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The "Knowledge for Growth" Expert Group advises the Commissioner for Science and Research, Janez Potočnik, on the economic implications of research and innovation. In addition to providing Policy Briefs, the Group also puts forward issues for a more wide-ranging debate. The report on which the paper is based can be downloaded at:
http://ec.europa.eu/invest-in-research/monitoring/knowledge_en.htm

Corporate R&D returns

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Europe as a whole spends a smaller fraction of GDP on R&D than the US and Japan. The Lisbon strategy calls for increased R&D spending in Europe. This policy debate explores the possible areas and causes of underinvestment. Is there too little public spending or business spending? Should large firms or SMEs be encouraged to do more or does the problem lie in the sectoral composition of European industry?

1. Why does European R&D intensity appear low?

In March 2000, the European Council in Lisbon set out a ten-year strategy to make the EU the world's most dynamic and competitive economy.[3] One of the main priority areas in the Lisbon strategy or Lisbon agenda (as it is sometimes known) is to increase investments in knowledge, research, and education, both by governments and by enterprises. Achieving this goal has been widely interpreted as calling for increased R&D spending in Europe, in order to attain a target in the neighborhood of 3 % of GDP overall.

To make progress in moving toward this goal some questions need to be answered: In what areas does Europe have an R&D deficit? Why is this the case? Government policies, low expected returns, or high costs of capital?

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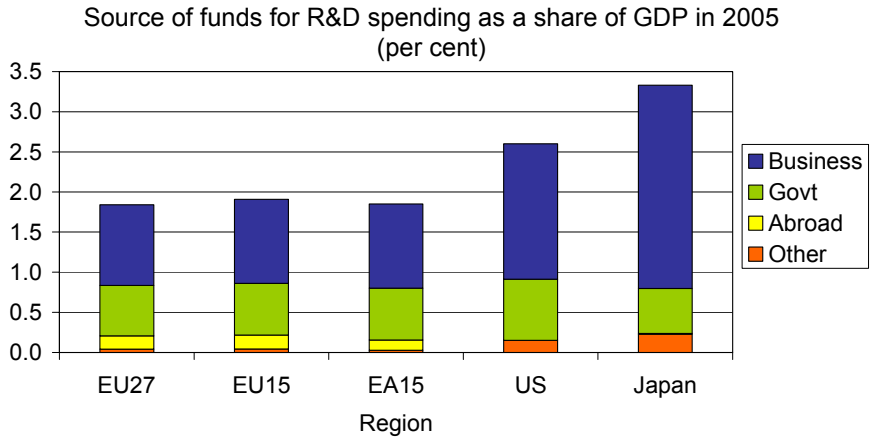
[3] http://europa.eu.int/comm/lisbon_strategy/index_en.html

This "debate" considers these questions, provides some answers based on available evidence, and suggests areas where our knowledge is incomplete.

2. The gap is larger in business R&D

From Figure 1, which shows the composition of the R&D/GDP ratio in 2005 for three major EU regions (the 27 member countries, the 15 pre-accession member countries, and the 15 countries in the euro zone) along with the US and Japan, we can draw two conclusions: first, the 3% target lies somewhere between the performance of the US and Japan, and second, the shortfall is particularly striking for business R&D.

Figure 1



However, some would argue that because the share of the economy in the public sector is larger in Europe than in countries such as the US and Japan, the government share of R&D spending should also be higher, suggesting that the shortfall is not only in business-funded R&D but also in public sector support of R&D. But the differences across the three regions seem rather small to account for the differences in the composition of R&D expenditure across region: according to the Heston-Summers data, the share of government in GDP is 17% in the EU, 16% in Japan, and 11% in the US.[4] Of course, the composition of government spending in the three regions also varies considerably, making precise comparisons difficult.

Mention should be made of another increasingly important phenomenon and its implications for Figure 1, the internationalisation of R&D performance. The data for the US and Japan in Figure 1 uses R&D sourced by business but performed within the relevant national borders. That is, US firm R&D conducted in Europe is counted as European R&D. Using some statistics on the top 1000 R&D performers worldwide available from a recent report by Booz & Co., it is possible to form an impression of the size of the discrepancy for the US and Japan (that for Europe is small, around 2% of total

[4] See Heston, A., R. Summers and B. Aten, *Penn World Table Version 6.2*, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006.

spending).[5] In 2008, adding in R&D performed by US firms outside the US and subtracting R&D performed by non-US firms in the US would increase US business R&D intensity from 1.65 to 2.2%. For Japan, the corresponding figures are 2.5 to over 4%. Note that these estimates are based only on the largest firms so that they are probably an overestimate, but the fact remains that correcting for this problem only increases the EU gap.

The larger question is whether increasing R&D spending in Europe to US and Japanese levels is the appropriate target for policy to improve European innovative performance. Although this brief does not take a position on this question, it deepens understanding of the reasons for the business R&D "deficit", in order to inform us about the innovative process in which R&D does play a large part.

3. Looking inside the business R&D gap

In an earlier paper written for this group, O'Sullivan reviewed the evidence on the source of an R&D deficit at the EU level and concluded that the differing importance of the Information and Communication Technology (ICT) sector was responsible for the bulk of this deficit between the EU and the US. There was also evidence that this sector accounted for differences in the share of young fast-growing firms between the two economies. Here we look at the top-1000 R&D-doing firms in the EU and compare them with those outside the EU.[6] We note that this comparison is different from that shown in Figure 1, as it focuses on R&D classified by the location of the firm's headquarters, rather than by where it is performed.

Figure 2 shows the composition and R&D intensities of the two groups of firms, EU and non-EU.[7] The conclusions that emerge from this figure confirm the analysis in the earlier paper.
1) Among top-1000 R&D-doing firms, there are fewer ICT firms and more service firms in the EU in comparison with the rest of the world.
2) In the EU, the R&D intensity of the typical firm is also lower in ICT firms and much lower in service sector R&D-doing firms than in the rest of the world. When one examines the composition of these two broad sectors in terms of industry and individual firms, one can see that this is due to differences in firm strategy within particular sectors, with firms outside the EU being more high technology-oriented. For example, several of the US service sector firms provide electronic services to financial service firms (Fiserv, Convergys, Automatic Data Processing).

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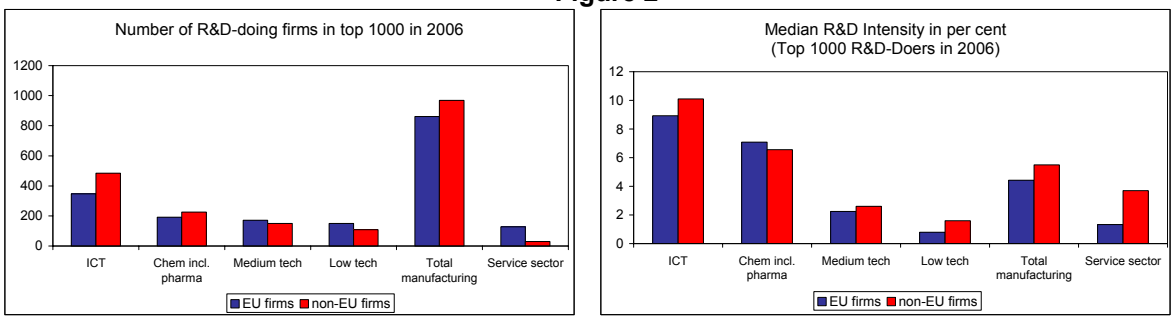
[5] See Jaruzelski, B., and K. Dehoff, "Beyond Borders: The Global Innovation 1000," *strategy+business magazine* issue 53: 53-67, Booz & Co., 2009.
[6] European Commission (2008). *EU R&D Investment Scoreboard.* Luxembourg, Office for Official Publications of the European Communities.
[7] In making these figures, we reclassified a few internet or technology-intensive firms such as WebMD, Expedia, Tivo, etc. into the ICT sector from the Service sector.

Figure 2



Overall, the median R&D intensities of these two groups of large firms are 5.4% outside the EU versus 3.7% in the EU.

Conventional wisdom in this area also says that Europe does not have enough small and medium-sized firms that perform R&D. Although this might be true, it does not account for the measured R&D deficit. A comparison of the R&D-weighted size distribution with that of US and the Japan shows that firms with fewer than 250 employees account for 19% of R&D in the EU15, 14% in the US, and 8% in Japan.[8] This fact suggests that it would be worthwhile to focus a more careful analysis on the size issue – is this result real or a consequence of faulty measurement? If it is real, why is there a perception that European SMEs do too little R&D?

4. Private R&D returns are slightly lower than in the US

If business R&D spending is indeed "too low" in Europe, simple economic analysis tells us that this might be for two reasons, both of which can occur together: supply of funds problems (too high a cost of capital) and/or R&D demand shortfalls (firms do not find opportunities that are profitable enough, or they find the cost of R&D inputs too high). From the perspective of policy, one needs to measure the marginal returns to R&D to decide which problem deserves the most attention. That is, if the rate of return to R&D among European firms is found to be high, that suggests that the cost of capital they face is high and requires that attention be paid to the functioning of financial markets. If the rate of return to R&D is found to be low, then our attention is directed to a number of other areas that influence the opportunities for R&D investment - the size of the market, entrepreneurship, regulation, the role of standards, the cost and availability of R&D labor, the presence of lead markets, and so forth.

There does exist considerable evidence on the rates of return to R&D for firms in individual countries. We have collected these estimates on a single chart shown in Figure 3. This figure shows cross-sectional estimates for the private gross rate of return to R&D capital from a number of European countries (France, Germany, Italy, Denmark, and the UK) along with the US for comparison. The samples of firms used are generally the largest R&D-

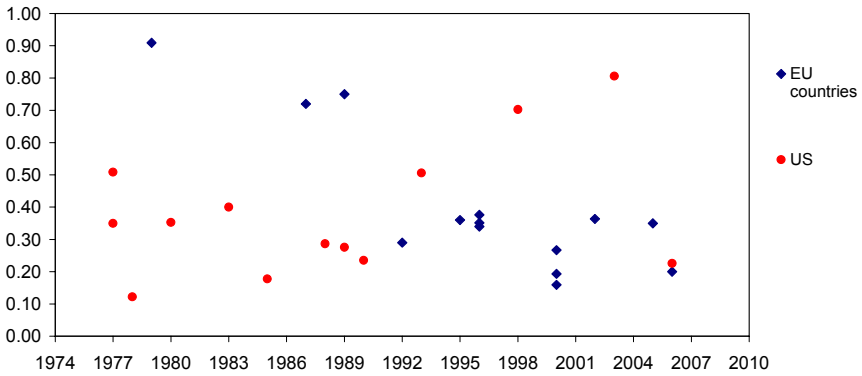
[8] OECD (2008). *OECD Science, Technology and Industry Scoreboard* 2007. Paris, France. Relative to GDP, these figures are roughly 0.2%, 0.23%, and 0.2% for the EU, US, and Japan respectively.

doers. Although there is considerable dispersion in the estimates, the majority cluster around 0.15 to 0.35.[9] The figure shows that the return to R&D in large EU firms have been generally below those for US firms in the period since the mid-1990s, ruling out the high cost of capital explanation for firms that already do R&D.[10] Also note that the data points for 2006 are estimates using data from the EU and US top 1000 firms, and it is striking that the estimates for these samples, which are based on similar methodologies, are so close.

The conclusion of this analysis is that for the large firms that do R&D, rates of return are not obviously different between the EU and US. Any underperformance must lie elsewhere. Evidence from Cohen and Lorenzi (2000) suggests that one difference between the EU and the US is the number of young firms among the large R&D-doers in the latter region.[11] That is, among the top 200 R&D-doing firms in the US, accounting for 80% of business R&D, almost half are 20 years old or younger and started quite small.

Figure 3

Cross-sectional estimates of the private firm-level rate of return to R&D



5. The debate

When taken together with the previous work on these questions by O'Sullivan, the preceding analysis reaches the following conclusions:

1) There are fewer ICT firms in Europe, and ICT is very R&D-intensive, which explains a large share of the differences in business-funded R&D shares.

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[9] One reason for the high variability is that the methodologies used to obtain the estimates are not always identical; a second reason is that *ex post* rates of return to R&D are estimated imprecisely and may vary greatly over time, reflecting the uncertainty inherent in innovative activity.

[10] ICT firms generally exhibit higher (gross) rates of return due to the rapid depreciation of R&D investment in that sector. Therefore we would expect the average rate of return to be somewhat lower in the EU than in the US, reflecting the lower ICT share of the R&D-performing sector.

[11] Cohen, E., and J.-H. Lorenzi (2000), *Politiques industrielles pour l'Europe*, rapport du CAE, no. 26, La Documentation française.

2) Even among non-ICT firms, there are fewer innovators applying new ICT technologies to other sectors, and those there are do not grow large.

3) Related to point (2), there are fewer young European firms among the large R&D-doers.

4) It is possible that the R&D deficit is not solely due to business-funded R&D.

Nevertheless, the following appear to be true and rule out simple explanations:

1) According to sources from corporate statistics average returns to R&D are not obviously higher (or lower) than in the US for those firms that do R&D.

2) Roughly the same amount of R&D is conducted by SMEs in Europe as in the US or Japan.

Therefore, it is natural to ask whether the problem is with R&D *per se.* Or should one look elsewhere for the explanation of what appears to be weaker innovative performance, perhaps at differences in labor or entry regulation, or at the failure to create a Venture Capital sector that is capable of financing fast-growing firms, or at some other cause?

R&D spending as investment

R&D spending is both similar to and different from ordinary investment. The similarity is that it is expenditure undertaken today to secure (uncertain) returns in the future, which is why it is referred to as "R&D investment" and why analysis of the R&D decision frequently uses the tools of investment analysis. The differences lie in the level of uncertainty, which is much larger, the public good nature of much research (it is useful to other firms as well as to the firm that performs it, and the fact that once done, the information produced can be used at almost any scale).

A second difference between R&D and ordinary investment creates some difficulties for analysis and interpretation: in the case of R&D, there is no well-developed secondhand market that would allow us to infer the price of R&D separately from its quantity, and to establish an independent measure of depreciation. Therefore R&D spending is usually deflated by the overall GDP deflator, and no account is taken of increases or decreases in its productivity in creating a stock of firm-based knowledge. This is why the analysis of the supply and demand for R&D is in terms of nominal rather than real quantities.