevant fields, to be summarised in the form of Wordle word clouds.[7] The picture that emerged from the open question is thus covering not only those fields of collaboration that should be extended in the future but also what had already been done in the Programmes.

The high relevance of entrepreneurship was common to all Programmes. A broad spectrum of scientific fields was also emphasised, reflecting the multidisciplinary nature of the Programmes.

Figure 4. The relevance of collaborative fields reported in the open answers: MIT

The 'collaborative fields' here relate to the scientific fields in which collaboration between the US and Portuguese partners is undertaken within one Programme, i.e. which scientific fields are covered in each of the Portugal-US Programmes.

In the case of MIT, it was generally felt that the collaboration covered most fields and the relevant ones were already largely active (Figure 4). The focus on entrepreneurship was welcomed, while in some responses it was felt that the focus on management could to some extent make room for more technical specialisation.

Many of the fields proposed were actually already active in two other collaborative programmes (e.g. advanced computing, human-centric computing). One could therefore propose a closer collaboration between the Programmes and a more concerted effort to guide potential PhD students to a suitable university. There are, however, other fields that may be worth considering across the Programmes (e.g. maritime, aerospace, nanotechnology).

[7] While this answer revealed to some extent the challenge of interpreting open questions, which are by defintion not as structured as closed structured questions would be, the word clouds are a useful illustrative method and here used as such. The fact that in the case of open questions people tend to provide supplementary information in addition to answering the actual question is not necessarily a problem for interpretation, however, as all respondents still had a clear answer to the most relevant disciplinary fields and as such the answers contained fully commensurable information.

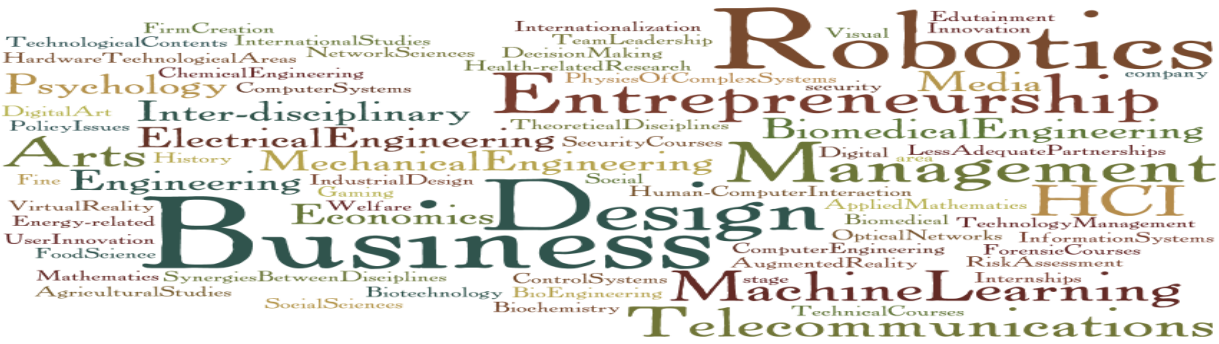


Figure 5. The relevance of collaborative fields reported in the open answers: CMU

In the case of Carnegie-Mellon, the close connections between academia and industry were highlighted in the answers (Figure 5). It was proposed that fields particularly focusing on close collaboration should be emphasised; such fields include robotics and biomedical engineering. Like in the case of MIT, most of the scientific fields of collaboration were seen highly relevant. The interdisciplinary nature of the collaborative fields also came across very strongly.

In the case of University of Austin, Texas, it is noteworthy that the word cloud did not cluster to any great extent (Figure 6). This reflects the fact that the open responses were scattered more widely and included a greater diversity of individual concepts and terms than was the case in MIT or CMU, where certain terms were clearly more often repeated.

The University of Austin Programme fields where more active collaboration should have been promoted included maritime sciences, biotechnology and nanotechnology. There was also a wish that digital media should not only take full advantage of multi- and interdisciplinarity but also its close connections to arts.

Figure 6. The relevance of collaborative fields reported in the open answers: UTA

In summary, all fields of collaboration were considered as highly relevant, both in the survey and also in the interviews conducted. However, interdisciplinarity and close connections of different scientific fields were seen as topics to be explored more extensively. The particular value added of the Programmes lies in this issue (see Chapter 3.2).

3.2 Value added

Value added of the Programmes was clearly significant to those who responded to the survey (see Figure 7). One third of respondents (20% to 33%, depending on the group) are of the opinion that most of the activities would not have happened at all without the Programmes. The extensiveness of networks was highly valued: as indicated in Figure 7, 36% to 56% of respondents are of the opinion that the networks would have been less extensive (in terms of

expertise, network, budget) without the Programmes. This is also in line with the interview findings, where value added of the Programmes is extremely highly valued overall.

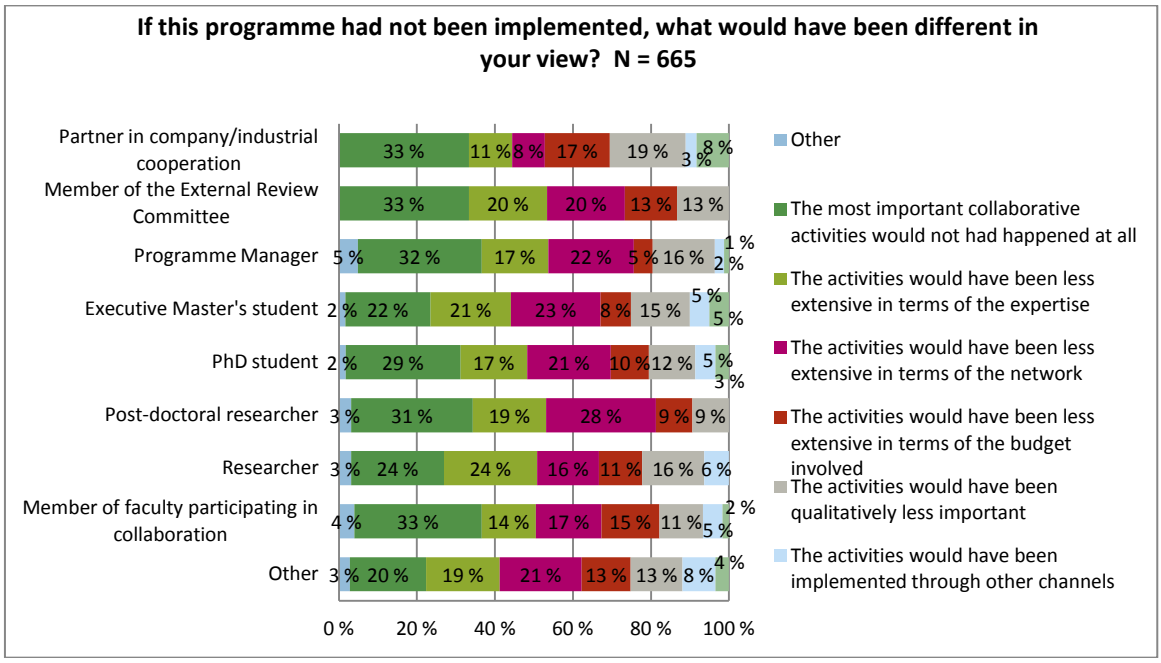


Figure 7. Value added: stakeholder perceptions

When these responses were analysed across the Programmes, the CMU Programme was the one where the largest majority of respondents considered that without the Programme, activities undertaken would not have been implemented at all (76% of CMU respondents were of this opinion). In all 58% of MIT and 68% of UTA respondents felt this to be the case, while 50% of UTEN respondents were of this opinion.

The outputs of the Programmes can be divided into the following categories: teaching and training, participating students, collaborative projects and other activities. Of the total body of survey respondents, 55% selected collaborative projects between the US and Portugal as the most significant output, while 36% considered the PhDs as the main output and another 32% chose new opportunities of exchanging ideas as the main output. The picture is quite similar across the types of respondents in this case.

The Programme-specific replies relating to the significance of the output are provided below (Figures 8–11).

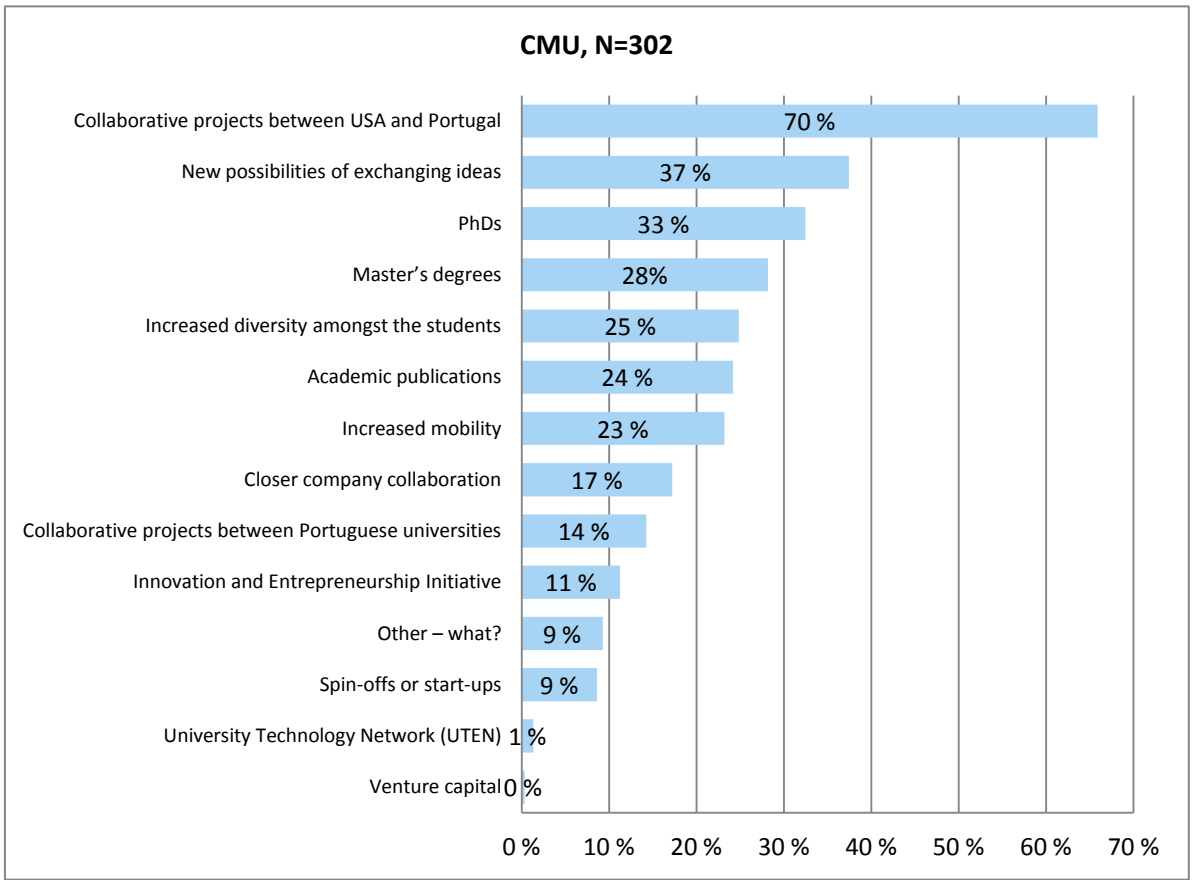


Figure 8. Significance of outputs, CMU respondents' view[8]

In all 66% of CMU respondents highlighted the collaborative projects between the US and Portugal. Possibilities of exchanging ideas were chosen by 37%, as shown in Figure 8. In many of the open questions to the survey and the interviews, the unique nature of the CMU innovation environment and the opportunities for close collaboration with the industry were highlighted. The exchange of ideas was also emphasised as stemming from the interdisciplinary fields in which the Programme works.

[8] "Other – what" for CMU included responses such as professional Master's prorammes, improvement of management processes in Portuguese universities, cultural change, training and mentoring for postdocs, improvement of confidence, etc.

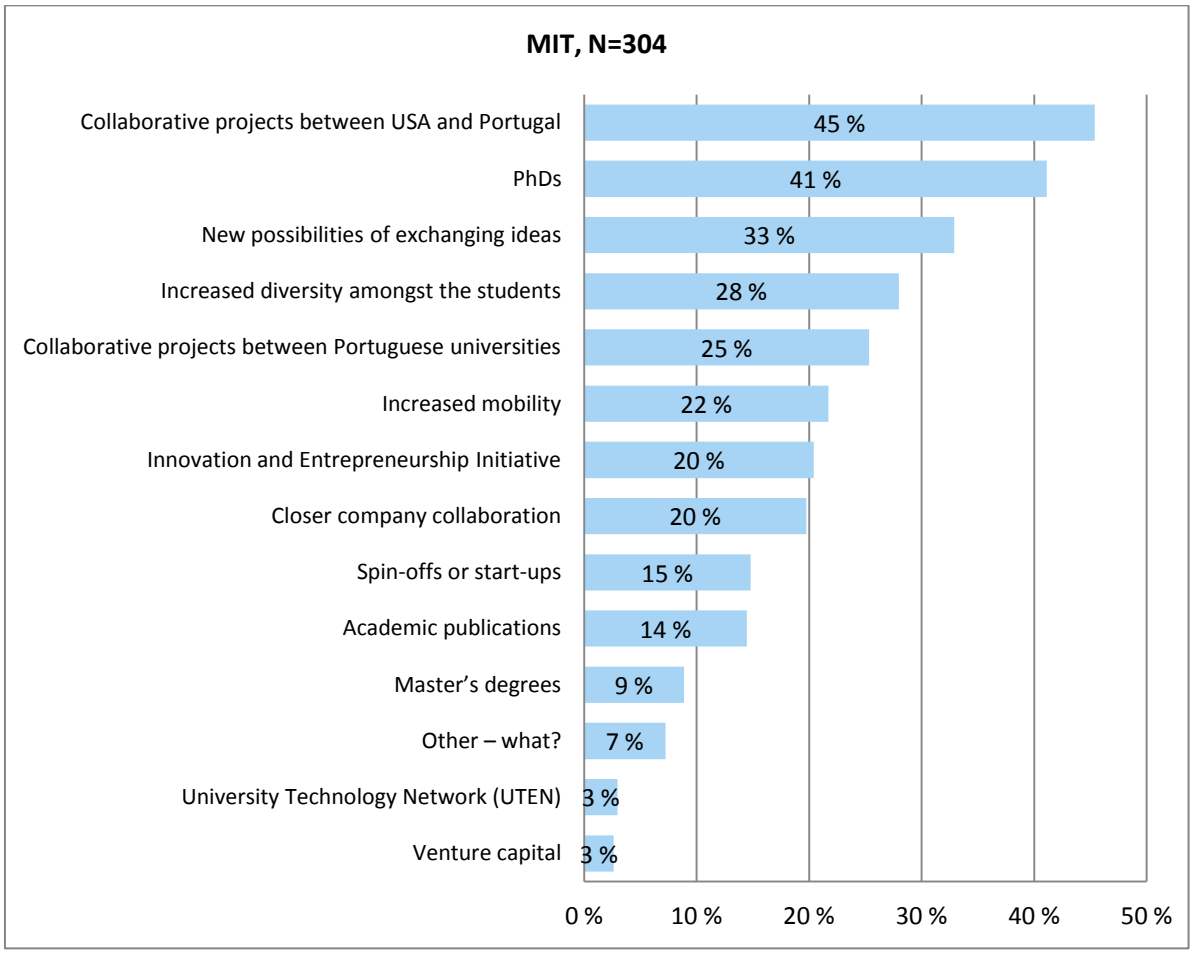


Figure 9. Significance of outputs, MIT respondents' view[9]

The MIT picture (Figure 9) seems to be well-balanced: both PhD training (41% of respondents) and collaborative projects (45%) are appreciated by the respondents. The third leg of the collaboration (commercialisation and entrepreneurship) is also strong. In light of this question, MIT has been particularly successful in balancing the three strands of activity. The low priority given to Master's degrees is clearly a difference to the CMU picture presented above (Figure 8), closer to the UTA case (Figure 10).

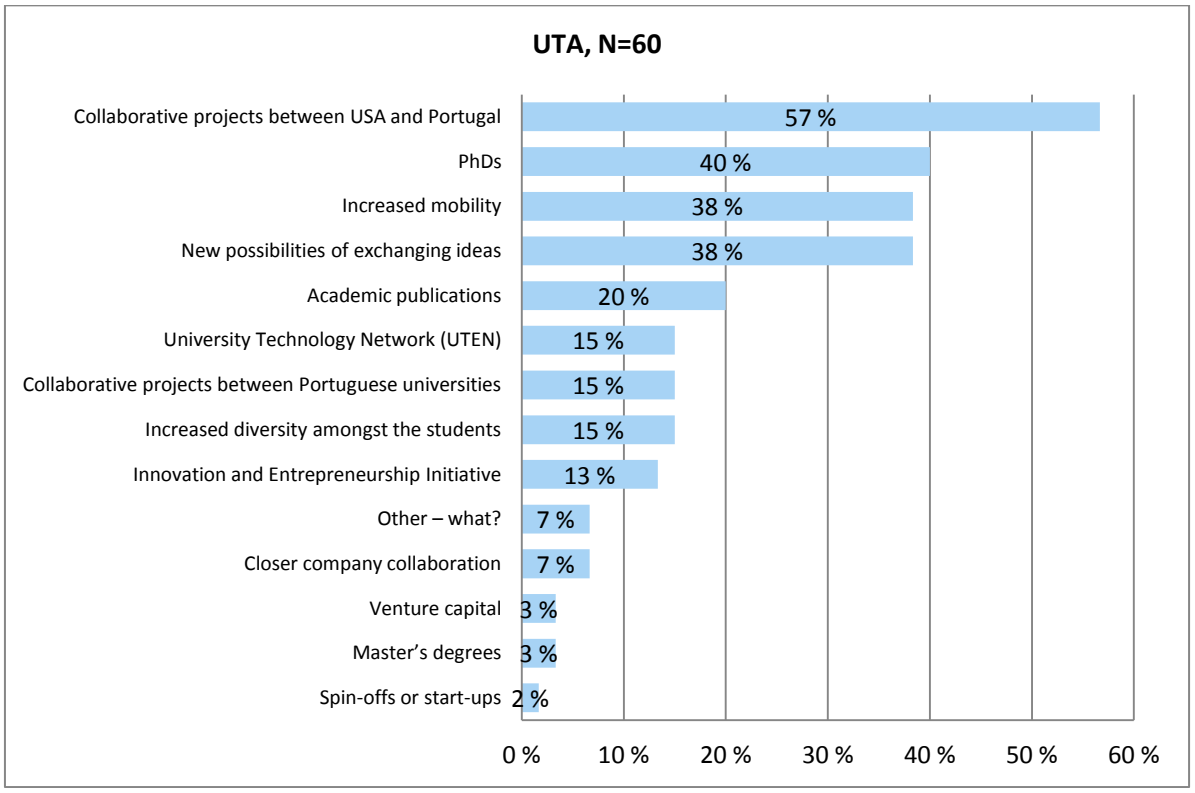


Figure 10. Significance of outputs, University of Texas at Austin respondents' view[10]

Figure 10 indicates that the University of Texas at Austin has been particularly successful in promoting project collaboration between the US and Portugal (57% of respondents). There is a considerably less focus on the third leg of collaboration, i.e. commercialisation and innovation, while the other areas are promoted in a balanced way. The Programme is smaller than the other ones, with considerably fewer respondents than in the MIT and CMU Programmes. As UTEN is part of the UTA collaboration, it should be considered as an extension of the Programme repertoire of methods available.

[10] "Other – what?" responses for UTA included better academic environment, tech transfer staff training, increased mobility and partnerships between R&D/university environments and society at large.

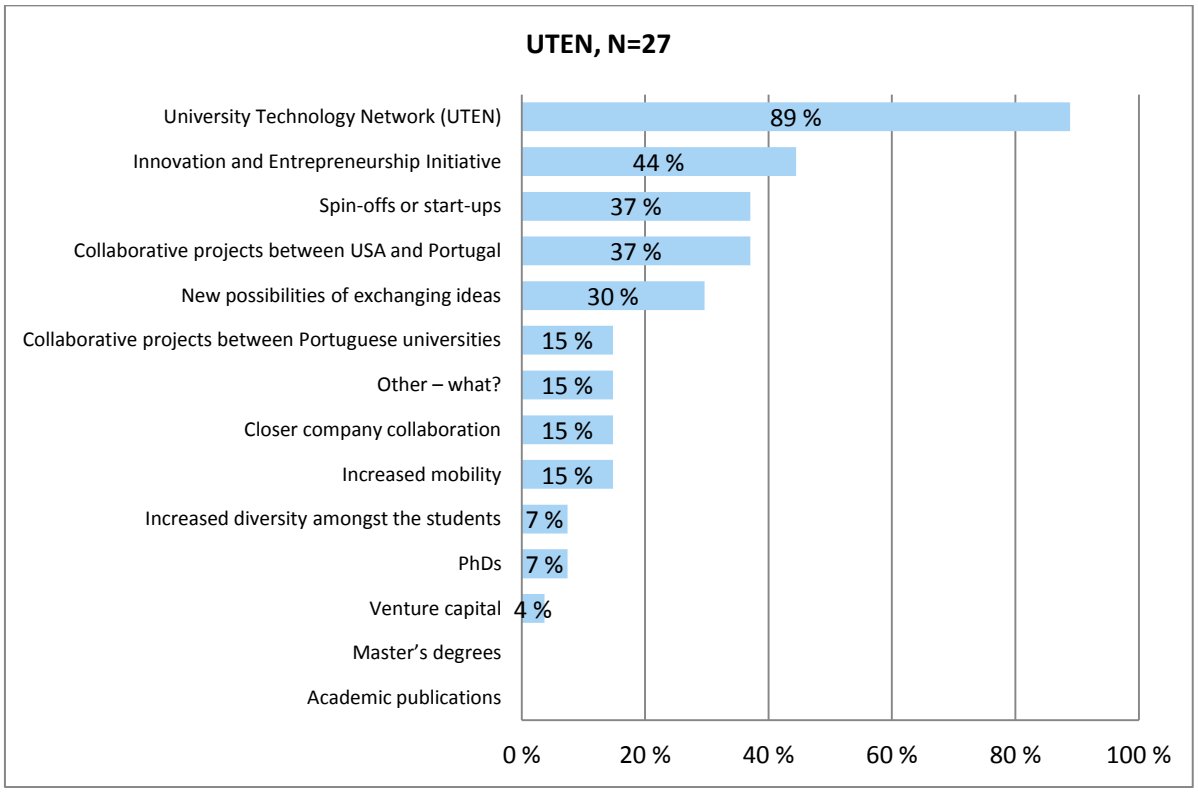


Figure 11. Significance of outputs, UTEN respondents' view[11]

The picture presented in Figure 11 reflects the UTEN Programme focus: technology transfer, innovation and entrepreneurship. The first alternative of UTEN refers to the initiative as a whole, while the other options were supplementary alternatives. The fact that Master's degrees and academic publications are invisible is in line with the Programme goals (not included in the activities). Through the other data gathering of the evaluation we also investigated the connections and flows between the three strands.

3.3 Assessment of the scientific, technological and academic returns from the Programmes

3.3.1 Education, training, study visits

The structures of the Programmes have been different: CMU and MIT have spent the largest proportions of their funding on educational infrastructure, while UTA has particularly been focused on fellowships (Table 2). The proportion of R&D projects has been quite similar in CMU and UTA.

	Educational infrastructure %	Fellowships %	R&D projects %	Management %	UTEN activity %
MIT-PT	57	31	8	4	0
CMU-PT	64	7	16	13	0
UTA-PT	22	38	14	12	14

Table 2. Structure of Programme activities as a percentage of funding allocated to different strands

[11] Open answers to the alternative "Other – what?" in the survey for UTEN included internships, internationalisation opportunities for companies, professionalisation of Technology Transfer Officers, etc.

These differences reflect the variations in selected programme strategies, though also partly the different disciplines and scientific fields chosen by the respective partners. In the case of MIT, the major focus is on education and training, with slightly less attention to project collaboration. UTA in particular has a very strong focus on fellowships and faculty exchanges, and CMU, while having the main focus on education and training, has the strongest focus on project collaboration.

One of the stated objectives of the collaboration between Portugal and the US was to internationalise students by providing more access and exposure to non-Portuguese teaching, supervision and fellow students, and by recruiting more students from outside Portugal. This has been particularly successful in the MIT Programme, though also overall considerable internationalisation has occurred. See Table 3.

	Different nationalities	Percentage of Portuguese students	Number of teachers and researchers
MIT-PT	44*	62%	208
CMU-PT	16	66%	150
UTA-PT	4	76%	40

* 70% of foreign students studied previously at universities that were ranked below Portuguese universities or not ranked.

Table 3. Participation of foreign students

The Programmes have been quite successful in attracting international students. To date, up to 40% of the students are international. In the interviews this was elaborated in many instances, both by Portuguese students and faculty and their colleagues and fellow students from other countries, who felt that the Programmes have increased Portugal's attractiveness considerably. Comparing the number of international students to other benchmarking cases is extremely difficult since different doctoral programmes have in general different strategic goals, as well as differences in science-policy background, objectives, implementation, funding, competition etc. If internationalisation is a real goal, it should be monitored with an appropriate indicator. For example, in the Finnish doctoral programmes the average number of international students is some 12%[12] .

Internationalisation of the curriculum and a more diverse educational and training portfolio have clearly been welcomed by the stakeholders, students and faculty. In light of the survey results, teaching and training benefits are viewed more critically (Figure 12) than project collaboration (Figures 16 and 17). Depending on the group, 35% to 100% of respondents see that teaching and training have not achieved the objectives of the Programme (Figure 12).

Those degree programmes that are not joint (non-dual) are perceived particularly critically. The fact that the studies of such programmes are not acknowledged in both countries has been taken as a negative motivation by the students. The reasoning behind this is that there were differences in standards across the countries, which is undesirable in such collaborative programmes. In cases where such non-dual degrees have originally been implemented (MIT and Austin), the interviewees described the situation as a two-tier system, in which the integration of visiting students into student and academic community was not particularly successful. In some cases, the lack of integration was even described as 'total isolation'. Similar criticism on the degree of integration was also confirmed by a student survey undertaken at MIT where only less than 20% of the respondents felt that they were well integrated in their campuses with other students. It should, however, be kept in mind that at the same time 70–80% of the respondents had the feeling that they were treated with respect by faculty and they got on well with their fellow students and felt that the Programme had supported their personal and professional goals (source: MIT Portugal, A Network of advanced studies involving Portuguese universities and the Massachusetts Institute of Technology, Vol. 2, p. 260). Recently, however, joint degrees have been becoming a norm across the Programmes, thereby responding to one of the main criticisms toward the Programmes (the existence of non-dual degrees and two-tier system).

[12] In the Finnish case, PhD students in clinical medicine with the highest level of international students are expected to do their specialisation and subsequently also work in Finland. Ibid.

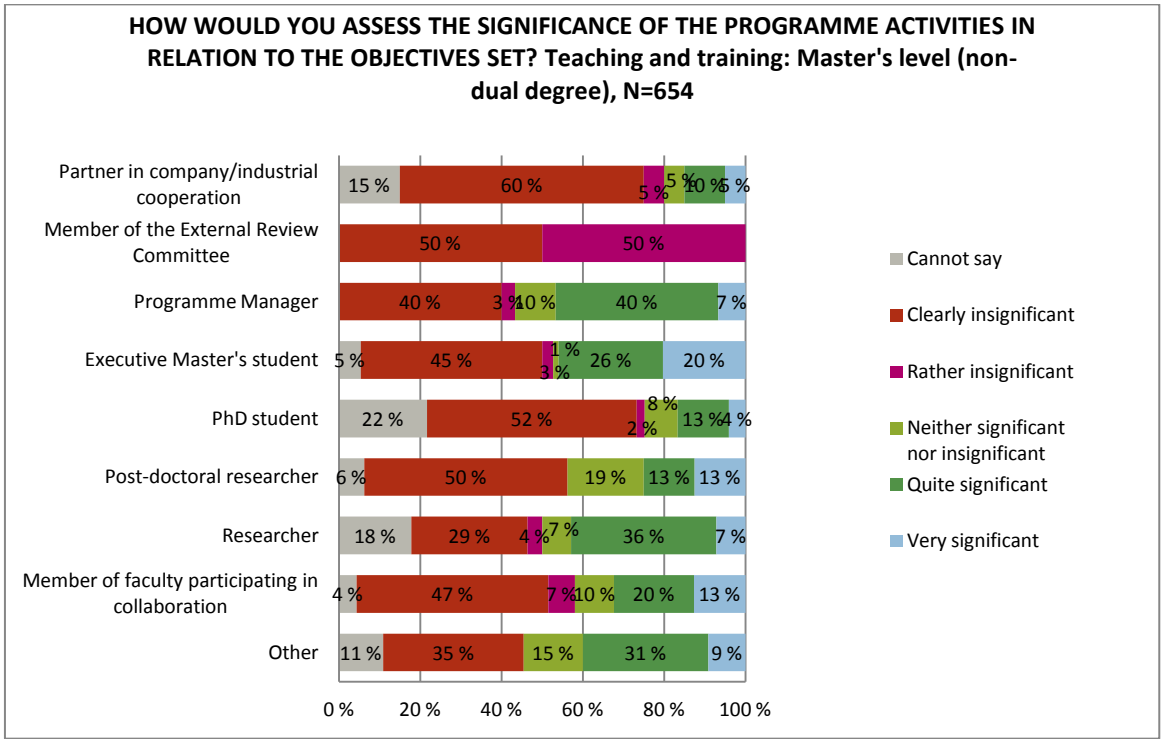


Figure 12. Teaching and training benefits: stakeholder perceptions

The non-dual degrees were perceived critically by all respondent groups, most critically by the External Review Committees and industrial affiliates, as well as by PhD students (Figure 12). The fact that in the early stages of the Programme in particular, joint degrees were not fully developed was indeed a source of criticism across the data (surveys, written reports and interviews, as well as the external evaluation panels). Using a joint degree as a means of attracting international students to Portugal may have its risks such as the international students dropping out more than average. Similar concerns are regularly expressed in doctoral programmes across Europe, though this is seldom an indicator followed very closely (e.g. Niemi et al 2011, p. 89). It has to be kept in mind that, as a rule, all collaborative US-Portugal PhD and Master's programmes are built on the idea that the students spend some time in the US, while most of the studies should take place in Portugal (in most cases, for a PhD candidate 2 years in the US, for Master's student a semester).

In this question the external respondent types (group "Other") were less critical than the internal stakeholders, i.e. those that were involved in the Programmes either did not feel particularly strongly about this question or felt that they did not know enough of the Programmes to respond (11% of the "Other" group felt this way) (Figure 12).

Some Programme stakeholders had expressed concerns over the fact that non-Portuguese students would prefer to stay in the US and not spend the equivalent time in Portugal. In light of the data available this does not happen often, however. Attracting foreign students seems genuinely successful in this regard, as a means of attracting new talent and high-value activities to Portugal (Figure 13). When a foreign student or faculty member is considering Portuguese university as an option, the quality of teaching, training and faculty activities are regarded as the most important issues. The large majority (approx. 2/3) of Programme stakeholders (from 49% to 86%, depending on the group) sees that attractiveness has improved, though at the same time, in the majority of respondent groups there are also almost 10% of those who believe that this goal has been advancing poorly.

Positive examples of fostering interdisciplinary academic culture were referred to both in the interviews and the survey. Among the numerous examples, CMU-PT Programme provides the one described briefly in Box 1.

Box 1. Promising Practice: Master's in Human-Computer Interaction: Interdisciplinarity in practice, CMU example

Professional Masters in Human-Computer Interaction

The Human Computer Interaction Institute (HCII) at Carnegie Mellon University and the University of Madeira offer a professional Master's double degree in Human-Computer Interaction under the CMU/Portugal agreement and with the cooperation of the Information and Communication Technologies Institute (ICTI).

Programme goals
The Human-Computer Interaction (HCI) Master's programme prepares you to participate in the design and implementation of software systems that can be used easily, effectively and enjoyably. With a Master's in HCI, you will be well prepared to contribute to the multidisciplinary teams that typically construct software systems. You will become broadly knowledgeable about techniques for building successful user interfaces, design principles that make user interfaces visually clear and appealing, techniques for identifying needs for software and its success, and the people and organisations that will use their systems.

Interdisciplinary orientation
The MHCI programme has an interdisciplinary orientation, with faculty and students from Computer Science, Design and Behavioural Sciences. The Master's takes three semesters to complete, one of which is spent at Carnegie Mellon and two of which are at University of Madeira. The curriculum consists of ten conventional semester-long courses and an extensive team-oriented studio/project experience. You will take courses to obtain a broad background in computer science, human behaviour, design, and evaluation and assessment, and you may elect to take more advanced courses to deepen your knowledge in a more specific area.

Capstone Project
The MHCI Project course is an eight-month long capstone project for the Master's of HCI programme and integrates everything the students have learned in their coursework into one "end-to-end" experience. Students work in interdisciplinary teams with an industry sponsor to produce a working prototype that serves as a proof of concept of a novel service or product idea.

Sponsors in the Portugal Programme have included Portugal Telecom, MEO, Sapo, Critical Software, Promosoft, Novabase, PT Inovação and Vodafone.

For more information, see http://www.m-iti.org/mhci

Interdisciplinarity and working culture can also be a factor that contributes to increased attractiveness of Portuguese academic milieus and innovation ecosystems. Attracting new talent was one of the aspects investigated in the e-survey, as illustrated in Figure 13.

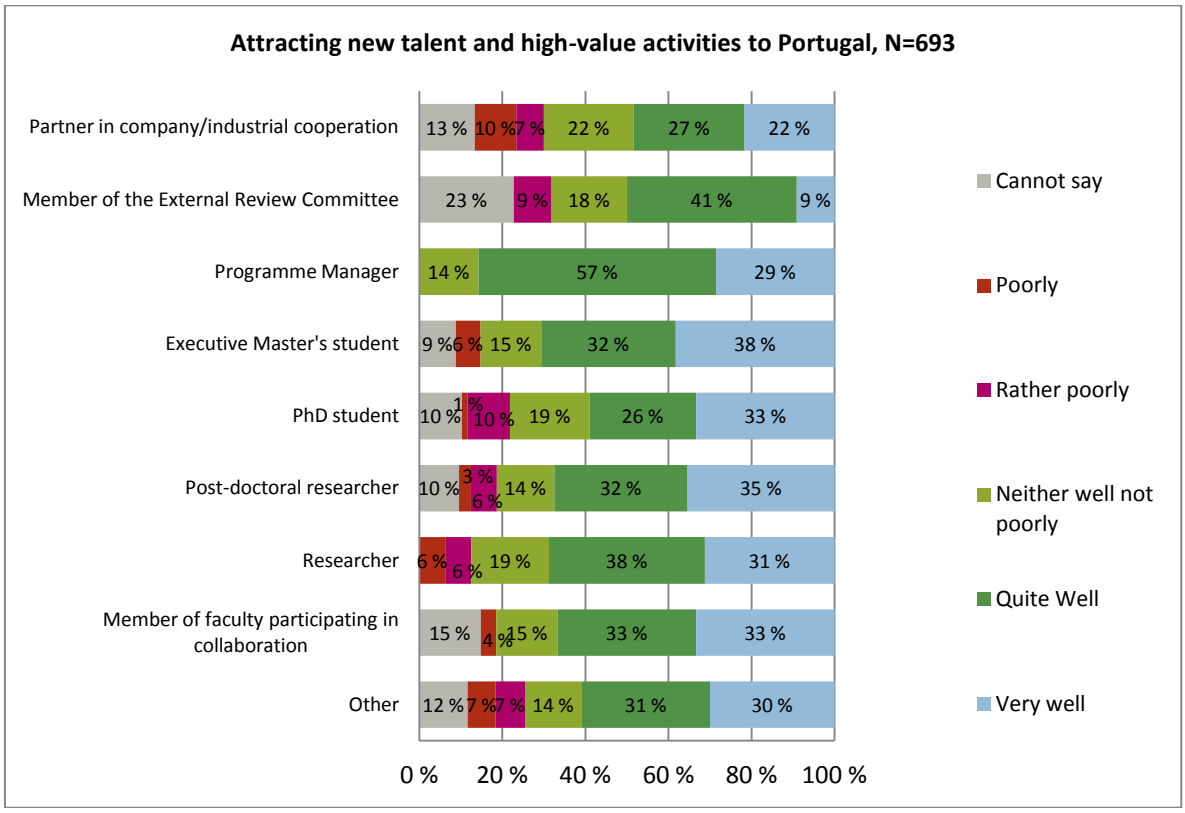


Figure 13. Attractiveness value added: stakeholder perceptions

Attracting new talent and high-value activities ranked quite high in the assessment, highest estimates were given by the CMU (74%) and UTA (64%) respondents, while the percentage of respondents who felt that the Programme had contributed to attracting new talent and high-value activities to Portugal was the lowest among the UTEN respondents, 30% of whom felt this to be the case (CMU: Figure 14; others: see attachment). Yet again the external respondents (group 'Other') ranked very similarly with the other types of respondents. The External Review Committee members also tended to be more cautious in this assessment, the relatively high (over 20%) percentage of "cannot say" responses tends to be indicative of the fact that they as non-Portuguese experts and not working in Portugal do not feel they know the Portuguese situation well enough to assess this.

Interviews have shed additional light on this important issue. One of the leverage effects for attractiveness has been the interest towards the Programme model itself: when travelling and working with non-Portuguese colleagues, the collaboration raises considerable interest and promotes the profile of Portugal as a country with innovative methods and ideas in the area of R&D&I, and working with the best US universities being an additional perk to be used in marketing.

The question for CMU "When compared to other R&D activities, how useful was the Programme? Do you agree with the statements below?" summarised the motivation of the students, faculty etc. as the most important element, while least effects were seen to have emerged for the availability of Venture Capital (Figure 14). This was the case in all three Programmes, as well as UTEN collaboration. The most positive picture emerged from the CMU collaboration (for responses for the other three, see attachment).

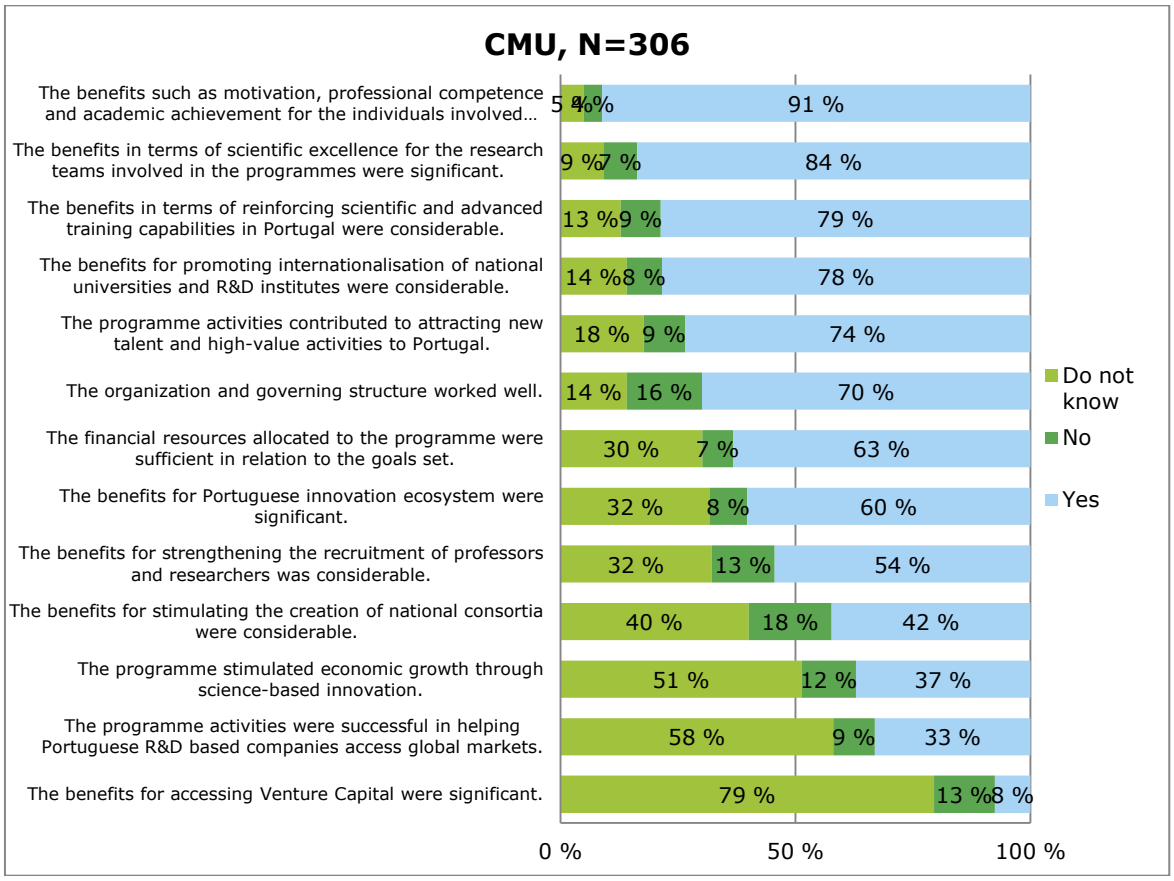


Figure 14. Main benefits of the CMU Programme: stakeholder perceptions

This reflects the views of the interviews where both students and faculty used strong positive expressions such as "life-changing experience" or "transformative experience". The scientific excellence was also a value added element, with which the respondents strongly agree. The findings are tentative at this stage and very few PhDs have been completed. Qualitative change is reported in the survey and the interviews, however.

3.3.2 Collaboration in research projects

The research outputs in terms of the project calls have been important in the first three years of the Programme execution. The number of academically published papers is considerable, taking into account that the academic publication process is known to be a slow one. It is thus in many respects still too early to judge even the outputs (Table 4).

	Open call projects			Publications
	Applications	Accepted	Acceptance rate (%)	Number of papers
MIT-PT	72	20	27.8	291
CMU-PT	43	25	58.1	290
UTA-PT	46	15	32.6	229*

* Many of these are not yet published or are not in peer-reviewed journals.

Table 4. Number of projects and publications of the Programmes

One can see that the application process is not particularly competitive (Table 4). When the Programmes are being compared with each other, clearly there is not any separate "MIT-Portugal" track of easy access, rather the quality requirements remain the same as for other Programmes. Yet the competition for Portugal-US Programmes seems to be less tough than for in

FP7 projects, where the acceptance rate for Portugal has been lower, i.e. 19.3%.[13] The acceptance rate in Portuguese national doctoral programmes is also lower than in the Portugal-US Programmes (see the benchmarking section 3.4.). For instance, the International Neuroscience Doctoral Programme (INDP) has an admission rate of 13%.

Collaborative projects and PhD education were assessed as amongst the overall most relevant outcomes of the collaboration, though there were Programme-specific differences as to the main elements of most valuable outputs (Figures 8–11).

There were both Programme-specific and respondent type–specific differences as to the main elements of most valuable outputs. According to the survey findings, all Programmes value the collaborative projects most highly, while the second important activities differ, ranging from mobility and new ideas value at UTA and PhDs at MIT, to exchange of ideas at CMU and spin-offs at UTEN (Figures 8–11).

In terms of project collaboration, many respondents are simply not in the position to answer, as they are not familiar with the project activities. Even amongst the Programme managers and researchers, more than half of them cannot say how important this project collaboration has been (Figure 15).

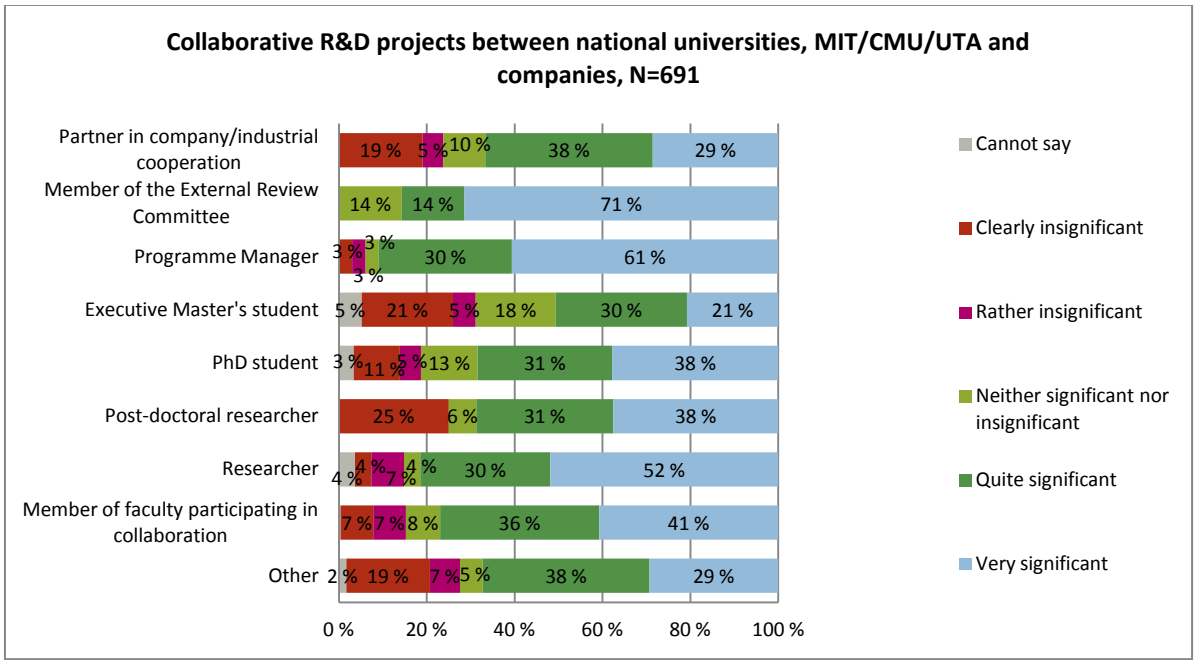


Figure 15. Collaboration in projects: stakeholder perceptions

The survey shows that as many as 67% of the companies see the project activity as quite or very significant and this is a positive sign as the project ownership often lies with the industrial partners, whose problems are to be solved or applied solutions found (Figure 15). This was also valued as a particularly important element of collaborative projects in the interviews across the Programmes.

Programme managers tend to give most positive estimations across the questions and this is probably only natural if they are committed to their Programmes and wish to see them in a positive light (Figure 15). The fact that postdoctoral researchers, executive Master's students, industrial affiliates and the group 'Other' respondents are most critical of the project collaboration between national universities (25%, 21% and 19%, respectively, assessing the project collaboration as 'clearly insignificant') is an important result, however. It is obvious that the

[13] The equivalent percentage for EU-27 is 21.5% and for Finnish applications in FP7 22.7%. Source: http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=country-profiles-detail&ctry=portugal.

external stakeholders have not yet been fully convinced that these Programmes have raised the Portuguese universities to the next qualitative and quantitative level. The benefits are still internal to the Programmes rather than visible to the broader innovation environment.

The opinion presented by the interviewees and survey respondents that the Portuguese universities are still in the early stages of forming new collaborative partnerships and implementing new initiatives, may have an impact on European collaboration, for instance with European funding and in the context of FP7.

3.3.3 Innovation and entrepreneurship activities

The interviewees, in particular, emphasised the cultural change and the increasing focus on innovation and entrepreneurship. The fact that research, training and the quality of education is improved was in a sense taken as given, while the benefits for the innovation ecosystem in the form of innovation and entrepreneurship activities were less planned, but perhaps all the more valued.

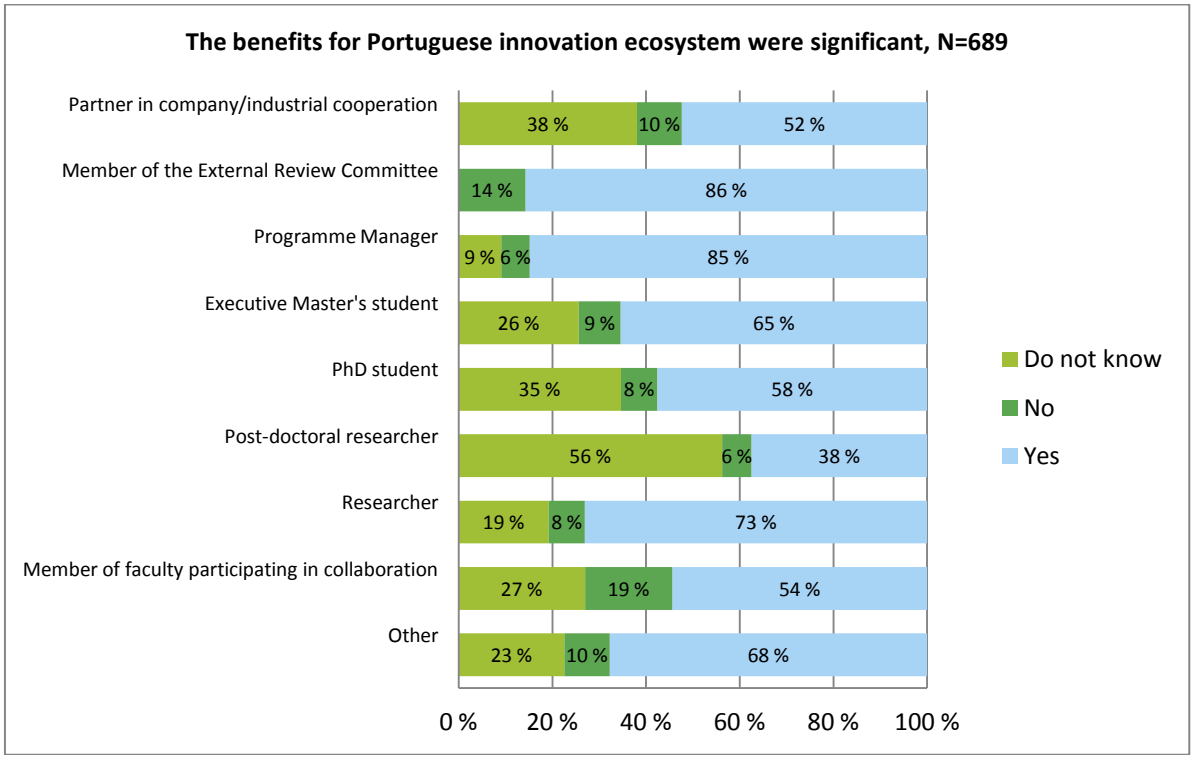


Figure 16. The perceived innovation ecosystem benefits

When compared with the other activities, UTEN rates highest when it comes to the innovation ecosystem effects. After all, it is UTEN that has most relevant activities for the innovation ecosystem, with technology transfer and innovation in focus.

MIT rates lowest in the survey data as regards the innovation ecology effects. That is, however, understandable in light of the Programme focus, since MIT has less focus in this area.

There are higher than average levels of "do not know" responses here and across the different types of respondents, reflecting perhaps the difficulty of the concept of "innovation ecosystem" (Figure 16). The external respondents (the group "Other", the External Review Committees, industry respondents) view the effects on the Portuguese innovation ecosystem as quite significant. The fact that 68% of the group "Other" respondents feel this has been the case suggests that the influence has been visible to the outside, to those not directly involved in the Programmes but involved in the innovation ecosystem. This is clearly a positive outcome in the view of the evaluation.

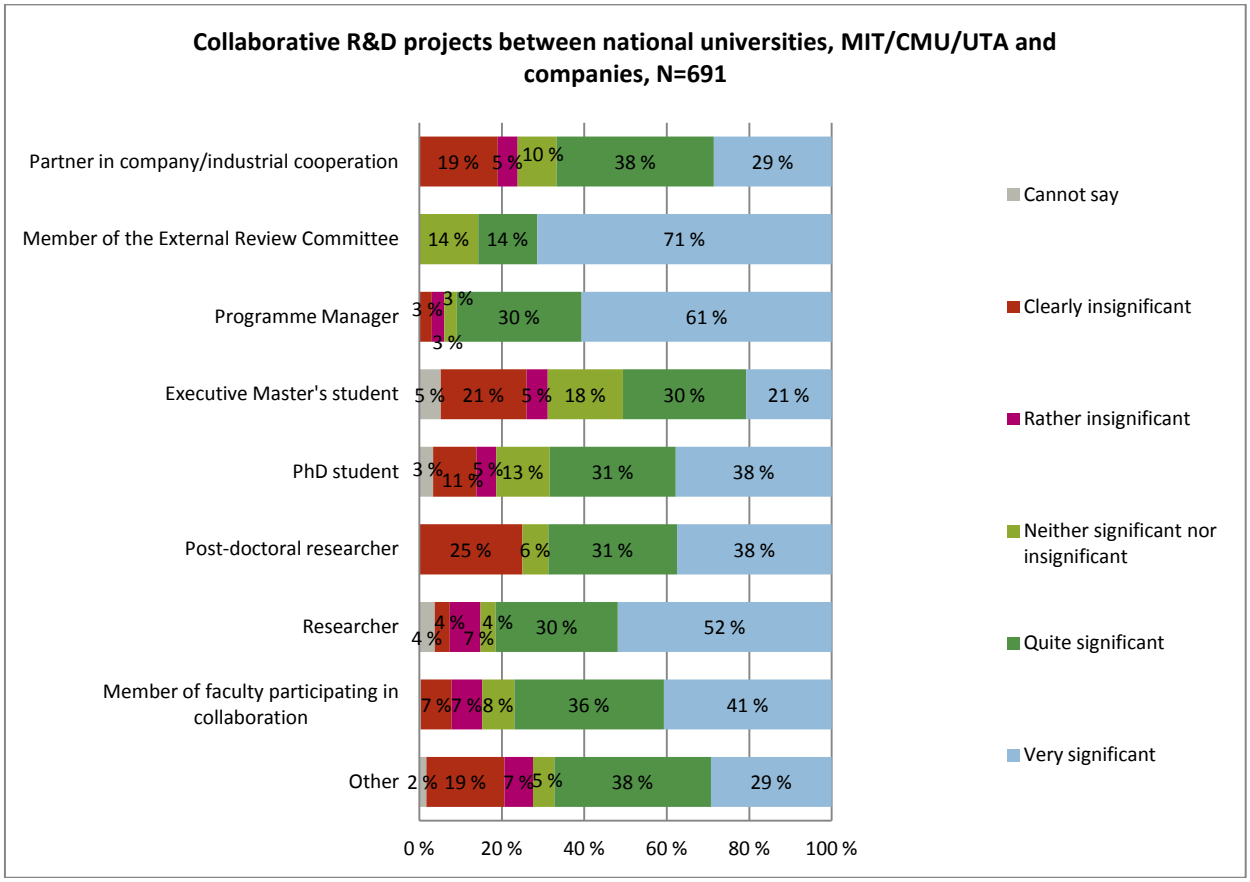


Figure 17. Collaboration in projects: stakeholder perceptions

The survey shows that as many as 67% of companies see the project activity as quite or very significant (Figure 17). This is a positive sign as the project ownership often lies with the industrial partners, whose problems are to be solved or applied solutions found.

However, industry collaboration is not limited to R&D projects only. In fact, fostering interaction with companies takes place in all Programmes. All Programmes have contracts with their formal industrial affiliates (whose annual financial commitments range from EUR 10,000 to EUR 1.5 million), but collaboration takes numerous other forms as well, e.g. professionals to projects and internships.

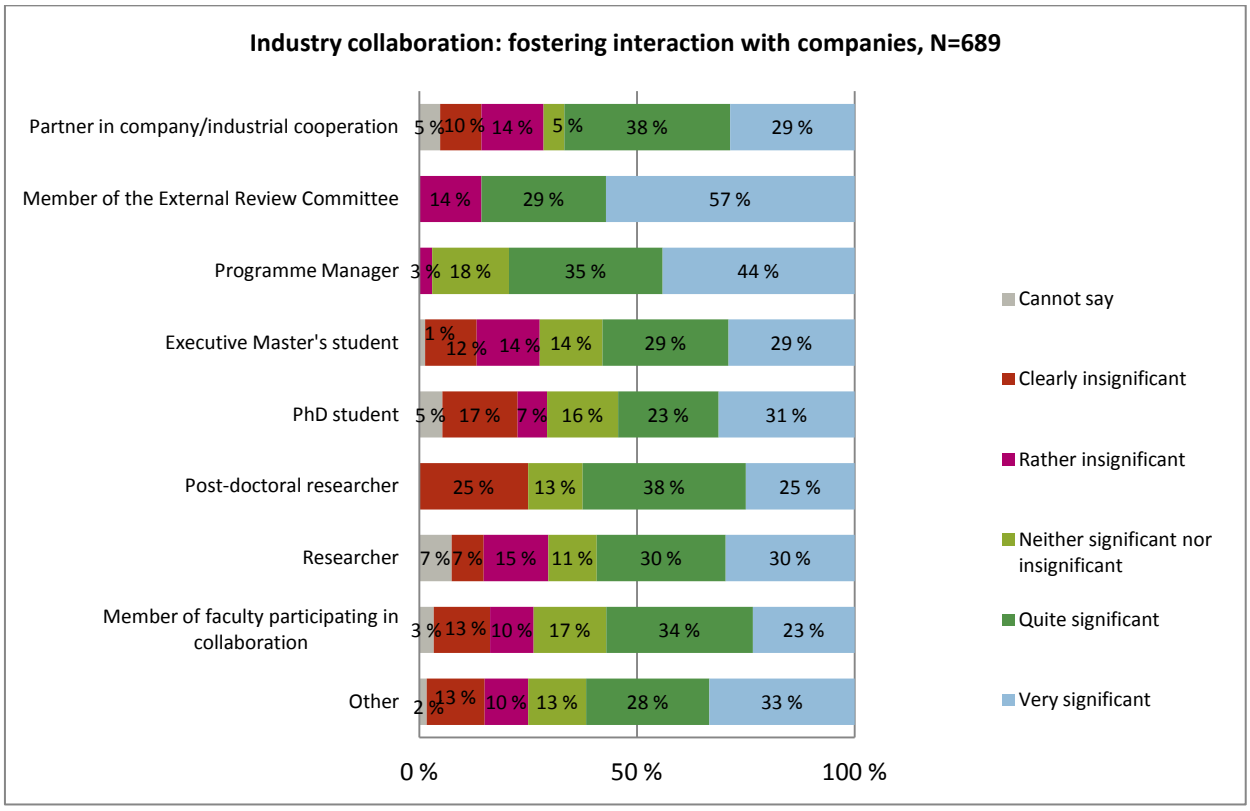


Figure 18. Value added for fostering interaction with companies: stakeholder perceptions

It is interesting that industry collaboration was seen more positively (very or quite significant) by the External Review Committee members and the Programme managers than by the industry partners themselves (Figure 18). Even though the group "Other" viewed the industry collaboration less significant than other external respondents (the industry partners, the External Review Committees), the percentage of very or quite significant was, however, 61% in this group.

According to the survey (Figure 19), collaboration in the Programmes is important both as bilateral cooperation between the US and Portugal and as the multilateral ties that have emerged between the universities and departments of the two countries, but equally important in terms of the closer collaboration that has ensued within Portugal. In fact, this is one of the value added factors and the most important changes that emerged from the evaluation data.

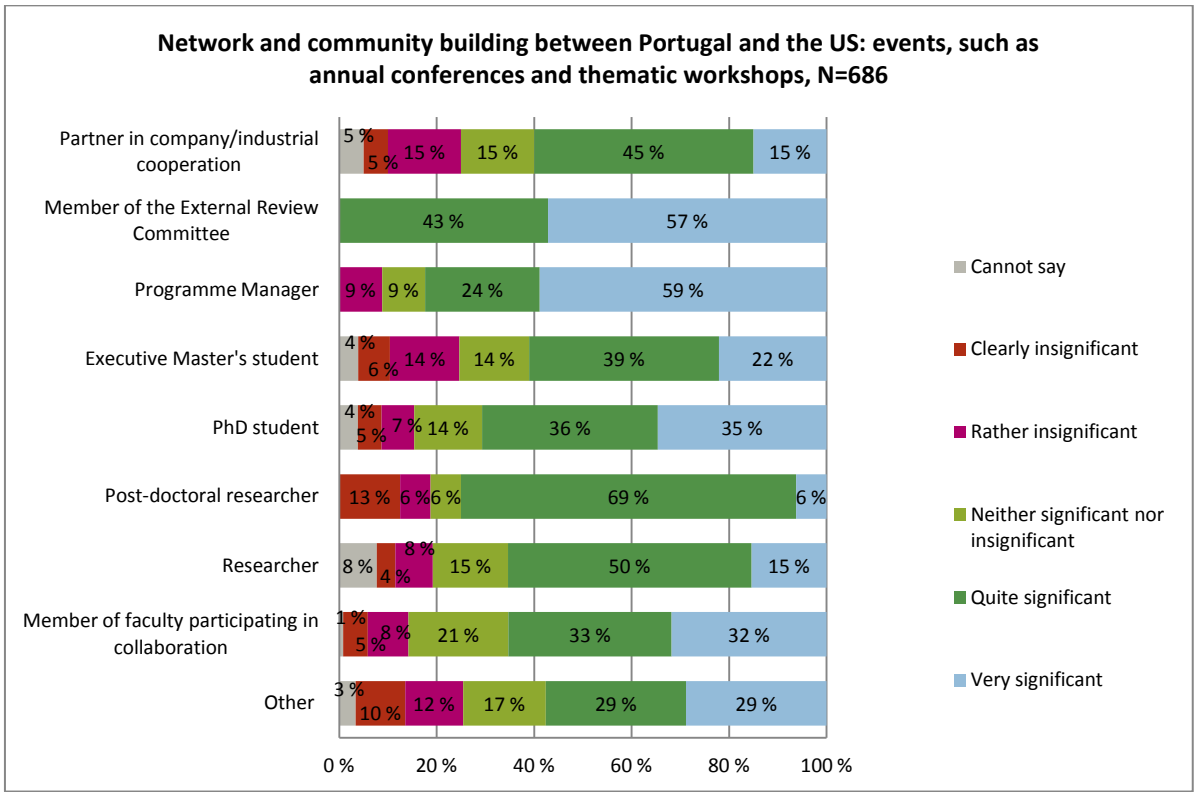


Figure 19. Network building between the US and Portugal: stakeholder perceptions

The survey respondents perceived the value added in terms of bilateral US-Portugal cooperation as more significant than the cooperation within Portugal. This is illustrated in Figures 19 and 20. The interviews, on the other hand, highlighted improved cooperation within Portugal as one of the most important cultural changes for Portuguese academia.

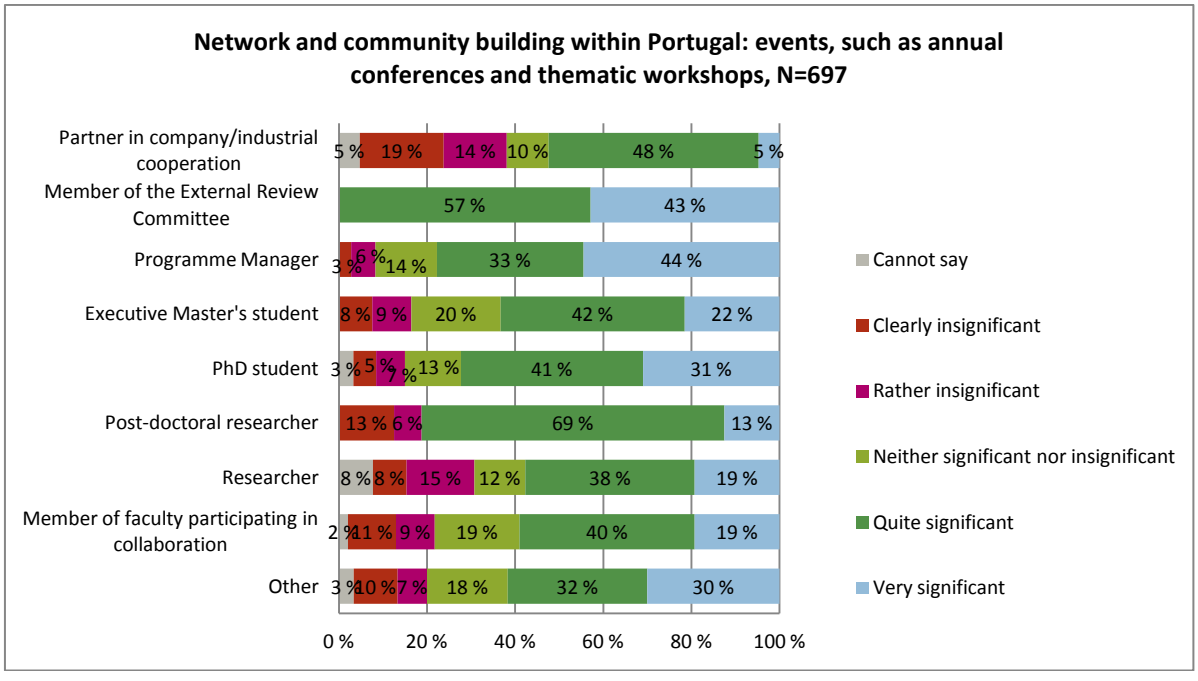


Figure 20. Network building within Portugal: stakeholder perceptions

It has been proposed by the interviews and the survey and the evaluation panels that the national consortia can also be used for other R&D activities in the future. This also relates to the question of sustainability, as one would hope that bilateral collaboration would lead to results and further initiatives that can be pursued in other collaborative constellations in the future (e.g. with European funding).

One way of examining more closely the consortia and community building is network analysis. In terms of following the community building more closely, network analysis has been used at least in some of the sub-programmes. UTA, for instance, has conducted a network analysis of their own and such methods are seen as important, also for peer-learning purposes across the Programmes.[14]

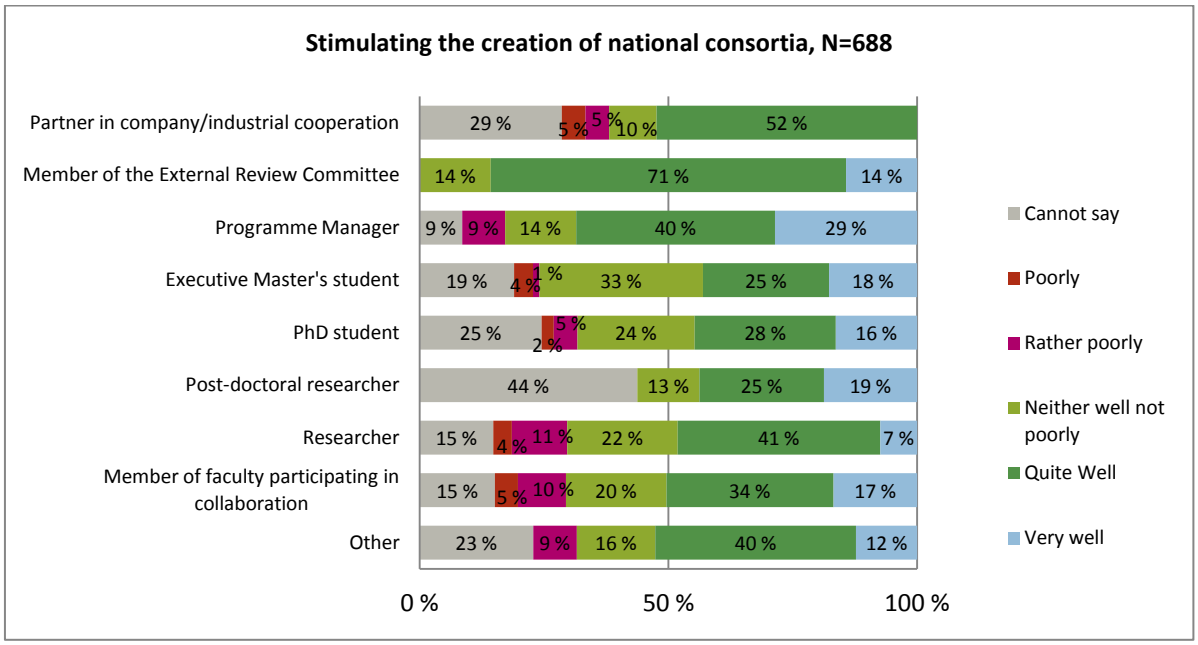


Figure 21. Benefits for stimulating national consortia[15]

Many survey respondents were not able to answer the question related to the creation of national consortia (Figure 21). There are, however, importantly more than half of the faculty members, industrial partners and Programme managers who see that the collaboration has led to stimulating national consortia.

In the interviews, all Programmes reported positive experiences of collaboration across the sectors, borders and disciplinary boundaries. Industrial collaboration of universities has emerged in Portugal later than in some other innovation environments, notable the US, where this type of collaboration has very strong historical foundations. Positive examples from the Portugal-US Programmes include for instance the PINC case, described briefly below (Box 2).

[14] Source: Year 4 Report to the External Review Committee Funded by Fundação para a Ciência e a Tecnologia, Ministério da Ciência, Tecnologia e Esino Superior.

[15] National consortia here refers to joint endeavors by domestic cooperation partners, such as projects financed by an external third party, e.g. the EU.

Box 2. Promising practice: Example of PINC

As is the case with many innovative environments across the globe, physical closeness and creative environments can be an essential prerequisite for public-private collaboration fostering innovation and entrepreneurship. One such Portuguese example is "The Creative Industries Center of the Park of Science and Technology of University of Porto" (UPTEC PINC). PINC is a joint project between UPTEC and INESC Porto (Institute of Systems Engineering and Computers of Porto).

The UPTEC PINC wants to address the global challenges of the new creative economy by aggregating the knowledge and skills developed at the University of Porto in various areas of the creative industries such as Architecture, Visual Arts, Design, Video and Film, Publishing, Radio and TV, Educational Software Entertainment, enhancing recognition of its importance, both internally and externally, and at the same time offering solutions and conditions for the sustainable development of the creative industries in the region. Thus, it has now 25 companies associated with this project, covering a wide range of business areas ranging from the Cinema, Audiovisual and Video, Television and Radio and Multimedia Design to the areas of Visual and Performing Arts, Music and Educational Software Entertainment.

Its location, at Praça Coronel Pacheco, puts UPTEC PINC in the heart of the new creative district of Porto, so it is absorbing the value and contributes along with several other entities for the regeneration of the urban centre of Porto.

While PINC has not only been developed with US-PT collaboration, it has close contacts with the University of Texas-Portugal/UTEN collaboration in particular. (For more information see http://uptec.up.pt/en/corporate/uptec/creative-industries-center).

In the survey, most positive perception of project collaboration emerged amongst the CMU respondents (66%). Figure 22 illustrates this. (Other Programmes are visible in the attachment.)

The interviews emphasised project collaboration as the most value creating activity. Especially the ways how project activities were planned, organised and implemented were seen as a significantly more customer-oriented and hands-on approach than traditionally in Portugal.

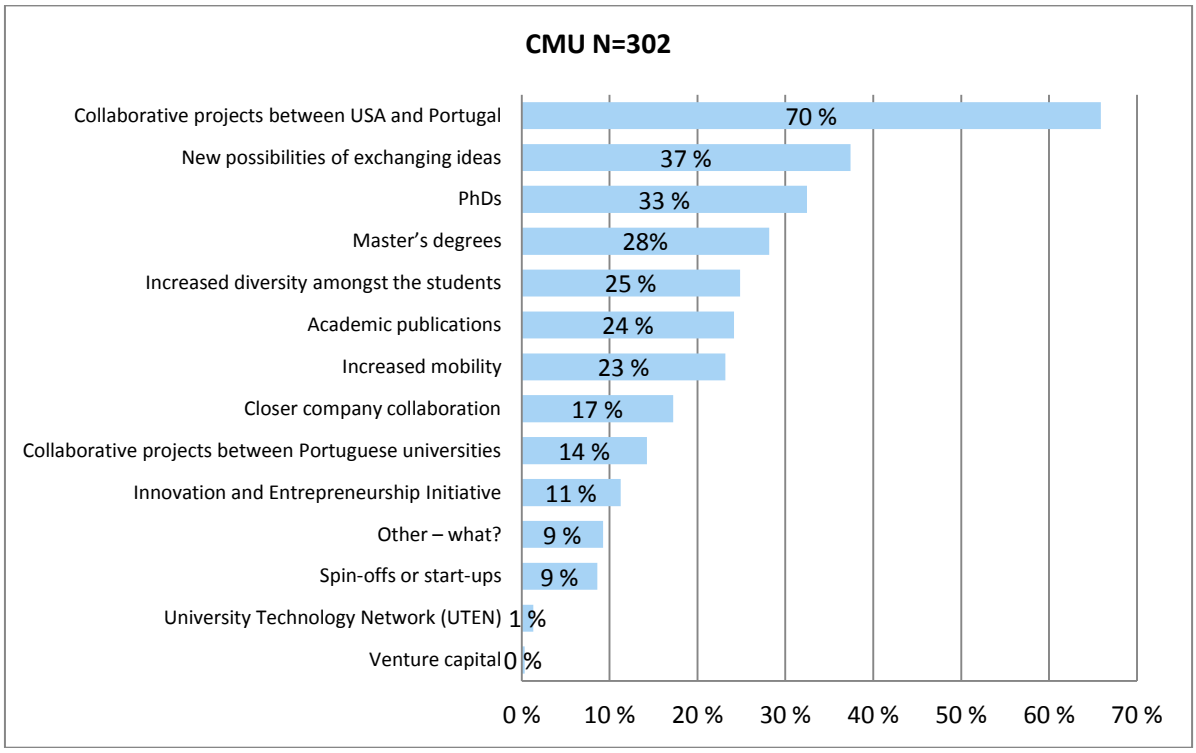


Figure 22. The main benefits: CMU example

The following examples of collaborative R&D projects implemented in the context of CMU-PT Programme were described by many survey respondents and interviewees as positive examples of innovative pilot projects. In these test-bed-like circumstances ("Living Labs") more broadly applicable innovations are developed. The test-beds themselves use unique environmental factors, such as the isolation of Portuguese islands.

- ***Drive-In**: Large-Scale Test-bed for Intelligent Transportation Systems*
    - *In Porto, Portugal, a large-scale vehicular ad-hoc network of 500 taxi cabs is currently ramping up, offering many practical examples of the economic and social benefits of intelligent transportation systems. The 500 taxi cabs are equipped with a prototype that helps researchers to collect and test data for improving security and efficiency of vehicular transportation.*
- ***Sinais**: Human-Computer Interaction Systems for Sustainable Living*
    - *More than 30 families in the Madeira Island have multi-sensor systems in their homes, which aim to detect and understand significant human activities related to resource consumption in a domestic environment. One major goal is to deploy smart meters, beginning with these 30 homes in Madeira and 100 homes in the North of Portugal, subsequently scaling up to 100,000 homes in Évora (in collaboration with EDP).*
- ***Vital Responder**: Cyber-Physical Systems for First Responders in Emergency Scenarios*
    - *Firemen both in Portugal and Pittsburgh area are participating actively in a project that seeks to develop supporting technologies for higher safety and better response to emergency situations. The research team of the project is providing the next generation of smart garments capable of capturing in-depth information about the vital signs and body condition of first responders in real time.*
- ***Interfaces**: Secure Software-Intensive Systems*
    - *Most often, security malfunctions are the result of "bugs," or mistakes in the programming. This project is developing programs, with the collaboration of the company OutSystems that automatically analyse software, helping developers to detect potential errors in the programming before they occur.*

In many cases, industrial affiliates were significant, as they provided the live environment where projects could be implemented. Examples of such cases included the following:

- *Lógica – Provision of infrastructure created*
- *ZON Madeira – Provision of access and data network infrastructure*
- *Porto Editora – access to online content*
- *Novabase – access to software source code developed*
- *Outsystems – access to the company's development platform and the software source code*
- *Vodafone – access to the database*

3.3.4 Technology transfer, innovation and entrepreneurship, commercialisation

In the survey, clearly the least positive views related to the ability of accessing Venture Capital. The interviewees also assessed the issue of Venture Capital and other types of external funding relatively critically. The interviews and the survey illustrate that the capacity-building in this regard is only in its initial stages. This is why the future expectations are likely to be realised in the longer term and why the issue of the value added is crucial. This is in line with studies which have analysed VC and entrepreneurialism and the ability of design of public policy initiatives to promote them (e.g. Lerner 2009, pp. 16–17). Long-term commitment and the process of building an environment where new ventures can thrive are a first step, and this has in fact been the approach of the Portuguese Programmes.

Methods for supporting innovation and entrepreneurship through practical work and interaction have been developed and taken into active use in the Portugal-US Programmes. Such examples include the i-teams at MIT.

Box 3. Promising practice: i-Teams at MIT

i-Teams, (short for "Innovation Teams") is a unique MIT course that assembles cross-disciplinary teams of students from across MIT. The goal of i-Teams is to teach students the process of science and technology commercialization focusing on how to judge a technology's commercial potential. Each team has access to faculty, practitioners, business mentors, and fellow students throughout their project.

Lectures focus on building tools and insights for thorough and analytical commercial due diligence of promising early-stage inventions. Some lecture topics include:
•Assessment of user needs and market opportunities
•Analysing market and technical risks and building roadmaps to address them
•Identifying the commercial risks (incl. intellectual property) that shape competitive advantage
•Understanding the politics and processes of commercialization.

For more information, see http://entrepreneurship.mit.edu/iteams/

There are also many events, summer schools and training forms where innovation and entrepreneurship skills and culture are promoted amongst students, experts and companies. One such example is given from the media sector and the UTA Programme.

Box 4. AUT methods for supporting innovation in digital media field

The Future Places media festival and International School on Digital Transformation (ISDT) have supported and enhanced the visibility of digital media creativity in Portugal while they also have provided additional training for students. One marker of success has been the increasing interest and involvement of media companies. Future Places attracted support from Sapo, one of Portugal's major media companies.

The programme homepage (and our interviewees) also emphasise the ***ZON Screenwriting Laboratory*** held in Austin as an important innovation. ZON agreed to sponsor the travel and housing for students selected competitively from 11 different schools around Portugal to receive intensive training for two months in writing and producing at the UT Austin facilities. The best instructors were selected to work intensively with this group of students, with the goal being to produce solid scripts that they would shoot and then edit from August-October 2010 in order to enter them into ZON's national contest by November 5. The Lab was seen as an important success from the perspectives of both students and instructors, and a similar event was subsequently initiated in 2011.

For more information, see
http://utaustinportugal.org/calls/zon_intensive_script_development_lab_at_ut_austin

The UTEN initiative under UTA-Portugal has been successful in developing technologies for commercialisation in international markets. More than 250 contacts have been made with private-sector companies and these have resulted in 51 manifestations of interest. In 13 cases negotiations have been started. Of these cases, three are concerned with licence technologies while ten tackle potential onshoring (via joint venture, IP bundling, spin-off, etc.) in the US market.

Technology transfer and innovation activities have not been on the Portuguese agenda for very long. This is also visible in many respects in the evaluation data. The changes required are considerable and the time used to implement the Programmes has been short for the technology transfer area. The critical view on the VC issue is similar across the Programmes (Figure 23).

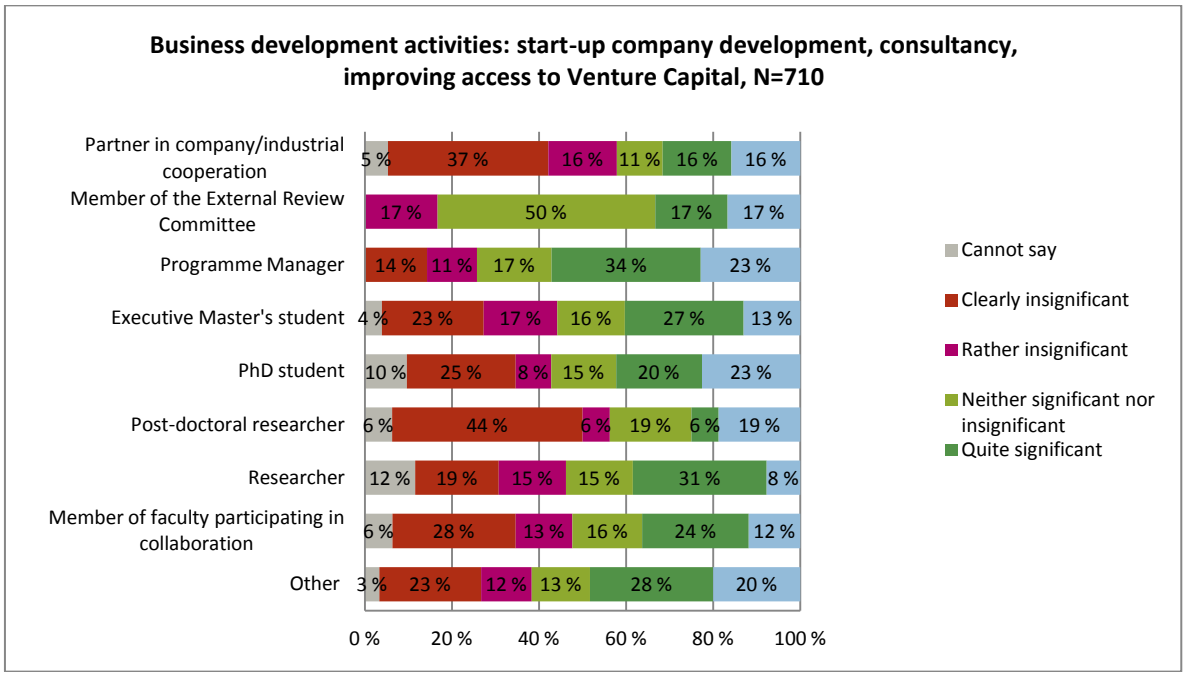


Figure 23. Business development activities: stakeholder perceptions

The Programmes' impacts on business development are naturally long-term, not least because the Portuguese companies have traditionally been reluctant and unlikely to employ PhDs. However, based on the interviews, there seems, to be a shift ongoing. The companies have worked more closely with students and doctoral candidates, who have been able to solve their practical problems or to put company-specific data into a broader comparative perspective. Both types of collaboration have improved mutual understanding and respect. The hope is to also attract new companies to Portugal, but this seems to be a slower process, as many of the interviewees pointed out.

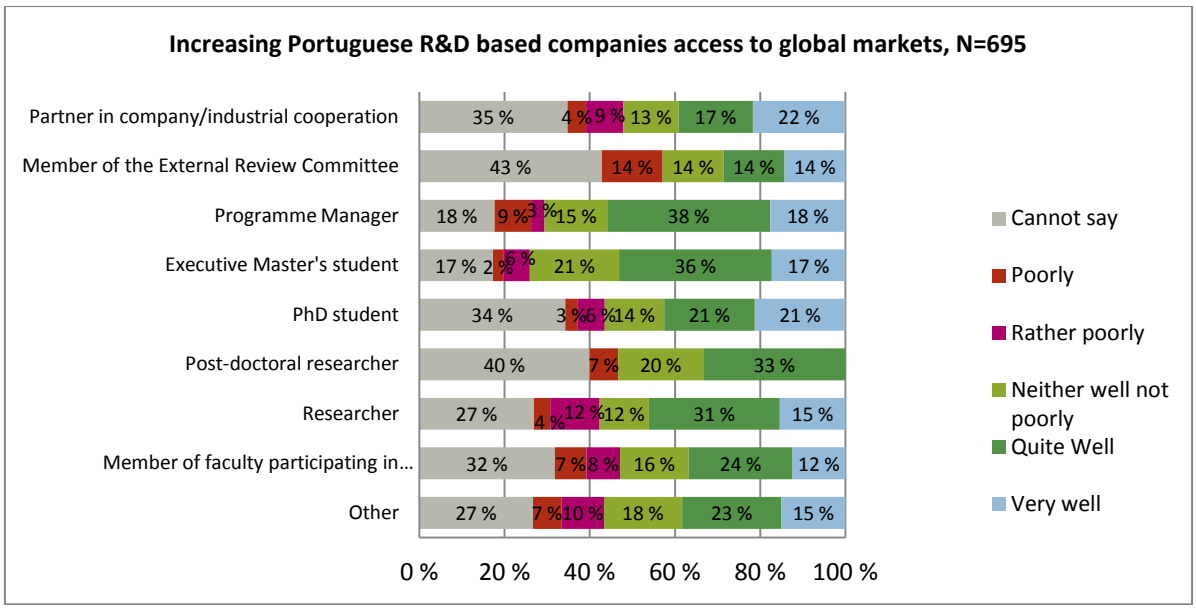


Figure 24. Improving Portuguese companies' market access: stakeholder perceptions

Figure 24 suggests that the stakeholders see the importance of emerging societal impacts. While many were unable to answer this question, 40–50% of respondents felt that access to global markets for companies has been impacted. This is a very high figure, given that the issue of global markets was in a relatively non-central role in the original Programme objectives (and to some extent in the strategies and actual activities).

The Programmes naturally have different strategic focus areas as to the business development and financing topics. The spin-offs created under the Programmes are presented in Chapter 2 and Appendix 1. Many interviewees were sceptical on this issue and felt that the road is so long, that the Programmes have thus far only started on this path. Many called for more action and concrete contacts and funding opportunities rather than more indirect issues, such as workshops or similar meeting venues.

Working in a global environment with global companies is an area where the Programmes have only started their work. The fact that such a large proportion of respondents are not familiar with what has happened in terms of improving market access is hardly surprising. It can be taken as an indication that this strand of Programme activity has perhaps been less actively promoted, compared to education and training activities.

3.4 Portuguese benchmark perspectives

The US-Portugal Programmes are a relative newcomer into the R&D field in Portugal but not without precedent. Graduate programmes have been launched in Portugal since the early 1990s. In order to contextualise the uniqueness, specificity and value added of the US-Portugal Programmes, a set of comparative benchmarks has been selected.

The Portuguese Ministry of Education and Science, who commissioned the present evaluation, proposed a benchmarking, for which evaluation team received data for eight doctoral programmes implemented by Portuguese universities and research organisations between 1993 and 2012. All of these programmes have focused on fostering and supporting high-quality research as a long-term process. Their approach and emphasis on internationalising the Portuguese academic and educational system and collaboration with international counterparts vary. Most of them are collaborations between a number of Portuguese universities and research organisations, including Associated Laboratories. All of the programmes have had the majority of their funding from the FCT.

The data was received from the following programmes and their institutional initiators:

Launched by GULBENKIAN (co-funded by FCT and other sources):
1. Programa Gulbenkian de Doutoramento em Biologia e Medicina, PGDBM[16]
2. PhD Programme in Biomedicine, PGDB
3. PhD Programme in Computational Biology, PDBC[17]
4. Programme in Integrative Biomedical Sciences, PGD/PIBS[18]

Launched by GULBENKIAN in collaboration with CHAMPALIMAUD (co-funded by FCT and other sources)
5. Programme for Advanced Medical Education, PFMA[19]

Launched by CHAMPALIMAUD (in collaboration with Gulbenkian, co-funded by FCT)
6. International Neuroscience Doctoral Programme, INDP[20]

Launched by UNIVERSITY OF PORTO
7. Graduate Programme in Basic and Applied Biology, GABBA[21]

Launched by UNIVERSITY OF COIMBRA
8. PhD Programme in Experimental Biology and Biomedicine, PDBEB[22]

More detailed basic indicators for the number of admissions, theses, costs per thesis etc. are given in Appendix 10.[23]

[16] For more information on the Gulbenkian programmes, see www.igc.gulbenkian.pt.

[17] For more information, see www.igc.gulbenkian.pt/node/view/33.

[18] For more information, see www.igc.gulbenkian.pt/node/view/32.

[19] For more information, see www.fchampalimaud.org/education/en/programme-for-advanced-medical-education1/.

[20] For more information, see www.igc.gulbenkian.pt/node/view/89.

[21] For more information, see http://gabba.up.pt/.

[22] For more information, see http://beb.cnbc.pt/about.asp.

[23] The data was collected with the kind help of the programme management at the University of Coimbra and Porto, Instituto Gulbenkian de Ciência (IGC) and Champalimaud Foundation. Their input and help in collecting the data was highly appreciated.

The PhD courses follow the same basic structure in that they provide a full year of graduate courses and laboratory rotations, followed by three years of supervised research work, leading to a doctoral thesis that can be submitted at a Portuguese or foreign university. During the first year, students take courses and have not yet selected their PhD topic or supervisor, which also explains why the figures for 2011 are not yet available, as the students have entered in the programme in the fall and are now in the process of going through their basic course work, not yet in thesis preparation stage.

The table below presents the total figures per programme, annual figures for each are available in the appendices section (Appendix 10).

Table 5. The total figures per programme

Admissions		PGDBM	PGDB	PDBC	PGD/PIBS	PFMA	INDP	GABBA	PDBEB	Total
Applications	Total	1,317	763	379	746	239	720	1,221	755	6,140
	Foreign	0	113	1	344	9	341	49	57	913
	Portuguese	1,317	650	379	392	230	379	1,172	698	5,217
	% foreign	0	15	0	46	4	47	4	7	Average: ~ 15
Enrolments	Enrolments	103	90	46	53	39	50	177	120	678
	% of applications	8	11	12	7	16	11	14	16	Average: ~ 12

Student thesis work[24]		PGDBM	PGDB	PDBC	PGD/PIBS	PFMA	INDP	GABBA	PDBEB	Total
Laboratory affiliation	Portugal	9	12	7	48	11	25	34	57	171
	Abroad	94	75	39	0	19	17	131	49	424
	% abroad	91	86	85	0	63	35	74	46	Average: 60
Status	Thesis in progress	0	5	34	46	30	49	57	86	307
	Transferred	0	2	0	4	0	2	0	2	10
	Dropped out	2	7	4	1	0	0	4	1	19
	Defended	101	76	8	2	0	0	104	43	334

Instructors/Faculty		PGDBM	PGDB	PDBC	PGD/PIBS	PFMA	INDP	GABBA	PDBEB	Total
Institutional affiliation	Portuguese	146	38	~120	175	188	184	1,021	478	2,350
	Foreign	500	241	~280	114	232	265	542	356	2,530
	Total	646	279	~400	289	420	459	1,563	834	4,880
	% from abroad	77	86	~70	39	55	60	34	43	58

	PGDBM	PGDB	PDBC	PGD /PIBS	PFMA	INDP	GABBA	PDBEB
Average cost per student to thesis **€**[25]	Students in Portugal 66,000, abroad 93,480	Students in Portugal 60,300, abroad 92,220	Students in Portugal 54,600, abroad 81 960	54,600	100,000	71,084	120,000	95,060

[24] In most cases, there are no figures on thesis work in 2011 because students admitted in 2011 have not yet started thesis work; no such information is available before March 2012.

[25] NB. The cost depends considerably on whether the student does his/her thesis in Portugal or abroad (more detailed data is available in Appendix 10). All Programmes rely on FCT funding for four-year student fellowships. The amounts (salary, bench fees) vary depending on whether the students work mostly in Portugal (€980/month + bench fees €2,750/yr), abroad (€1,710/month + bench fees €12,500/yr) or a mix of the two (all first year students attend national classes, for example). Therefore, the costs cited are indicative and calculated as averages.

The selection process is competitive by international standards: between 7% and 14% of applicants are accepted to these PhD programmes. The number of PhD scholarships is considerably lower than in the US-Portugal programmes, where the competition in this regard is less fierce.

Strategies of the different programmes vary. This is also reflected in the number of applications and students doing their thesis from outside Portugal, which is in line with the programme strategies. For instance, in the PDBC, the objective is not only to introduce students to the interdisciplinary field of computational biology but also to offer in-depth research training in one of the areas of computational biology as chosen by the student him/herself at the end of the first year of the programme. The students were nurtured and strongly encouraged to have a critical and open mind. The first-year courses were given mostly by renowned invited researchers from Europe and beyond (source: Programme website). According to the programme management, the programme was not open to applications by non-residents, as it aimed specifically at educating Portuguese students abroad (source: data received from programme director on 3 January 2012).

In the case of applications, the percentage of foreign applicants ranges from 0% to 47%. Both the PGD/PIBS and the INDP have almost half of their applicants from outside Portugal. It is difficult to judge their stage of internationalisation, however, as both programmes are at very early stages and have only two defended PhDs to date.

The formula for calculating average costs per PhD student/thesis defended for the FCT is the same across the programmes and therefore does not allow for an in-depth assessment of the value for investment. However, the programmes have provided an average estimation of euros per student, and it is clear that the costs for Portugal-US programmes are higher per PhD student. As there are no PhDs defended yet, it is impossible to compare the value for money in terms of the investments made.

In the view of the evaluation, the assessment should be made for each level of value added: from the student level to the level of institutions involved, external partners committed to the research cooperation, as well as the national innovation ecosystem and the R&D&I policy level.

The report as a whole has assessed the perceived value added and efficacy of the measures undertaken and the value for investment for the instrument in question. The effectiveness is naturally always in relation to the goals selected: Has the programme in question achieved its goals? What are the reasons for success or failure in this regard? The Portuguese benchmarking cases seem to have provided an effective way of producing PhDs in the selected areas. As to their other goals, we do not have the data or a comprehensive enough assessment or understanding of their dynamics to provide an evaluative assessment. For instance, we do not have data on various stakeholder perspectives on these programmes.

3.5 Future perspectives

Each of the Portugal-US Programmes has developed their own strategy, and this should also be taken into consideration before drawing conclusions on the Programmes. We have summarised the key suggestions made for 2011–2016 under the main headings: Strategic focus, Scaling up activities (dissemination), Working methods, Governance, and Cooperation.

Table 6. Some characteristics of the future plans drafted by the Programmes

	MIT	CMU	AUT	UTEN
Disciplinary fields	Stem cell research; Sustainable energy and transportation systems	ICT and connected fields such as energy, retail, tourism and manufacturing	Digital media	As previously, technology transfer and commercialisation
Strategic focus	Fostering emerging concepts; Training future leaders	Promoting flow between academic and industry; Enabling fast launch of new high-risk ideas Promoting	Building capacity for undertaking interdisciplinary research; Cultivating a critical mass; Bringing international recognition to Portugal as a site where cutting- edge research and exploration occur in digital media projects and applications in advertising, journalism, art, music, education, tourism and related fields; Producing environments such as conferences, festivals and schools where new collaborations and creative ideas can be fostered and tested with a particular focus on improving quality of life and civil society through digital tools; and Working with media industries in Portugal to explore new products and formats for their endeavours, including internationalising the Lusophone community	Focus on capacity building through learning mechanisms and innovation technology transfer practice, and commercialisation skills.

New working methods	Test beds as scalable living laboratories (e.g. Green Island project)	Awarding a fraction of the research budget to seed funding by means of fast, competitive process = "Exploratory grants" Living Labs Mentorship	Annual open research calls (as previously), internships (10/year)	Reverse Internships, training-the-trainers, in situ training etc.
Scaling up[26]	See above	New double degree programmes with international partner universities; Large-scale research op	Solidifying Portugal's position as an international leader in digital media innovations through continued sponsorship of the Future Places Conference and the International School for Digital Transformation	Technology Transfer Competition
Cooperation	Open competition; Aim to create a 'Network of advanced studies in engineering'; Intellectual Property Rights framework	Stronger participation in the FP7 and subsequent EU framework programmes	Integrating additional Portuguese universities into the programme in some disciplinary fields: in the case of technology and digital media arts programme e.g. Catolica University, School of Arts in Porto and the University of Minho in Braga. In the case of interactive media, the University of Madeira's Interactive Technologies Institute and IST in Lisbon. In the case of digital media, performing arts is also to be included, e.g. Polytechnic of Porto.	Strengthening the existing collaborative ties within the existing network of TTOs, Council of Rectors, INPI, and international partners
Governance innovations	Independent body created that is directly associated with MIT partner institutions and ensures operational flexibility, efficiency and accountability	Continuous calls for early bird projects and faculty exchange; More focus on evaluation and accountability	Improved coordination[27]	Annual UTEN survey and case studies on spin-offs; appointment of scientific and executive directors to improve coordination

[26] Here scaling up refers to the process of expanding and multiplying, setting in motion a process of reaching a larger number of potential partners and potentially also expanding into in a broader geographic area by the process of improved leverage and institutionalisation.

[27] All of the current partners agree that there is need to improve the organisational infrastructure in order to achieve more efficiency and transparency. Having academics exclusively dedicated to the programme should also be established. The director should be a faculty member who works at least half of the time in the programme. In the previous period, having the programme leaders maintaining the same work overload at their universities was one of the weakest points of our experience and should not be repeated. Each university partner with doctoral and Master's programmes require staff support. The staff should work with faculty and others to coordinate activities; produce annual reports and newsletters; work with students on their degree plans and their UT Austin semesters; promote more dissemination of our projects; and liaise with industry. (Digital Media Studies and Research: A Collaborative Proposal for Portugal, 2011, p. 11)

The Programmes have identified the difficulties with governance that the evaluation also refers to. The need for coordination support (on the operational level) addresses this need (MIT), as does the evaluation and accountability theme (CMU).

In the CMU case, it is argued in the future plan for 2011–2016 that

> *The directors of the Program shall be responsible for the implementation of reporting mechanisms that allow for continuous assessment of the quality and the impact of every funded activity. Beyond traditional measures of success, such as scientific and technological significance of results, quality and number of publications, patents, degrees conferred, and number of students, post-doctoral and other young researchers, the impact of projects will be measured also by the effective deployment of research prototypes, the adoption of new services by leading companies and the existence of partnerships between industry and academia.*
>
> *The principal investigators of each research project and multi-disciplinary Initiative must submit detailed descriptions of the proposed work and a clear execution plan with verifiable milestones and success metrics by which progress can be measured. The directors shall be assisted by internationally recognized experts, who will carry out independent evaluations of every project and initiative on a regular basis.*
>
> *The External Review Committee (ERC) shall be responsible for evaluating the progress of the Program as a whole, providing feedback on the performance of the directors, the quality and impact of the research, the degree of excellence of the educational programs and the active participation of industrial partners. Every year the ERC shall make detailed recommendations on how to improve the Program and converge towards the stated goals.*
>
> *Particular attention shall be devoted to the institutional development of partner universities in Portugal and how they can leverage the collaboration with Carnegie Mellon to increase their international visibility and participation in European funding schemes for research, as well as in the establishment of new double degree programs with other reputed institutions in Europe and beyond.*[28]

The governance and scaling-up efforts are seen as holding considerable potential for the future. They are also largely in line with the proposals of the evaluation panels, who emphasised the need to reconsider whether the scale, scope and focus of the Programmes are appropriate also in the future, particularly considering a more open approach, as compared to targeted collaboration. There was also the wish to re-assess the volume and focus within the current financial situation, with more attention on leverage. The proposals made by the Programmes do go some way towards clarifying these issues. Other views and recommendations for the future from the evaluation panels included the proposal to extend the Programme scope beyond the US (in particular to Portuguese-speaking countries) and other international universities.

The panels also placed special emphasis on the monitoring, good management and evaluation, which could pave the way for developing a path of continuous improvement through monitoring, indicators, ex-post evaluation and a logic model clarified from the start. These are partly included in the future plans.

The second evaluation panel also called for an improved publicity and information flow, which would allow the dissemination of lessons learnt and in the longer run also transferability of approach.

[28] ICT Portugal: A work document for the 2nd phase of the Carnegie Mellon Portugal Partnership 2011-2016, p. 14.

4. CONCLUSIONS AND IMPLICATIONS FOR THE FUTURE

Conclusions here seek to provide support for taking the Programmes further and making use of the valuable inputs and processes that they have facilitated for the benefit of the Programmes themselves, the stakeholders, the Portuguese Government and perhaps also the innovation policy actors outside Portugal aiming at similar ambitious and diverse programme instruments.

The picture below depicts some of the core themes that emerged from the open answers of the e-survey. While only a snapshot of the issues could be presented here and there are much more detailed data available, the picture is revealing in many respects.

Figure 25. Relevant collaborative fields as viewed by survey respondents (open answers)

The message from the e-survey and interviews could perhaps be summed up in the following way: Even though interdisciplinarity has been the main shared organising principle and areas of research and project activities have oscillated around the many scientific fields, innovation, business and entrepreneurship have been in many cases those novel perspectives through which the academic fields have been approached.

The *Research and Education Collaboration* and its individual Portugal-US Programmes have been an extremely important social innovation as such and a unique model for providing support for R&D&I activity in every aspects included in the original plans and programme targets. The overall Programme approach is well-thought and the three focus areas complement each other well. The Programmes have made a clear difference in terms of Portuguese higher education, training and study visits, which in turn has led to a qualitative shift and helped to contribute to the creation of critical mass which was not previously there. One area in which particular value added has been achieved is interdisciplinarity. In addition, the Programmes have brought Portugal to the international forefront in some of the selected areas, in terms of moving away from the previously perceived geographical, sectoral and disciplinary isolation. Teaching and training has benefitted from the more application-oriented and industry-friendly methods and practices that are typical to US universities.

Collaboration within research projects has improved considerably and the Programmes have been particularly important in promoting cultural change in this regard, not least by placing entrepreneurship and innovation in a more central role in R&D&I policy and by engaging the industry in research to a significant degree.

Technology transfer, innovation and entrepreneurship, and commercialisation have previously not been considered to be in focus in Portugal, especially compared to basic research, and therefore relative advances have perhaps been even more significant.

The above mentioned elements have made an important difference in terms of the needs which they were intended to respond to (Figure 26). The core is "Portuguese R&D&I" but it could also be called "Portuguese innovation environment". The goal of the Programme is not to develop R&D but it has rather sought to create deeper and more far-reaching new dynamics and a positive cultural change in the innovation environments in the chosen fields across the country.

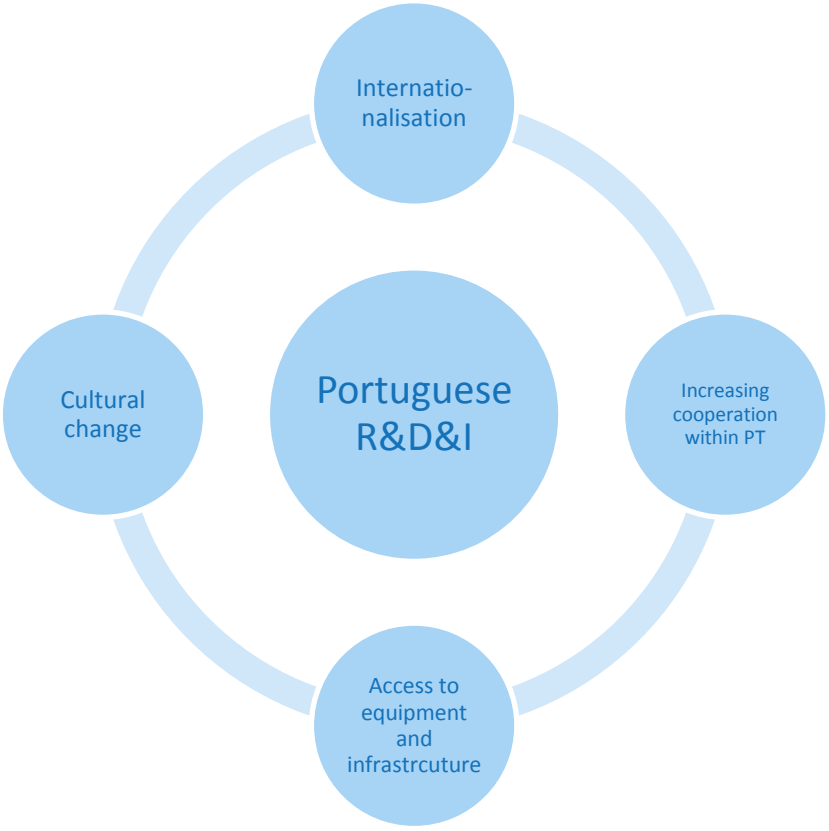


Figure 26. The key goals of the Programme

While the added value has been considerable, it should, however, be pointed out that the investments have also been considerable. Due to the high Portuguese budget share, cost-effectiveness is not particularly good, though the unique nature of the initiatives makes it difficult to identify a benchmark against which the Programmes could be compared.

Portugal has clearly made a significant effort to boost its R&D&I activity: the total FCT budget has increased to EUR 366.5 million in in 2009. Both the overall budget and the relative share of the PT-US Programmes (at its highest in 2007) have decreased since. The internationalisation has thus been given a considerable boost by the Portugal-US Programmes even though extensive doctoral programmes have already been running since the 1990s (see the benchmark section 3.4).

When assessing the value for investment, we need to bear in mind that the effectiveness of programmes always relates to the selected goals and objectives in question. The doctoral programmes presented briefly as benchmarks have ambitious, though more limited goals than the Portugal-US programmes that were launched by the Portuguese Government, and had high-profile objectives in science and innovation policy. From the perspective of the funding organisations and sponsors, the key issue, however, is how Portuguese doctoral training can be most efficiently and comprehensively developed as a whole. This goal would benefit from more

comprehensive metrics that would provide a means of assessing the value added and value for investment for the various beneficiaries in question: researchers and the scientific community, universities and research institutes, companies, and society as a whole. Options include a range of programme types from expensive, though thematically perhaps more targeted, to broad and perhaps more traditional doctoral education and innovative research. However, essential in all cases is that the objectives, their indicators and monitoring should be planned and implemented carefully at an early stage. In addition, all choices made along the planning process should be aware, transparent and as articulated as possible, in order to ensure the commitment of key stakeholders.

When calculating the cost per PhD, it is natural that the price for international excellence and quality is high. However, there may also be less tangible, more long-term benefits that are more difficult to measure, such as international recognition and visibility. The challenge in the benchmarking cases, as in the Portugal-US programmes, lies in identifying and assessing in a commensurable way the effects of a longer duration: when PhDs work in enterprises, perhaps as a result of the cultural changes that have gradually emerged, their contribution is only shown in the years to come.

The outputs of the Programmes have been assessed to the degree possible, though in many cases the Programme implementation is at too an early stage yet to determine this in full. The relevance of the outputs in international terms has been significant, not least because the Programme model is unique and interesting in itself. The most significant outputs are clearly those that would not have been achieved without the interventions in question.

4.1 Main conclusions on the objectives

The present instrument *Research and Education Collaboration* is seen as a unique tool in promoting R&D&I, cultural change and an ambitious agenda for taking Portugal further in innovation activity. The fact that positive international attention has been gained by the Programmes is a significant achievement of the Programme, not least at times of recession, where all news tend to be negative ones. The experts of the evaluation panels emphasised that the overall Programme approach seems well-thought and the focus areas complement each other well.

At the same time, it is clear that it may not be realistic to continue such as a broad-based and large Programme in the current circumstances. Focussing the Portuguese public funding so strongly on US universities was not easily accepted by all of the stakeholders. The financial dependence and trading on European public funding is of concern. In the European context, this type of service-provision relationship is usually referred to as 'collaboration'; while 'partnership' is used as a term that also implies a financial commitment from both parties.

We conclude that the model used is not a real partnership, as the parties seem to follow purchaser-provider model, where the subscriber and producer roles are administratively separated from each other. The "Client" is a public entity (in this case the parties acting in Portugal, FCT and the individual universities), which acts as Client and service purchasers vis-à-vis the American university parties.

Based on the analysis of the extensive data, the evaluation steering group concludes that the outputs from the Programmes, and their relevance in international terms, are significant. In many cases, it is too early to judge the impacts. The outputs are still at an early stage, as most of the PhDs students are still being trained and most of the projects still ongoing. The scientific, technological and academic returns from the Programmes are significant, but the cost has been high, if calculated per PhD, per student, per academic publication.

In terms of the societal objectives driving the Programme, a cost-effectiveness analysis is insufficient, however. Achieving cultural change in teaching and training is a long process. A new way of thinking and a more entrepreneurial and risk-taking mindset are ambitious long-term

goals that can only be achieved after years of concerted efforts, maybe even only after the next generation of leaders and teachers are working in Portuguese academia.

The evaluation panels also cautioned against putting an end to the positive trends already identified. Changes may be required, however, and the experts in the two evaluation panels emphasised the need to reconsider whether the scale, scope and focus of the Programmes are appropriate also in the future. It was particularly seen as necessary to consider an open approach, as compared to this targeted collaboration.

As an overall conclusion, the evaluation has identified a strong need for sustainability. Research, both in basic and applied forms, requires sustainability, which should be achieved before the public funding is withdrawn.

A more open competition, involving also universities from outside the US should be closely considered. The lessons learnt should be drawn and used across the research community in Europe and beyond. Extending the scope of the Programme beyond the US and opening to other than top universities was also raised by the second evaluation panel.

Improving educational and training ability:
Based on the available evidence (monitoring data and report, interviews and survey), significant effects have been achieved, though it is currently too early to quantify full impacts at this point. Quality assurance systems, methods and practice have all improved, though there is little standardised data on this. The PhD programmes have been successfully launched. There is, however, a need for joint degrees in these Programmes. The doctoral programmes themselves have been developed in a more focussed way and in seeking to provide a holistic and better integrated model. The US model of more structured supervision and training has been seen as an important part of the Portuguese higher education system. In some cases, supervision and training has not yet worked as expected, as the students have had difficulties in finding supervision and project teams.[29]

When the PhD grants are allocated, the candidates should at that stage already have defined their topic. This would make it easier for the receiving institution to provide supervision. This could ensure a smooth process and good results for both parties involved. A quality assurance system should be developed for the FCT in this regard.

Increasing the number of national consortia:
The monitoring data indicates that the number of consortia within the Portugal-US Programmes context has increased only to some extent so far. The interviews clearly show that the willingness to work together has been positively impacted. The full systemic effects will take a longer time to emerge. This is one of the key trends that have emerged. This is a longer cultural process that will still take time, however. The "new" domestic consortia are not yet very active in applying for European funding.

Promoting internationalisation of universities and research organisations:
Internationalisation has been one of the most positive achievements in light of the survey and interview data, both in terms of getting more professional international standards in teaching, research collaboration and in attracting international students and faculty. The interviewees identified the risk that some non-Portuguese students may use the Portugal-US Programmes as a means of accessing prestigious universities in the US. This does not, however, seem to be a major trend. The drop-out rate reported in the programme data is not unusually high, as

[29] The question of supervision is central to doctoral programmes anywhere. In a recent study of PhD training and doctoral programmes in Finland, this was also a central issue. Here the focus groups agreed that supervision is a key element in making doctoral programmes and PhD training more systematic and an essential part in improving the quality of PhD training and making the graduation times shorter.
At the same time, there was considerable reluctance to make supervision relationships more formal and better monitored, as it is considered a deeply personal relationship, and more structured monitoring practices may make the relationship more bureaucratic, which is frowned upon. However, a clearer definition of roles and responsibilities is called for. (Niemi et al. 2011, p. 34.)

confirmed by the evaluation panels. Attractiveness has increased in many key areas selected, both in geographical and academic terms. Many stakeholders identified a risk of the attractiveness significantly diminishing without the current Portugal-US Programmes.

Strengthening the recruitment of professors and faculty:
The qualitative improvements to strengthen PhD training are well under way. In the long term, this will most likely strengthen the recruitment of professors and other faculty members. In the view of the survey respondents and interviewees, the Programmes have contributed to increasing the attractive career options available to young academic professionals in Portugal. As contacts between universities and companies have become closer, alternative career paths are also seen within the industry.

Promoting economic growth through science-based innovation:
According to programme documentation, interviews and the survey, there are still too few indications of anything having taken place here. It is difficult to determine what would have taken place in different circumstances. The numbers of Venture Capital and spin-offs etc. are still modest, though the Programmes have made a difference in supporting the preconditions for innovation, entrepreneurship and technology transfer, from working together across companies and academic environments. A more professional technology transfer staff and process, as well as a more developed innovation ecosystem have been promoted, however. UTA-Portugal and CMU have been particularly important in this regard, UTA through the UTEN activity, and CMU through the significant cultural change that it has promoted (opening door, providing access, creating communities).

Improving attractiveness (new talent and high-value activities):
The Programmes have contributed to the positive visibility of Portugal, based in particular on the interviews. Individual talent has been attracted and Portugal has been put on the map, but more high-value activities are perhaps still too early to judge. It is significant, however, that expertise in attracting and promoting these high-value activities has been improved. This was highlighted in particular in the interviews, with capacity building and expertise been positively impacted. In addition to the general improvements in quality, entirely new research niche areas have been developed in previously relatively isolated locations such as Madeira. Public-private partnerships, entrepreneurship and fund-raising skills are all mentioned in the interviews and survey as major improvements. Many of these areas are the ones where the US is a market leader or expertise in the US is significantly more advanced than in Europe, thereby justifying the original selection of partners. It may be time to expand and open up the collaboration to new partners within Europe and globally as well.

Enabling access to international markets for Portuguese companies:
At this stage, there is no evident trend of progress in this area. The stakeholders and external experts who have participated in the evaluation agree that it is too early to expect such effects to have emerged. There are only a hand-full of spin-offs and start-ups that have resulted from the programme activities. Many SMEs in particular, which are in great majority among the Portuguese companies, are reluctant to internationalise and quite happy with the local market and more small-scale operations. There are, however, a few large companies that have been very active and committed and that in the long term could become significant in bringing their sub-contractors and with them to collaborative efforts.

4.2 Recommendations

Strategic focus:
In terms of the advice for the future, this assessment raises the issue of focus and importance of strategic planning and management support. The Programmes have succeeded in many respects, facilitating and supporting both qualitative (in terms of standards and excellence) and quantitative (in terms of critical mass) advances and almost against the odds, one might argue. While the Programmes were in many cases built on existing individual and institutional ties, the institutional embeddedness and commitment is clearly central. In the early stages, some problems occurred due to issues such as lack of clear rules and practices, as well as lack of leadership and commitment from the Portuguese universities. There is currently, however, a very strong commitment and this should be maintained and not compromised or put under risk.

The separate streams of activities (education, research, innovation) require different approaches and strategies, though it is also important to keep them in close dialogue (as they complement each other):

- *Building stronger universities (education, training, study visits)*
- *Applying the improved knowledge (research collaboration)*
- *Building innovation ecosystems (technology transfer, commercialisation).*

The current approach works quite well in the research stream, but not equally well in the innovation stream. Having been dependent on the big companies thus far, in the future there is a need for greater involvement of SMEs in the innovation stream.

Sustainability:
High-quality research necessarily requires a long-term commitment and sustainability. It is important to maintain this, even in the current difficult circumstances. One should consider, however, whether the scale, scope and focus of the Programmes are appropriate also in the future. Particularly one should give serious consideration to a more open approach, as compared to targeted collaboration.

Future prospects:
All the Programmes have drafted their plans for the future. One should identify the best practice from the first years. In academic excellence, this has been closely followed by the External Review Committees, whose views are central in targeting the Programmes' future. The fact that individual PhD students and faculty have had a chance to expand their horizons is naturally important, but not unique to these Programmes. The cultural change, the way of working in close collaboration with the industry and with application-driven mind-set seems useful in the current circumstances.

Innovation and entrepreneurship:
In terms of innovation and technology transfer, there has been a considerable boost and new professionalism that needs to be maintained and built on. Instead of the Programmes, this should be provided a more firm footing, perhaps with the help of European funding sources and ministry collaboration, as this topic is also very much an issue for the economic development side of the government.

The CMU Programme in particular seems to have been successful in fostering a community-building and innovation ecosystem benefits that should be maintained and learnt from.

From pioneering phase to strategic institutionalisation:
The pioneering phase of the present instrument *Research and Education Collaboration* through Portuguese-US Programmes can definitively be seen as a success, but it is time to move on. As was visible from the plans of the Programmes themselves, there is a sense of taking the Collaboration into a new level. The collaborative model should be developed into a service that can also be provided to other countries. By so doing it can also become an important Portuguese export that could be expanded into the emerging markets, in particular in the Portuguese-speaking world. Lessons should be drawn for the policy level as well.

R&D&I policy should be developed in a way that ensures the embedding of best practice from initiatives such as the ones evaluated here. Essential elements that are needed to be focused when developing R&D&I policy include:

- *Quality: covering not only the quality of research but also doctoral education, researcher training and research environments as well as processes that are used for assessing, prioritising and selecting those research fields in which research funding can produce genuine excellence on an international level.*
- *Strategic choices paving the way for renewal: made possible by systematic foresight and continuous strategic intelligence.*
- *Best practice: ensuring a management and monitoring culture and methodologies that provide timely and accurate data and information for decision-making.*
- *Internationalisation: covering research, education and training, as well as commercialisation and technology transfer.*
- *Sustainability: including financial model that is based on accountability and sound financial management.*

This policy focus should be accompanied by good management practice, relating to issues such as:

- *Good governance: transparency and coherence of rules, goals and criteria*
- *Monitoring and evaluation: ensuring the availability of reliable data and information for decision-making*
- *Financial model: increasing leverage by a transparent and open model. (See also 'good management' definition in the key concepts appendix.)*

There is a need to create a path of continuous improvement and a more systematic management support. This could include programme support functions, but also shared standards and indicators: a logical model upon which selected indicators would be connected and a system providing support in the form of quality assurance, monitoring and documentation. This is required to assess the programme continuously and to make changes when required. While the External Review Committees have been able to do this on occasion, there should be a more formalised institutional support. Transferability of the model to other directions needs to be explored. Lessons and practices should be made public as much as possible to allow people to learn from it. The External Review Committees could also play a role in this, as they are well placed in their scientific communities to diffuse the best practice identified.

A more systematic model of programme logic and an explicit mapping of the mechanisms behind these Programmes, with a goal hierarchy, more clearly spelled-out sub-objectives and indicators and monitoring data to be collected is a very strong recommendation for the future. An example of a simple logical model is provided as a simplified impact tree below.

On the level of Portuguese science policy, *the Research and Education Collaboration* has been a unique and valuable pilot. The evaluation concludes that *the Research and Education Collaboration* in question has been an excellent instrument and an ambitious and commendable initiative. It is interesting for the whole European Research Area and should be paid close attention to in terms of mapping good practice. The pioneering stage has been successful in many respects (attention to quality, internationalisation, attractiveness, national collaboration), and it should be followed by a second-generation Programme built on the lessons of the current one.

On the governance level, the evaluation argues that there should be a more concerted institutional effort on the national level to find a method by which strategic choices can be taken in a more broadly-based high-level dialogue and collaboration. While the evaluation acknowledges that such bold choices and ambitious initiatives may be easier to achieve in a less broad consensus, there are benefits to embedding and ensuring sustainability through commitment that can only be achieved with broader collaboration. When it comes to strategic choices on the level of a broad-based R&D&I dialogue, the Finnish example of a high-level Research and Innovation Council may be an inspiring model to be explored. This type of organ

could ensure a better embedded and systematic approach to monitoring and evaluation as well, with various organisations and authorities committing themselves to shared management models.

Furthermore, steering mechanisms of the universities could include incentives to further support such concerted efforts. One possibility is to build a funding model of the universities in a way that is predicated on supporting internationalisation of universities. In this case, the universities' funding should entail a component that supports and rewards internationalisation, not only in specific programme contexts but across the activities.

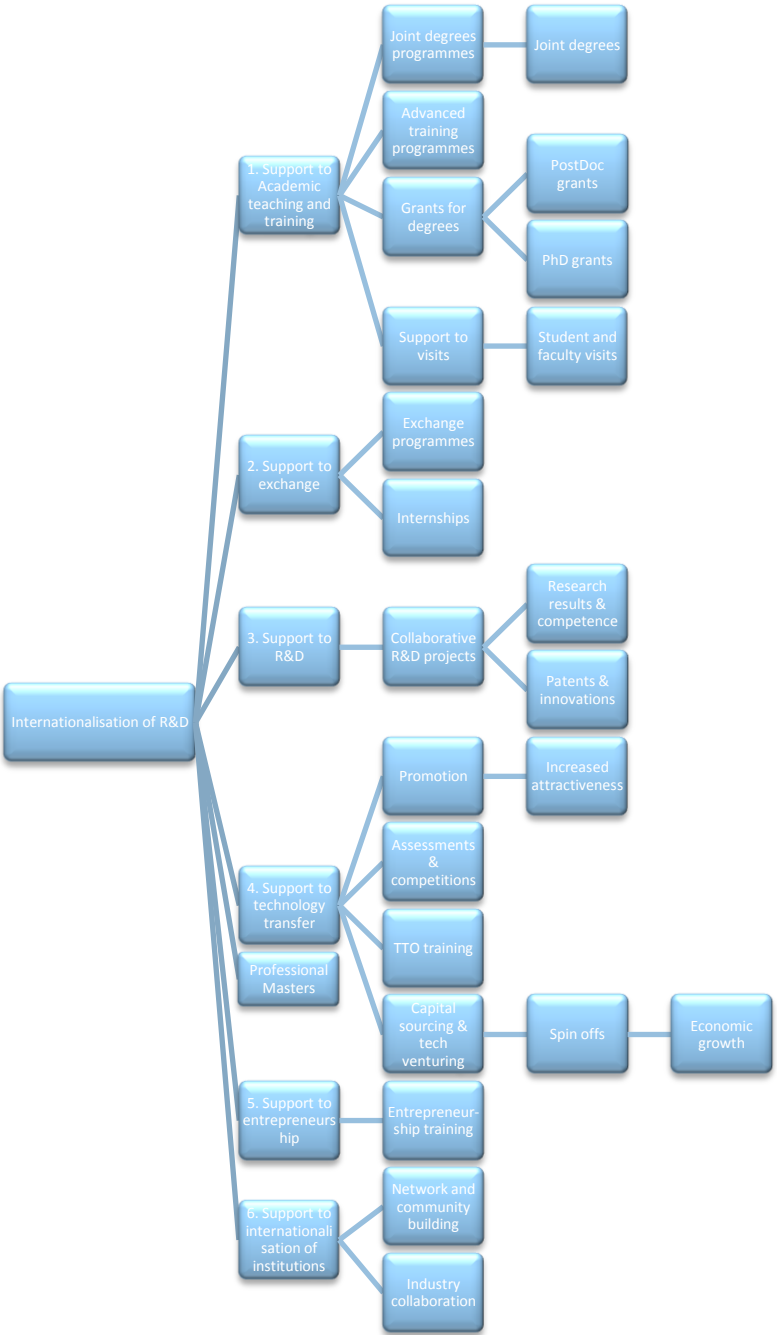


Figure 27. Logical model of partnerships (an example)

The collaborative Programmes between Portugal and the US have been unique tools with a highly ambitious and important agenda for bringing the Portuguese R&D&I system to an international level. While already in its current form, there have been important lessons learnt and knowledge and methods tested and diffused, even more could have been achieved if more attention had been paid to following and documenting the successes and failures at an earlier stage. Good management practice and accountability, including a transparent and comprehensive picture of the funding allocated to and used by the Programmes, should be fully integrated into programme practice, and coordination support should be made available. By so doing, the Programmes themselves will be more easily accessible to outsiders, the good outcomes, results and effect more widely distributed and leverage supported.

4.3 The evaluation and its recommendations in a nutshell

Portuguese collaboration with US universities (Massachusetts Institute for Technology, Carnegie-Mellon University and the University of Texas at Austin) in research and education is a bold example of an international university-government programme with high-profile science and innovation policy objectives.

The assessment recommends to continue these programmes.

However,

- ➔ Good management practice and sound financial management must be incorporated into all FCT practice in all programme activity. This includes transparent selection criteria, monitoring indicators, reporting practices, and financial model.

- ➔ A quality assurance system should be developed for the FCT to ensure systematic standards applicable across all FCT programmes.

- ➔ The Research and Education Collaboration Programme could be opened to universities other than the current three US partners and, indeed, to other than US parties. Co-funding should be ensured.

- ➔ Technology transfer, innovation and entrepreneurship should be promoted, and possible alternative sources of funding should also be investigated.

The programmes' significance and value for money should be assessed by comparing their value added with that from other existing or planned investments. As a whole, Portuguese-US university collaboration programme has been a significant pilot and it should be followed by a second-generation programme built on the lessons of the current one. The main approach is to find those strategic choices that are most effective to Portugal through broadly-based, high-level dialogue and collaboration.

5. REFERENCES

Academic Ranking of World Universities (ARWU) 2010. http://www.arwu.org/

Andersson, Thomas (2010): Building long term strategies and public-private alliances for export development: the Finnish case, United Nations Publications.

Centre for Neuroscience and Cell Biology (CNC): PhD Programme in Experimental Biology and Biomedicine (PDBEB): Report of PDBDB, 2005–2008, http: beb.cnbc.pt.

Commission of the European Communities (2001): White Paper on Governance, Brussels, 25.7.2001, COM(2001) 428 final.

Commission of the European Communities, DG Research & Innovation (2011): Innovation Union Competitiveness report 2011

Duarte, Joana & Mendonca, Joana (2011): "Doctorate Holders in Portugal: A Full Recording System and measures of International Flows", OECD.

Godinho, Manuel Mira and Vitor Corado Simões (2009): ERAWATCH Country Report 2008, An assessment of research system and policies: Portugal, JRC Scientific and Technological Reports, Luxembourg, Office for Official Publications of the European Communities.

Godinho, Manuel Mira and Vitor Corado Simões (2009): ERAWATCH Country Report 2009, Analysis of policy mixes to foster R&D investment and to contribute to the ERA: Portugal, JRC Scientific and Technological Reports, Luxembourg, Office for Official Publications of the European Communities.

Godinho, Manuel Mira and Simões, Vítor Corado (2010): ERAWATCH COUNTRY REPORT 2010: Portugal.

Idea et al. (2011): Study on mobility patterns and career paths of EU researchers, Prepared for: European Commission, Research Directorate-General, Directorate C – European Research Area Universities and Researchers. Report available at http://www.researchersmobility.eu/

Lemola, Tarmo (2002): "Convergence of national science and technology policies: the case of Finland", *Research Policy*, 31, 1481–1490.

Lemola, T. (2003). "Transformation of Finnish Science and Technology Policy", *Science Studies* 16:1, 52–67.

Lerner, Josh (2009): Boulevard of Broken Dreams, Why Public Efforts to Boost Entrepreneurship and venture capital Have Failed – and What to Do About It, Princeton University Press.

Manoel, Diogo (ed.) (2011): A Decade and a Half in the Life of a Graduate Programme 1996–2011,
MIT Portugal, A Network of advanced studies involving Portuguese universities and the Massachusetts Institute of Technology, Vol. 2.

Niemi, Hannele et al. (2011): Tohtorikoulutuksen rakenteet muutoksessa: Tohtorikoulutuksen kansallinen seuranta-arviointi, [Changing Structures of Doctoral Training], Publications from The Finnish Higher Education Evaluation Council (FINHEEC), 15/2011.

Suomen Kuntaliitto (2005): Kumppanuus konsultointitoiminnassa. [Association of Finnish Local and Regional Authorities: Partnership in Consultation Activity].

Year 4 Report to the External Review Committee Funded by Fundação para a Ciência e a Tecnologia, Ministério da Ciência, Tecnologia e Esino Superior.

Ylä-Anttila, Pekka & Lemola Tarmo (2006): ”Transformation of innovation system in a small country – The case of Finland” in Tarmo Kalvet & Rainer Kattel (eds.): Creative Destruction Management: Meeting the Challenges of the Techno-Economic Paradigm Shift, Praxis International, Tallinn.

In addition for each of the programmes:

Programme-specific documentation included for each of the programmes the Council of Ministers Resolution No 132/2006, the Assessments and Assessment Agreements, No cost Agreements between FCT and MIT 2011, Agreement FCT – Portuguese Institutions, Agreement - Portuguese institutions, Cooperation Protocols, Agreements with the Industrial Affiliates, Annual report per sub-programme, Formal letters, Work Plans and Governance description, future plans and a variety of project reports and publications, reports from the External Review Committees.

6. APPENDICES

Appendix 1. Fact sheets per Programme

MIT-PT

Type of activity / outputs	
Areas of collaboration	Bioengineering systems Engineering design and advanced manufacturing Sustainable energy systems Engineering Design and Advanced Manufacturing (EDAM) Transportation systems
Teaching and training	6 universities and 8 schools that assign degrees 13 universities participating in R&D 9 associated laboratories 1 state laboratory 59 companies MIT: 5 schools, 25 departments Faculty teachers hired through the programme: 23 Portuguese university professors involved: 214 Portuguese teachers who have extended stays at MIT: 28 MIT professors involved: 62 Advanced training programmes: 4 doctoral programmes (BES, EDAM, SES, Transportation), 3 Master's (SES, Transportation, EDAM)
Students	Total number of students: 578 of whom 369 doctoral students, 209 Master's students (representing 44 and 16 nationalities, respectively) Students currently registered: 489 (doctoral students: 369, Master's students: 120) Students who have completed degree: 89 (Master's) PhD scholarships: 204 Students with extended stays at MIT: 120 Percentage of Portuguese students enrolled in 2010/11: 62% Percentage of international students who enrolled in 2010/11: 38%
Collaborative projects	20 R&D projects with average duration of three years (from 72 applications)
Other activities	Patenting: 2 (2009: 1, 2011: 1) Spin-offs: 4 (2008: 1, 2010: 1, 2011: 2)

CMU-PT

Type of activity	
Areas of collaboration	Cyber-Physical Systems for Ambient Intelligence Next Generation Networks for High-Quality Trusted Services Software Engineering for Large-Scale Dependable Systems Human-Centric Computing Mathematics of Information and Communication Public Policy & Entrepreneurship Dynamics in New ICTs
Teaching and training	9 universities and 14 schools that assign degrees 5 associated laboratories 1 institution of applied research 81 companies CMU 7 universities and 9 research centres More than 150 professors and senior researchers involved in projects and educational programmes 30 teachers from 9 different Portuguese universities participated in the Faculty Exchange Programme (a period of stay at CMU to investigate and teach) Faculty members hired through the programme: 56 Advanced training programmes: 7 doctoral programmes (CS, LTI, ECE, TCE, EPP, LT, Math) 5 Master's programmes (MSIN, MSIT, MHCI, MSE, METC)
Collaborative projects	25 R&D projects with average duration of three years (from 43 applications).
Students	Total number of students: 273 (doctoral students 85, Master's students: 183, postdocs: 5) Number of students currently 148 (doctoral students: 75, Master's students 70, postdocs: 3) Students who have completed degree: 104 (PhD: 1, Master's: 101, postdocs: 2) Students who dropped out (or otherwise): 21 (PhD students: 9, Master's students: 12) Scholarships to be awarded: 85 + 5 doctoral scholarships postdoc Stays CMU: all PhD students spend two years at CMU, most graduate students spend a semester at CMU Students supported by CMU Portugal Programme: All students supported with a grant CMU Portugal are both university students and CMU Portuguese Percentage of Portuguese students who enrolled in 2010/11: 66% Percentage of international students who enrolled in 2010/11: 34%
Examples of other activities	Large-Scale Testbed for Intelligent Transportation Systems (Project Drive-In) Human-Computer Interaction Systems for Sustainable Living (Project Sinais) Cyber-Physical Systems for First Responders in Emergency Scenarios (Project Vital Responder) Secure Software-Intensive Systems (Project Interfaces)

UTA-PT

Type of activity / outputs	
Areas of collaboration	Advanced Computing, Digital Media Mathematics
Teaching and training	14 universities and 14 schools that assign degrees 3 associated laboratories 2 public agencies 16 companies PhD scholarships granted: 68 Postdoctoral scholarships grants: 11 Student and faculty visits at UT Austin: 256 (DM: 97, AC: 41, Math: 118) Workshops and courses: 112 (DM: 87, AC: 14, Math: 11) Advanced training programmes: 3 doctoral programmes (Digital Media, Advanced Computing, Math), 1 Master programme (Digital Media)
Students	Total number of students: 314 of whom 91 doctoral students, 211 Master's students, amongst the Master's, 15 nationalities represented, 4 amongst the PhD students Number of students currently registered: 301 (doctoral students: 85, Master's students: 211) - Students who have completed the degree: first expected in 2012 PhD scholarships: 68 Students with extended stays at UTA: 256 Percentage of Portuguese students enrolled in 2010/11: 76.5% Percentage of international students who enrolled in 2010/11: 23.5%
Collaborative projects	15 R&D projects (of which 2 of Mathematics together with CMU-Portugal) with average duration of three years (from 46 applications). Support of professional and research internships to 19 students, including ZON prize winners
Other activities	UTEN collaboration, responsible for coordination

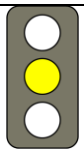
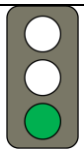
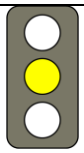
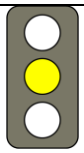
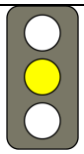
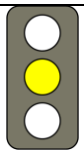
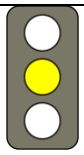
UTEN

Type of activity	Outputs
Events and workshops	The workshops, training weeks, leaders brainstorm roundtables and initiation took place in various universities, attended by national and international experts, to an audience of researchers, leaders and staff of technology transfer offices (TTOs), entrepreneurs and potential partners and investors. 13 workshops (2 in progress) in areas such as Marine Sciences, Information and Communication Technologies, Nano and Life Sciences, Social Entrepreneurship, Space Technologies, etc. have been organised in collaboration with network members UTEN and international partners. Participants were exposed to major challenges and market trends in specific areas of each event together and discussed issues such as international partnerships, sponsored research agreements, consortium agreements, licensing, start-ups, etc., favouring in this way the analysis of the critical issues of transfer and commercialisation of technologies associated with each research project. Ten-week training, in areas such as Licensing and Negotiation, Capital Sourcing and Technology Venturing, and University Spin-off Venture Creation, University-based Technology Business Incubation, Setting Up and Managing an Industrial Liaison Office, Evaluation of Intangible Assets, etc. were performed, resulting in specialisation of TTOs in critical areas of the process of commercialisation of technologies associated with the economic value of the results of science and technology. 3 Leader Roundtables: Benchmarking Best Practices on TT have enabled TTOs senior corporate in-depth discussion of the practices and methodologies used by Portuguese and foreign universities and sharing knowledge and experiences 6 Initiation Brainstorms: Entrepreneurship Day, conducted in partnership with students, promoting entrepreneurship and creating new technology-based businesses and home university.
Internships and faculty exchange events	26 stages (5 in progress) at: UT Austin Office of Technology Commercialization (OTC), UT Dallas OTEC, South Texas Technology Management, San Antonio, Texas A & M OTC, College Station, Texas, Emergent Technologies, IC2, Austin Technology Incubator (ATI), incell (Biosciences Incubator), Texas, MIT Technology Licensing Office, Center for Technology Transfer and Enterprise Creation, Carnegie Mellon University, Boston University Office of Technology Development, Fraunhofer, European Space Agency and Enterprise Cambridge, UK Current situation of trainees: 21 teams are part of technology transfer offices in universities which held the stage, two are placed in private companies, two are researchers at universities and promoting spin-offs and one is to teach in secondary education issues related to entrepreneurship.
Evaluation and development of technologies for commercialisation in international markets, particularly in the US, originating from Portuguese universities	64 reviews ('Rapid screen' assessments), 19 assessments of market potential ('market look' assessments), more than 250 market contacts, which resulted in 51 manifestations of interest, 13 negotiations started, 3 of which to license technologies and 10 for potential onshoring (via joint venture, IP bundling, spin-off, etc..) in the US market

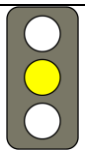
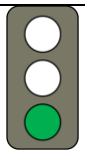
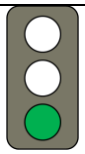
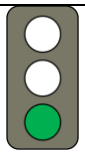
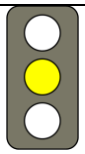
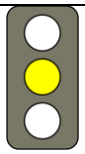
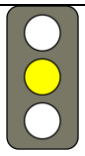
Appendix 2. Summative assessment

This summative assessment was done by combining four questions of the survey, relating to the impact chain of the Programmes: one on the most positive outputs and results, one on the perceived significance of the activities, effectiveness = the extent to which the goals have been achieved, and the overall judgement. Each resulting average was given a point value between 0 and 3 and anything above 3.71 equals GREEN, values between 3 and 3.70 YELLOW and below 3 RED. The headings or the main objectives have been summarised in an integrated fashion, i.e. as 1) Improving educational and training ability, 2) Increasing the number of national consortia, 3) Promoting internationalisation, 4) Strengthening the recruitment of professors and faculty, 5) Promoting economic growth through science-based innovation, 6) Attractiveness, and 7) Access by Portuguese companies to international markets. These have slightly different formulations and conceptualisations in each of the Programmes, however (reflected in the sub-headings).

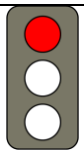
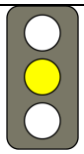
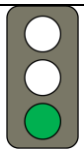
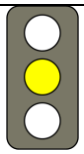
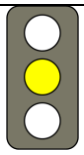
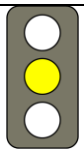
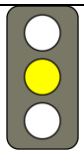
MIT-Portugal Programme

DIMENSION / OBJECTIVE		SYNTHETIC ASSESSMENT
1) Improving educational and training ability		PhD training in particular receives very good scores in the MIT Programme. The focus on innovation and entrepreneurship in teaching and training is highly valued. Benefits should be taken from the individual level to the institutional. There are also some important examples of and development in using innovative methods for entrepreneurship and innovation (e.g. innovation boot camp) in the PhD training, which are highly appreciated by the research community. Students sometimes find it difficult to find their footing at MIT, and some initial problems were associated with commitment and supervision. These are largely been solved.
2) Number of national consortia		Still at early stages, difficult to judge. MIT does rank highest in this regard in the survey.
3) Promoting internationalisation,		Best results were reported in areas where Portuguese R&D institutions already had a critical mass.
4) Strengthening the recruitment of professors and faculty		MIT-Portugal Programme ranked higher than average on this dimension. The recruitment of university professionals may be a less significant benefit, however, than the new opportunities for academic careers (e.g. opening doors and creating opportunities for careers in industry).
5) Economic growth through science-based innovation		While there are at this stage relatively few examples of effects in this area, the value added for cultural change in the longer term is considerable. The leadership issue is seen as a particularly relevant one and also implies close interplay with the industry.
6) Attractiveness		The importance of collaborating with one of the top US universities has been significant, even if the estimated benefit for the Portuguese innovation ecosystem is slightly higher than in the other Programmes.
7) Access to international markets		Though these benefits were seen as most modest at the moment in all the Programmes, MIT scored higher than average on this and second only to UTEN.

CARNEGIE-MELLON – Portugal Programme

DIMENSION / OBJECTIVE		SYNTHETIC ASSESSMENT
1) Improving educational and training ability		Relatively positive effects, too early to judge fully.
2) Number of national consortia		While EU projects or collaborations are still in embryonic forms, there have been important advances in creating collaborations with industry, including the Master's programme with Novabase.
3) Promoting internationalisation		Very positive assessment of making Portugal more interesting as an academic environment for students and faculty from around the world, as well as of the best practices systematically assessed and promoted.
4) Strengthening the recruitment of professors and faculty		CMU got highest scores in this question in the survey and other sources also indicated that the relative benefits of the CMU Programme in this regard were more considerable than in the other Programmes. The added benefit came from the more distant and marginal research environments making a qualitative leap in their selected research fields.
5) Economic growth through science based innovation		CMU ranked highest on this dimension in the survey and though the process is still ongoing, there are positive indications of creating new dynamics in this area.
6) Attractiveness		A positive overall picture, many international students and PhD candidates who would not otherwise have chosen Portugal. Management problems, e.g. funding allocations across years and communication in the early stages in particular.
7) Access to international markets		Still in the early stages, despite the commitment on paper has to be made more tangible.

UNIVERSITY OF TEXAS AT AUSTIN – PORTUGAL PROGRAMME (including UTEN)

DIMENSION / OBJECTIVE		SYNTHETIC ASSESSMENT
1) Improving educational and training ability		Due to the technology transfer focus, these were not the main target areas, yet some very positive stories and exceptions could be given in areas such as digital media.
2) Number of national consortia		Interaction between universities and companies regarded as successful, but many respondents unable to answer questions relating to this issue.
3) Promoting internationalisation		Technology transfer has been seen in a particularly positive light, and the qualitative shift here has been significant for the innovation system. Digital media has received a considerable boost, even if this is still relatively small-scale in terms of economic impact. New innovation environments and research fields have been introduced to the Portuguese environment.
4) Strengthening the recruitment of professors and faculty		Promising signs are visible and international impact in the long term is expected to be significant.
5) Economic growth through science-based innovation		Expanding the presence of advanced digital media in Portugal through educational and research exchange, Promoting interaction between universities and companies, Promoting the development of globally competitive and sustainable Portuguese technology commercialisation infrastructure
6) Attractiveness		In the area of technology transfer particularly important new initiatives have been undertaken, in connection with the UTEN collaboration. Entrepreneurship has been given a considerable boost by the Programme.
7) Access to international markets		Not successful yet, but positive signs are visible

Appendix 3. List of statistics

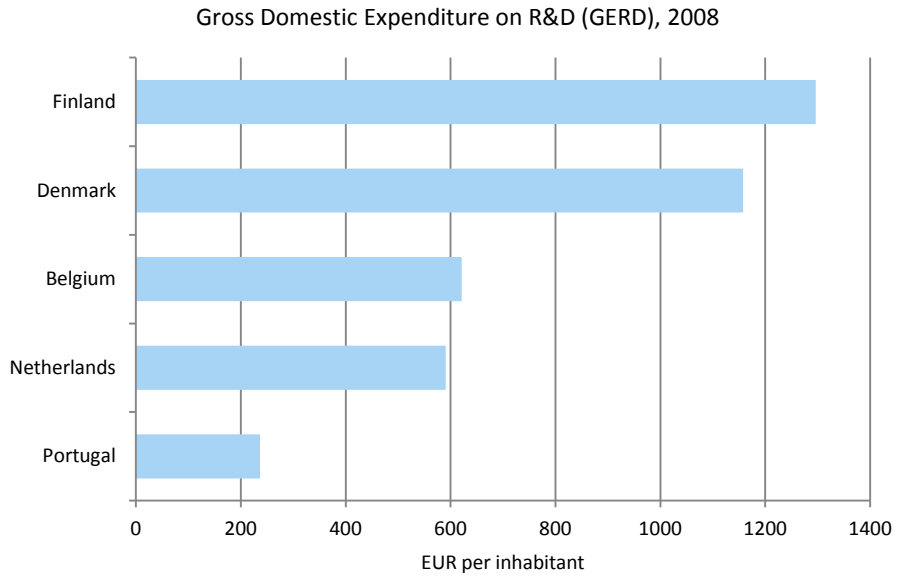


Figure 1. Gross Domestic Expenditure on R&D (GERD), Eurostat 2008

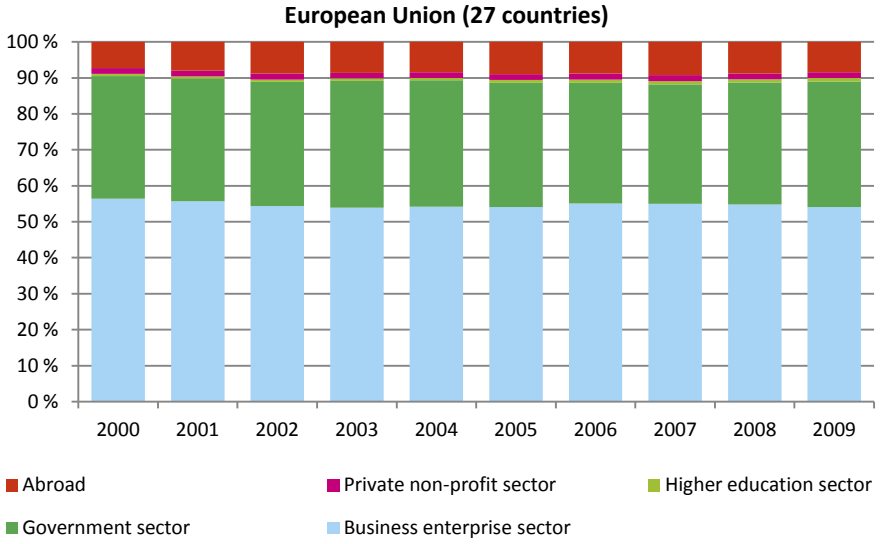


Figure 2. R&D expenditures in EU27 by sector

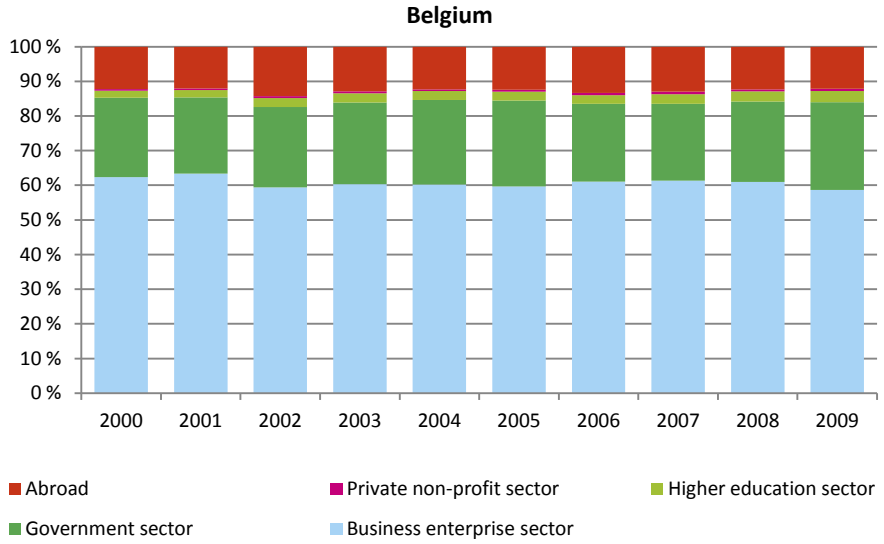


Figure 3. R&D expenditures in Belgium by sector

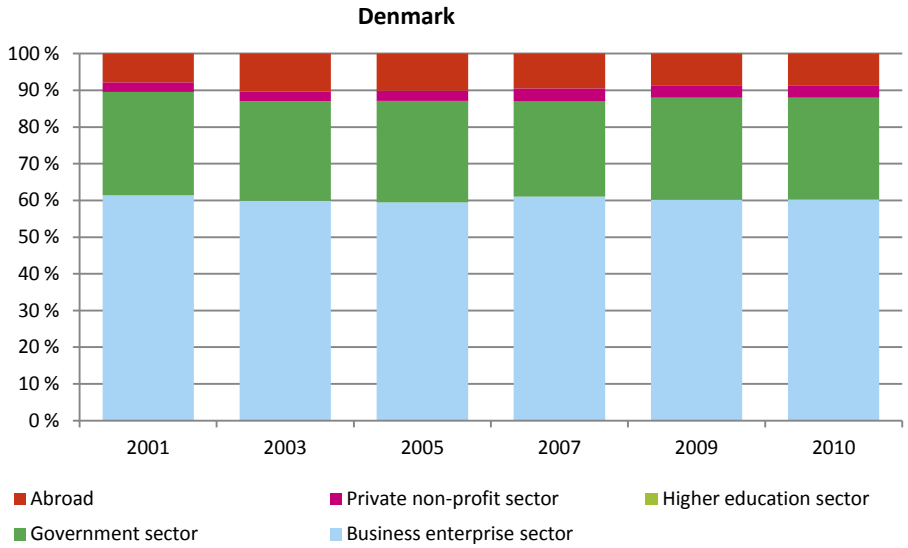


Figure 4. R&D expenditures in Denmark by sector

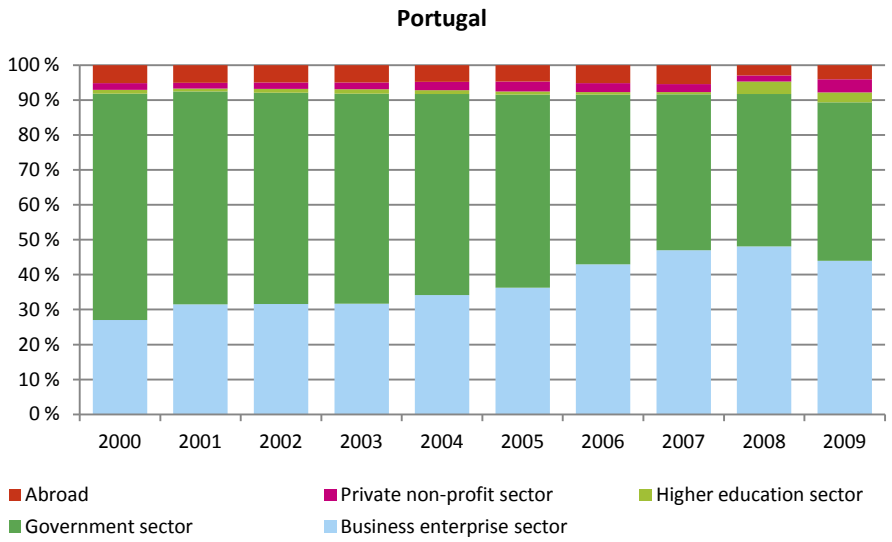


Figure 5. R&D expenditures in Portugal by sector

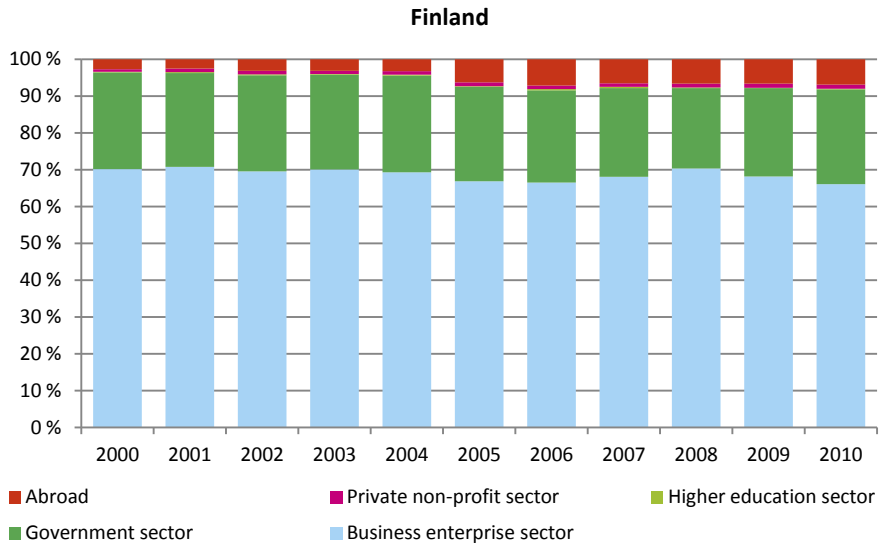


Figure 6. R&D expenditures in Finland by sector

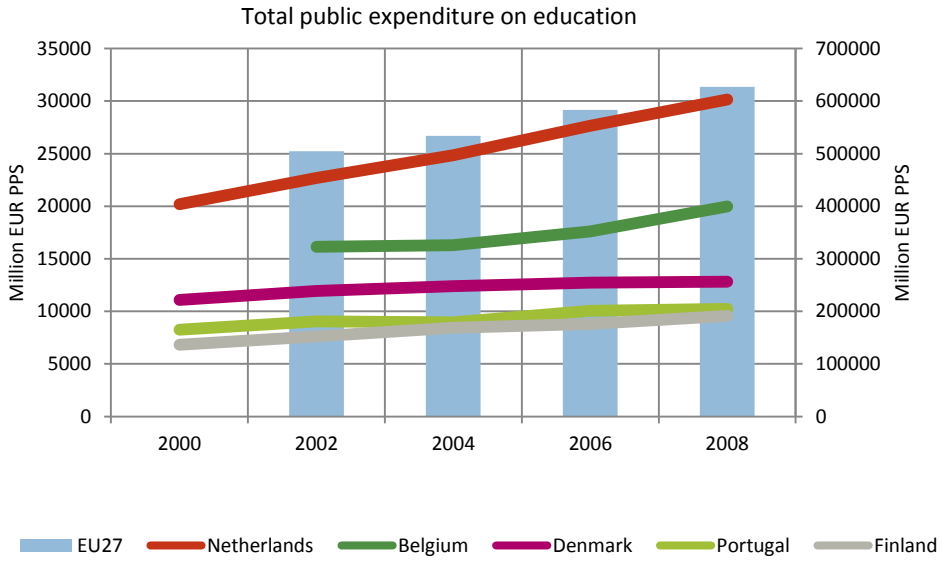


Figure 7. Total public expenditure on education

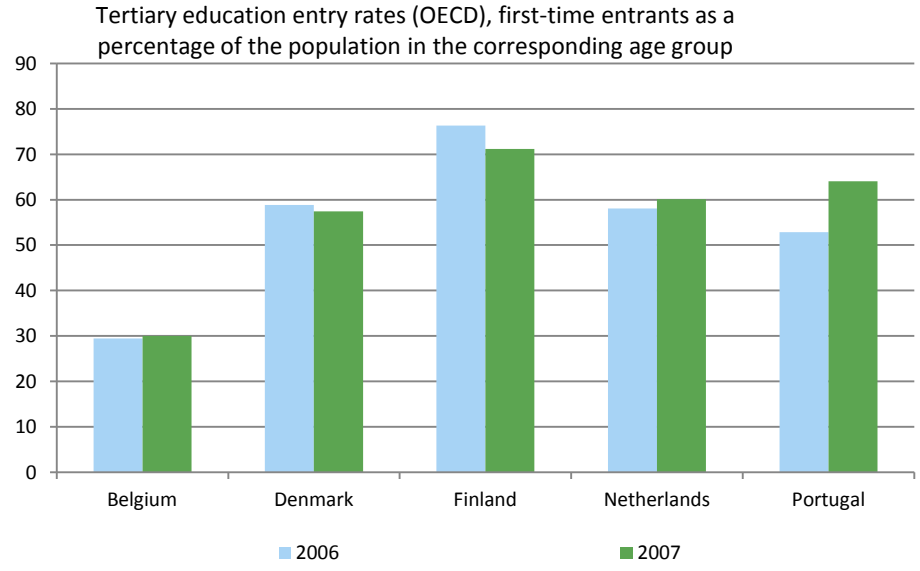


Figure 8. Tertiary education entry rates, first-time entrants as a percentage of the population in the corresponding age group

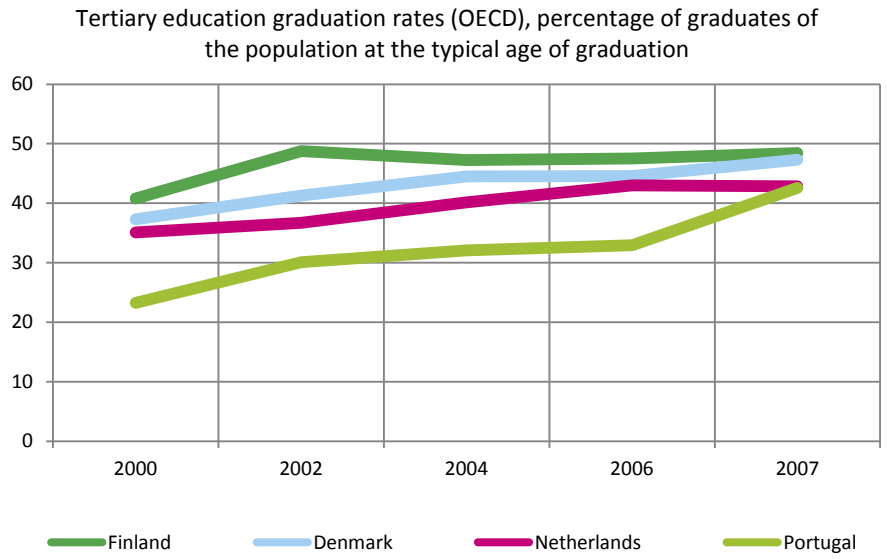


Figure 9. Tertiary education graduation rates, percentage of graduates of the population at the typical age of graduation

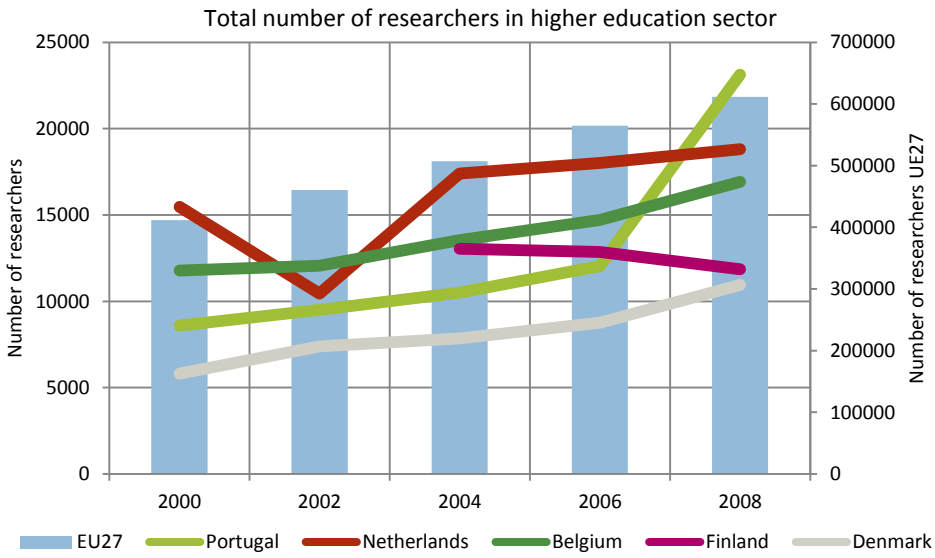


Figure 10. researchers in higher education sector, TOTAL

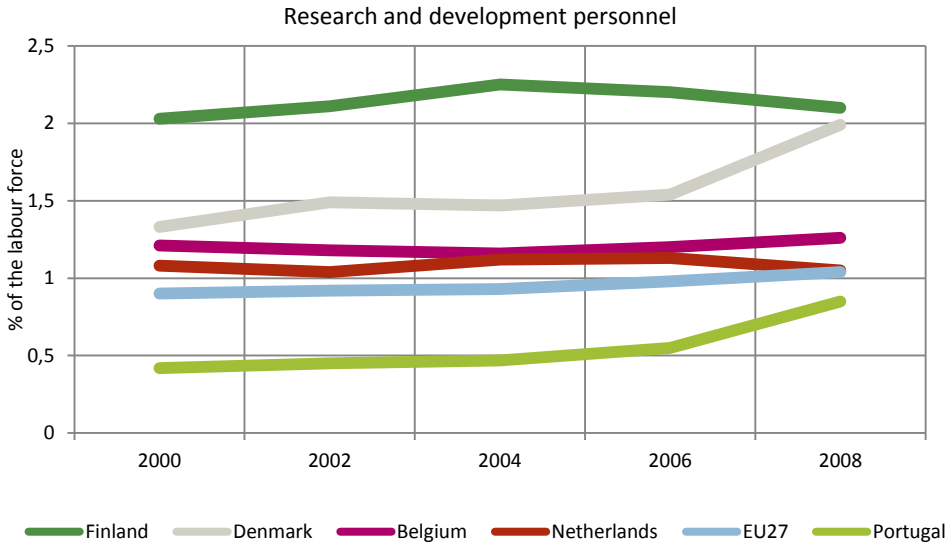


Figure 11. Research and development personnel, percentage of the labour force

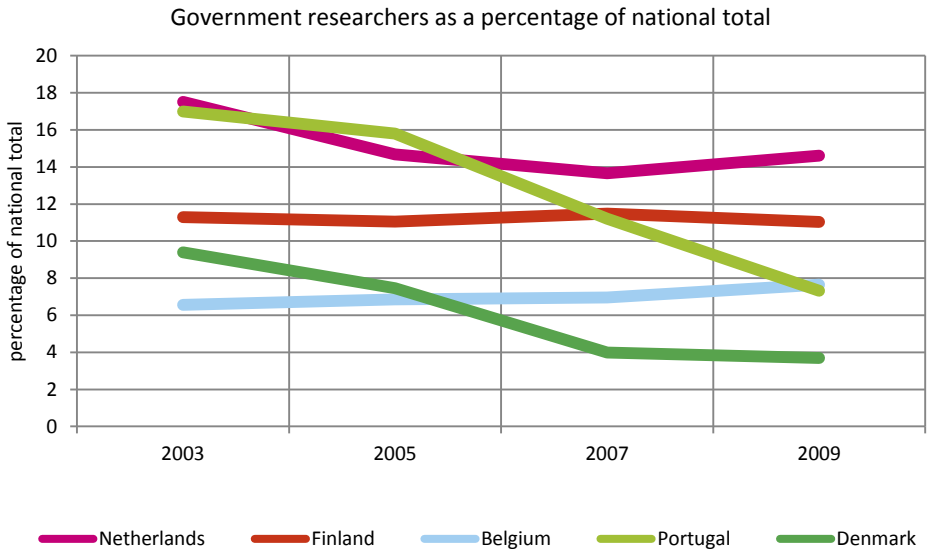


Figure 12. Government researchers as a percentage of national total

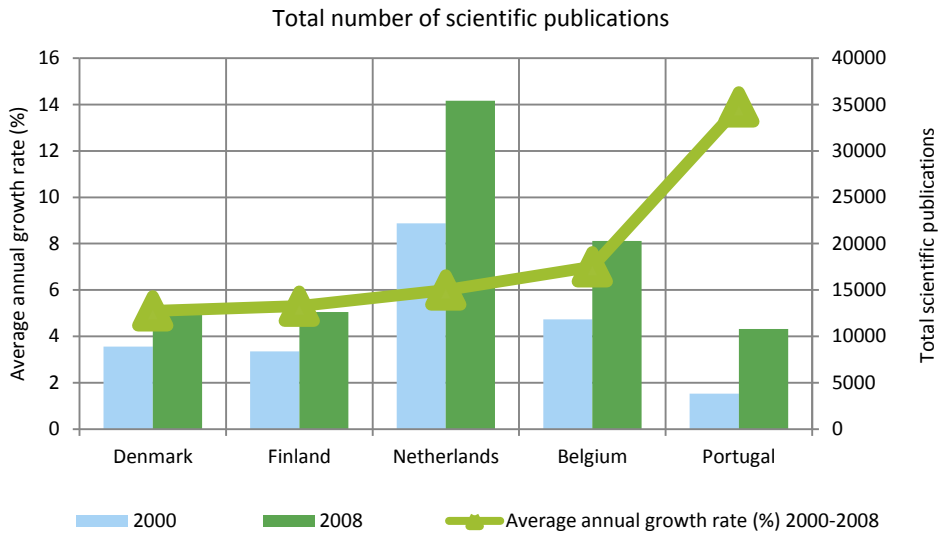


Figure 13. scientific publications, total

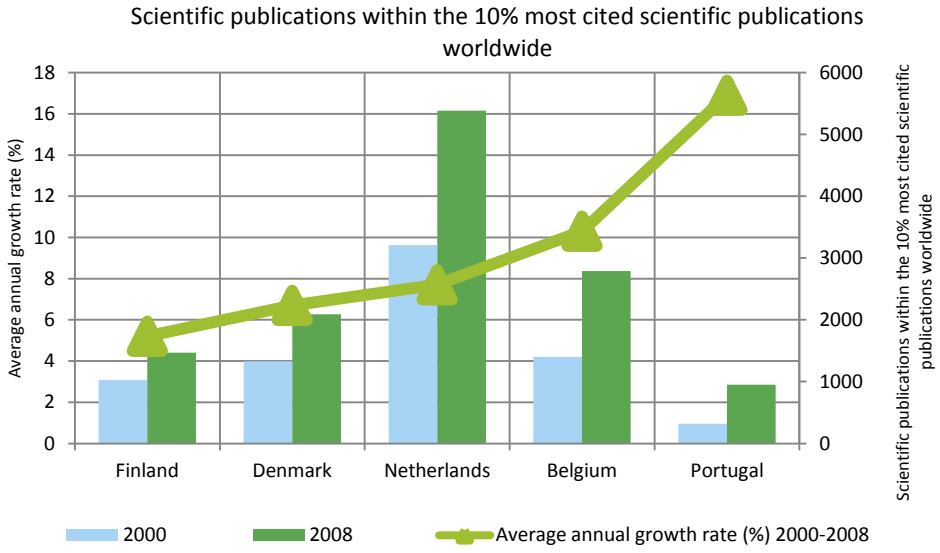


Figure 14. Scientific publications within the 10% most cited scientific publications worldwide

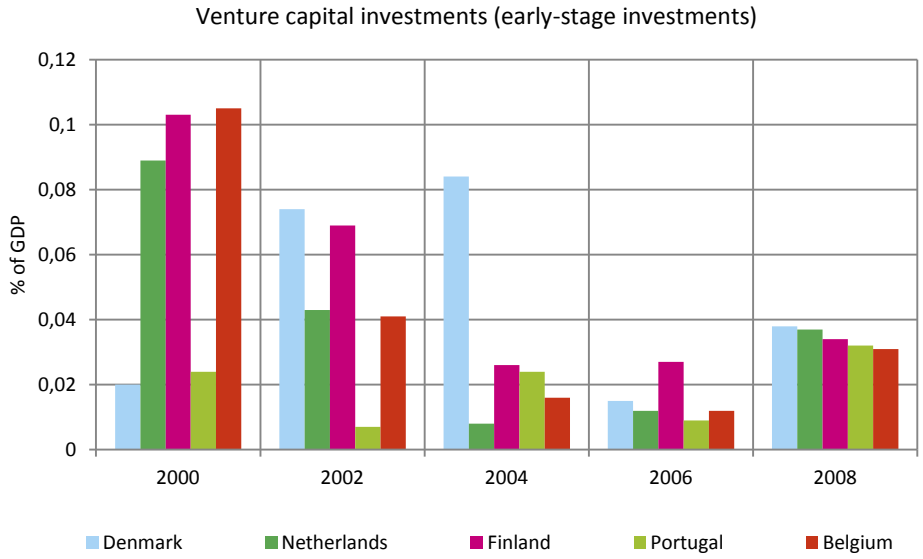


Figure 15. Venture capital investments (early-stage investments)

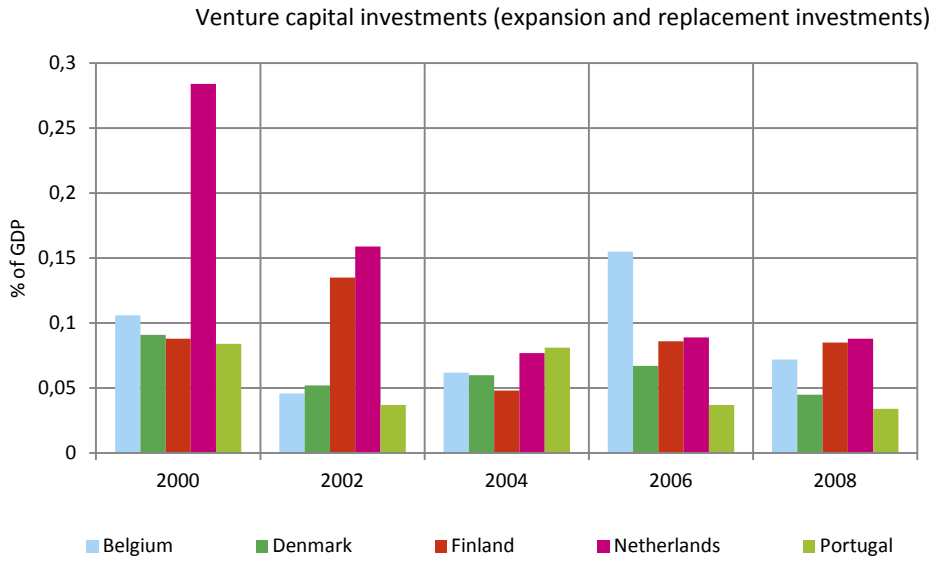


Figure 16. Venture capital investments, percentage of GDP (Expansion and replacement investments)

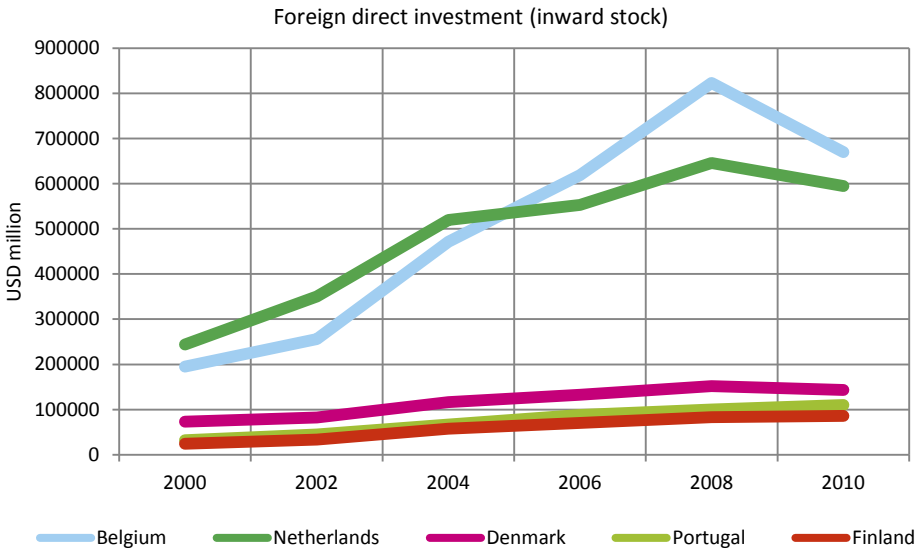


Figure 17. Foreign direct investment (inward stock)

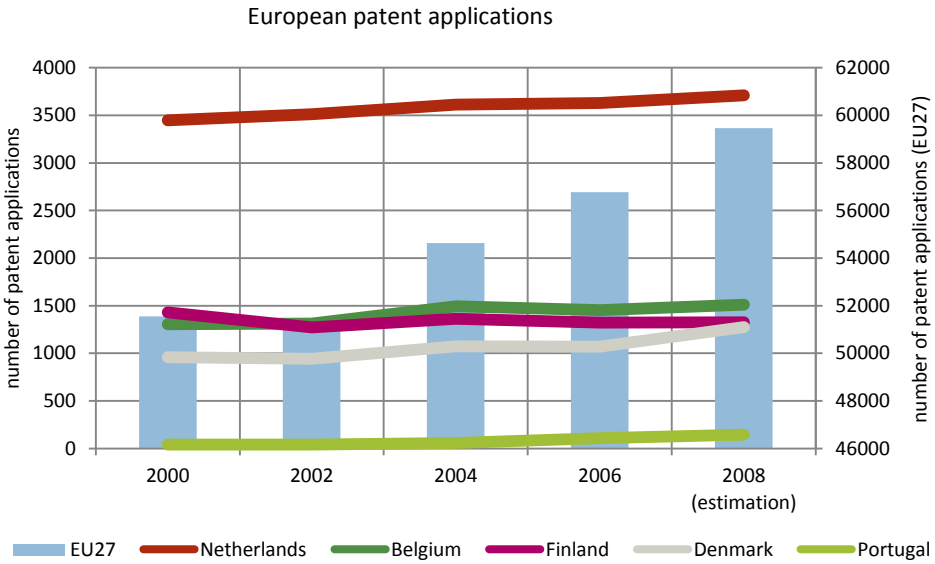


Figure 18. European Patent Applications

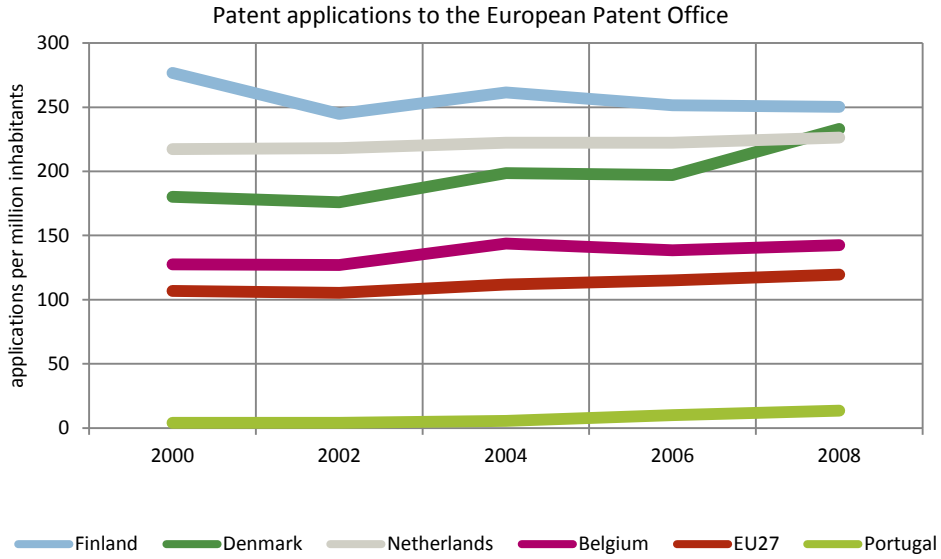


Figure 19. Patent applications to the European Patent Office

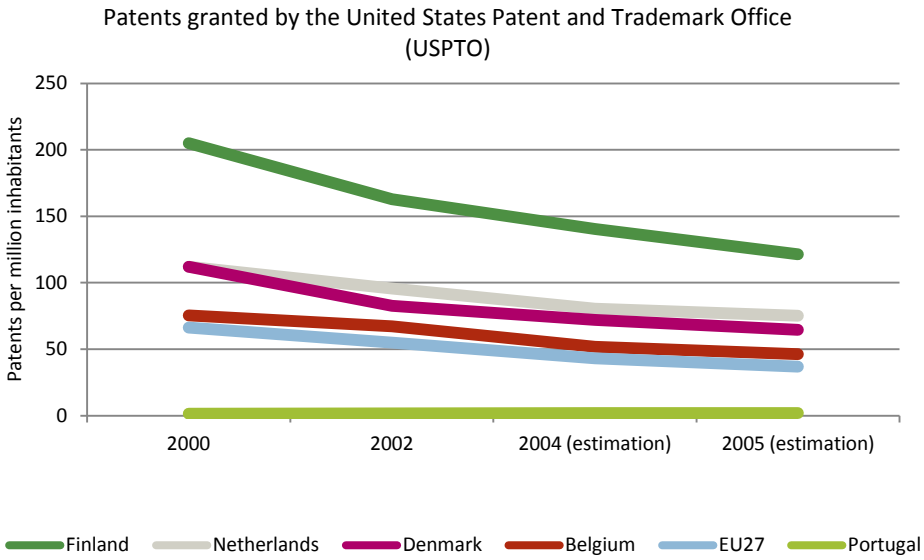


Figure 20. Patents granted by the United States Patent and Trademark Office (USPTO)

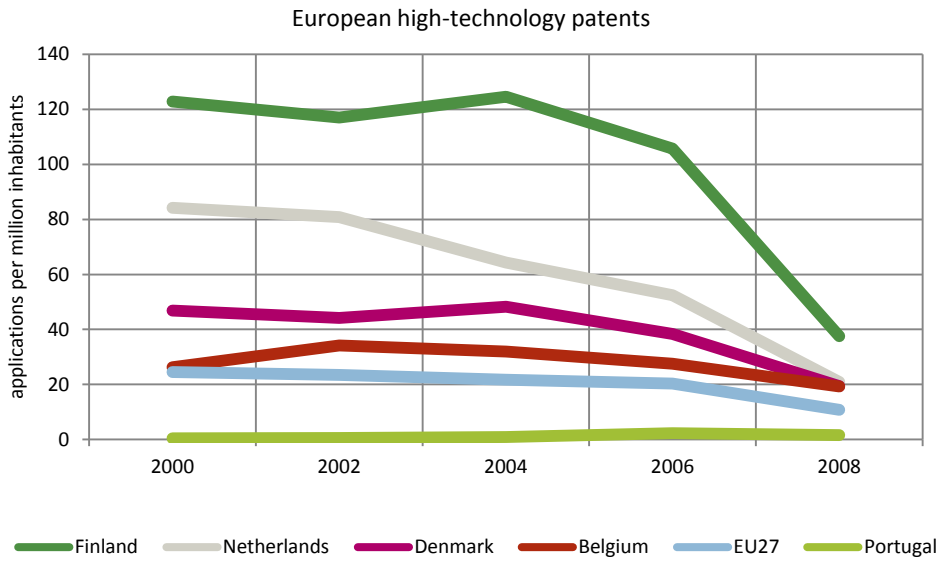


Figure 21. European high-technology patents

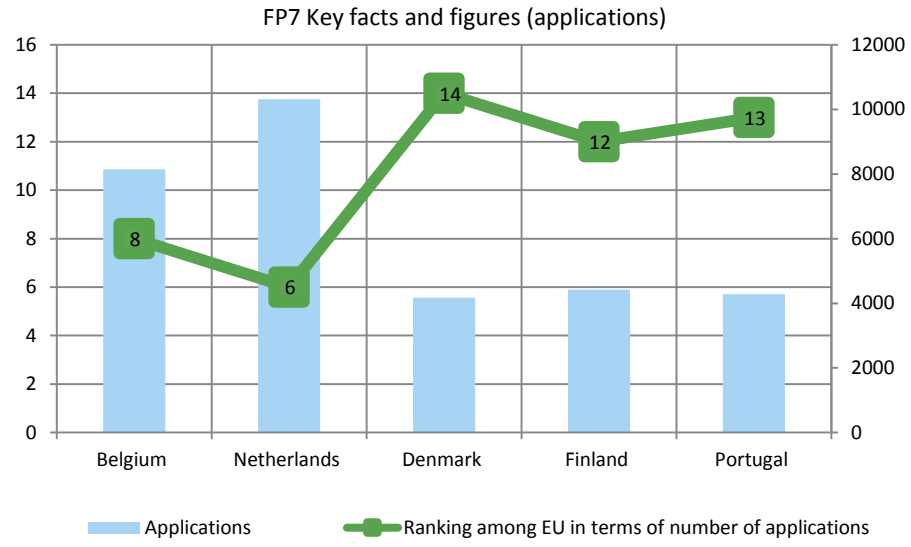


Figure 22. FP7 key facts and figures (applications)

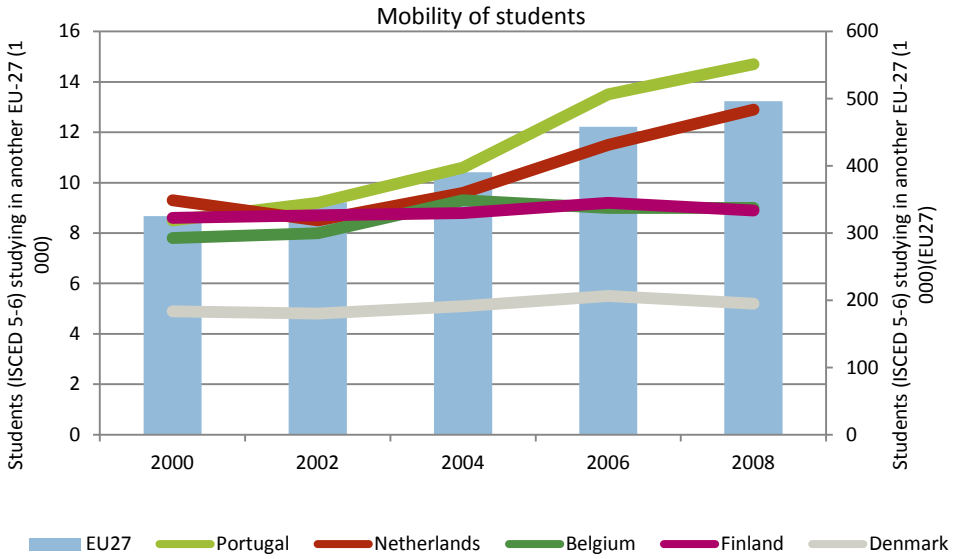


Figure 23. Mobility of students

Appendix 4. SWOT analyses

The analysis of ***Strengths, Weaknesses, Opportunities and Threats*** is based on interviews undertaken in Lisbon with the Programme stakeholders on 19, 20 and 23 October. More than 100 stakeholders have been interviewed and heard face-to-face or Skype/video conference link in this process (a list of interviewed persons is attached to the final report). The different datasets provide a good overview of the materials required for the triangulation process. Triangulation entails bringing together different perspectives, with complementary value and comprehensive data coverage is essential here.

At the evaluation panel meetings and in the reporting we have started with a common SWOT and subsequently pursued a summative analysis that both provides an analysis of the different actor perspectives, and in cases where relevant, of programme-specific differences. As the actor perspectives are clearly relevant it has been seen as important to see which views are prevalent among the programme management, which among the students, which are more reflective of the faculty staff and which perhaps more likely to emerge amongst the long-term stakeholders such as industry affiliates.

Table 1. Program level

STRENGTHS	**WEAKNESSES**
Unique model of promoting R&D&I Close collaboration within Portugal Good infrastructure to attract people to Portugal, opening doors Critical mass (a lot of colleagues) Collaboration with industry, always starting from a problem to be solved Different way of teaching, focus on improved quality, standards Systematic way of working with industry Holistic and practical way of addressing problems, teaching based on finding solutions for industry problems So far successful demonstration and validation, next step institutionalisation Initial scepticism by the leadership of Portuguese universities shifted to support, strategic agreement on innovation and entrepreneurship Strategic partnership with large Portuguese companies	"Calvin ball" = lack of clear shared rules, rules changing by year (especially students felt this) In some cases, no credits gained (non-dual degrees; MIT and UTA) Lack of synchronisation and marketing of the Programmes Lack of common project funding and Labs (Digital media?) Lack of information and communication Lack of supervision (in some cases) Exclusive grants (exclude the possibility of working while studying) Portuguese companies small, with limited tradition of R&D Limited number of international companies involved, small number of large Portuguese companies monopolising the benefits Basic research underdeveloped
OPPORTUNITIES	**THREATS**
High-quality PhD training of major importance Network management across the Programmes Higher visibility and higher profile Quality assurance systems to be developed assessed by the Ministry of Education Expertise in fund-raising	Brain drain (? Though conflicting views on this) Lack of transparency and perceived problems in governance putting the R&D inputs under threat[30] Commercialisation opportunities lost if VC and industrial affiliates not mobilised more effectively Two-tier system (if dual-degrees not implemented across the board) Overall: Possible missing opportunities in disciplines, scientific fields and universities; which are not currently in the Programmes, but relevant to the future of PT? "Future fields" and "weak signals" not paid enough attention to -> More systematic foresight needed

[30] The importance of transparency and good governance is not to be underestimated here. This applies to most countries, as indicated for instance by the recent assessment of Finnish doctoral programmes, where the e-survey found that the increases and improvements in transparency, consistency and systematic nature of the selection process have been a major improvement, where definition of shared selection criteria and clearly communicating this criteria has contributed to the perception of an equal treatment of candidates. (Niemi et al, 2011, p. 33)

Table 2. Education, training, study visits

STRENGTHS	WEAKNESSES
Unique model of promoting R&D&I Close collaboration within Portugal Good infrastructure to attract people to Portugal, opening doors Critical mass (a lot of colleagues) Collaboration with industry, always starting from a problem to be solved Different way of teaching, focus on improved quality, standards Systematic way of working with industry Holistic and practical way of addressing problems, teaching based on finding solutions for industry problems (iTeams and similar methods) Initial scepticism by the leadership of Portuguese universities shifted to support Joint programmes valuable for improving quality Good networks and trust to build on, many collaborative ties based on individual contacts	"Calvin ball" = lack of clear shared rules, rules changing by the year (esp. students) In some cases no credits gained (non-dual degrees; MIT and Austin initially) Lack of synchronisation and marketing of the programmes Lack of information and communication Lack of supervision (in some cases) Exclusive grants (exclude the possibility of working while studying) Basic research under-developed Lack of transparency, shared indicators and monitoring practice, insufficient communication across the programmes
OPPORTUNITIES	**THREATS**
High quality PhD training of major importance Network management across the programmes Possibility to develop a 'brand' and a 'model' that can be exported (to Portuguese-speaking world in particular) Higher visibility and higher profile Institutionalisation Using the External Review Committees to plan for the future in a more systematic way	Brain drain (? Though conflicting views on this) Lack of transparency and perceived problems in governance putting the R&D inputs under threat Two-tier system (if dual-degrees not implemented across the board) Over emphasis on applied science at the expense of basic research Overall: Possible missing opportunities in disciplines, and areas and universities; which are not currently in the programmes, but relevant to the future of PT? "Future fields" and "weak signals" not paid enough attention to -> Foresight needed?

Table 3. Collaboration in research projects

STRENGTHS	WEAKNESSES
Unique model of promoting R, D & I Close collaboration within the PT Good infrastructure to attract people to PT, opening doors Good collaboration with industry Systematic way of working with industry Holistic and practical way of addressing problems, projects selected based on finding solutions for industry problems (iTeams and similar methods) So far successful demonstration and validation, next step institutionalisation Initial scepticism by the leadership of PT universities shifted to support Strategic partnership with large PT companies Good visibility for Lighthouse / Keystone projects Good networks and trust to build on, many collaborative ties based on individual contacts	"Calvin ball" = lack of clear shared rules, rules changing by the year (esp. students) Lack of synchronisation and marketing of the programmes Lack of information and communication Lack of transparency, shared indicators and monitoring practice, insufficient communication across programmes
OPPORTUNITIES	**THREATS**
Network management across programmes Possibility to develop a 'brand' and a 'model' that can be exported (to Portuguese-speaking world in particular) Higher visibility and profile Expertise in fundraising Possibility to focus further on interdisciplinary, up-and-coming areas with most potential for effectiveness and business possibilities	Brain drain (though conflicting views on this) Lack of transparency, perceived problems in governance putting R&D input under threat Possible missing opportunities in disciplines, scientific areas and universities, which are not currently in the programmes, but relevant to the future of Portugal? "Future fields" and "weak signals" not paid enough attention to -> Foresight needed?

Table 4. Technology transfer, innovation and entrepreneurship, commercialisation

STRENGTHS	WEAKNESSES
Unique model of promoting R&D&I Close collaboration within Portugal Good infrastructure to attract people to Portugal, opening doors Increasing Critical mass (a lot of colleagues) Collaboration with industry, always starting from a problem to be solved Different way of teaching, focus on improved quality, standards Systematic way of working with industry Holistic and practical way of addressing problems, teaching based on finding solutions for industry problems (iTeams and similar competitive methods) So far successful demonstration and validation, next step institutionalisation Initial scepticism by the leadership of Portuguese universities shifted to support Increasingly professional TTOs, expertise developed	"Calvin ball" = lack of clear shared rules, rules changing by the year (esp. students) In some cases, no credits gained (non-dual degrees, MIT) Lack of synchronisation and marketing of the programmes Lack of information and communication Lack of supervision (in some cases) Exclusive grants (exclude the possibility of working while studying) Basic research underdeveloped Lack of transparency, shared indicators and monitoring practice, insufficient communication across programmes
OPPORTUNITIES	**THREATS**
High quality PhD training of major importance Network management across programmes Possibility to develop a 'brand' and a 'model' that can be exported (to Portuguese-speaking world in particular) Higher visibility and profile Quality-assurance systems to be developed, assessed by Ministry of Education Expertise in fundraising Possibility to focus further on areas where the value added is greatest (interdisciplinary, up-and-coming areas with most potential for effectiveness and business possibilities)	Improvements in professional standards and status of technology transfer lost Lack of transparency, perceived problems in governance putting R&D input under threat Commercialisation opportunities lost if venture capital and industrial affiliates not mobilised more effectively Difficulties in engaging SMEs and their potential Overall: possible missing opportunities in disciplines, scientific areas and universities, which are not currently in the programmes, but relevant to the future of Portugal? "Future fields" and "weak signals" not paid enough attention to -> Foresight needed?

Table 5. Actor perspectives: student perceptions

STRENGTHS	WEAKNESSES
Good infrastructure to attract people to Portugal, opening doors Critical mass (a lot of colleagues) Collaboration with industry, "hands-on" approach Equal footing (students treated the same as domestic students) Good (joint) supervision (for some) Different way of teaching, improved quality Systematic way of working with industry Holistic and practical way of addressing problems, teaching based on finding solutions for industry problems Design of Master's and PhD courses, student-friendly and close to practical reality of companies (improves potential employability) Mixed teams, interdisciplinarity Learning a common language (across disciplines) Possibility of being "guaranteed" a job, improved career prospects Unique possibility for large-scale research with unique Portuguese data in the US Exposure to new ideas Easy access and international exposure Quality stamp of degrees (in case of dual degrees) Possibility to influence policy and 'make a difference' (e.g. engineering and policy brought together) Best expertise, "best persons" Good supervision and colleagues	"Calvin ball" = lack of clear shared rules In some cases, no credits available (non-dual degrees, MIT and AUT in the initial stages in particular) Lack of synchronisation and marketing of the programmes (poor visibility) Lack of common project funding and labs (Digital media?) Lack of information and communication Lack of supervision (in some cases, MIT in particular) Exclusive grants (exclude the possibility of working while studying, may exclude some from participating) Insufficiently developed model of coordination and administrative support Interdisciplinary tradition weak (falling between departments, e.g. digital media), integration of different subjects challenging, there should have been closer interaction between students from different areas Visa procedures and bureaucracy Collaboration across programmes and disciplines still weak (only emerging) Students sometimes isolated Quality not always up to standard (Most of) Portuguese companies still not recognising the value of PhDs

Table 6. Faculty perspective

STRENGTHS	WEAKNESSES
"Remarkable transformative effect" Attracting the best students Identifying innovation and entrepreneurship as strategic core areas Thinking differently (e.g. innovation, entrepreneurship, interdisciplinary nature in areas such as human-computer interaction) Institutional impacts (changing the minds of the students the first step) Improved ecosystem Raising funding from companies Engaging business angels Catalytic role, mimicking the ecosystem, expertise in fundraising (CMU in particular) Access to venture capital "Quality stamp"	Timing, slow start (in particular UTEN got later start than others) Project management underdeveloped, no shared management practice and coordination Weak tradition of (academic) entrepreneurship Companies outside Portugal not involved Too academic a focus (in Portugal, in comparison to the applied approach of the US) Budgetary restrictions ("1997 level") Inflexibility of some partners (MIT in particular)

Table 7. Management perspective

STRENGTHS	WEAKNESSES
Unique approach, interdisciplinary nature, cross-fertilisation Critical mass Dual degrees a qualitative boost Boost for self-confidence in Portuguese R&D Cultural slippage from the US Whole country involved Research and CV competition Cultural change (e.g. culture of cultivating indigenous talent of UTA and monitoring, standards, certification) Integrated approach capacity-building Bottom-up process International expert panels and external review committees with high-level international expertise Improved confidence and self-confidence Complete change in image (credibility, professionalism)	Whole country involved (maybe too large, diluted) Not enough cross-fertilisation (between programmes) Lack of large companies in Portugal, and SMEs being cash-strapped (difficulties in mobilising industry funding) Different timeframes and planning cultures Professional Master's degrees not achieved in all areas Difficulties in combining grants with working (grants exclusive, no possibility of other source of work income while enjoying a FCT grant) Different criteria for all projects FCT project management, no clear rules at the start Some disciplines missing (stem cell research) Should have had stronger links to society and industry from the start Inflexibility of some partners (MIT), contracts agreed too early (before all needs were clarified) Not enough communication across programmes

Table 8. Industrial collaboration – Company perspective

STRENGTHS	WEAKNESSES
Unique integrated approach Interaction with industrial partners, applied and solution-based science Exceptional people Best talent Projects as platforms for dialogue Students as change agents Model for entrepreneurial ecosystem to be replicated Venture capital competition Innovation education turning the thinking around (slow process) iTeams and BioTeams (as a new community, MIT)	Faculty exchange the most effective means of transferring knowledge and best practices, in practice the most difficult to execute Too academic Disorganised at the start, no clear rules "Expensive badge" "Show me the numbers!" (no figures to show the effectiveness, lack of clear data on financial return on investment, the counterargument: maybe too early to judge?)

Table 9. Technology transfer perspective

STRENGTHS	WEAKNESSES
Improved professionalism Closer dialogue Templates for internal work Systematic evaluation criteria New career paths developed and made visible and attractive Status improved, rectors beginning to see the value of technology transfer Integration into university strategies	Formal structures lacking at the start Junior status of TTOs in Portugal (not only a weakness, also an opportunity)

POTENTIAL BEST PRACTICES

- *Creative City (Porto), PINC*
- *Network analysis (Digital Media)*
- *More structured interaction in digital media ("new discipline" emerging)*
- *Executive education and professional Master's degrees*
- *CMU's experience of fundraising → transfer of best practices, institutional effects*
- *Programmes for entrepreneurship*
- *Helping PhDs find employment in the industry (e.g. IST paying 30% of the salary if PhDs employed in companies, PhDs in residence – similar to Entrepreneurs in Residence initiative)*
- *Keystone projects process at MIT*
- *iTeams/bioteams as innovation teams*
- *Distance-learning room at CMU*
- *Co-Lab → "new culture of doing things"*
- *Innovation boot camps*
- *Pollution monitoring project (CMU) and "Hospital of the future" → improving societal impact and visibility*

Appendix 5. Survey summary

Background information

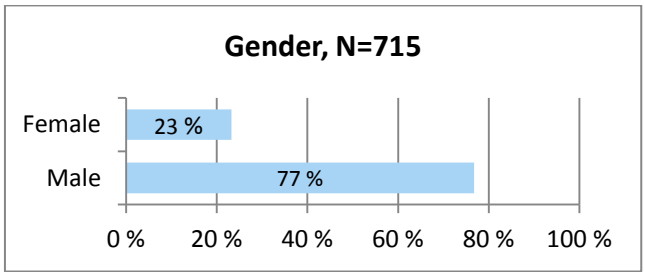


Figure 1

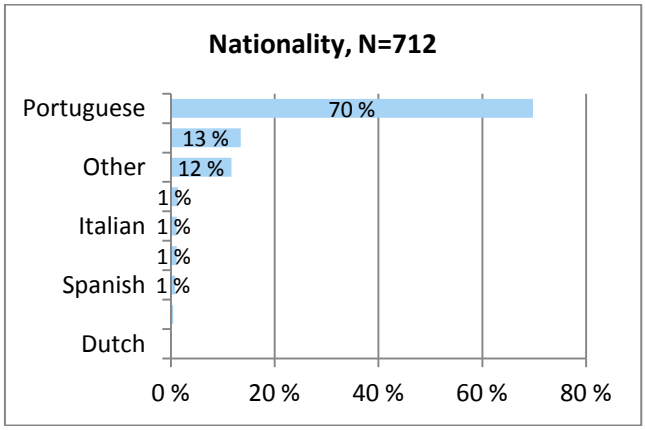


Figure 2

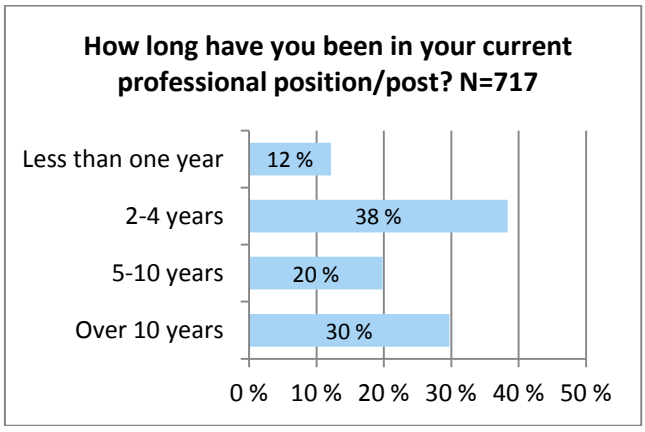


Figure 3

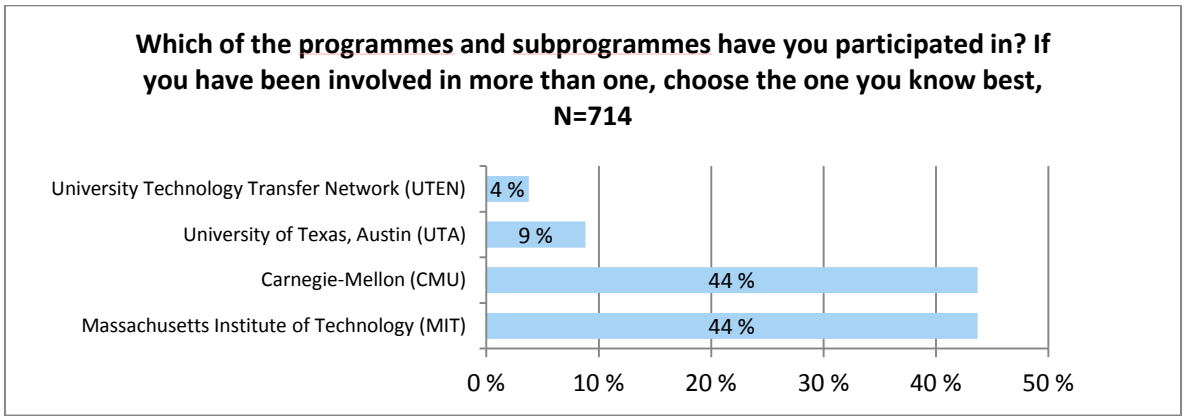


Figure 4

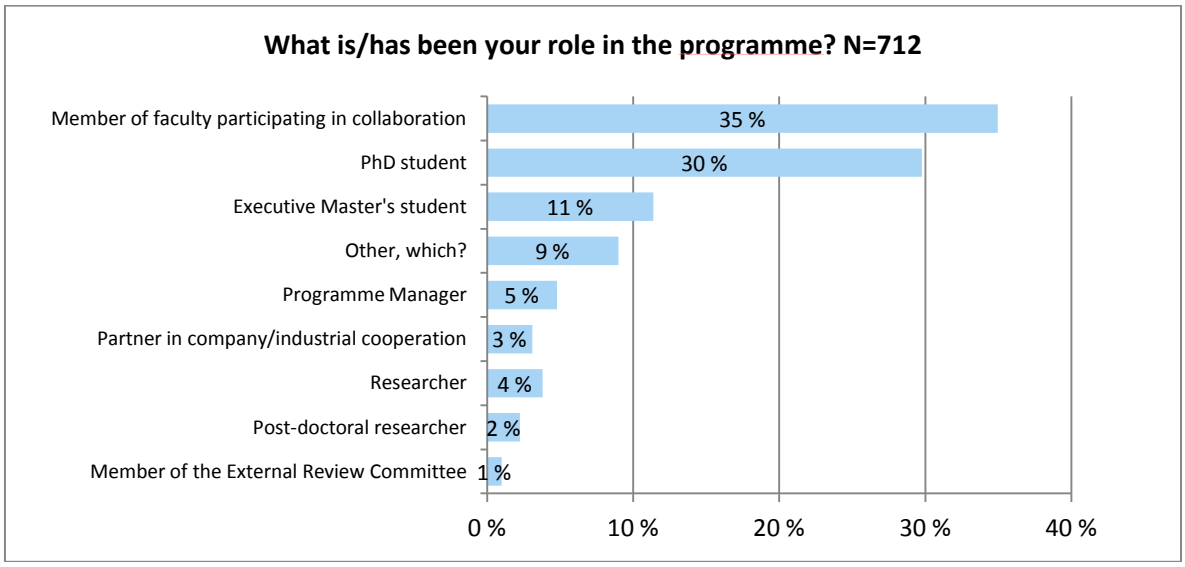


Figure 5

Internationalisation and cultural change the most relevant motivation overall, access to equipment and infrastructure least significant

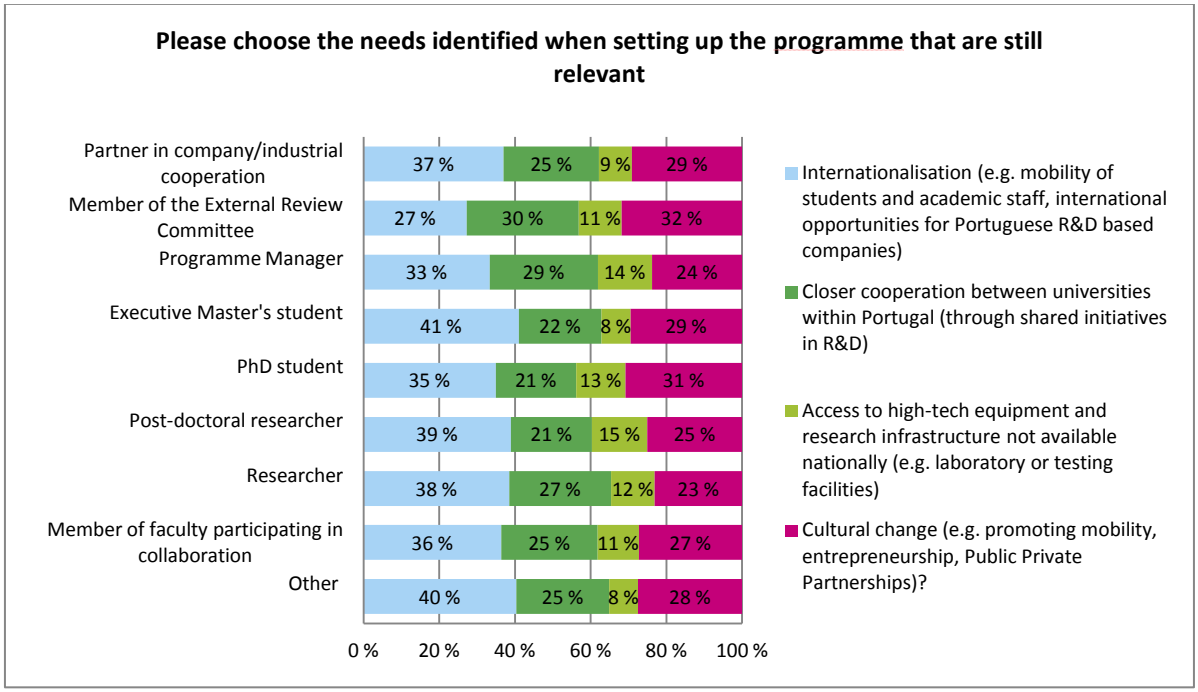


Figure 6

Critical views on significance of training activities, apart from students themselves and the ERCs

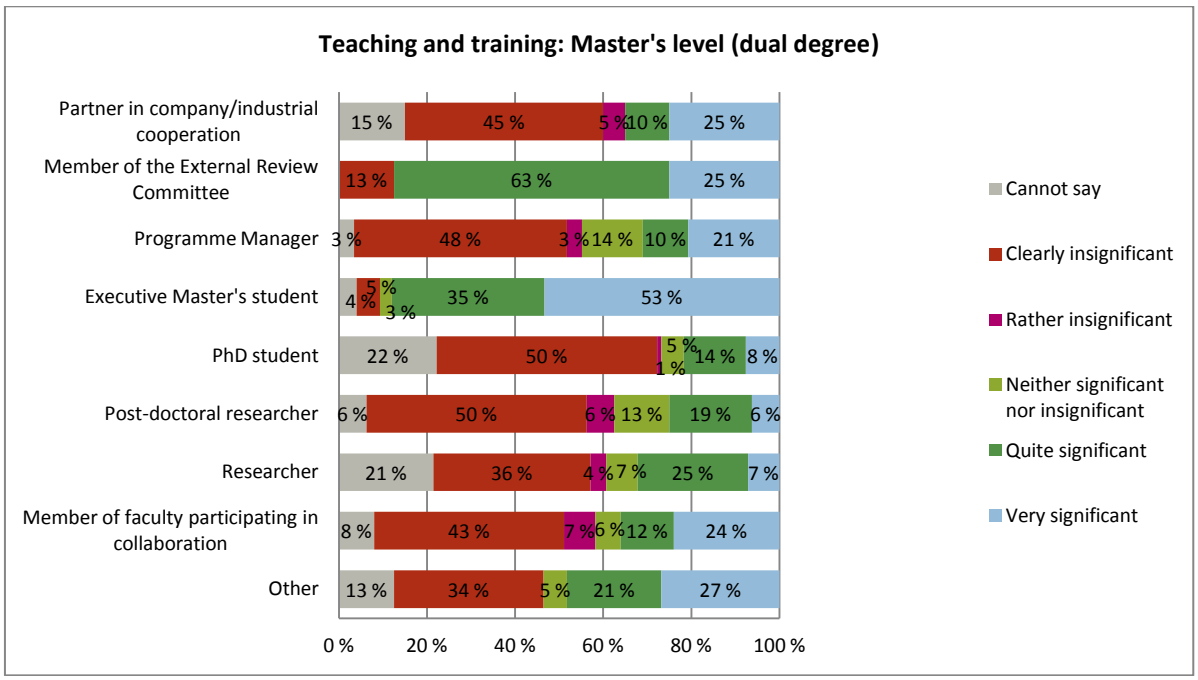


Figure 7

Master's-level training perceived critically, non-dual degrees particularly insignificant

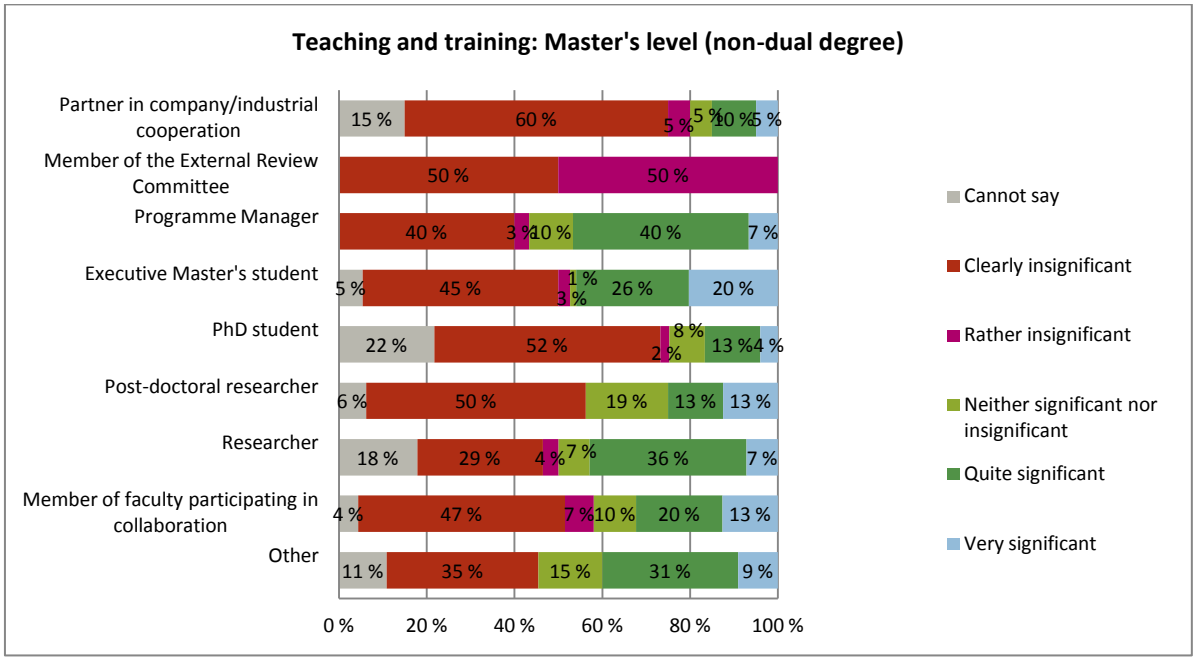


Figure 8

PhD-level studies perceived as more central, though not a major success

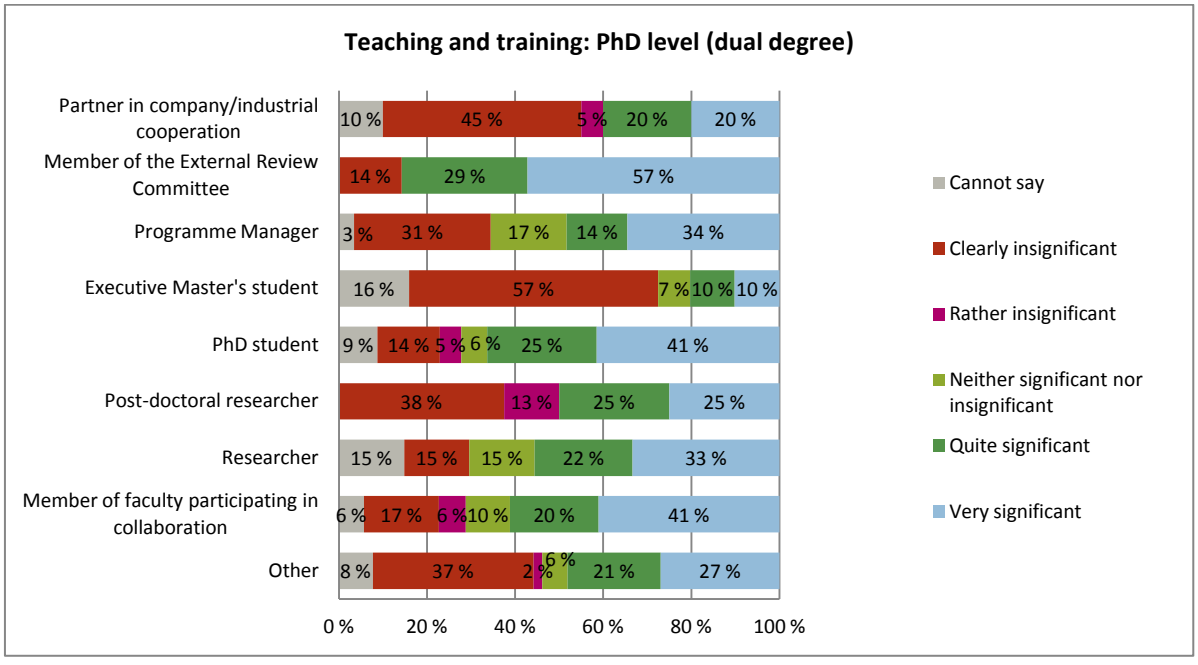


Figure 9

Non-dual degrees viewed very critically across the board

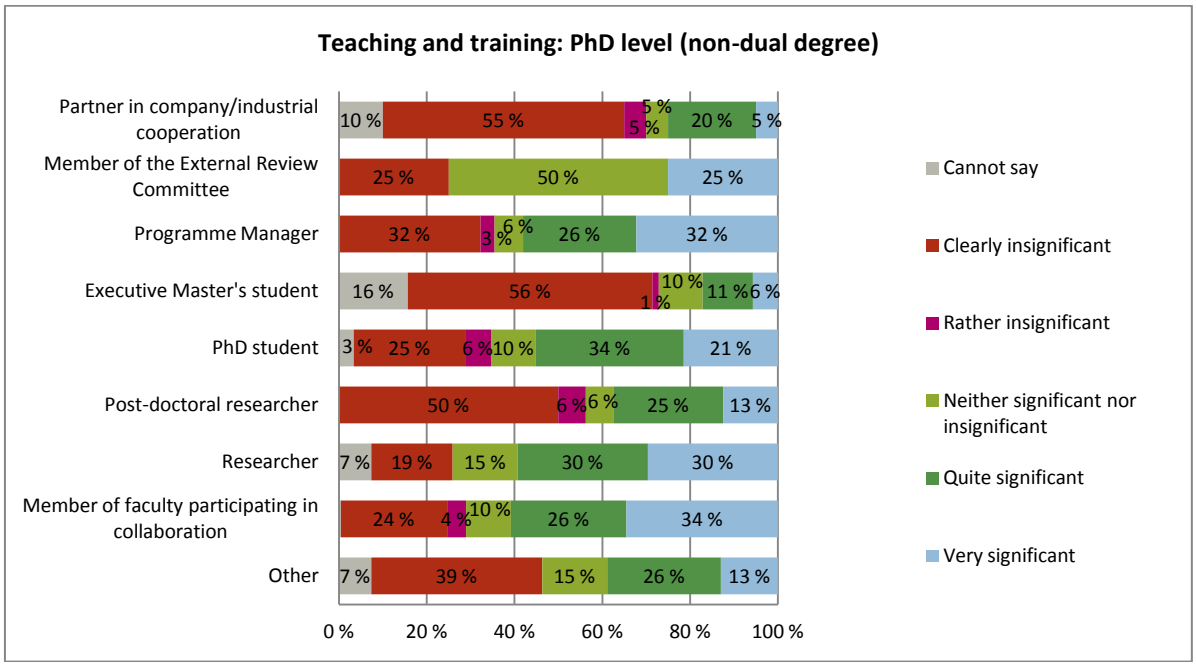


Figure 10

R&D projects perceived positively, in particular by ERCs and researchers

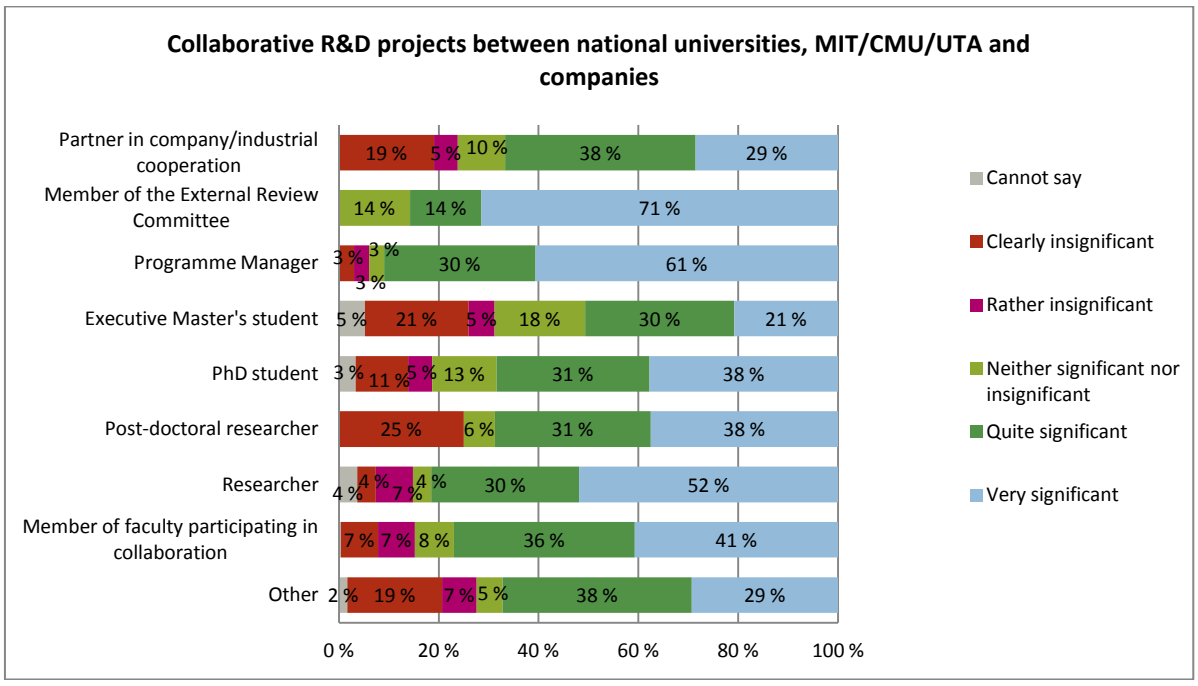


Figure 11

Exchange programmes viewed positively across the board

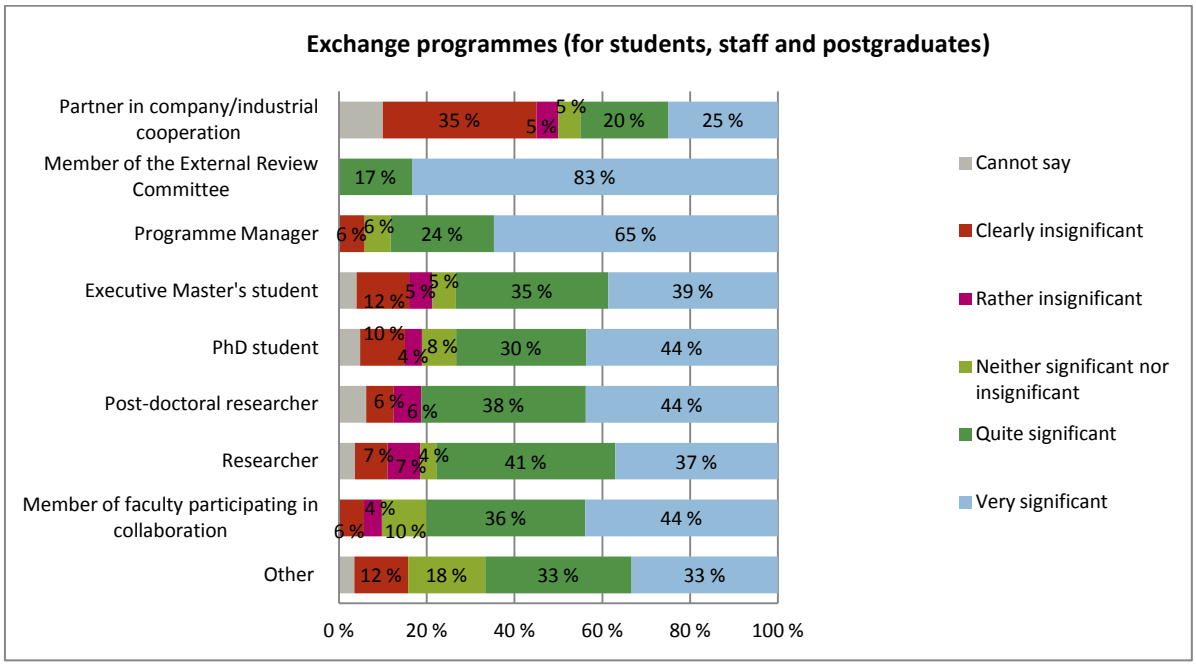


Figure 12

Interaction with companies a significant achievement, ERCs and industry affiliates most positive

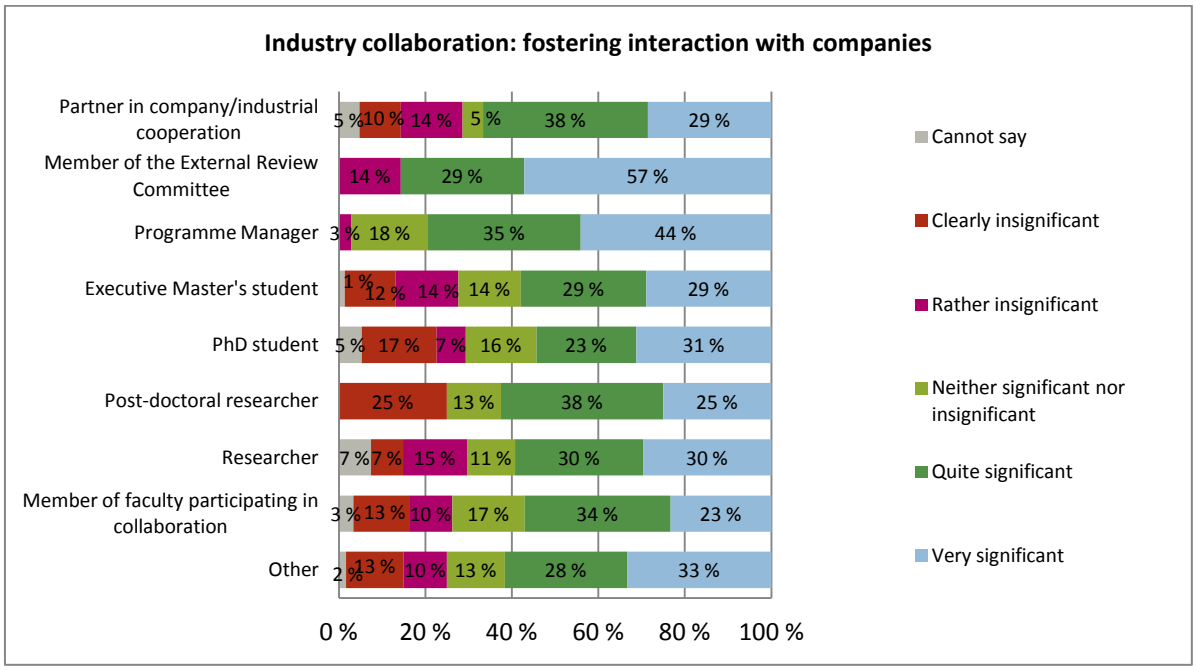


Figure 13

Network building within Portugal a major success, ERCs, programme managers and PHD students most positive

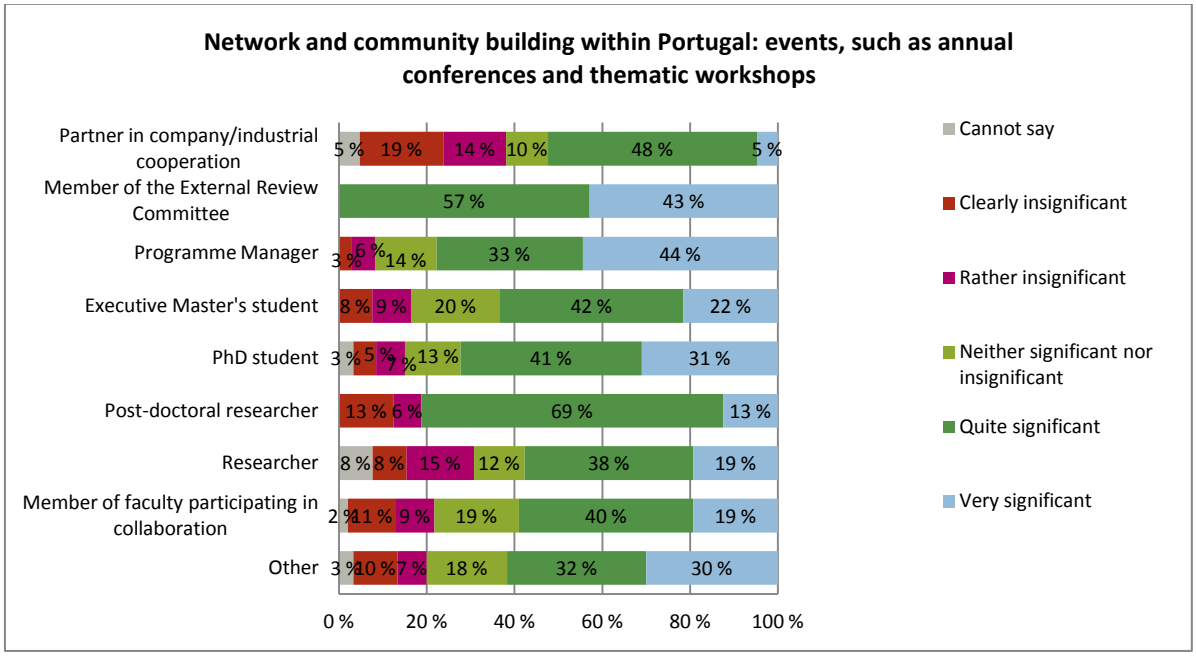


Figure 14

Network building between the US and Portugal perceived positively, postdoctoral students and companies most sceptical

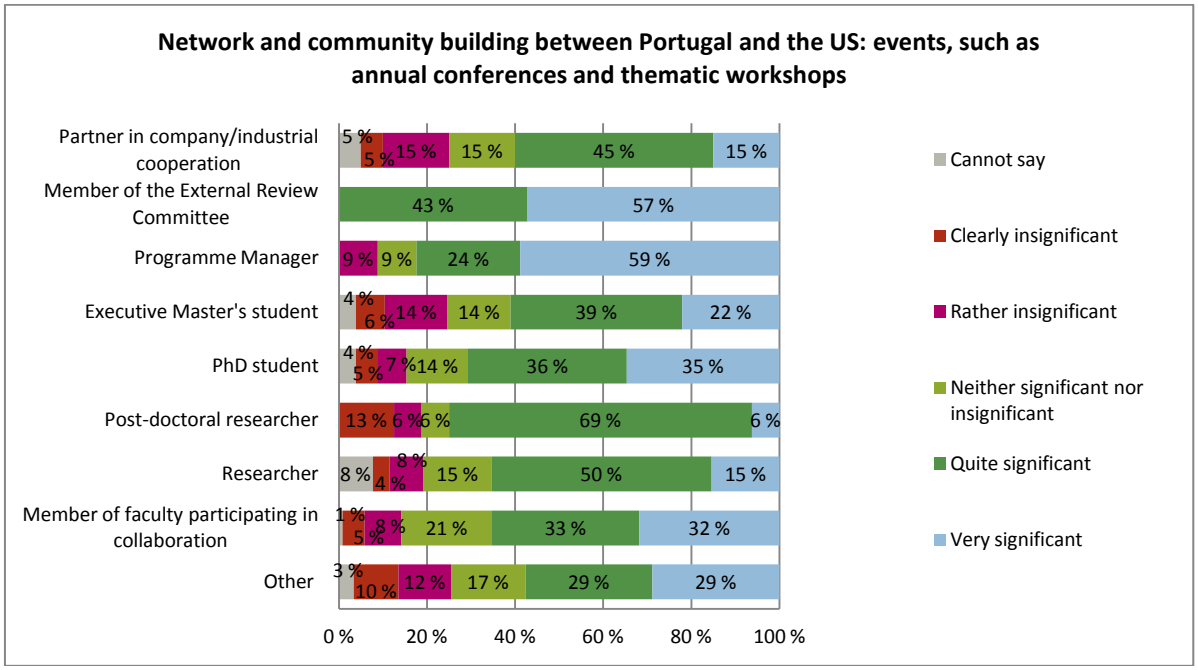


Figure 15

Benefits of support activities not perceived to be particularly significant

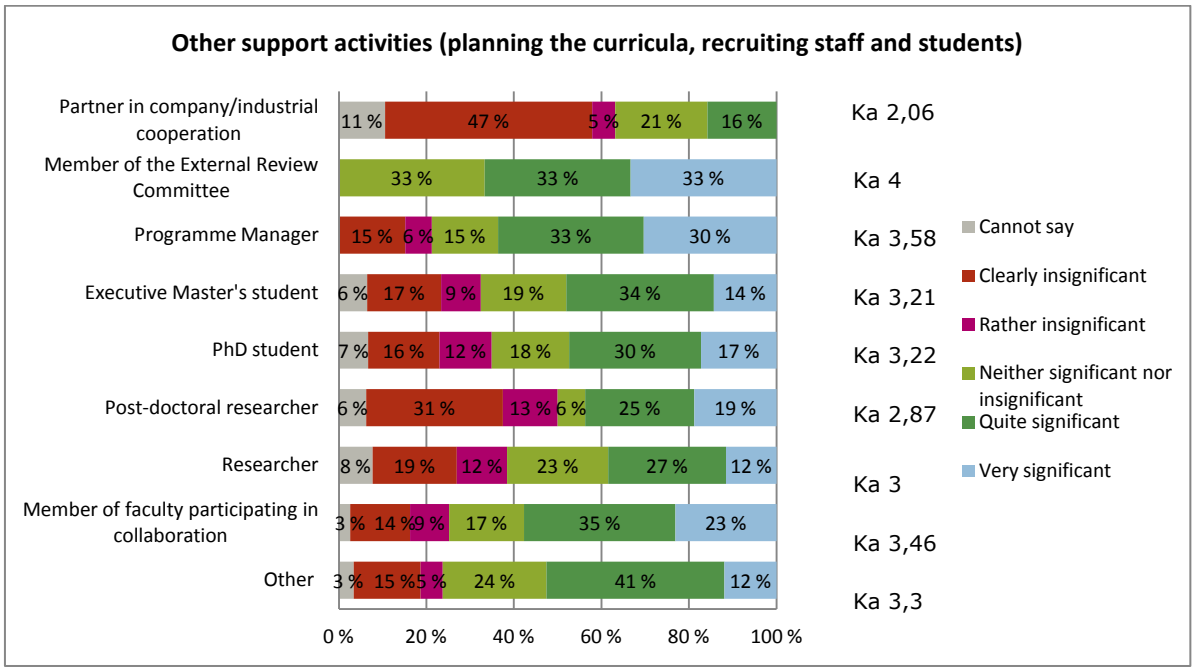


Figure 16

Business development and access to venture capital perceived critically

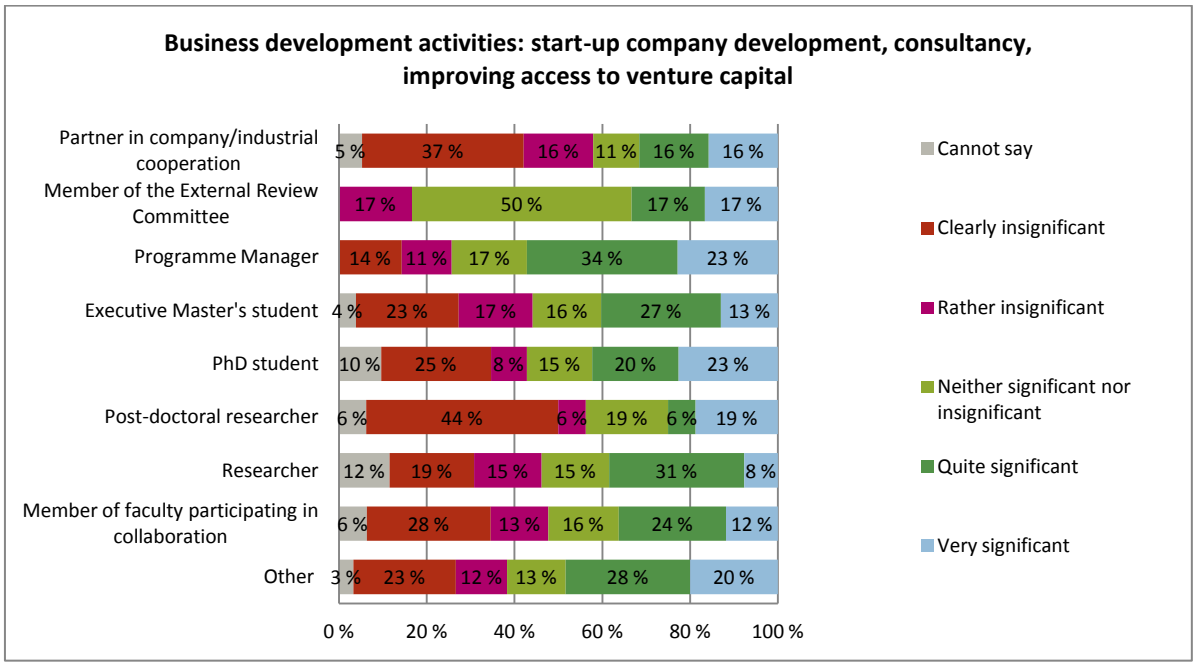


Figure 17

Benefits for the scientific and training capability significant

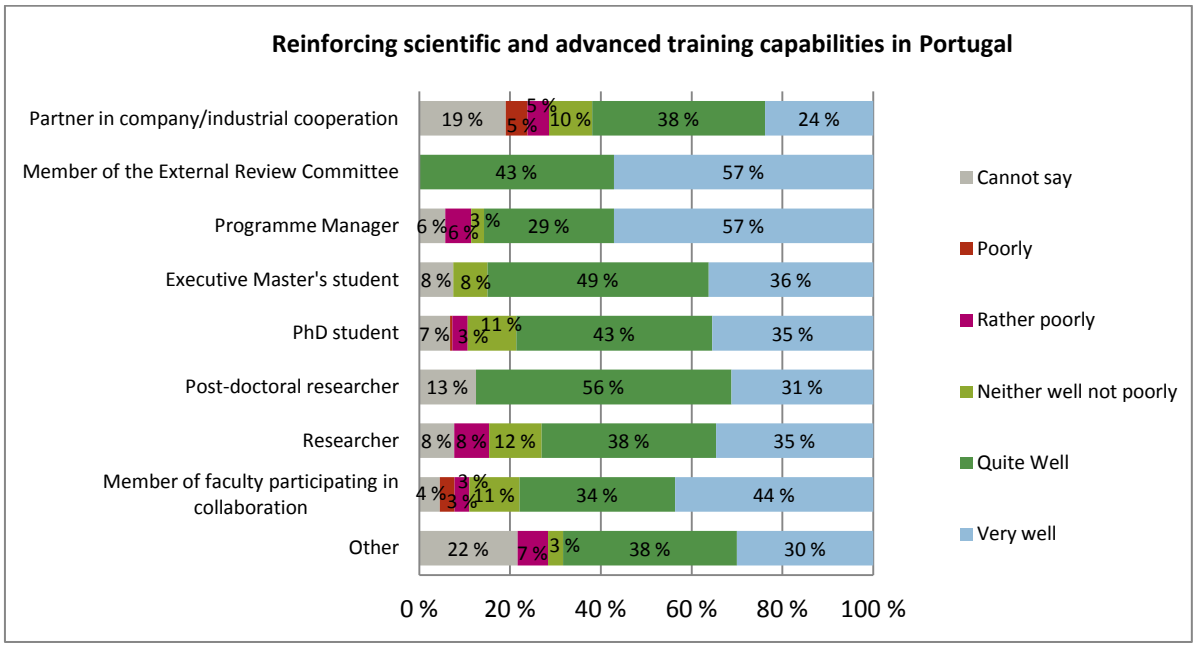


Figure 18

National consortia viewed quite positively, though at the same time awareness relatively low

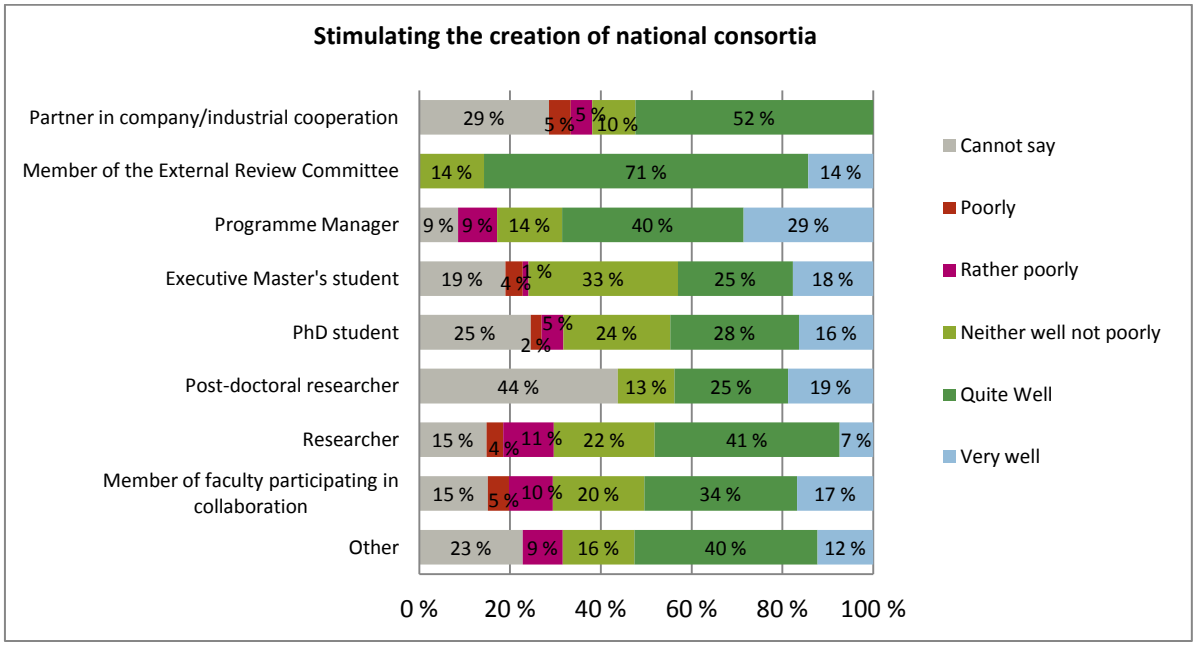


Figure 19

Recruitment perceived positively, postdoctoral researchers most critical

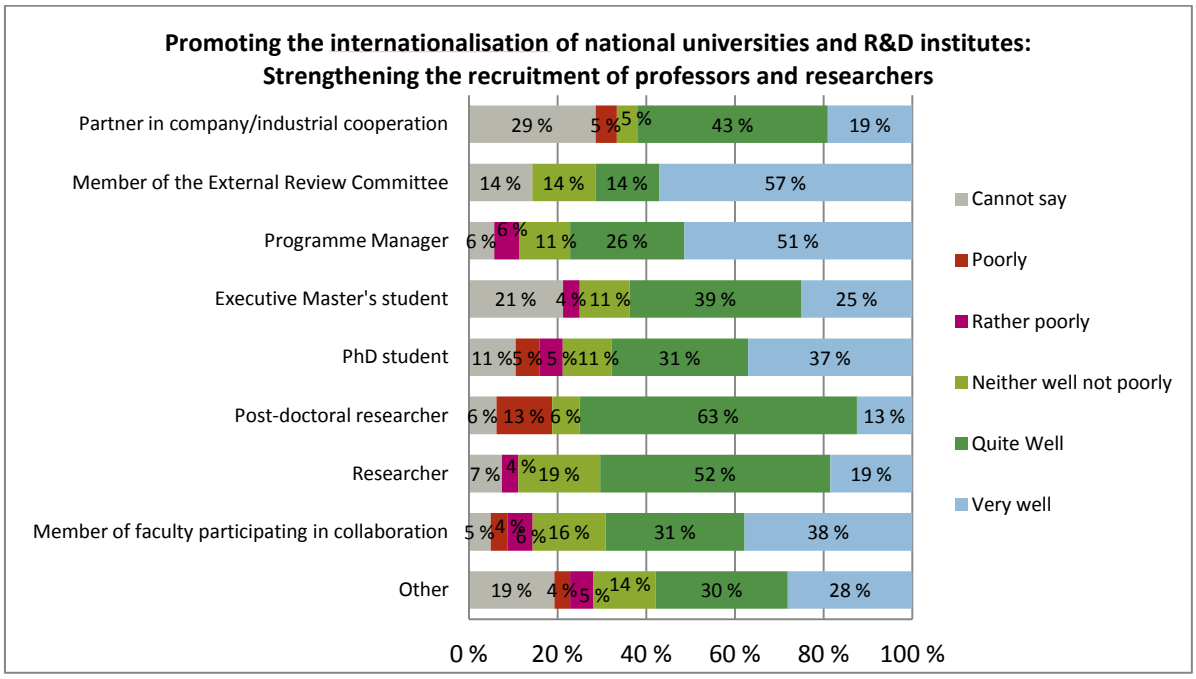


Figure 20

Economic growth/impacts not known (even to ERCs)

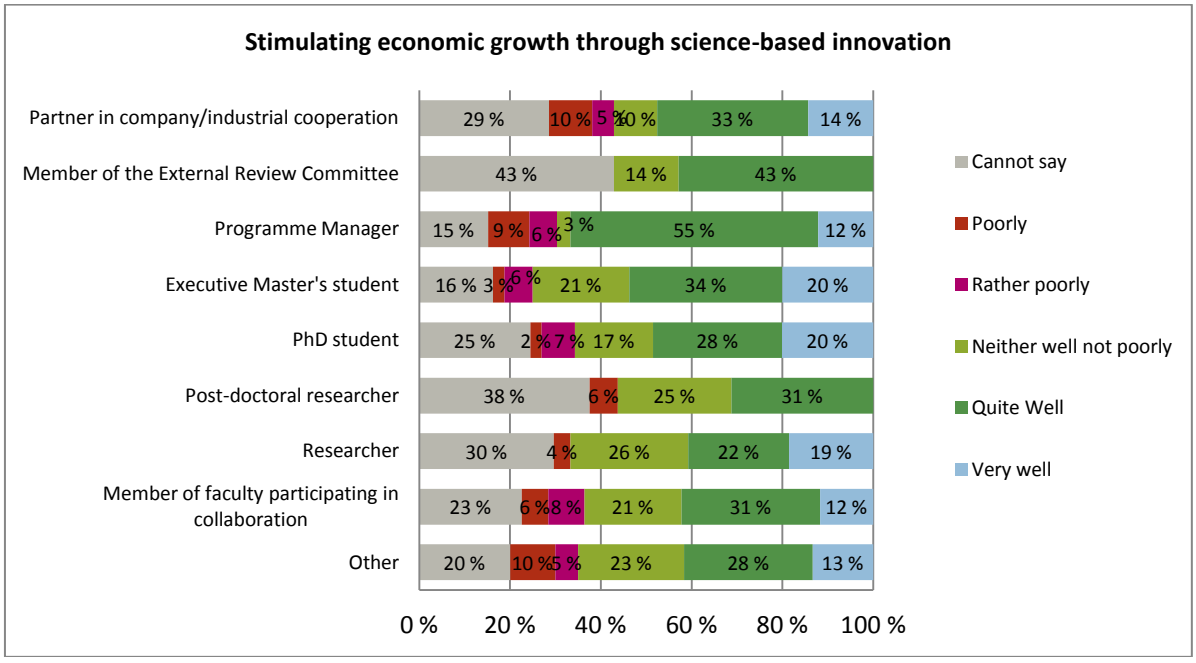


Figure 21

Attractiveness seen to have received a relatively important boost (though not a uniformly positive view, divided opinion, for instance, over 40% of researchers not of this opinion)

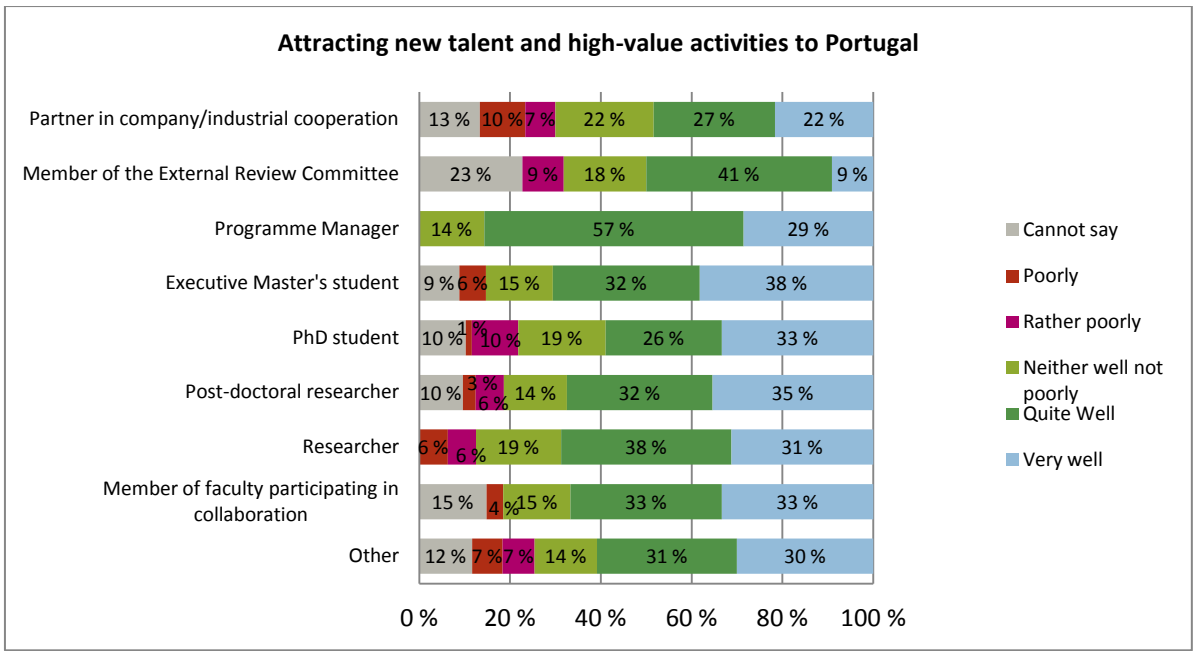


Figure 22

Divided views on access to global markets, ERCs or companies not aware of this to a particularly high degree

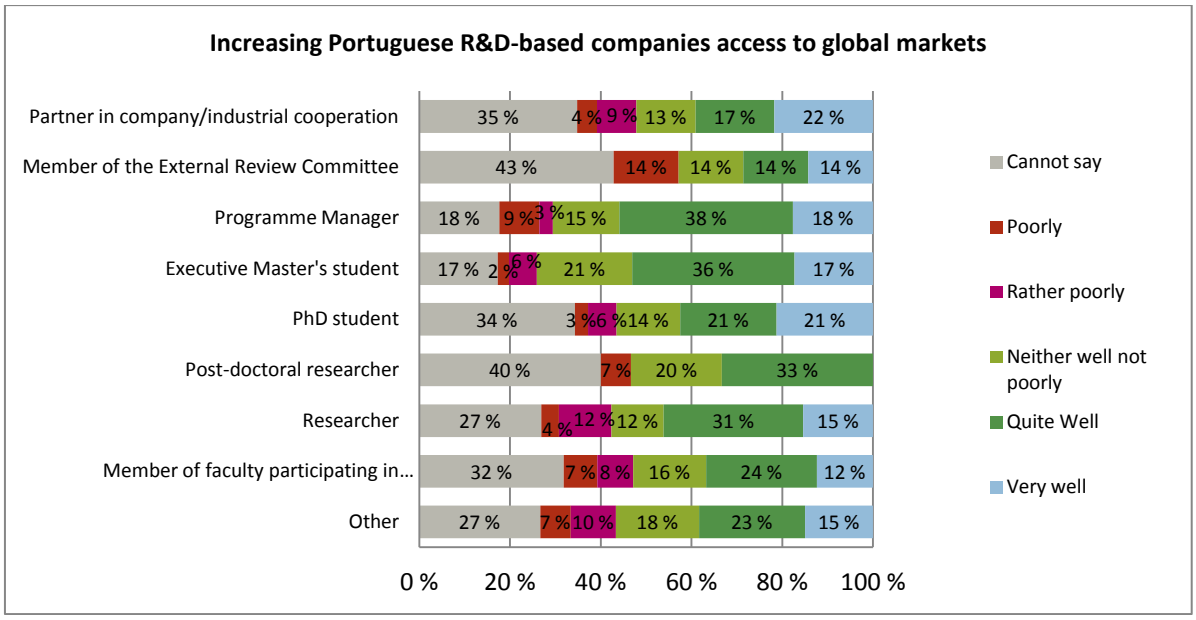


Figure 23

More than one-third of respondents believe that the absolute value added has been important

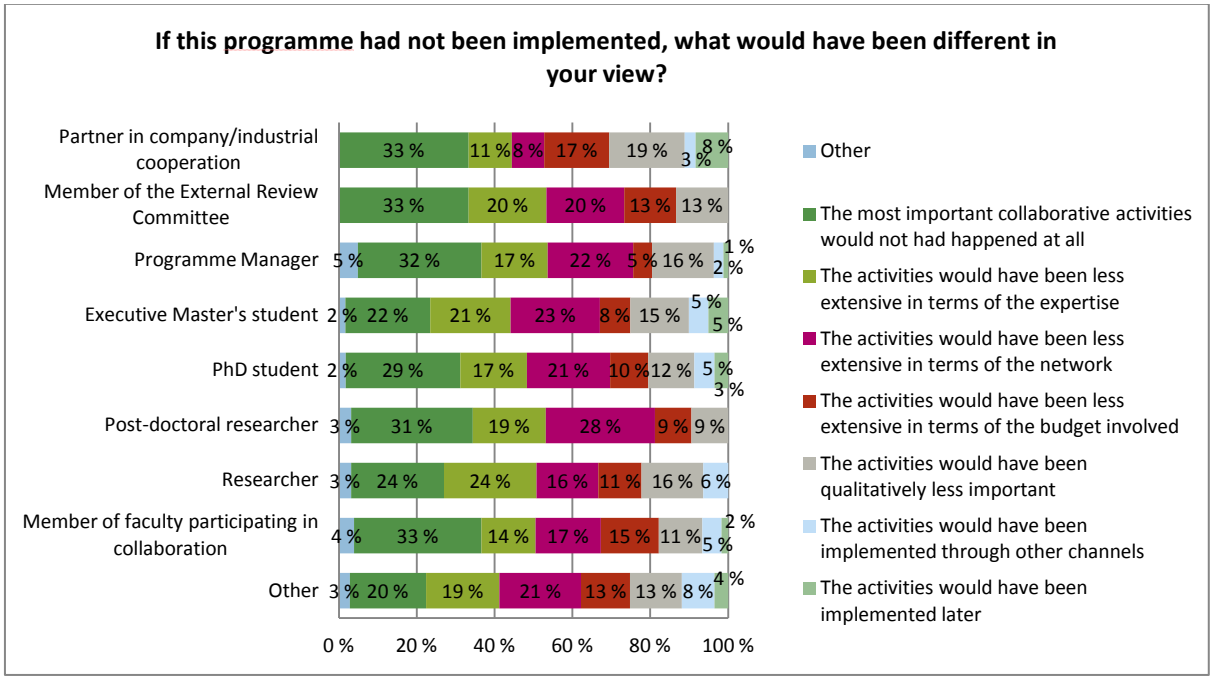


Figure 24

Programmes perceived as well-resourced by ERCs and management, but also faculty share this view

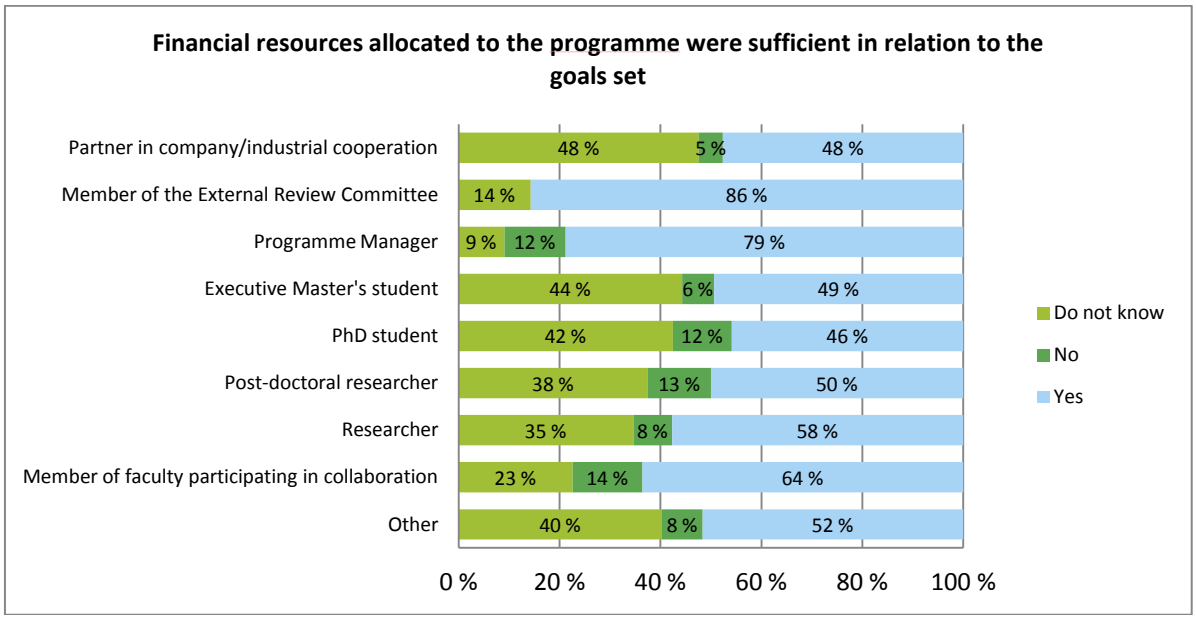


Figure 25

Relatively positive view on governance

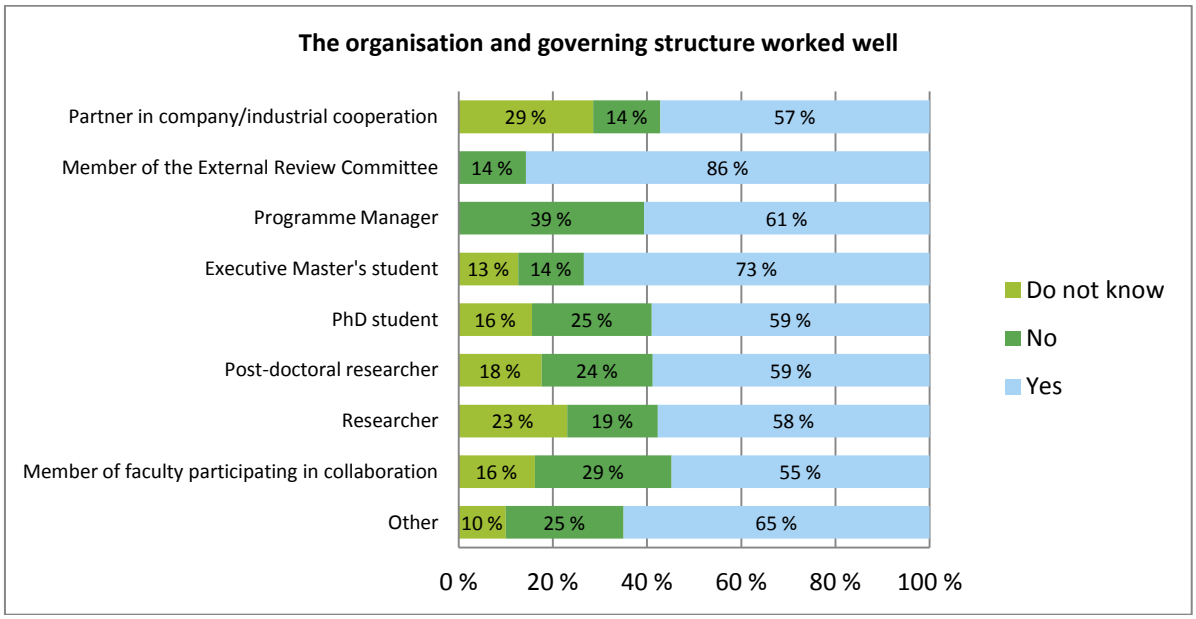


Figure 26

Innovation ecosystem effects perceived positively, also over 50% of companies share this view

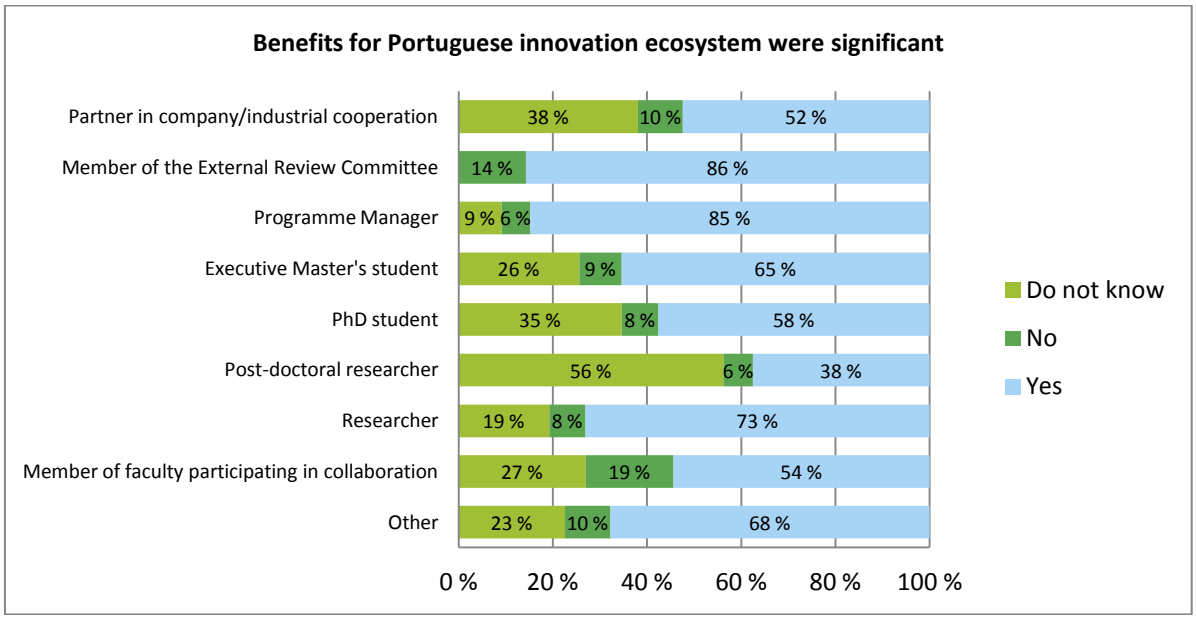


Figure 27

Research teams perceived to have gained significant qualitative boost

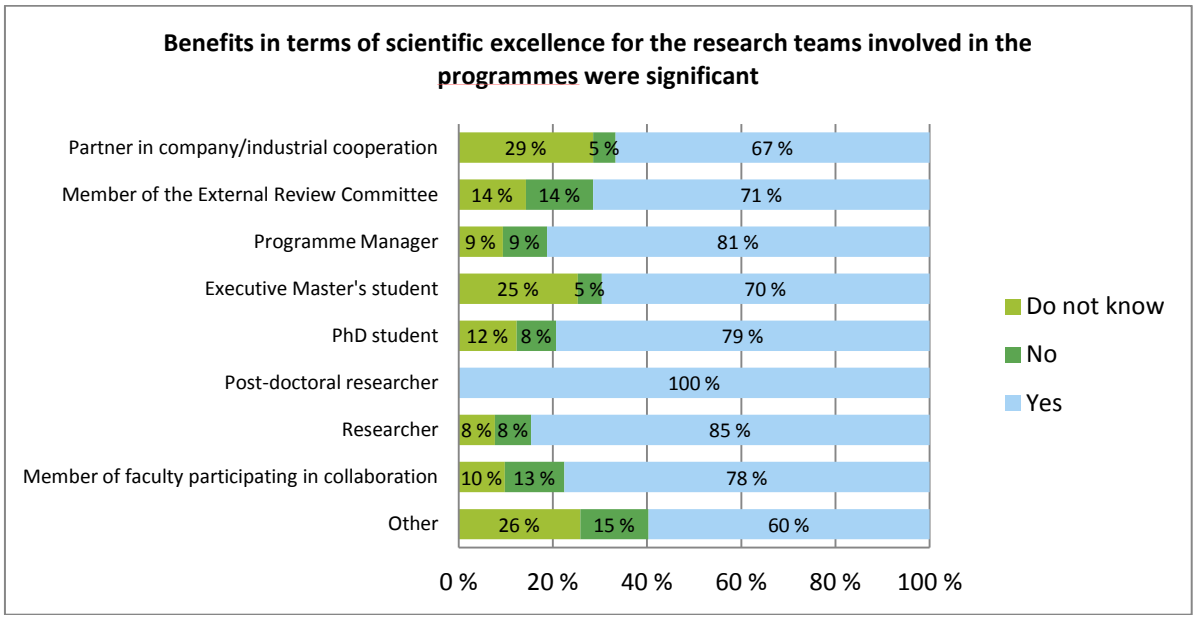


Figure 28

Individual effects one of the greatest successes

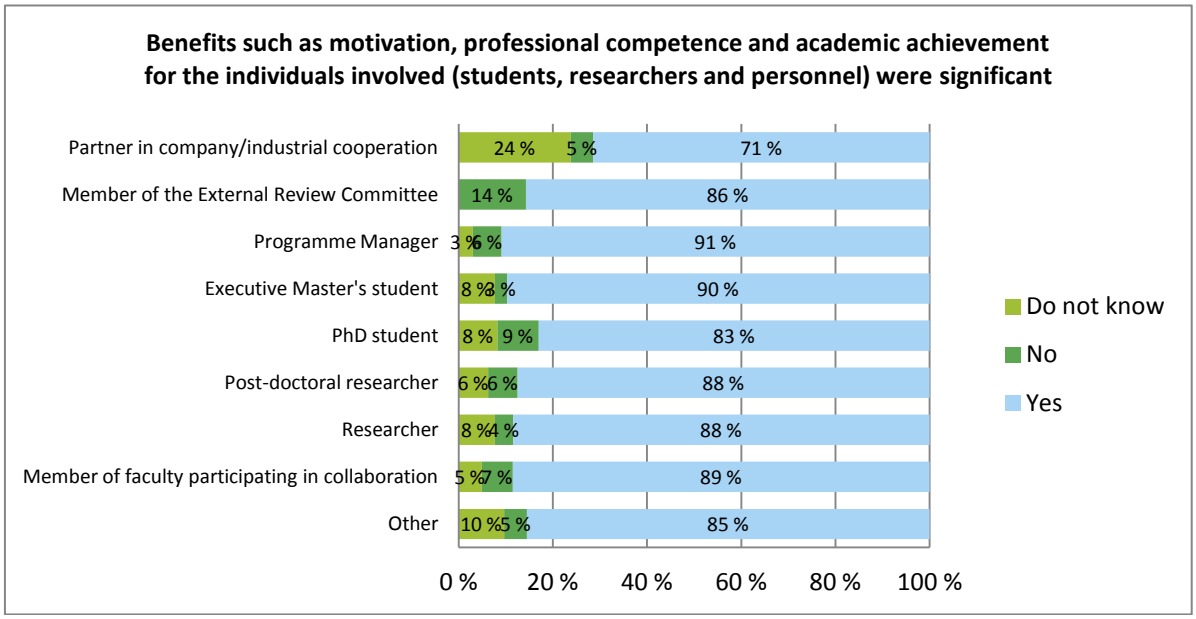


Figure 29

Benefits for training also important, though some critical views from all respondents (except ERCs)

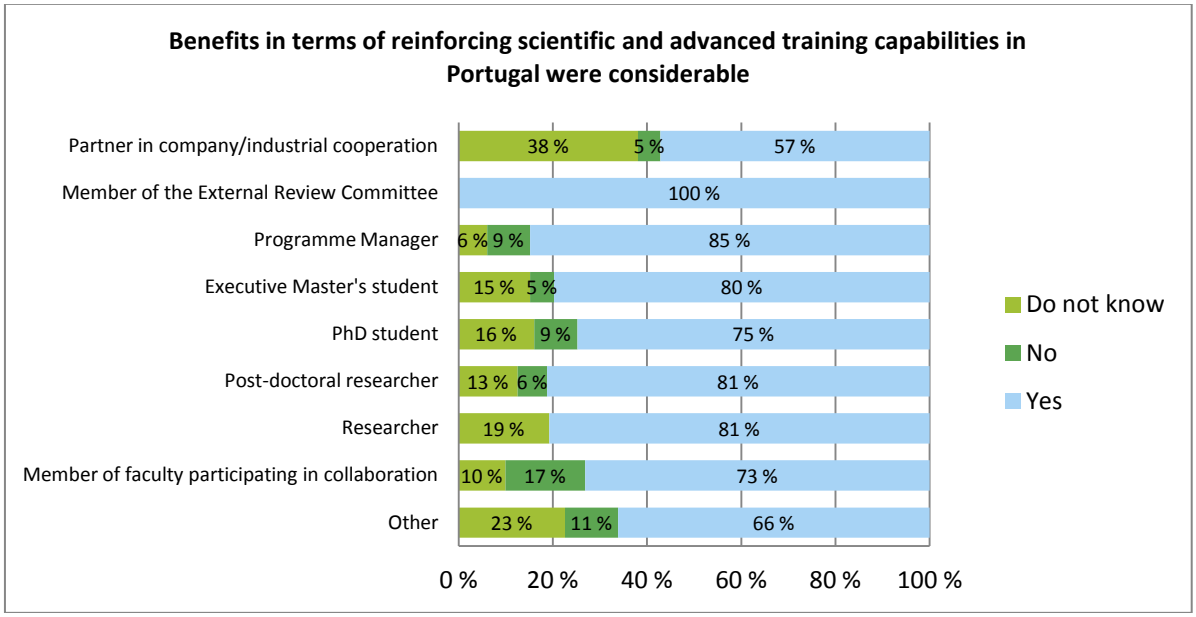


Figure 30

National consortia only partially a success, many are not aware of these benefits

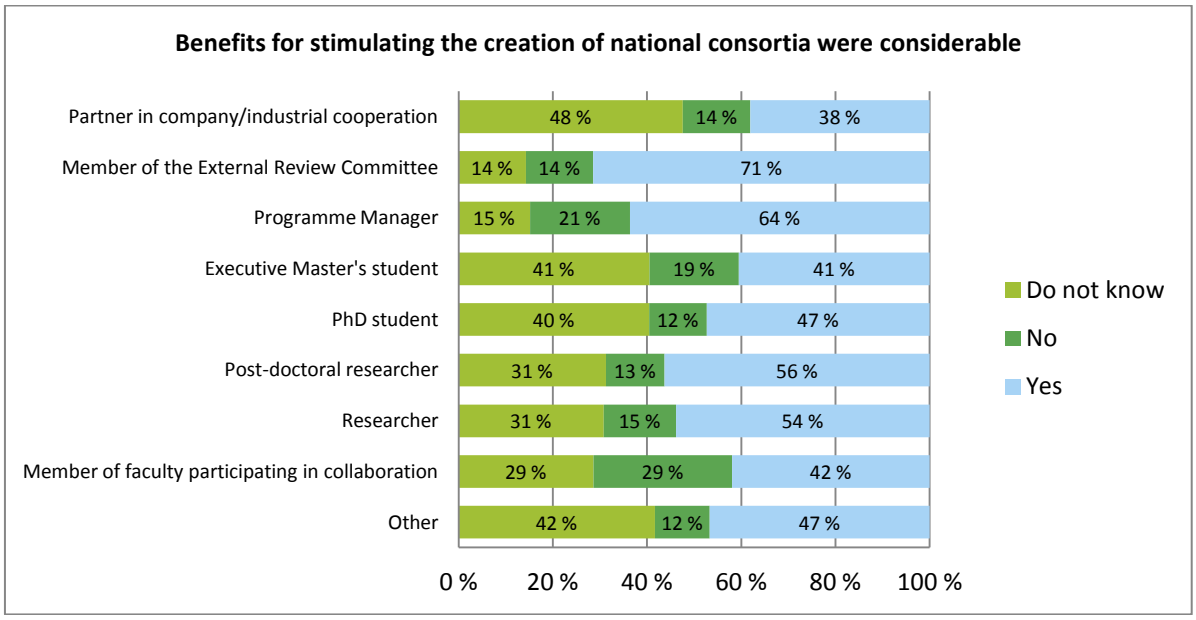


Figure 31

Benefits for internationalisation quite good, but also critical views emerge

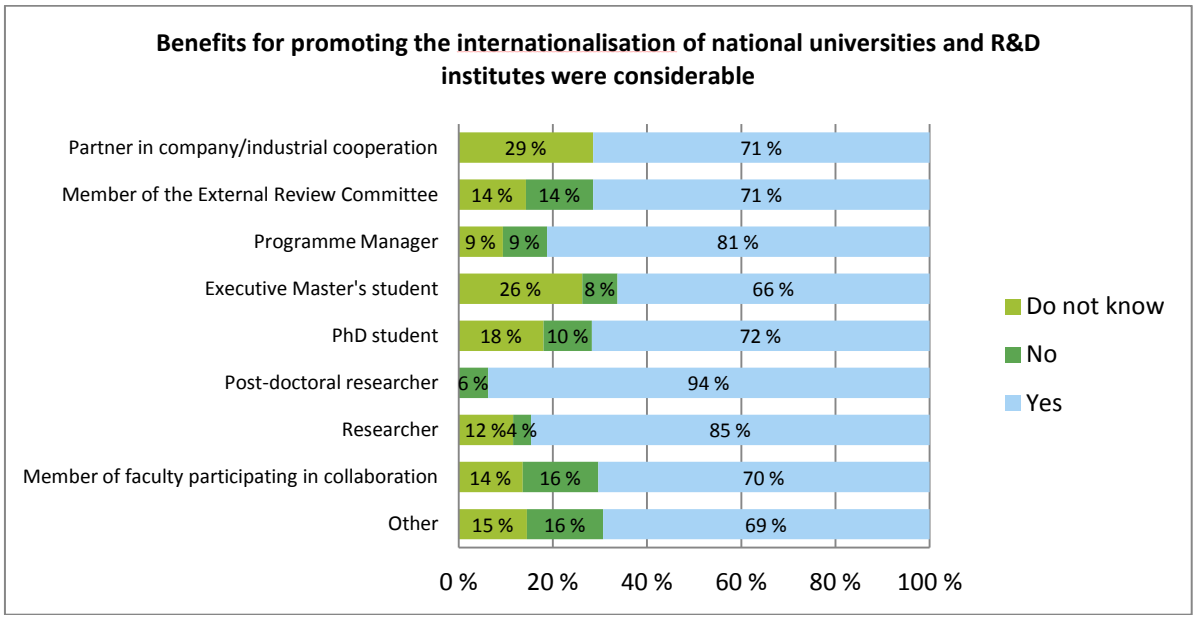


Figure 32

Recruitment only a partial success

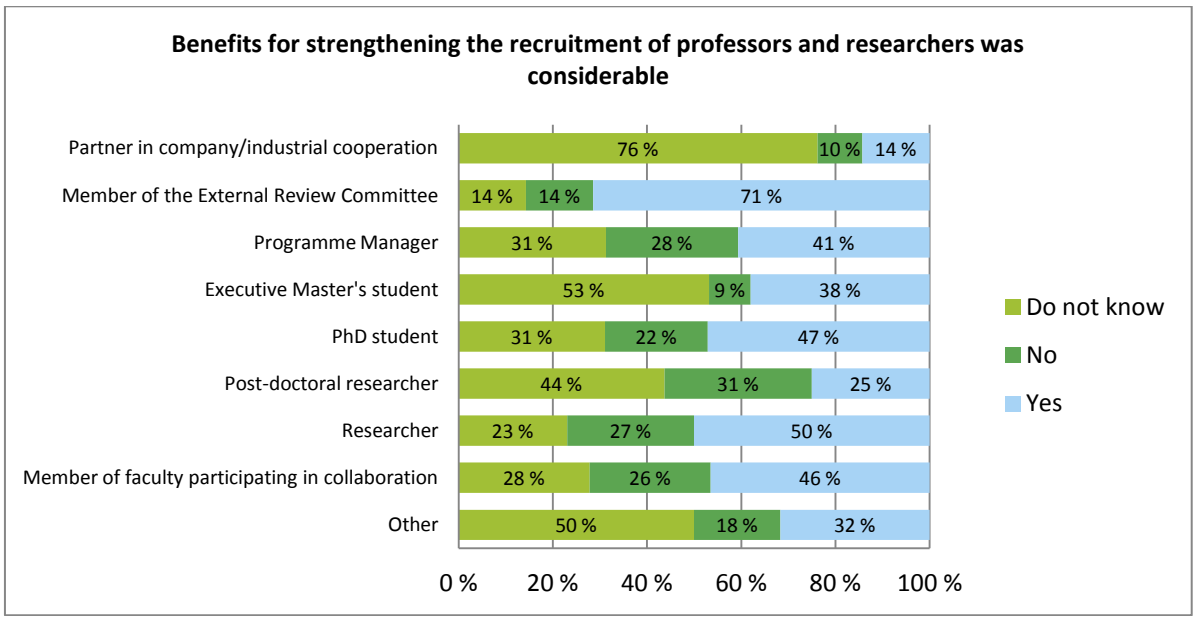


Figure 33

Access to international markets: a critical view

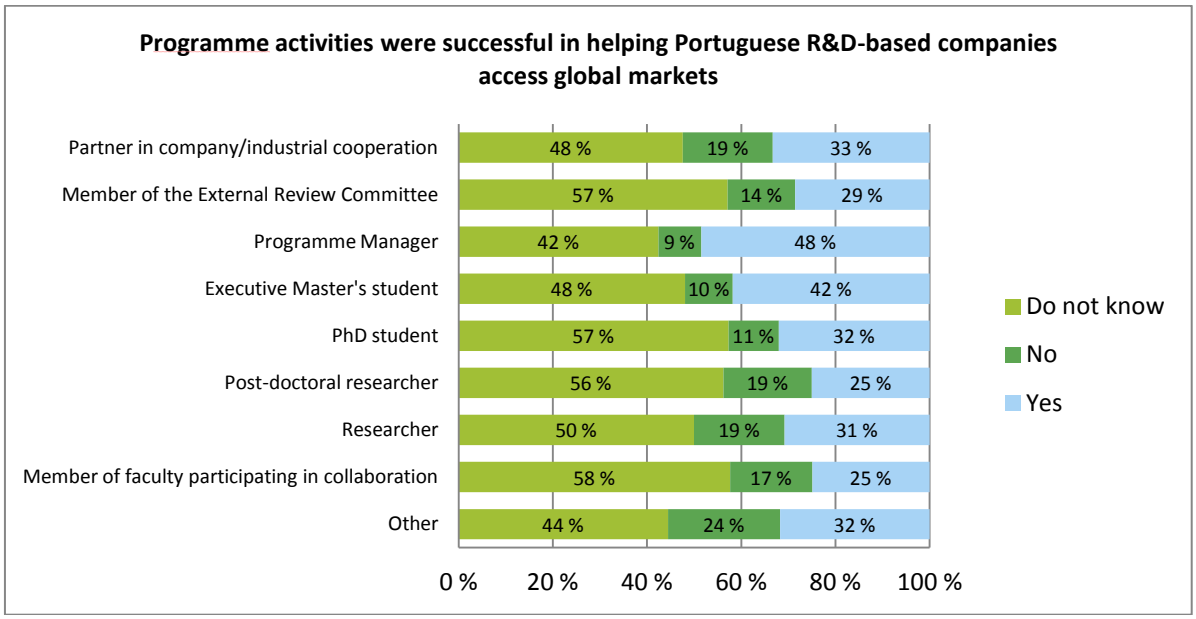


Figure 34

Venture capital still poorly available

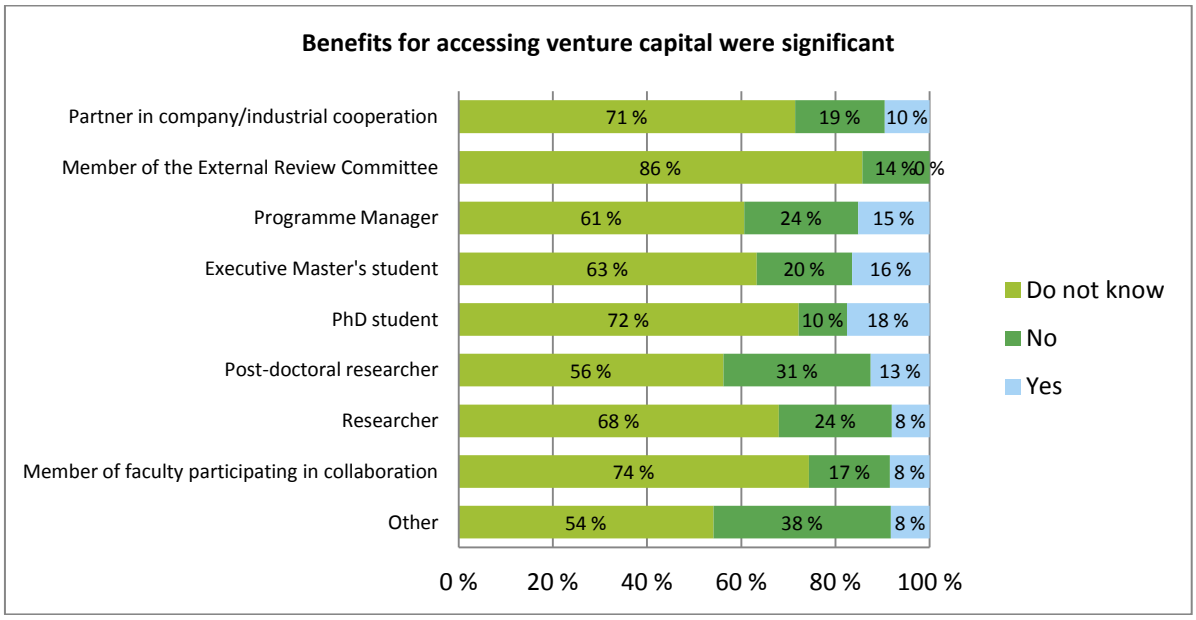


Figure 35

Collaborative projects (US-PT) the main benefit for CMU respondents, by far the most positive view

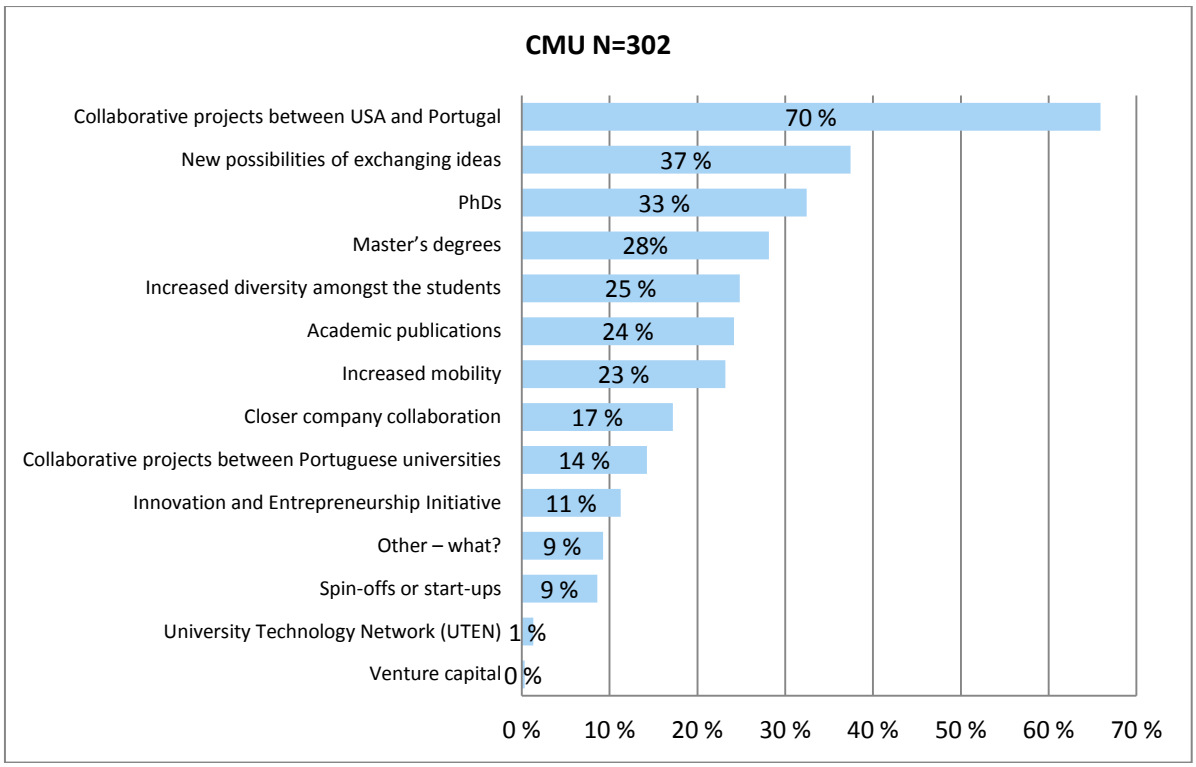


Figure 36

Collaborative projects and PhDs emerge as key outputs of MIT collaboration

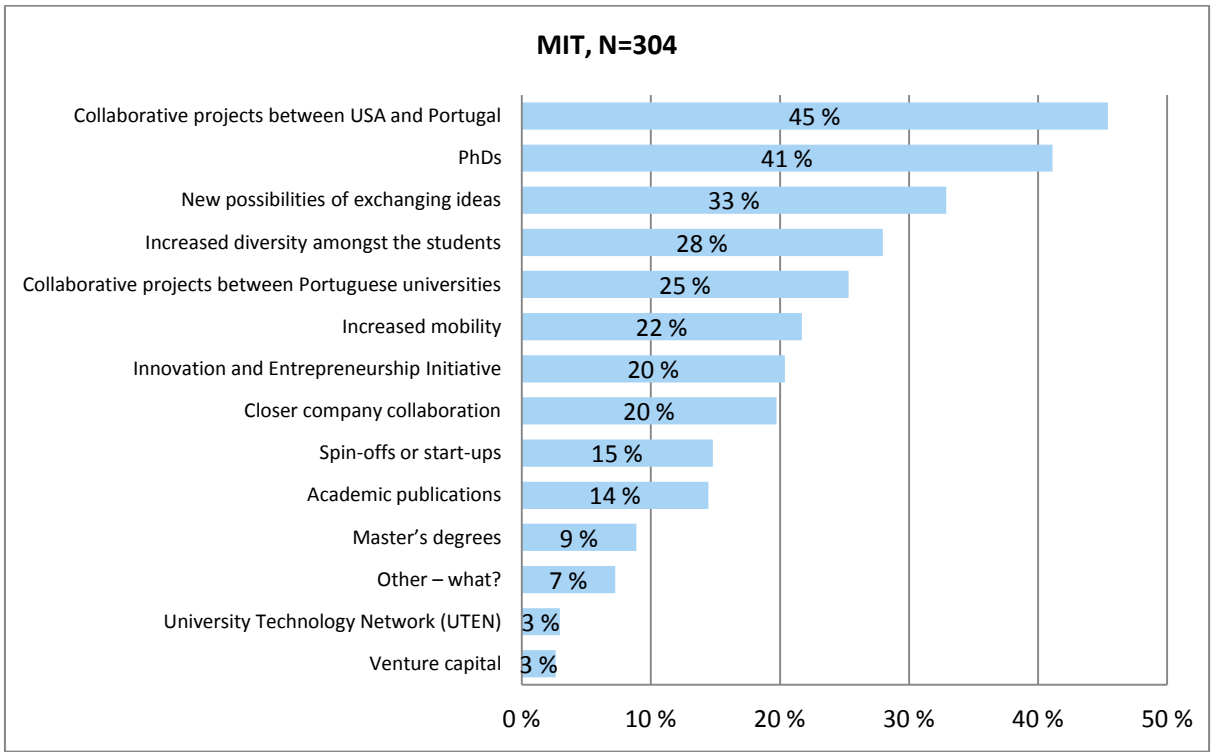


Figure 37

UTA perceptions of mobility more positive than those of the other programmes

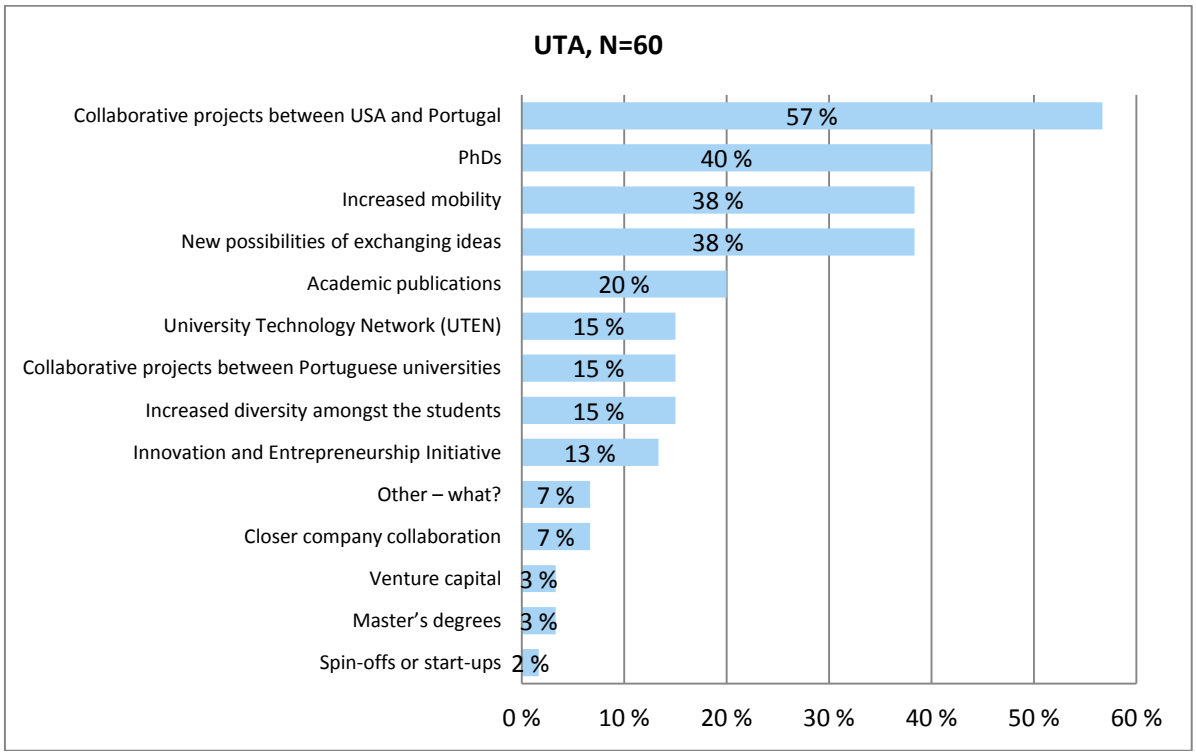


Figure 38

Technology transfer core in UTEN collaboration, but also similar benefits to other programmes (e.g. exchange of new ideas)

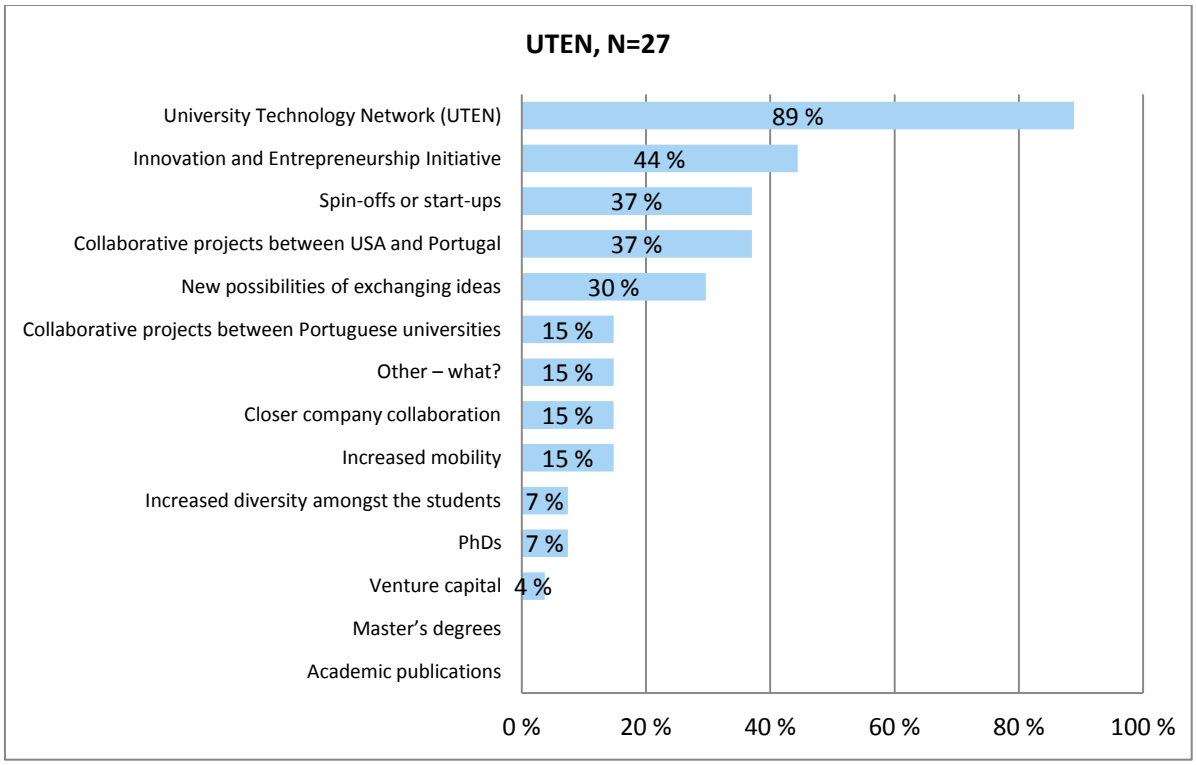


Figure 39

Internationalisation and training and teaching capability perceived most positively at CMU

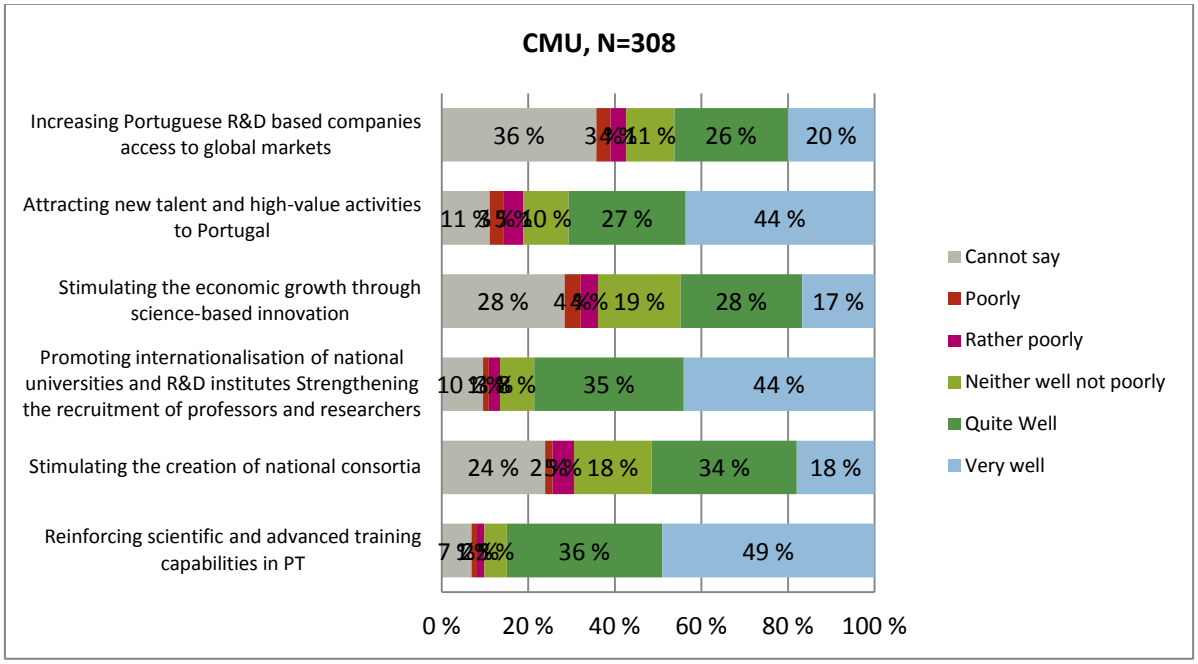


Figure 40

Access to R&D most critically perceived

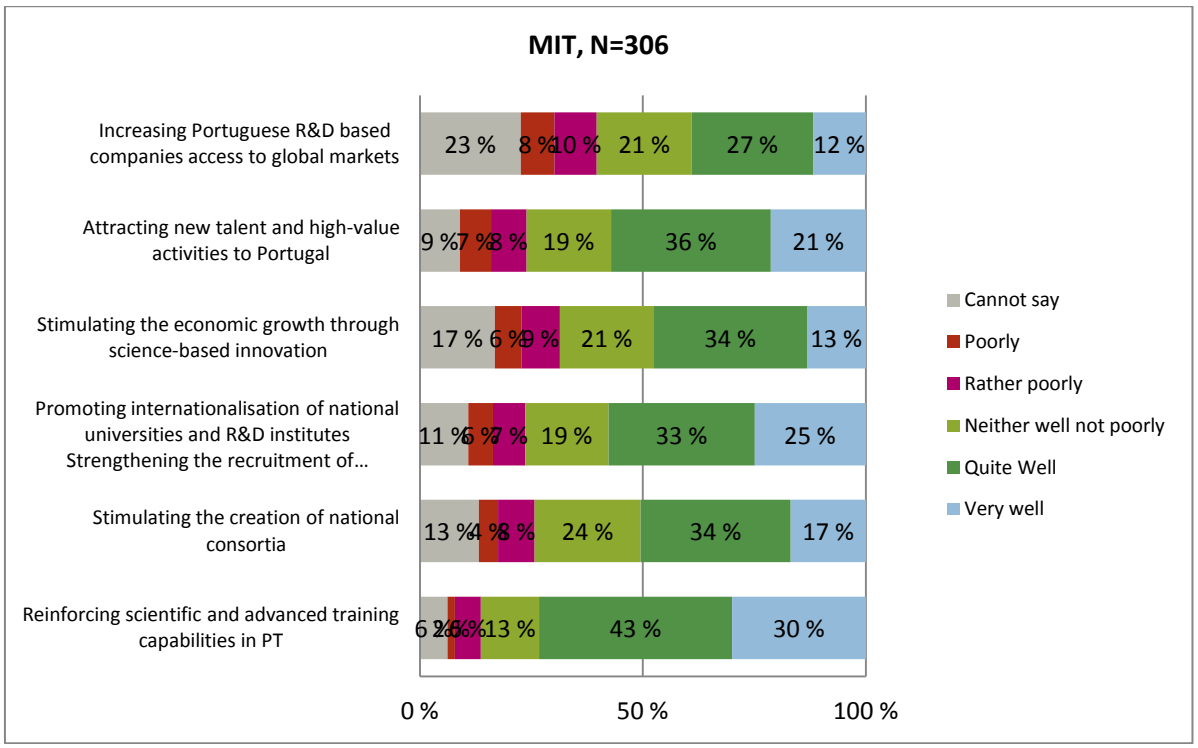


Figure 41

UTA respondents most positive about scientific and advanced training capabilities, critical about access to global markets and economic growth

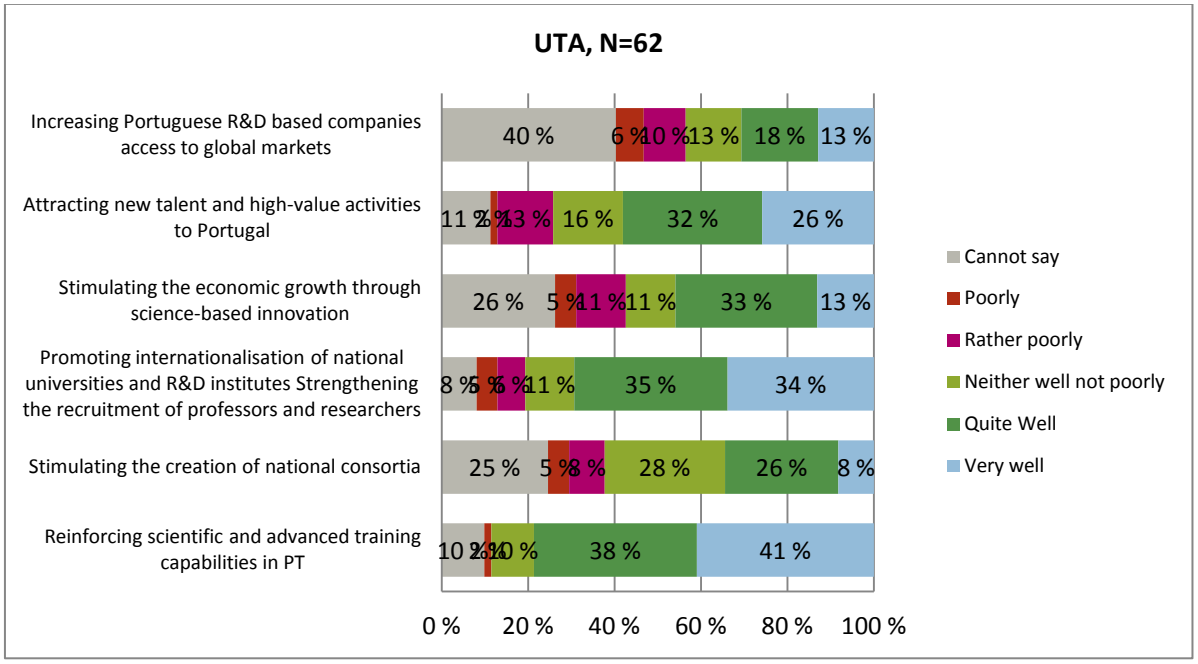


Figure 41

Different profile of UTEN responses understandable due to the different focus

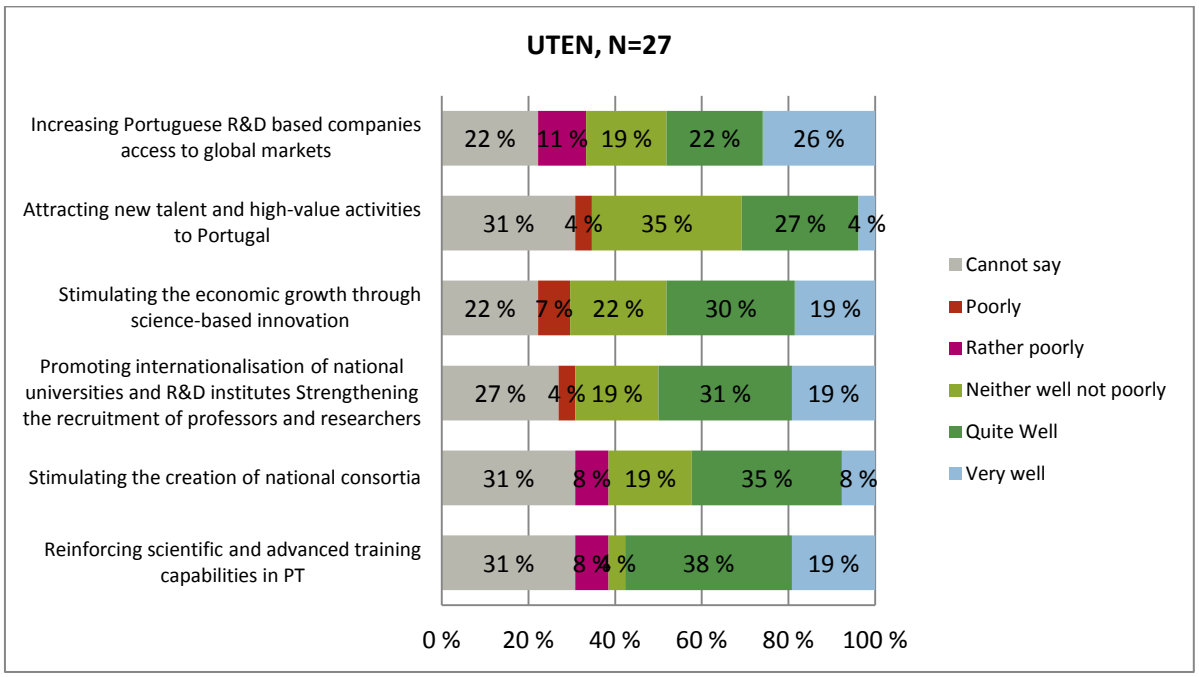


Figure 42

When compared to other R&D activities, how useful was the programme? Do you agree with the statements below?

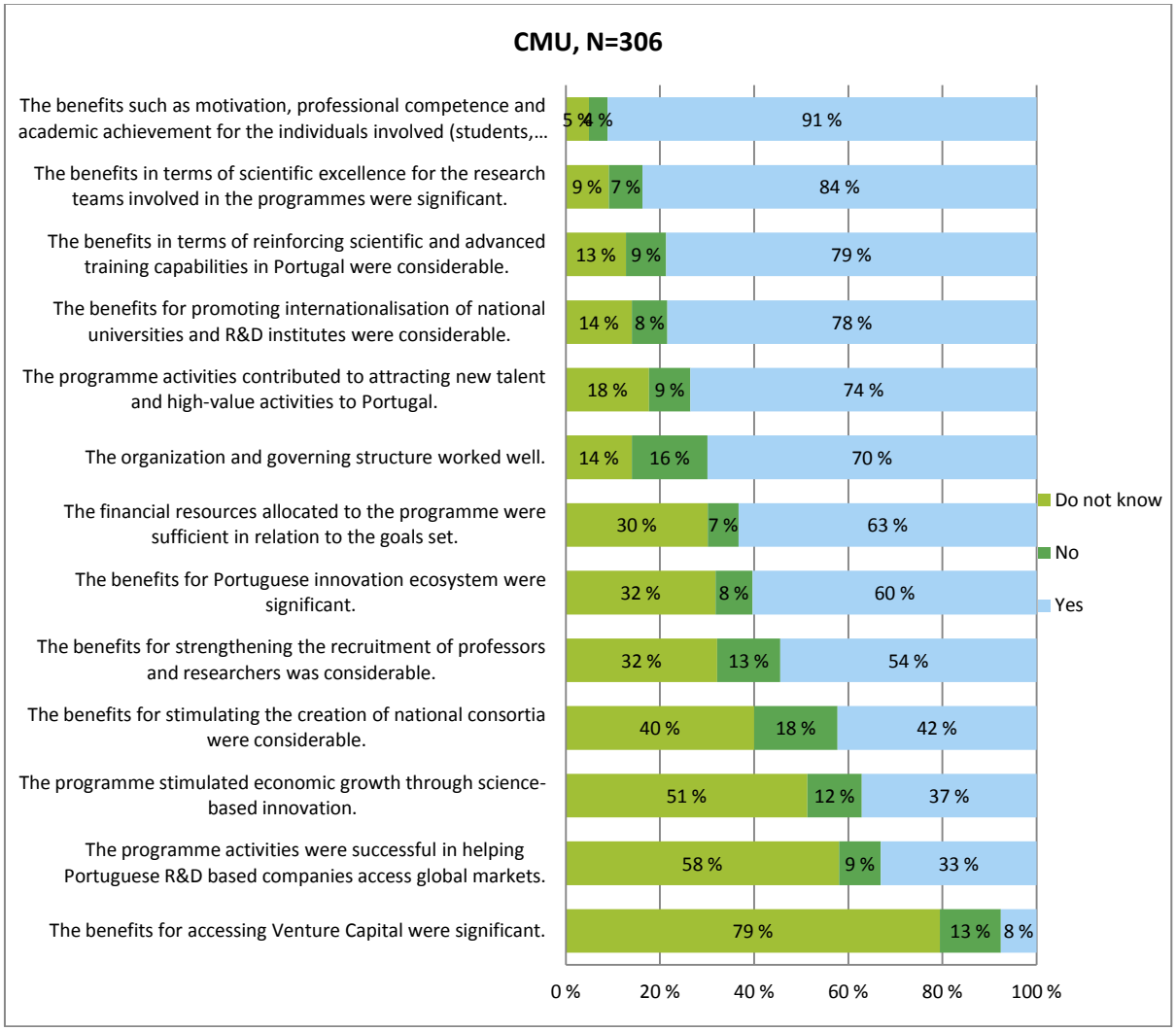


Figure 43

When compared to other R&D activities, how useful was the programme? Do you agree with the statements below?

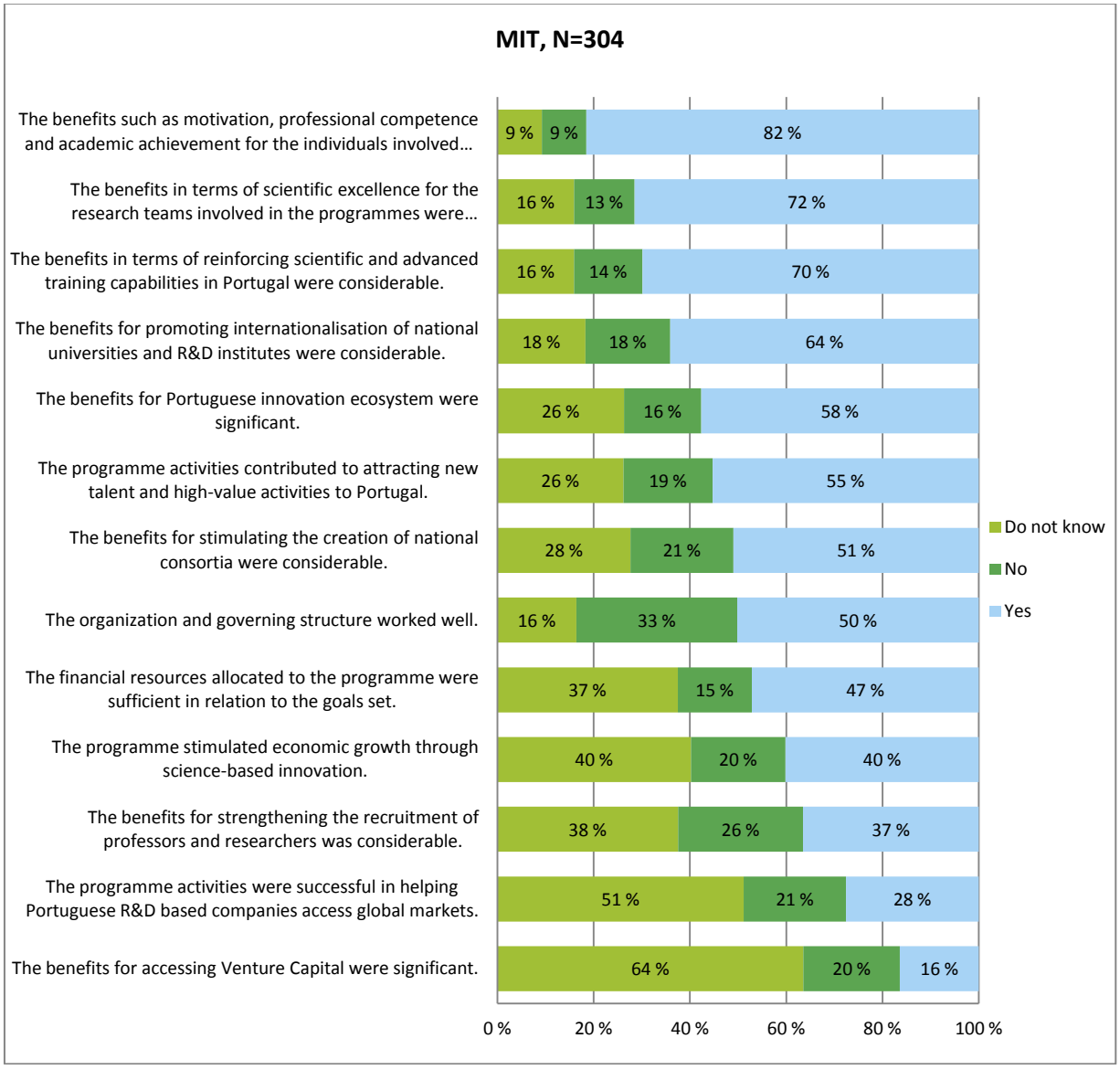


Figure 44

When compared to other R&D activities, how useful was the programme? Do you agree with the statements below?

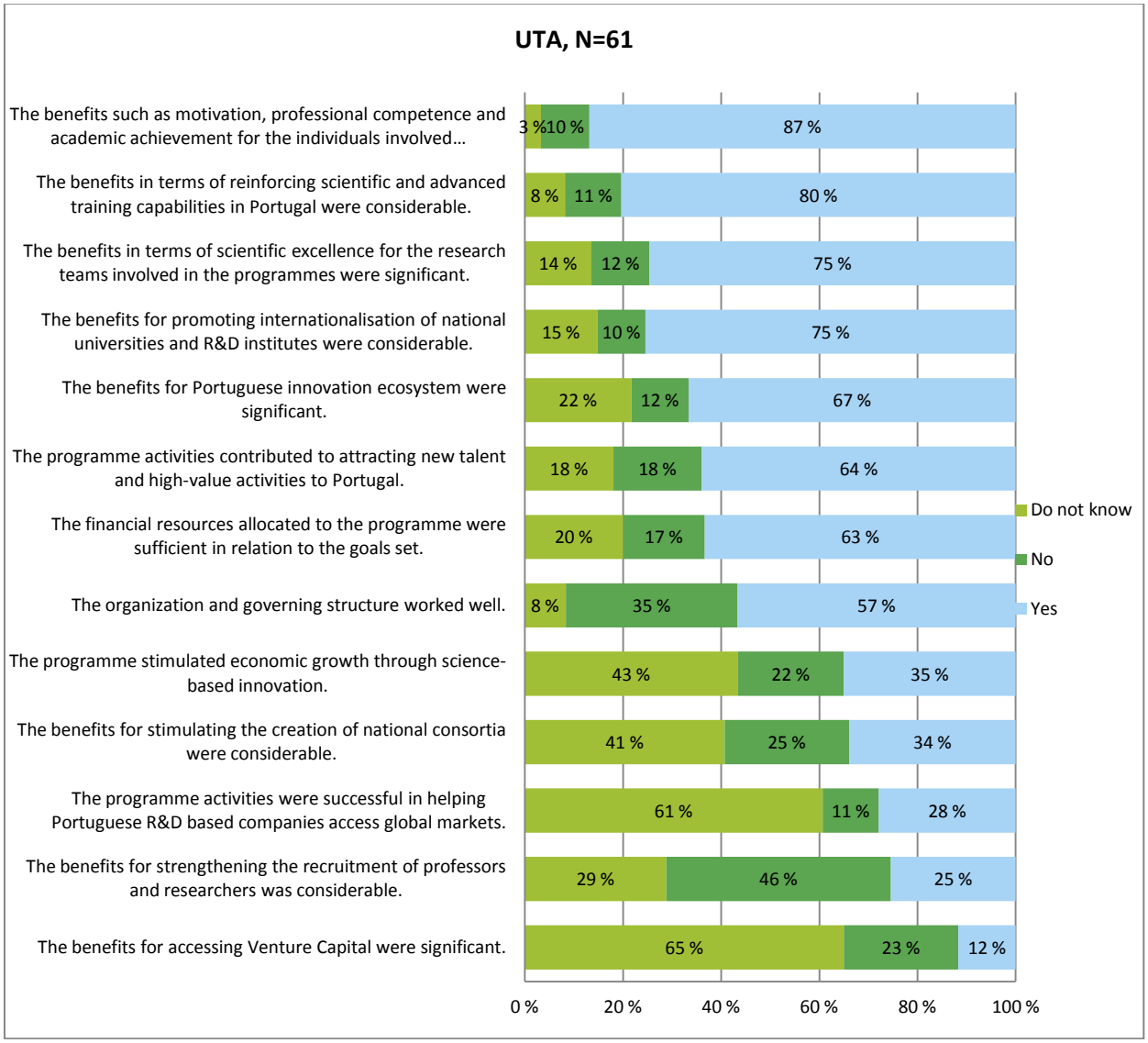


Figure 45

When compared to other R&D activities, how useful was the programme? Do you agree with the statements below?

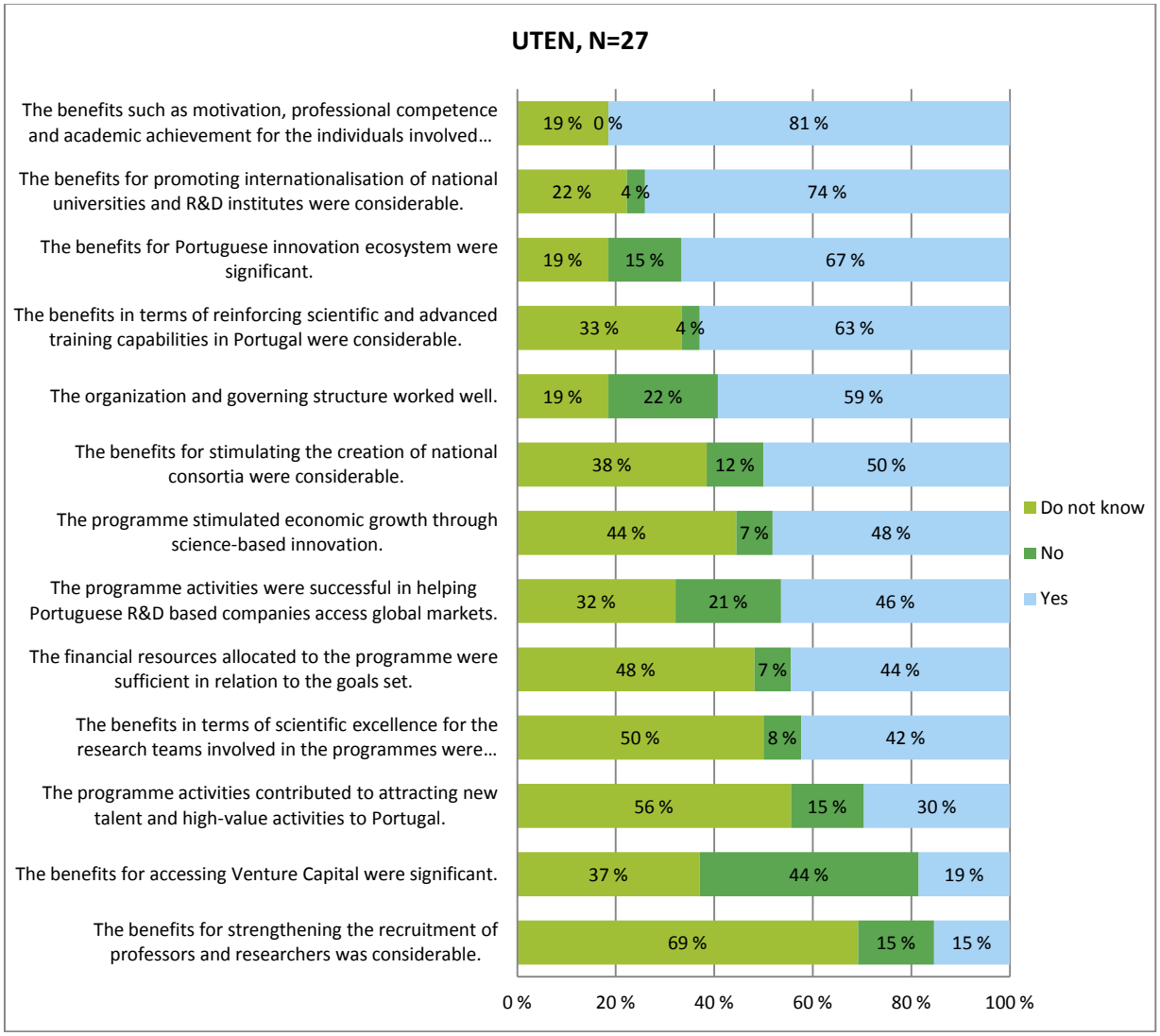


Figure 46

Appendix 6. List of interviewed persons

MIT-PT

Paulo Ferrao
Dava Newman
Dan Roos
John Clarke
Tom Blundell

Manuel Abecassis
Ana Aguiar Ricardo

Chris Zegras
Jose Estbail
Luis Peres-Breva

Manuel Nunes da Ponte
Olga Carneiro
Manuel Mota
Carlos Silva
José Paulo Esperança
Gonçalo Amorim
Richard de Neufville

José Gouveia
Sérgio Pinheiro
Tomé Canas
Rui Amandi de Sousa

Isabel Furtado
António Cunha
Paulo Ferrão
Joaquim Sampaio Cabral
Bruce Tidor

Ruben Eiras
Francisco Barreiros
Ryan Allard
Nelson Teodoro

Filipe Grácio
João Guerreiro
Alexandre Silva
Kiti Suomalainen
Daniel Wiesman
Patrícia Baptista
Maria Spandou

Daniela Couto
Hugo Gamboa
Isabel Rocha
André Pina
Frederio Ferreira

UTA-PT

Robert Peterson
Antonio Camara
Nuno Correia
Pedro Madeira
Sharon Strover
Diogo Nuno Crespo Ribeiro Cabr
André Miguel Guedelha Sabino
Paulo Nuno Gouveia Vicente
Rui Miguel Fernandes Robalo Coelho
Ana Duarte Cabral Martins
Luís Filipe de Matos Martins Gomes
Maria José Quirino Rosa Duarte
Bob Hodgson

David Ribeiro Alves
João Carlos Garcia Barbosa
Luis Manuel Frias Machado
João Filipe Fernandes Castanheira Beira
António Carbalho Maneira
Marta Isabel Santos da Conseição
Isabel Maria Silva Paiva
Rossana Henriques Santos

Diogo Nuno Crespo Ribeiro Cabral
Filippo Cagnetti
Cláudia Cristina da Silva
Luís Filipe de Matos Martins Gomes
Rui Carlos Araújo Gonçalves
Maria José Quirino Rosa Duarte
José Rui Faustino Sousa

CMU

João Barros
José Manuel Fonseca de Moura
John O'Reilly
Tariq Durrani

Rogério Carapuça
Paulo Marques
João Paulo Cunha
Michel Ferreira
Rodrigo Ventura
Monchu Chen
Pedro Bizarro
Valentina Nisi

António Cruz Serra
Isabel Trancoso
Pedro Carvalho
Diogo Gomes
João Xavier
Francisco Veloso

José Carlos Marques dos Santos
João Gabriel Silva
Nuno Nunes
Luis Caires

Rui Meireles
Miguel Godinho de Matos
Jeronimo Moreira
Ana Venâncio
Tiago Carvalho
Kátia Serralheiro
Catarina Pereira
Ricardo Silveira Cabral
Filipa Jervis

Ricardo Morla

UTEN

José Mendonça
David Gibson
Marta Catarino
Luis Mira
Maria Oliveira
Jose Rainho
Sofia Catarina Mosca Ferreira Mota
Rossana Henriques Santos
Tiago Miguel Gonzaga Videira
Marta Isabel Santos Paiva Conceição
João Filipe Fernandes Castenheira Beira
Cláudia Cristina da Silva
David Ribeiro Alves
João Carlos Garcia da Cunha Barbosa

OTHER STAKEHOLDERS

Vasco Varela, FCT
Graham Vickery, independent expert, formerly with the OECD
Nuno Sebastião, CEO, FeedZai

Appendix 7. Members of expert panels

Members of the panel of 4 November:

- Professor Yannis Caloghirou, National Technical University of Athens, Greece
- Research Director Gabriella Cattaneo, IDC European Government Consulting, Italy
- Professor Seppo Hölttä, University of Tampere, Finland
- Scientific Director Pieter de Pauw, Free Brussels University (VUB), Belgium
- Director of International Affairs Emilie Normann, Aalborg University, Denmark
- Stv. Direktorin Sonja Sheikh, KMU Forschung, Austria

Members of the panel of 28 October:

- Professor Arto Mustajoki, Chair of the Board of the Academy of Finland
- Professor Kimmo Kaski, University of Helsinki
- Professor Risto Nieminen, Aalto University
- Research Development Manager Johanna Hakala, Tampere University of Technology
- Chancellor Eero Vuorio, University of Turku
- Dr Terttu Luukkonen, Research Institute of the Finnish Economy
- Professor Yrjö Neuvo, EIT Executive Committee
- Professor Markku Mattila, President of the Academy of Finland

Both meetings were chaired by Vice President Riitta Mustonen (Academy of Finland) and facilitated by RMC consultants and Academy of Finland experts.

Appendix 8. The Portuguese context

Population (2010)	10.64 million
GDP per capita (2010)	EUR 16,200
R & D intensity(GERD/GDP): % of GDP (2009)	1.66
Share of private sector R&D: % of GERD (2009)	46.7
Share of public sector R&D: % of GERD (2009)	42.8

Portugal, one of the oldest European nation-states and the longest lived of the European colonial empires is today a small and open economy. The GDP per capita of Portugal corresponds to 79% of the EU27 average and the real GDP growth has been modest throughout the past decade. Both GERD (Gross Expenditure on R&D) and BERD (Business Expenditure on R&D), however, have experienced significant growth rates through the 2000s, hence in 2009 BERD represented 0.8% of GDP, a significant change when compared to 0.3% in 2005 and less than 0.2% until some ten years ago.

Innovation system

The innovation system in Portugal is less complex than in many other European countries.[31] The most important institution in the governance of the research system is the Ministry of Education and Science (previously Ministry of Science, Technology and Higher Education), which manages the greatest share of the national science and technology (S&T) budget. It has also implemented the most important recent changes in the system: the reform of the government labs and the establishment of a new universities' governing law together with the new university career institute. These have sought to establish a more self-financing funding model and accentuated the need to mobilise external financing. At the same time, the tertiary education system has been reformed, the social basis for recruitment of students has been enlarged, and industry-science links have been strengthened. The system is, however, dominated by a top-down approach, with few participatory mechanisms for the involvement of interest groups, business, NGOs and society at large.

The research and innovation system is characterised by a growing private sector share in both financing and performance. Portugal is outperforming in the number of graduated and employed doctoral researchers having exceeded the EU average on these resources. Portugal has progressed well and reached about the EU average in the international scientific co-publications and their citation worldwide. Portugal also shows a remarkable growth rate in terms of publications (13.9%) and even higher with cited publications (16.9%) between 2000 and 2008.

On the other hand, tertiary and upper secondary education still remains low. Additionally, there are problems related to the capacity of the existing business firms exploiting their possibilities. This is further aggravated by the current economic climate, which inhibits firms of investing and adopting a more innovative behavioural posture. The very large firms, which usually have greater R&D intensity, are absent. The venture capital market is insufficiently developed. Moreover, the fraction of capital provided by business angels is residual.

Portugal has been a late-comer into the R&D development field, but has made considerable progress throughout the early 2000s. In 2009, per capita GDP expressed in purchasing power parities was 79% of the EU27 average. Real GDP growth has been very weak throughout the present decade, forecasts for 2010 and 2011 being rather low, according to Eurostat. In spite of Portugal's economic weaknesses and the current economic and financial crisis, both GERD (Gross Expenditure in Research and Development) and BERD (Business Expenditure in Research and Development) experienced significant growth rates. GERD reached 1.7% of GDP, in 2009, as against 0.83% for 2003. BERD amounted to 0.8% of GDP, while the corresponding figure for 2003 was 0.2% only (GPEARI, 2010b, 2009b, cited in Godinho & Simões 2010, p. 3).

The structural and systemic problems of the innovation system are the very drivers behind the Programmes assessed in this evaluation. As argued in Godinho & Simões (op. cit.), the main

[31] This section is largely based on Godinho and Simões (2010): ERAWATCH COUNTRY REPORT 2010: Portugal.

barriers to private R&D investments are associated with the following five main features: (1) The structural characteristics of the economic fabric; (2) the size distribution of Portuguese firms, where very large firms, which typically have greater R&D intensity, are absent; (3) the nature of the domestic demand (intermediate and capital goods demand patterns are less sophisticated than European average, so hindering the local companies supplying advanced products); (4) average company absorptive capacity is relatively weak, not only in terms of purchasing advanced inputs but also in terms of integrating in their staff qualified human resources; and (5) the insufficient development of the venture capital market. Besides these barriers, reference is due to the insufficient applicability concerns that still dominate research policy. Despite a recent move to more targeted initiatives, the situation is still far from a healthy collaboration between academic research and potential end-users. This is a systemic problem, which is related to both the orientation of the policies and the weak absorptive capabilities of the economic fabric.

Context indicators

In order to analyse the effectiveness and the ability of the collaborative Programmes between the US and Portugal to contribute to the goals of internationalisation and the qualitative leap in R&D activity, one needs to take into account the starting point of the Portuguese innovation system. To this effect, the evaluation steering group has compiled a set of indicators that reflect the state of development and maturity in the R&D environment and innovation system (see Appendix 3 for a list of statistical indicators used in the evaluation).

The performance of Portugal can be benchmarked against other small European countries (e.g. Belgium, Denmark, Finland and the Netherlands). In terms of total public expenditure on education (million EUR PPS), the 2008 figure for Portugal was 10,222.4, being higher than in Finland but lower than in the other reference countries. There is an abundance of researchers in Portugal, clearly exceeding the number of the reference countries. This, however, is not reflected in the number of R&D personnel (% of the labour force), which is the lowest (although on the rise) in Portugal (0.85) compared to the Netherlands (1.05), Belgium (1.26), Denmark (1.99) and Finland (2.1). Portugal is also below the EU27 average (1.04). The difference is even greater measured by HRST (Human resources in science and technology as a share of labour force as a percentage of total population). The figure for Portugal in 2010 was 23.9%, while for Belgium it was 49.3%, for Finland 50.6%, and for Denmark and the Netherlands 51.9%.

Considerable catching up is illustrated in Portugal in the analysis of most indicators relating to scientific outputs, from scientific publications to employment of R&D personnel. Some examples are presented below.

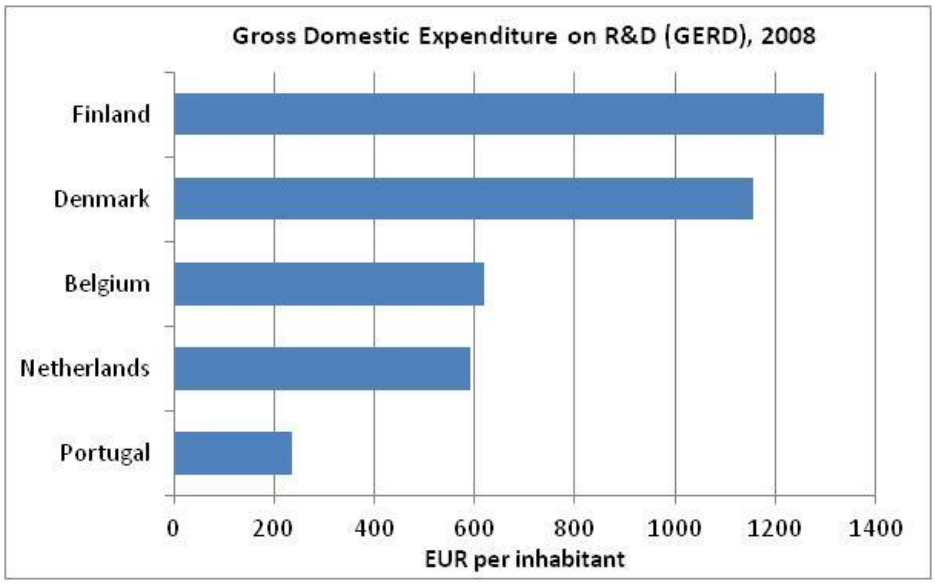


Figure 1. GERD of selected countries, 2008 (Source: Eurostat)

In 2008, GERD/EUR per inhabitant (Gross Domestic Expenditure on R&D) was clearly lower in Portugal (236.7) than in the Netherlands (590.4), Belgium (620.8), Denmark (1,157.5) and Finland (1,296.3). The situation is similar when measured by R&D expenditure as a % of GDP. The figure for Portugal in 2008 was 1.5%, whereas in the Netherlands it was 1.76%, in Belgium 1.96%, in Denmark 2.87% and in Finland 3.72. The EU27 average in 2008 was 1.92% and was therefore above the Portuguese number. The low input level of Portugal has led to low levels of outputs as well. Portugal falls far behind the other countries in terms of European patent applications and patents granted by the United States Patent and Trademark Office (USPTO). On the other hand, Portugal has had significantly higher average annual growth rate of scientific publications from 2000 to 2008. So far, this has not had an effect on the university rankings of Portuguese universities. Currently, no Portuguese universities are listed among the best 200 European universities, while the list includes several universities from Belgium, the Netherlands, and Denmark and one from Finland.

National rank	Institution*	World Rank	Country	Regional Rank
4	MIT	4	USA	4
29	University of Texas, Austin	38	USA	31
1	University of Copenhagen	40	Denmark	7
1	Utrecht University	50	The Netherlands	11
39	Carnagie-Mellon	58	USA	41
1	University of Helsinki	72	Finland	22
1	Ghent University	90	Belgium	29
1-2	University of Lisbon	401-500	Portugal	169-204
1-2	University of Porto	401-500	Portugal	169-204

* Institutions within the same rank range are listed alphabetically.

Table 1. Academic Ranking of World Universities (ARWU) 2010 (Source: www.arwu.org)

Mobility is both a programme-specific indicator and one that reflects the situation of Portuguese R&D system more broadly. Development in this regard has been very positive and Finland seems to have a lot more to learn from Portugal than vice versa. In previous studies on mobility similar picture is confirmed, with estimated percentages of internationally mobile researchers in the higher education sector by country, a particularly high mobility is visible for Greece (73%) and Portugal (70%), while Finland (33%) and Slovakia (40%) have the lowest mobility. (Idea et al., p. 76). While the issue of brain drain is often discussed as a negative aspect of internationalisation, the topic should be seen as more complex than that: the attractiveness of a R&D environment may in a longer-term perspective increase with the number of domestic staff and students having spent extensive times abroad. The topic of brain drain has been discussed in more detail in the interviews and will be reported in connection with these.

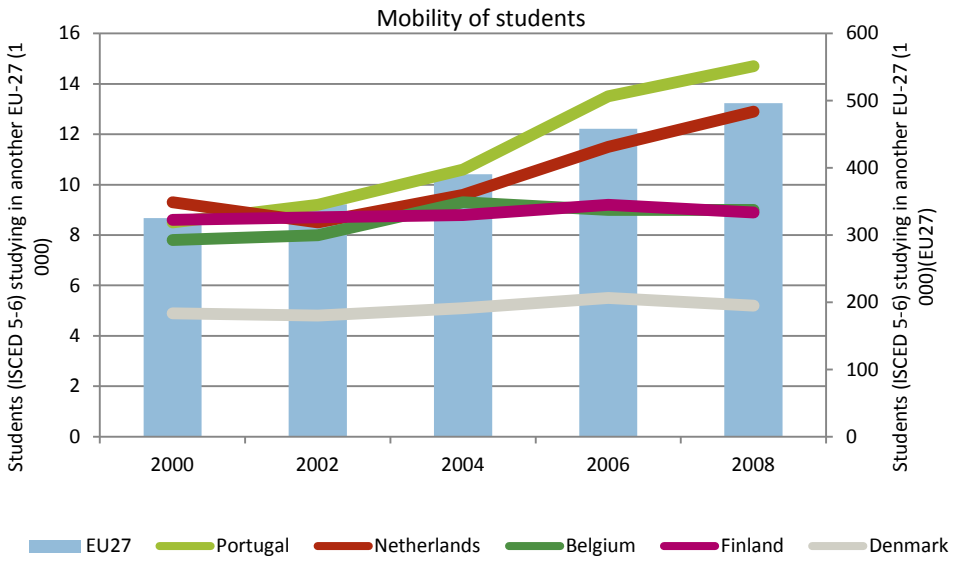


Figure 2. Mobility of students in selected countries, (Source: Eurostat)

Internationalisation has improved as indicated by numerous context and programme indicators. Mobility of students and staff are amongst the key instruments by which the Programmes work, and the mobility of students has improved overall in Portugal, clearly exceeding the EU27 average.

Appendix 9. List of key terms and acronyms

Key terms:

- **Research and Education Collaboration** = the three Portugal-US Programmes (MIT, CMU and UTA) and University Technology Enterprise Network (UTEN)
- **Programme** = individual Portugal-US university research and education collaborations, when the specific PT-US Programmes are referred to, a capital P is used, otherwise when relating to generic programme issues are discussed without the capital P.
- **Sustainability** = temporal concept, capacity to endure and to maintain over time. In the case of research and development.
- **Partnership** = ranging from a relationship of two or more entities conducting business for mutual benefit (Cordis 2011). In some cases, there is a co-financing model assumed in the definition. Partnership relationships contain actors in various roles from client to service providers, contractors to sub-contractors. In most cases, partnerships are taken as containing a deeper commitment to the cooperation than simply a service provision and purchaser, rather there is a more long-term commitment and trust that is gradually built over time. Partnership entails on the level of participating organisations a ***mutual strategic choice***. (Suomen Kuntaliitto/Association of Finnish Local and Regional Authorities 2005).
- **Context-sensitivity** = analysis/evaluation etc. which takes into account the context and the contextual preconditions.
- **Collaborative fields/scientific fields =** collaborative fields/scientific fields are disciplinary topics and combinations thereof where the Programmes have initiated and implemented activities.
- **Collaboration** = refers to all types of innovation promoted in cooperation within projects (incl. non-technological types, social and organisational)
- **Good management practice (in the context of R&D&I activity) =** covers work on programme or project level from initiation and idea-stage to implementation and monitoring, with focus in the first instance on **OBJECTIVES** that should be "SMART": Specific: expressed singularly, Measurable: ideally in quantitative terms, Acceptable: to stakeholders, Realistic: in terms of achievement, Time-bound: a timeframe is stated. This is naturally but one aspect of good management practice, but a very central one. Good governance norms are also connected to the good management ideals, i.e. the principles of openness, accountability, effectiveness, transparency and coherence, which are referred to in many cases in norms and standards for doctoral studies, as well as for European governance more broadly (e.g. Niemi et al. 2011, p. 33, CEC 2001).

Acronyms:

AUT = Austin University
BES = bioengineering systems (MIT-PT Doctoral Programme)
CMU = Carnegie Mellon University
CS = Computer Science (CMU-PT Dual PhD Programme)
ECE = Electrical and Computer Engineering (CMU-PT Dual PhD Programme)
EDAM = Engineering Design and Advanced Manufacturing (EDAM) MIT-PT Doctoral Programme)
EPP = Engineering in Public Policy (EPP) CMU-PT Dual PhD Programme)
ES = Engineering systems
FCT = Foundation for Science and Technology (Fundação para a Ciência e a Tecnologia)
HCI = Human-Computer Interaction CMU-PT Dual PhD Programme)
IST = Instituto Superior Técnico, Technical University of Lisboa
FEUP= Faculdade de Engenharia da Universidade do Porto, Faculty of Engineering, University of Porto
FCUL = University of Lisboa Faculty of Sciences
LTI = Language Technology (CMU-PT Dual PhD Programme)
MCTES = by The Ministry of Science, Technology and Higher Education, Portugal (Ministério da Ciência, Tecnologia e Ensino Superior in Portuguese)
MET = Entertainment Technology (CMU-Portugal Master's Programme)
MHCI = Human-Computer Interaction (CMU-Portugal Master's Programme)
MIT = Massachusetts Institute of Technology
MSE = Software Engineering (CMU-Portugal Master's Programme)
MSIT-IS = Information Technology – Information security (CMU-Portugal Master's Programme)
R&D(&I) = Research & Development (&Innovation)
SES = Sustainable Energy systems

TCE = Software Engineering in Technological Change and Entrepreneurship (CMU-PT Dual PhD Programme)
UMIC = The Knowledge Society Agency (UMIC) is the Portuguese public agency with the mission of coordinating the policies for the Information Society and mobilising it through dissemination, qualification and research activities. It operates within the Ministry of Science, Technology and Higher Education.
UTA = University of Austin, Texas
UTEN = University Technology Transfer Network

Appendix 10. Key information from the benchmarking programmes

PROGRAMA DE FORMAÇÃO MÉDICA AVANÇADA (PFMA) [ADVANCED MEDICAL EDUCATION PROGRAM]

Admissions		2008	2009	2010	2011	Total
Applications	Total	97	55	65	22	239
	Foreign	4	5	0	0	9
	Portuguese	93	50	65	22	230
	% foreign	4	9	0	0	**4**
Enrollments	Enrollments	10	10	10	9	39
	% of applications	10	18	15	41	**16**

Student Thesis Work		2008	2009	2010	2011*	Total
Laboratory Affiliation	Portugal	4	4	3	N/A	11
	Abroad	6	6	7	N/A	19
	% abroad	60	60	70	N/A	**63**
Status	Thesis in progress	10	10	10	N/A	30
	Transferred	0	0	0	N/A	N/A
	Dropped out	0	0	0	N/A	N/A
	Defended	0	0	0	N/A	N/A

Instructors/Faculty		2008	2009	2010	2011	Total
Institutional Affiliation	Portuguese	53	70	32	33	188
	Foreign	64	44	69	55	232
	Total	117	114	101	88	**420**
	% from abroad	55	39	68	62	**55**

Budget	Total
Variable average cost per student to thesis (total: 87% private, 13%public)**	3 000 000€
Costs of teaching/administration (private – FCG)/year 200 000 €	800 000€

Table 1.

* Students admitted in 2011 have not yet started Thesis work; no such information is available before March 2012.
** Most of the private investment comes from Fundação Calouste Gulbenkian (FCG) and it includes a significant contribution from Fundação Champalimaud, as well as a minor participation of private health-service providers; the public contribution comes from Fundação para a Ciência e a Tecnologia (FCT) and from the Health Ministry.

PROGRAMA GULBENKIAN DE DOUTORAMENTO EM BIOLOGIA E MEDICINA (PGDBM)
[GULBENKIAN PHD PROGRAMME IN BIOLOGY AND MEDICINE]

Admissions		**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**Total**
Applications	Total	202	184	216	176	184	164	191	**1317**
	Foreign*	0	0	0	0	0	0	0	0
	Portuguese	202	184	216	176	184	164	191	1317
	% foreign*	0	0	0	0	0	0	0	**0**
Enrollments	Enrollments	16	14	14	13	14	16	16	103
	% of applications	8	8	6	7	8	10	8	**8**

Student Thesis Work		**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**Total**
Laboratory Affiliation	Portugal	1	5	0	1	0	0	2	9
	Abroad	15	9	14	12	14	16	14	94
	% abroad	94	64	100	92	100	100	88	**91**
Status	Thesis in progress	0	0	0	0	0	0	0	0
	Transferred	0	0	0	0	0	0	0	0
	Dropped out	0	0	0	1	0	1	1	2
	Defended	16	14	14	12	14	16	15	**101**

Instructors/Faculty									
Institutional Affiliation	Portuguese	20	32	36	32	30	31	40	**146
	EU	45	55	56	60	55	79	69	**281
	Other	17	38	35	36	37	23	18	**219
	Total	82	125	127	128	122	131	127	****646**
	% from abroad	**76**	**74**	**72**	**75**	**75**	**76**	**69**	**77**

Budget* **	**Total**
Average cost per student to thesis in Portugal (public/JNICT, FCT) 66 000 € Average cost per student to thesis abroad (public/JNICT, FCT) 93 480 €	9 381 000 €
Costs of teaching/administration (private - FCG)/year 200 000 €	1 400 000 €

Table 2.

The final report on the evaluation of this Program by an external international committee is attached.

JNICT: Junta Nacional de Investigação Científica e Tecnológica; FCT: Fundação para a Ciência e a Tecnologia; FCG: Fundação Calouste Gulbenkian

* This Program was not open to applications by non-residents, as it aimed at educating Portuguese students abroad.
** Many instructors participated in several years; hence, the "Total" is lower than the sum of the all years.
*** Average costs consider, for all students, 1 year of graduate courses in Portugal and 4 years of thesis work, either in Portugal or abroad; as some of the students completed their work in less than 4 years, total costs are somewhat overestimated. Bench/tuition fees are considered for students in Portugal only, as those in the UK and US were covered by agreements with the British Council and the FLAD (Fundação Luso-Americana para o Desenvolvimento), respectively.

PROGRAMA DE DOUTORAMENTO EM BIOLOGIA COMPUTACIONAL (PDBC) [PHD PROGRAM IN COMPUTATIONAL BIOLOGY]

Admissions		2005	2006	2007	2008	Total
Applications	Total	172	71	72	64	379
	Foreign*	0	0	0	0	0
	Portuguese	172	71	72	64	379
	% foreign*	0	0	0	0	**0**
Enrollments	Enrollments	12	12	11	11	46
	% of applications	7	17	15	17	**12**

Student Thesis Work		2005	2006	2007	2008	Total
Laboratory Affiliation	Portugal	0	1	1	5	7
	Abroad	12	11	10	6	39
	% abroad	100	92	91	55	**85**
Status	Thesis in progress	6	9	9	10	34
	Transferred	0	0	0	0	0
	Dropped out	0	2	1	1	4
	Defended	6	1	1	0	8

Instructors/Faculty*		2005*	2006*	2007	2008	Total
Institutional Affiliation	Portuguese	N/A	N/A	31	30	~120
	EU	N/A	N/A	58	51	
	Other	N/A	N/A	20	10	~280
	Total	N/A	N/A	109	91	**~400**
	% from abroad	N/A	N/A	72	67	**70**

Budget***	Total
Average cost per student to thesis in Portugal (public/FCT) 54 600 € Average cost per student to thesis abroad (public/FCT) 81 960 €	3 296 400 €
Costs of teaching/administration (private - FCG, Siemens SA)/year 200 000 €	800 000 €

Table 3.

FCT: Fundação para a Ciência e a Tecnologia; FCG: Fundação Calouste Gulbenkian; Siemens Portugal SA.

* This Program was not open to applications by non-residents, as it aimed at educating Portuguese students abroad.
** Due to change in Directors, detailed data from the first two years of execution of the Program are not currently available.
*** Only already committed costs are considered; all students are expected to complete thesis work in 3 years (in Portugal or abroad), after one year of graduate courses in Portugal; tuition/bench fees are paid to Portuguese Universities were all students are registered; "dropped out" are considered for the first year only.

PROGRAMA GULBENKIAN DE DOUTORAMENTO EM BIOMEDICINA (PGDB)
[GULBENKIAN PHD PROGRAM IN BIOMEDICINE]

Admissions		2000	2001	2002	2003	2004	Total
Applications	Total	104	134	161	182	182	763
	Foreign	4	18	40	35	16	113
	Portuguese	100	116	121	147	166	650
	% foreign	4	13	25	19	9	**15**
Enrollments	Enrollments	16	19	18	19	18	90
	% of applications	15	14	12	10	10	**11**

Student Thesis Work		2000	2001	2002	2003	2004	Total
Laboratory Affiliation	Portugal	3	4	2	3	1	12
	Abroad	13	15	16	14	17	75
	% abroad	81	79	89	88	94	**86**
Status	Thesis in progress	0	3	1	1	0	5
	Transferred	0	0	0	2	0	2
	Dropped out	1	0	2	2	2	7
	Defended	15	16	15	14	16	76

Instructors/Faculty*		2000*	2001*	2002*	2003*	2004*	Total
Institutional Affiliation	Portuguese	n/a	n/a	n/a	n/a	n/a	38
	EU	n/a	n/a	n/a	n/a	n/a	173
	Other	n/a	n/a	n/a	n/a	n/a	68
	Total	56	58	44	71	50	**279**
	% from abroad						**86**

Budget**		Total
Average cost per student to thesis in Portugal (public/FCT) 300 €	60	7 074 360 €
Average cost per student to thesis abroad (public/FCT) 220 €	92	
Costs of teaching/administration (private - FCG)/year 000 €	200	1 000 000 €

Table 4.

FCT: Fundação para a Ciência e a Tecnologia; FCG: Fundação Calouste Gulbenkian.

*Yearly data on Instructors/Faculty are not currently available, but the total figures are confirmed.
**Committed costs concerned 1 year of graduate courses in Portugal and 3 years of thesis work, in Portugal or abroad; yet, most students individually required (and obtained) a variable number of months of extension; these extra costs are considered here, estimated to 6 months/student; "dropped-out" are also included but for the first year only.

PROGRAMA GULBENKIAN DE DOUTORAMENTO (PGD) [GULBENKIAN PHD PROGRAM]/PROGRAM IN INTEGRATIVE BIOMEDICAL SCIENCES (PIBS) [PROGRAMA EM CIÊNCIAS BIOMÉDICAS INTEGRADAS]

Admissions		2007	2008	2009	2010	2011	Total
Applications	Total	147	226	144	131	98	746
	Foreign	55	121	50	80	38	344
	Portuguese	92	95	94	51	60	392
	% foreign	37	42	35	61	39	**46**
Enrollments	Enrollments	10	11	11	9	12	53
	% of applications	7	5	8	7	12	**7**

Student Thesis Work		2007	2008	2009	2010	2011	Total
Laboratory Affiliation	Portugal	9	9	10	8	12	48
	Abroad*	0	0	0	0	0	0
	% abroad*	0	0	0	0	0	**0**
Status	Thesis in progress	7	9	10	8	12	46
	Transferred	1	1	1	1	0	4
	Dropped out	0	1	0	0	0	1
	Defended	2	0	0	0	0	2

Instructors/Faculty		2007	2008	2009	2010	2011	Total
Institutional Affiliation	Portuguese	28	16	45	44	42	175
	EU	12	10	12	18	25	77
	Other	6	8	10	9	4	37
	Total	46	34	67	71	71	**289**
	% from abroad	39	53	33	38	41	**39**

Budget**	Total
Average cost per student to thesis (public/FCT) 54 600 € Average cost per student in 3 years of thesis work (private/FCG) 43 200 €	2 577 600 €
Costs of teaching/administration (private - FCG)/year 200 000 €	1 000 000 €

Table 5.

This is a single program that was renamed as it changed Director.

* The Program aims at educating all students (Portuguese and foreigners) in Portugal, with mandatory registration in Portuguese Universities.
** Costs that are committed by FCT for fellowships are considered, covering all students for the first year, as well as for 3 years of thesis work for all those admitted in 2007, 2008 and 2009, but only 6/8 for thesis work of students admitted in 2010, and at least 6/12 for those admitted in 2011. Total costs include a committed 345 600 € from private (FCG) funding.

INTERNATIONAL NEUROSCIENCE DOCTORAL PROGRAMME – INDP

Admissions		2007	2008	2009	2010	2011	Total
Applications	Total	122	130	179	192	97	**720**
	Foreign	32	52	95	129	33	341
	Portuguese	90	78	84	63	64	379
	% foreign	26	40	53	67	34	**47%**
Enrollments	Enrollments	10	10	12	8	10	50
	% of applications	8	8	7	4	10	**7%**

Student Thesis Work		2007	2008	2009	2010	2011	Total
Laboratory Affiliation	Portugal	4	8	7	5	N/A	24
	Abroad	6	2	4	3	N/A	15
	% abroad	60	20	36	37,5	N/A	**37,5**
Status	Thesis in progress	10	10	11	8	N/A	39
	Transferred	0	0	0	1	N/A	1
	Dropped out	0	0	0	0	N/A	0
	Defended	0	0	0	0	N/A	**0**

Instructors*		2007	2008	2009	2010	2011	Total
Institutional Affiliation	Portuguese	15	13	14	13	N/A	18
	EU	2	2	0	3	N/A	7
	Other	4	0	4	0	N/A	8
	Total	21	15	18	16	N/A	**33
	% from abroad	**29%**	**13%**	**22%**	**18,75%**	N/A	**45%**

Budget	Total
Average cost per student to thesis (public/FCT) 71 084 €	2 772 270 €
Costs of teaching/administration (private – FC/FCG)/year 150 000 €	735 000 €

Table 6.

* Thesis Supervisors and Thesis Committee members
** Faculty total for all programme years 2007-2010

PROGRAMA GRADUADO EM ÁREAS DA BIOLOGIA BÁSICA E APLICADA * GRADUATE PROGRAM IN AREAS OF BASIC AND APPLIED BIOLOGY

Admissions		**1996**	**1997**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Total**
Applications	Total						106	142	174	124	84	164	127	90	89	121	**1221***
	Foreign						1	0	7	3	3	6	4	12	4	9	**49***
	Portuguese						105	142	167	121	81	158	123	78	85	112	**1172***
	% foreign						1%	0%	4%	2%	4%	4%	3%	13%	4%	7%	**4%***
Enrollments	Enrollments	9	13	12	12	12	12	12	12	12	12	11	12	12	12	12	**177**
	% of applications						11%	8%	7%	10%	14%	7%	9%	13%	13%	10%	**14%***

Student Thesis Work		**1996**	**1997**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Total**
Laboratory Affiliation	Portugal	2	5	4	6	0	4	1	5	0	2	0	1	3	1		**34**
	Abroad	7	8	8	6	12	8	11	7	12	10	11	11	9	11		**131**
	% abroad	78%	62%	67%	50%	100%	67%	92%	58%	100%	83%	100%	92%	75%	92%		**74%**
Status	Thesis in progress	0	0	0	1	0	0	1	0	3	5	11	12	12	12		**57**
	Transferred	0	0	0	0	0	0	0	0	0	0	0	0	0	0		**0**
	Dropped out	0	0	0	2	1	1	0	0	0	0	0	0	0	0		**4**
	Defended	**9**	**13**	**12**	**9**	**11**	**11**	**11**	**12**	**9**	**7**	**0**	**0**	**0**	**0**		**104**

Teaching Staff		**1996**	**1997**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**TOTAL**
Institutional Affiliation	Portuguese				51		81	98	89	94	94	124	143	116	131		1021
	EU				18		29	26	35	68	48	43	57	60	52		436
	Other				3		8	6	16	11	8	17	14	8	15		106
	Total				72		118	130	140	173	150	184	214	184	198		1563
	% from abroad				**29%**		**31%**	**25%**	**36%**	**46%**	**37%**	**33%**	**33%**	**37%**	**34%**		**34%**

Budget	**TOTAL 15 editions**
Average cost per student to thesis (public/FCT)# 120.000 €	21.240.000 €
Costs of teaching/administration (public/FCT)/year 100.000 €	1.500.000 €

Table 7.

* Data available only from 2002 (when GABBA started to have a secretary)

This value includes the monthly living allowance, social security and other subsidies (tuition and bench fees, travel, installation and others)

Doctoral Programme in Experimental Biology and Biomedicine (PDBEB at CNC-UC, University of Coimbra, Portugal)

Admissions		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Applications	Total	56	87	137	59	79	90	75	54	62	56	755
	Foreign	1	2	6	10	5	11	7	2	9	4	57
	Portuguese	55	85	131	49	74	79	68	52	53	52	698
	% foreign	2 %	2 %	4,38 %	16,90 %	6,32 %	12,20 %	9,33 %	3,70 %	14,50 %	7,14 %	**7 %**
Enrollments	Enrollments	12	12	12	12	12	12	12	12	12	12	120
	% of applications	21 %	14 %	8,76 %	20 %	15 %	13 %	16 %	22 %	19 %	21 %	**16 %**

Student Thesis Work*		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Laboratory Affiliation	Portugal	6	9	8	3	6	7	3	5	10	not applicable	57
	Abroad	6	3	3	9	6	5	8	7	2	not applicable	49
	% Abroad	50 %	25 %	27 %	75 %	50 %	42 %	67 %	58 %	17 %	not applicable	**46 %**
Status	Thesis in progress	12	2	1	6	7	11	11	12	12	12	86
	Transferred	0	0	1	0	0	0	1	0	0	0	2
	Dropped out	0	0	0	0	0	1	0	0	0	0	1
	Defended	12	10	10	6	5	0	0	0	0	0	**43**

Instructors		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Institutional Affiliation	Portuguese	35	36	29	43	48	66	48	89	84	not applicable	478
	EU	17	19	20	30	21	25	40	26	16	not applicable	214
	Other	10	17	10	24	17	17	21	9	17	not applicable	142
	Total	62	72	59	97	86	108	109	124	117	not applicable	834
	% from abroad	**44 %**	**50 %**	**51 %**	**56 %**	**44 %**	**39 %**	**56 %**	**28 %**	**28 %**	not applicable	**43 %**

Budget		Total
Average cost per student to thesis (public/FCT)**	95060€	11 407 200 €
Costs of teaching /administration (private/other)/year	35000€	350 000 €

Table 8.

* Most students involved in the Programme work in a non-CNC lab (national or international) during their PhD for different periods on collaborative projects (as this is one of the Programme goals), what is listed is the main place of work

**FCT funding for 4 year student Fellowships. The amounts (salary, bench fees) may vary if the students work mostly in Portugal (980 Euros/month + bench fees 2750/yr), abroad (1710 Euros/month + bench fees 12500/yr). A mix of 2+2 years of each regimen was considered in this exercise, as an average.