Economic Development, Scientific Excellence, Entrepreneurial Activity

*Reflections from the **workshop High Tech Entrepreneurship: Implications for Science Policy and Education** Jointly organized between the CMU-Portugal Program, PhD Program in Technological Change and Entrepreneurship and the Portuguese Presidency of the European Union, as in* http://www.mctes.pt/lisbonworkshops .

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Making Europe "the most competitive and dynamic knowledge-driven economy by 2010" was the goal set in 2000 when Portugal last led the European Union (EU) in what became known as the "Lisbon Strategy". With three years to reach the target date, some progress has been reported, but Europe is still far from fulfilling this vision. A critical question is thus what policies can help Europe enters the path to the desired vision.

A recent workshop held recently within the scope of the Portuguese Presidency of the EU and the Carnegie Mellon-Portugal Program offers some insights into this important issue. The workshop brought to Portugal some of the leading international scholars in the areas of entrepreneurship and technological change from the U.S.A. and Europe to debate the role of science and education policies in the promotion of High Tech Entrepreneurship in both sides of the Atlantic. While the reality and history of Europe and the US are quite different, making a comparison across the two regions a difficult exercise with important limitations, a few dimensions with a broad applicability did emerge from the discussion. These are shared in this document.

Taking a long term perspective

When reflecting on the challenge of fulfilling the vision of the "Lisbon Strategy", an important aspect to consider is that the difficulty of Europe to ground its competitiveness in the exploitation of advanced knowledge is not new. If one looks at the top 50 firms in the world with the largest stock market valuation (see table), only 15 firm are based on the EU, against 25 in the U.S.A. and 10 in the rest of the world. Perhaps more important is the fact that old firms dominate the list of the largest EU firms, with Vodafone the only one of top 25 European leaders established after 1927. In the last 57 years, the EU has not been able to generate a new company that reached a top position in the world economic order.

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Global firms with the largest stock market valuation*

Top 25 –European Union			Top 25 – USA		
Rank	**Firm**	**Founded**	**Rank**	**Firm**	**Founded**
7	BP	1901	1	ExxonMobil	1870
12	GlaxoSmithKline	1873	2	General Electric	1890
15	Total	1924	3	**Microsoft**	**1975**
17	**Vodafone**	**1950**	4	AT&T	1885
21	EDF	1884	5	**Wal-Mart Stores**	**1962**
23	ENI	1926	6	Procter & Gamble	1837
25	Sanofi-aventis	1924	9	Johnson & Johnson	1886
31	Telefónica	1924	10	Pfizer	1849
34	Siemens	1871	11	Altria Group	1847
36	Nokia	1896	13	**Cisco Systems**	**1984**
37	E.ON	1929	16	Chevron	1870
38	AstraZeneca	1926	19	IBM	1911
41	Rio Tinto	1905	20	**Google**	**1998**
44	Unilever	1874	26	**Intel**	**1968**
45	Deutsche Telekom	1871	27	Verizon	1885
53	Schlumberger	1927	28	Coca-Cola	1886
58	France Telecom	<1900	29	ConocoPhillips	1870
59	Arcelor Mittal	1882	30	Hewlett-Packard	1939
60	Anglo American	1917	32	PepsiCo	1898
64	DaimlerChrysler	1890	33	Merck & Co	1891
66	Tesco	1924	39	**Oracle**	**1977**
70	L'Oréal Group	1909	40	Abbott Labs	1888
72	ENEL	<1900	42	**Home Depot**	**1978**
73	B.A. Tobacco	1902	43	**Comcast**	**1963**
74	Suez Group	1858	46	Time Warner	1903

*source: Forbes *Global 2000 firms* e Hoovers; rank is the relative position in market capitalization; Date of founding associated with the first company who is in the origin of the current unit

In the U.S.A., by contrast, eight of top 25 firms by market valuation have been created since 1950, with five after 1975. Microsoft, Intel, Oracle, Cisco and Google are superior entrepreneurial firms that have been the protagonists of a succession of technological revolutions in the area of information technologies. The one company in the EU with such a distinction, SAP, was created in 1972 and is number 78 in the ranking presented in the table.

Given the strong difference between the two realities, it appears to be of paramount importance for Europe to understand the origin of great firms and technologically dynamic regions composed of such firms, like Silicon Valley in the USA. A critical analysis of the long term processes behind the emergence of these strong entrepreneurial firms and regions was precisely at the core of the discussion in the workshop.

A network of universities and scientific excellence

The first clear conclusion that emerged from the workshop is the critical need for a strong investment in new knowledge and the generation of talent, from which opportunities for innovation and entrepreneurship emerge. This perspective, supported by several studies (see Audretsch 2006; Audretsch and Feldman,1996; Hounshell & Smith 1988; Hounshell 1996; Oliveira et al. 1998), is consistent with some dimensions of the "Lisbon Strategy," including the emblematic objective of having the member states invest 3% of their GDP in R&D. In fact, the examples of leading firms noted above are consistent with this perspective. Google emerged from a research project by two Ph.D. students at Stanford University; Oracle and Cisco involve the commercial exploitation of research projects, the first also developed within Stanford and the second developed inside IBM. Many other examples in the US could be presented.

But the importance of generating strong talent and human capital is broader. For example, the emergence of Ireland and, especially, Israel as important software exporters owes a great deal to the development of human capital (Arora and Gambardella 2005). Israel has long invested in research and developed a genuine comparative advantage in technology intensive sectors such as medical devices, computer hardware, and software. In fact, nearly 32% of the adult Jewish Israeli population has tertiary education, and 9% have graduate degrees (Arora and Gambardella 2005). This comparative advantage is based on a growth in human capital, particularly in science and engineering. Between 1979 and 1999, the number of engineering students in Israel nearly doubled from about 7,000 to about 14,000. During the same time, the number in mathematics and natural sciences nearly trebled, from about 6,500 to about 17,000. A similar path was pursued in Ireland. Since 1968, the number of students at the tertiary level increased more than four fold so that, by 2001, Ireland had the third highest fraction of the working population with a tertiary education, behind only the United States and Canada (Arora and Gambardella 2005).Moreover, in 2000, 30% of Irish graduates had a science or technology degree, compared to the OECD average of 21%. This rapid expansion in the supply of human capital played a major role in the rise of Ireland as a software exporter. Not only were MNCs, that account for the bulk of these exports, attracted by it, the indigenous Irish software companies are largely founded by graduates from the science and engineering programs from the top universities. With a similar story for the Indian success in software, the lesson from the 3Is is clear – investing in human capital is key.

But a critical element needs to be considered when investing in the generation of talent and new knowledge, especially when learning from the US examples: the distribution of such talent. Analyses of successful cases of technological innovation, firm creation and growth, and wider industrial development suggest that the birth of firms with potential for real economic impact is not uniformly distributed across places with scientific and technological expertise (Audretsch 2006; Audretsch and Feldman, 1996). Instead, it requires concentration of scientific excellence, in particular a system of high quality universities that compete in attracting and nurturing exceptionally talented individuals. In the U.S.A., despite the large number of research universities, a select number of institutions across the nation, including Stanford, MIT, Columbia, Carnegie Mellon, among others dominate the attraction of talent at the global level, the mobilization of private and public R&D funds, and the generation of new companies and transfer of

technology to the private sector (Shane, 2004; Mowery et al., 2004). Again if we look at some of the extreme examples of the IT industry presented in the table above, we find that Google and Cisco come directly from research done at Stanford, and Robert Noyce as well as Gordon Moore, the founders of Intel received their PhDs from MIT and Berkeley respectively. Even Bill Gates, although he was a university drop-out, abandoned no other than Harvard.

High impact entrepreneurship

A second perspective presented by the participants in the workshop is that the successful cases of creation and reconfiguration of industries in the US has most often happened, not through established companies, valuable as they are to the economy, but through a particular breed of spinoffs from these established companies (Klepper and Sleeper, 2005) and new startups, frequently created from ideas generated in elite universities such as those noted above (Shane, 2004; Mowery et al., 2004). Established firms and their R&D are very important for the economies because they are a source of new ideas and an important magnet for talent that is by nature somewhat risk averse (Hounshell and Smith 1988). Yet, these firms most often fail to recognize or support innovative ideas that are far from their core business (Klepper 2007). As a result, some of these R&D employees leave to commercialize the idea; or sometimes the ideas are appropriated and explored by others. This is certainly the case of Oracle and the relational databases, which were developed by Edgar Codd, a researcher with IBM, and then initially commercialized by Oracle, which got the inspiration from the IBM work. These firms with the potential to generate real economic value are a select few high growth firms. These are companies which, since their founding, demonstrate strong leadership, attract outstanding talent, develop unique capabilities and commit to research and product and process development (Klepper 1996; 2001; 2002; Klepper and Sleeper, 2005)

In the case of spinoffs, for example much of the growth of Silicon Valley can be explained by the birth of firms tracing their "ancestry" to "defectors" from Fairchild Semiconductor—the so-called "Fairchildren," or firms that ran with ideas that Fairchild's employees wanted to see introduced to the market but which in one way or another were resisted by Fairchild's top-level managers (Holbrook et al., 2000). The political, social, and economic environment of the region was such that defection and new firm-founding were seen as a positive good for the region and society as a whole, thus breeding a culture of risk-taking and entrepreneurship. In the case of "startup" firms, university professors who are usually among the top publishers in their fields are key actors in inventing new technologies and then taking these inventions to the marketplace through the start-up process, which often involves financial support from venture capitalists (Lowe and Brambila, 2007).

The spinoff phenomenon is widespread throughout numerous industries in Silicon Valley, including lasers and disk drives. Similar to Silicon Valley, spinoffs have been distinctively successful in both industries, with the leaders of the industry disproportionately drawn from spinoff entrants. Invariably, the leading spinoffs were formed to pursue innovative ideas that their parents resisted (Klepper, 2007). It turns

out that the spinoff phenomenon and its influence on the formation of regional industry clusters in the US actually dates back at least as far as the beginning of the twentieth century. Two of the most extreme clusters without an obvious geographic rationale in the history of the US, autos in Detroit and tires in Akron, Ohio, were driven by spinoffs (Buenstorf and Klepper 2005; Klepper 2002; 2007; Klepper and Simons, 2000). In both industries, a few early successful entrants were located in Detroit and Akron, with one firm in each area most responsible for this early cluster. Subsequently, both Detroit and Akron were characterized by much higher spinoff entry than in other regions, and their spinoffs were exceptional performers relative to other entrants. They pushed the industry's technology forward and were critical in the vibrant clusters that developed in Detroit and Akron.

Although both spinoffs and startups often fail, the entrepreneurs who found them continue to generate ideas and publications and then start the process all over again., In both types of new firms, there is an on-going flow of information and ideas among firms and universities in the region, further strengthening the culture of entrepreneurship and technological innovation This culture of entrepreneurship could not exist without public policies that encourage established technology-based corporations to invest in R&D, which leads to spillovers, and strong intellectual property regimes while at the same time not constraining too rigidly the process of employee defections. Access to capital is also critical to the entrepreneurs who found both spinoffs and startups. Risk taking and willingness to fail must also been seen as socially beneficial to the larger process of economic growth.

Perspectives on the European Union

Given the perspectives highlighted above, the European context has several important characteristics that may limit the potential to unleash the creative force of high-tech entrepreneurship as experienced in the US. Major European universities are typically public institutions, with a relatively homogenous level of research preeminence and not of as consistently high quality when compared to their U.S. peers. This is the result of public incentives that have mostly promoted equity among institutions, as opposed to fostering the creation of concentrations of excellence that compete in the generation of talent and advanced knowledge.

Another important aspect is that the main policy instruments supporting R&D in the context of the EU are projects divided between countries and innumerable participants and controlled by old European industrial giants. These old giants are by default project leaders and owners of the intellectual property. Established firms in the EU that have consistently funded large R&D programs have long maintained both intellectual property management regimes and research personnel management practices that often can tend to discourage extensive intrafirm networking and team-building and limited the flow of research talent and ideas back and forth between corporations and universities (Hounshell, 1996).. Such long-standing practices have, when compared to the U.S. case, acted as a brake on research-based entrepreneurial activity such as spin-offs and start-ups. The result is a process that limits entrepreneurship and leads to stagnation in the context of the enterprise system, as noted above.

These observations lead to potential implications when considering the establishment of European policies. Overall, it suggests that the process needs to be loosened up such that universities and their faculties are encouraged to pursue excellence in strategically important areas of knowledge production; similarly, policies need to be implemented that will allow scientific and technical talent to leave established firms and to found new firms willing to run risks in the implementation of new technological products and processes.

A first aspect is to consider that, as important as aiming towards increasing the average level of investment in R&D, it is critical promote apply resources so that they promote concentrations of excellence. In particular, it is critical to have a system of universities that distinguish themselves through their ability to generate unique talent and knowledge. This has to be achieved assuring that universities have to compete for talent, for students and for resources. This may require mobility of faculty, changing laws so that faculty are no longer civil servants, the creation of a cultures that frown on in-breeding and secretiveness, among others. A step in this direction could be the creation of the *European Research Council*. For the first time, the EU is expected to have an institution that will command and manage significant resources as a function of the quality of the proposals from any institution across the EU. Thus, it is critical to make sure that this Council is indeed an instrument of university excellence by providing it with meaningful financial support and a system of merit that cuts across national boundaries.

A second aspect is to find ways to reduce the market entry barriers for new technology-based firms. For example, it would be important to assure that these small players have more access and can control the intellectual property in European R&D projects. Likewise, it would be important to abolish non-compete covenant clauses, insuring that employees of large established firms can easily leave and create start-ups that compete with their previous employer. Restrictions also need to be imposed on the ability of incumbent firms to claim otherwise unprotected intellectual property as a trade secret, which can be used to block employees from founding their own firms. It is also important to limit employee claims on failed new firms to foster risk taking.

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Workshop High Tech Entrepreneurship:

Implications for Science Policy and Education

Thursday July 5, 2007.

Registration: 16:00

Session 1: 16:30-19:30

Chair and Introduction: Manuel Heitor, MCTES, PT

- '*Entreprenomics*', A. Roy Thurik, Erasmus Univ. Rotterdam, NL
- '*What Do We Know about Entry and Entrants in Innovative New Industries?*' Steven Klepper, Carnegie Mellon University, USA
- '*Longitudinal Studies of Entrepreneurs and Firms*', Rui Baptista, Instituto Superior Técnico, PT

Initial Discussion by:

- Paulo Rosado, Outsystems, PT
- José Mata, Fac. Economia, Universidade Nova de Lisboa, PT
- António Gomes Mota, ISCTE

Reception and Visit to the Portuguese Communication Museum: 19:30

Friday, July 6, 2007.

Session 2: 9:00-10:45

Chair: David Audretsch, Max Planck Institute of Economics e Indiana University

- '*Why Do Small Firms Produce the Entrepreneurs*' Simon Parker, University of Durham, UK
- '*From Underdogs to Tigers? The rise of the software industry in emerging economies*', Ashish Arora, Carnegie Mellon University, USA

Initial Discussion by:

- Joaquim Paiva Chaves, A.P. Business Angels PT
- Carlos Noeme, Inst, Superior Agronomia, UTL, PT

Coffee Break: 10:45-11:15

Session 3: 11:15-13:00

Chair: Ashish Arora, Carnegie Mellon University, USA

- *'The Predictive Strength of Absorptive Capacity on New Firm Performance'* Frédéric Delmar, EM Lyon, FR
- '*Entrepreneurs and Managers: Dynamic Actions and Interactions in the US*', David Hounshell, Carnegie Mellon University, USA

Initial Discussion by:

- Nuno Carvalhosa, Portugal Telecom, CMU-Portugal Porgram
- José Manuel Mendonça, Fac. Eng, Univ. Porto e INESC, PT
- Teresa Mendes, IPN, Universidade de Coimbra, PT

Lunch: 13:00-15:00

Session 4: 15:00-17:00

Chair: Steven Klepper, Carnegie Mellon University, USA

- '*The Knowledge Spillover Theory of Entrepreneurship*', David Audretsch, Max Planck Institute of Economics and Indiana University

Final Discussion of the Workshop led by:

- Francisco Veloso, Carnegie Mellon University, USA
- Pedro Oliveira, Universidade Católica Portuguesa, PT
- Isabel Grilo, European Commission

Closing: Manuel Heitor, MCTES, PT