

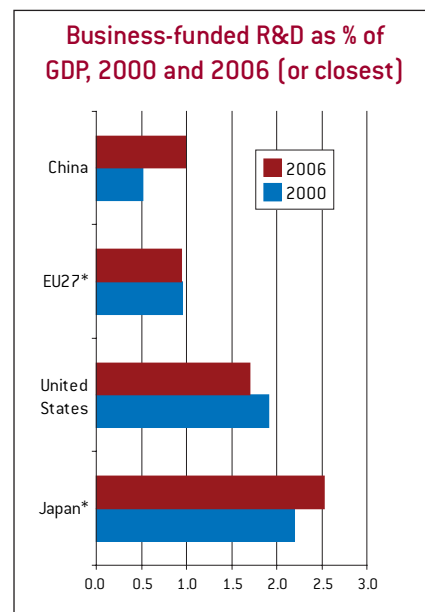
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EUROPE'S R&D: MISSING THE WRONG TARGETS?

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SUMMARY Europe is not delivering on its Lisbon agenda commitment to increase its R&D-to-GDP ratio to three percent by 2010. This is worrying, not only because Europe seems unable to reach an objective it has publicly set itself, but mainly because in 2006 its R&D intensity was still below two percent, having flatlined for more than two decades. As far as business-funded R&D is concerned, the Chinese business sector has even outperformed European firms. The Lisbon-inspired national R&D targets are equally overambitious. The European Commission's benchmarking of member states against the headline three percent figure is questionable because such comparisons rarely take into account the effect of industrial specialisation. For most countries, R&D intensity is a by-product of specialisation. However, Swedish and US R&D intensity is higher than their industrial structure would suggest, implying that other factors are at work, such as a large integrated technology market and a superior academic research environment.



Source: OECD MSTI, 2007. Industry-financed GERD as a % of GDP; * indicates the year 2005 instead of 2006.

POLICY CHALLENGE

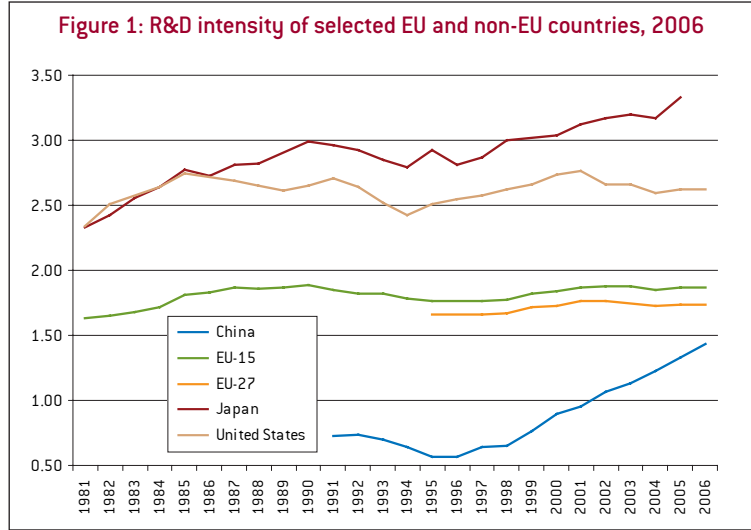
At EU level, the aggregate government sector should first correct its own failure and support research activities up to a threshold of one percent of GDP. Setting targets for private R&D is ineffective. The drivers of private R&D call for a more integrated European market for technology, notably an EU patent in lieu of the current system, which involves prohibitive costs. Also, more funding is needed for academic research, as a magnet for local and foreign business R&D activity in Europe.



ONE OF THE MAIN GOALS of the EU's Lisbon agenda is to achieve a higher level of research and development (R&D) spending. Two sub-targets for R&D spending were clearly defined in 2002: EU R&D intensity (R&D expenditure divided by GDP) was to increase from about 1.8 percent in the late 1990s to about three percent by 2010; and two-thirds of this spending was to be funded by the business sector, the rest being funded by governments.

As illustrated in Figure 1, R&D intensity in the EU has been stable since the early 1980s, fluctuating between 1.6 percent and 1.8 percent. In 2006, R&D intensity in the EU was still under 1.8 percent. The relative spend on research activities in the US has also been stable, but on average above 2.5 percent. Japan exhibits an impressive performance, with a constantly increasing R&D intensity that has remained well above three percent since the early 2000s. Figure 1 also illustrates the dramatic increase in China's total R&D expenditure relative to GDP, from about 0.5 percent 10 years ago to 1.5 percent in 2006. Bottom line: the EU is not really catching up with the US or Japan in terms of research spend, while China is catching up with the EU.

The objective of this Policy Brief is to provide a critical assessment of the R&D component of the Lisbon agenda. Section one underlines the considerable gap between the current levels of R&D intensity and the national objectives that were announced as part of the relaunch of the Lisbon agenda. This section also illustrates governments' sluggish, and in certain cases



Source: OECD, MSTI, 2007. The figures are gross expenditures on R&D as a percentage of GDP. The 2006 figures for the EU have been extrapolated from Eurostat figures. OECD sources are used because they provide comparable figures for China, Japan and the US.

counter-intuitive, behaviour with regard to their own self-set agenda. In section two we explain why common R&D targets make little economic sense in an EU where industrial specialisation differs substantially across countries. Failing to account for national industrial structures may actually lead to skewed country benchmarks. Section three investigates what can be done to improve the expected return to R&D in Europe, and hence the propensity to invest in R&D. It sets out two broad policy recommendations which would improve Europe's R&D prospects.

1. DELIVERY FAILURE

The intensity of R&D spending across EU member states varies considerably. Figure 2 shows that some countries have reached relatively high levels, especially Finland and Sweden, which several years ago leapfrogged the three

percent threshold. Sweden's performance lies close to four percent. Denmark, Austria and Germany are around the 2.5 percent threshold, whereas France is just above two percent. However, the vast majority of countries has an R&D intensity of well below two percent, fluctuating between 0.5 percent and two percent of GDP, with a median of 1.2 percent. This broad range of intensities is also observed within the US, but with a median R&D intensity that is much higher than in Europe, as illustrated in Table 1. The best European performer, Sweden, has an R&D intensity which is less than half that of the top US performer, New Mexico¹. Seven US states have an R&D intensity higher than four percent, against none for the EU.

Trends in the R&D-to-GDP ratio provide an interesting insight into how active countries have been in

¹ New Mexico is a relatively small state, which has a remarkably high level of R&D intensity. This is largely attributable to federal support to federally funded R&D centres (FFRDCs) provided by the US Department of Energy.

'Europe's R&D effort has been flatlining for two decades.'



	EU27, 2006	US, 2004
Maximum	Sweden 3.8%	New Mexico 8.0%
Minimum	Cyprus (0.42%) Romania (0.46%)	Wyoming (0.40%) South Dakota (0.50%)
Median across states	1.2%	1.9%
Average across states	1.4%	2.2%
90th percentile	2.5%	4.3%

Source: Bruegel based on Eurostat, US National Science Foundation, Division of Science Resources Statistics, National Patterns of R&D Resources (annual series), Science and Engineering Indicators 2007. The full state-level data is presented in Figure 2.

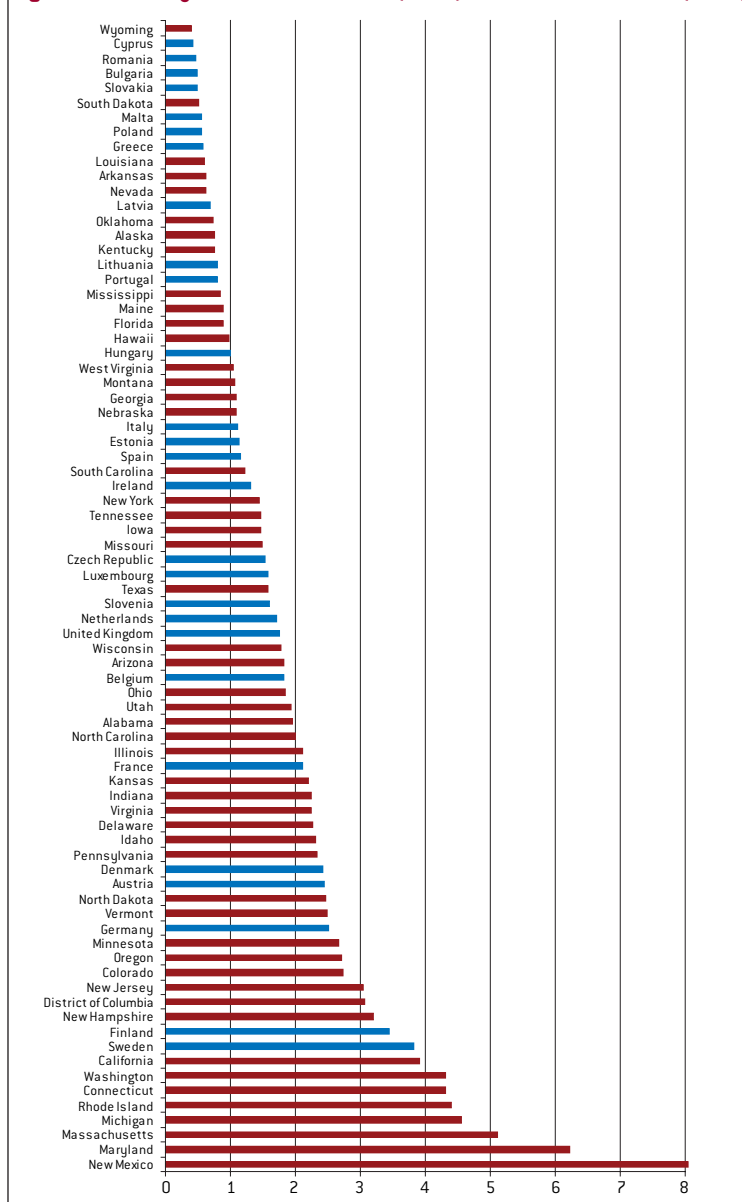
seeking to improve their relative performance. From 1996 to 2006 the median R&D intensity in Europe increased only slightly. In absolute terms, the most dynamic countries have been Finland (+1.2 percent), Austria (+0.9 percent), Denmark (+0.6 percent) and Sweden (+0.5 percent). These four countries already had a very high level of R&D intensity in 1995, and have made the most marked improvement over the subsequent decade. It is worth mentioning that three countries have seen a drop in their levels of R&D intensity: France (-0.1 percent), the United Kingdom (-0.2 percent), and the Netherlands (-0.2 percent). Their levels of R&D expenditure play an important part in aggregate EU R&D intensity. As illustrated in Table 2 (overleaf), this drop may be explained in part by a drop in government-funded R&D observed in the three countries, which has not been offset by an increase in business R&D expenditure. Table 2 presents government-financed and industry-financed R&D as a percentage of GDP, in 1995 and 2006. Three main observations can be made about these figures:

- First, none of the EU member states has fulfilled its self-set commitment, as no country

actually devotes one percent of its GDP to funding public (higher education, laboratories) or business-channelled (subsidies and procurement) research activities. The only countries that are close to the one percent target are Sweden, Austria and Finland.

- Second, despite the Lisbon agenda, a large number of countries have actually

Fig 2. R&D intensity of US federated states (2004), and EU member states (2006)



Source: Bruegel based on Eurostat, National Science Foundation, Division of Science Resources Statistics, National Patterns of R&D Resources (annual series), Science and Engineering Indicators 2007



reduced their government funding of R&D as a percentage of GDP. The aggregate EU27 government-funded R&D intensity fell between the mid 1990s and 2005. Interestingly, a drop also occurred in the US and Japan over the same period, but it was largely compensated for by a more than proportional increase in business-funded R&D, which was not the case for EU27.

- Third, the Chinese business-funded R&D intensity is at the same level, in fact a little higher, than that of Europe, bearing

witness to the dramatic increase in private R&D activity in China.

In addition to this counter-intuitive behaviour whereby the 'average' EU government has actually reduced its support to R&D activity over the past ten years, the spending targets which individual countries have chosen to set themselves were overly ambitious. Indeed, Figure 3 illustrates a clear positive relationship between a country's distance from the three percent target in 2004 and the target it has set itself for 2010. The

further away from the Lisbon target a country was, the bigger the increase projected in the national programme implementing the Lisbon agenda. Although this could be seen as expressing political will to catch up with the best performers, many of the targets set are clearly unrealistic. They appear to represent wishful thinking rather than political momentum. The right-hand side of Figure 3 shows that some countries have set 2010 targets that are between two and four times higher than their level of R&D intensity in 2004.

2. SKEWED COUNTRY BENCHMARKING

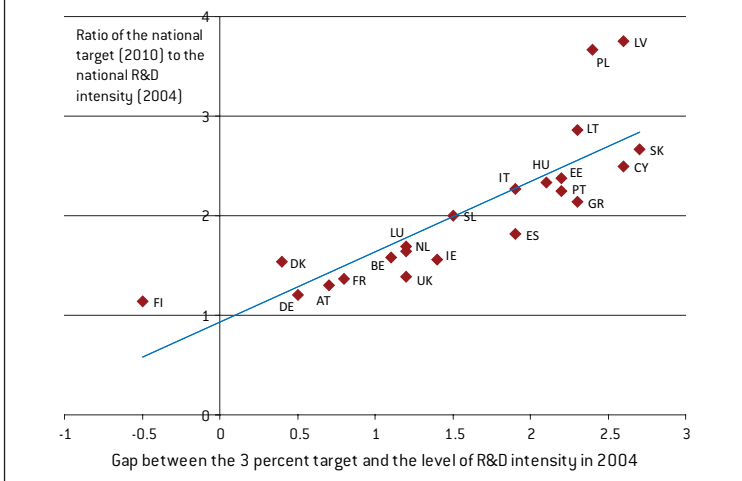
In addition to the relative government spend on research activities, a second issue that must be examined when evaluating countries' R&D performance is industrial specialisation. A country specialised in finance (eg Luxembourg) would not need a high level of R&D expenditure in order to ensure growth – at least as commonly measured [the innovative efforts that are required to introduce new financial products are not included in R&D statistics]. Similarly, a country specialised in tourism, fashion, services or food would logically have lower R&D intensity than a country specialised in the pharmaceuticals, engineering or biotech industries. Interpretations drawn from Figure 2 and Figure 3 are therefore to be treated with a substantial degree of caution. For instance, Finland has a reputation for specialisation in information and communication technologies, an industry which is very intensive in R&D. Taking into account this specialisation, the Finnish R&D

	Industry-funded GERD			Government-funded GERD		
	2006	1995	Difference	2006	1995	Difference
Sweden	2.55	2.17	0.38	0.91	0.96	-0.05
Finland	2.30	1.35	0.95	0.87	0.79	0.08
Germany	1.68	1.31	0.37	0.70	0.83	-0.13
Denmark	1.46	0.82	0.64	0.67	0.72	-0.05
Luxembourg	1.28	na	na	0.27	na	na
Austria	1.14	0.70	0.44	0.90	0.72	0.18
France	1.12	1.10	0.02	0.82	0.96	-0.14
Belgium	1.11	1.12	-0.01	0.46	0.39	0.07
Netherlands	0.90	0.90	0.00	0.64	0.83	-0.19
Czech Republic	0.88	0.60	0.28	0.60	0.31	0.29
Slovenia	0.82	0.72	0.10	0.56	0.64	-0.08
Ireland	0.79	0.85	-0.06	0.40	0.28	0.12
United Kingdom	0.75	0.94	-0.19	0.58	0.64	-0.06
Spain	0.52	0.35	0.17	0.48	0.35	0.13
Italy	0.43	0.41	0.02	0.56	0.52	0.04
Hungary	0.43	0.27	0.16	0.45	0.38	0.07
Portugal	0.29	0.11	0.18	0.45	0.35	0.10
Poland	0.18	0.23	-0.05	0.32	0.38	-0.06
Slovak Republic	0.17	0.55	-0.38	0.27	0.35	-0.08
Greece	0.16	0.10	0.06	0.24	0.20	0.04
Romania	0.14	0.31	-0.17	0.29	0.46	-0.17
Median	0.82	0.70	0.10	0.56	0.46	0.00
EU27	0.94	0.86	0.08	0.61	0.66	-0.05
United States	1.70	1.51	0.19	0.77	0.89	-0.12
Japan	2.53	1.96	0.57	0.56	0.67	-0.11
China	0.99	na	na	0.35	na	na

Source: OECD, MSTI, 2007.



Figure 3: R&D intensity targets for 2010 compared 'the Lisbon gap' in 2004



Source: Bruegel based on European Commission, National Reform Programmes and annual reports on implementation. Bulgaria, the Czech Republic, Romania and Sweden not included as we were not able to find an explicit R&D target in the National Reform Programmes of those countries.

intensity may be perceived as not being particularly high.

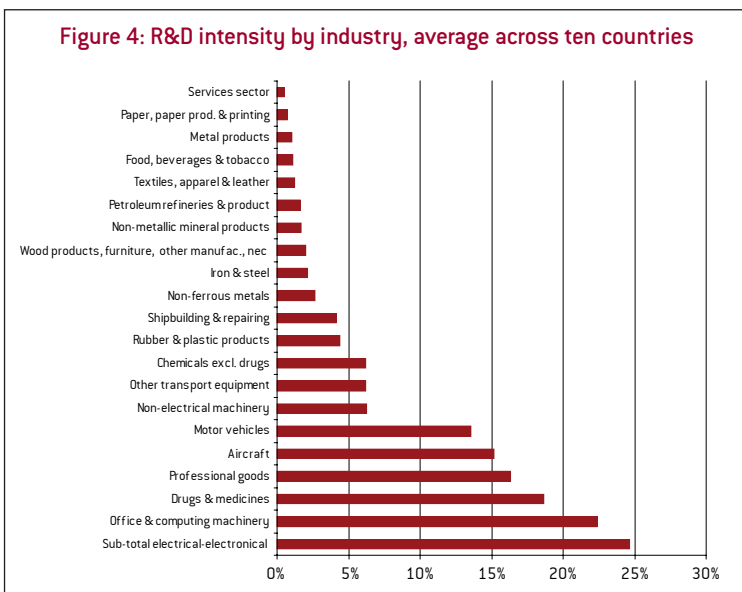
The role of specialisation has received increased attention in recent European reports on innovation (see the Aho Group report (2006), the second report of the Knowledge for Growth Group (2007) and the Commission's Key Figures 2007). This is important, as some countries generally praised for their above-average

R&D intensity may actually not be performing particularly well given their specialisation in R&D-intensive industries. Figure 4 shows the R&D intensity of most manufacturing industries averaged over ten OECD countries. It is clear that there are very considerable differences between sectors. This confirms that international comparisons of R&D intensities should take account of the particular specialisation of each country.

In order to evaluate the extent to which industrial specialisation may affect our assessment of national R&D performance we rely on the estimates provided by Mathieu and van Pottelsberghe (2008), which seek to shed light on the drivers of business-funded R&D at the industry level. They use panel data of industry-specific R&D spending for about 20 industrial sectors in 10 countries over the period 1991-2002. Their results lead to three observations:

- Technological specialisation explains the variation in R&D intensity much better than any other country specificities.
- Not taking into account industrial specialisation may lead to a highly skewed ranking of countries.
- When industrial specialisation is taken into account, only Sweden and the US still outperform other countries. Neither Japan nor Finland has a particularly high R&D intensity in relation to what their industrial structures would suggest.

Figure 4: R&D intensity by industry, average across ten countries



Source: Mathieu and van Pottelsberghe based on OECD, ANBERD and STAN databases (2005).

In a nutshell, business R&D intensity is endogenous, not exogenous. Governments should therefore go beyond traditional incentive policies such as direct R&D subsidies or tax credits. To set a business-funded R&D target at the country level is thus either wishful thinking or an implicit industrial policy – a way to alter the country's industrial structure. In other words, there is no basis for the setting of EU-wide or country targets in the Lisbon programmes unless the EU's intention is to determine member states' industrial structure. Pouring R&D money into low-tech sectors would



² "The lack of visible progress between 2002 and 2005 is largely due to the fact that business research expenditures depend on the structure of industry, which evolves slowly", European Commissioner Potocnik, December 2007, 'Towards an open and competitive European Research Area', in 'The future of Science and Technology in Europe', MCTES.

³ "...The EU/US BERD deficit cannot be attributed to the fact that individual European companies perform less R&D than their US counterparts in the same sector: the main reason for the deficit is linked to differences between the European and American industrial structures." [Key Figures 2007, p. 35]

⁴ In addition to the numerous innovation-related policy recommendations proposed by expert groups, such as the Aho Group report (2006) and the second report of the Knowledge for Growth Group (2007) mentioned in section 2 of this Policy Brief.

clearly have only a very small impact on aggregate efficiency.

The strong increase observed in the R&D intensity of Finland, Denmark and Sweden is attributable in large measure to the trend in their technological specialisation towards R&D intensive industries, as illustrated in European Commission's Key Figures 2007. At EU level, technological specialisation has not evolved much towards R&D intensive industries, which explains the lack of 'visible progress' over the past few years². This technological specialisation factor is taken by the Commission to explain both the European R&D 'inertia' (the business R&D intensity has been very stable over the past twenty years) and the EU gap with respect to the business R&D intensity of the US³.

However, the results obtained by Mathieu and van Pottelsberghe (2008) suggest that when the technological specialisation of countries is taken into account, Sweden and, to a lesser extent, the US still display above-average R&D intensity. Something other than technological specialisation thus seems to drive R&D intensity in Sweden and the US. The next section puts forward tentative explanations for the US and Swedish exceptions and draws lessons for EU and national policy.

3. HOW CAN EUROPE STIMULATE BUSINESS R&D?

One important driver of business R&D expenditure is the expected

return on the investment. What would improve this expected return? Beside fashionable R&D tax credit or direct subsidisation policies designed to reduce the cost of carrying out R&D, two specific policy areas deserve particular attention in Europe⁴:

An integrated market for innovation

Larger markets would logically result in a higher expected return on investment in R&D. The market size hypothesis may explain why the US has an above-average R&D intensity [larger than its industrial structure would suggest]. The US benefits from a huge and homogeneous market, with one main language and one regulation⁵. In Europe, sending a product from Amsterdam for sale in Brussels is still considered an 'export', whereas in the US a product made in New York and sold in Los Angeles is labelled 'distribution'. Besides these proverbial examples, a large body of evidence has been published on the lack of European integration. And an additional key growth ingredient is still missing: an EU-wide financing solution for emerging companies⁶.

Emblematic of the lack of market integration is the way the innovation system works in Europe. The European patent system, and hence the European market for technology, is highly fragmented. Once a patent has been granted by the European Patent Office (EPO), it must be validated, translated, monitored

and enforced in all relevant national patent offices. For that reason, a patent examined by the EPO and then enforced in 13 European countries costs about 11 times more than a patent granted by the United States Patent and Trademark Office (USPTO), and 14 times more than a patent granted by the Japanese Patent office (JPO)⁷. The gap is still considerable for 20-year protection. In 2004, a European patent examined by the EPO and validated in 13 member states cost more than €20,000, against €1,800 in the US and €1,500 in Japan.

Table 3 European patent costs (enforced in 13 countries) relative to the US and Japan		
	Cumulated fees and translation costs (*)	Total cost for 20 years (**)
US	11	9
Japan	14	7

Source: Adapted from van Pottelsberghe and François (2006). These figures represent the simulated costs of a European patent divided by the simulated cost of an average patent in the US and in Japan. (*) The costs include the expenses (fees and translation costs) for a patent examined by the European Patent Office (EPO) and validated in 13 European countries after granting. (**) The total cost for 20 years also includes the renewal fees for 20 years in 13 European countries. These costs are related to the absolute cost of an average patent. The recently ratified London Protocol will reduce translation costs somewhat.

These costs only include the filing examination, validation, translation and renewal fees. They do not reflect the managerial complexity of enforcing patent portfolios in several European countries, nor do they include the litigation costs in case of infringement. The policy implication is straightforward. The

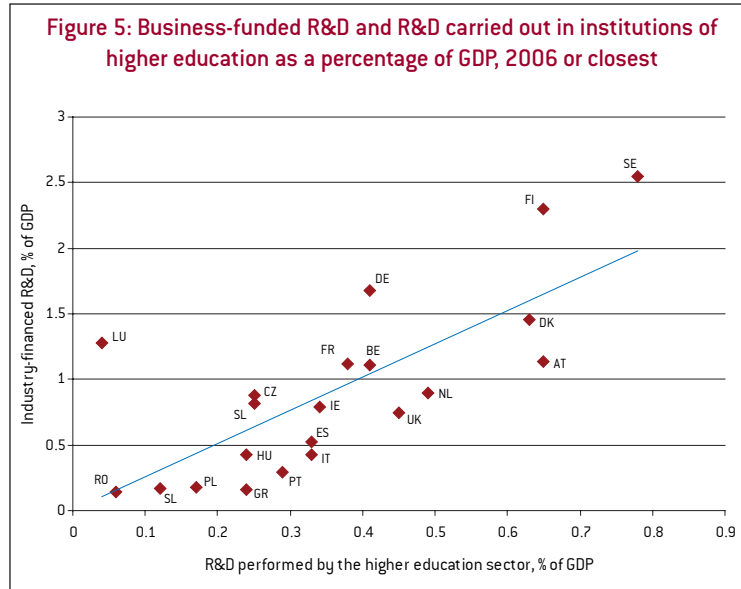


failure to create an EU patent places a heavy burden on the shoulders of European innovators and entrepreneurs at the very beginning of the innovation process - a clear comparative disadvantage for Europe with respect to the US and Japan.

More and better academic research

Market size may explain US performance with regard to R&D intensity, but it does not explain the performance of Sweden. The explanation here is probably linked to the relatively very high level of spending on academic research, the highest (as a percentage of GDP) in the whole OECD area, as illustrated by Figure 5. This strong emphasis on academic research is also a stimulus for business R&D: universities generate new ideas which are then transferred to the private sector. The transformation of these ideas into products or processes requires further applied research activity and development. Not surprisingly, the four countries in Figure 5 with the highest academic R&D intensities are also the four countries with the highest business R&D intensities. Provided effective technology transfer systems are put in place, academic research is probably the most effective source of new ideas, which in turn induce further research in the business sector⁸. In this respect, the European Research Council (ERC), which provides merit-based fundamental research grants, is a recent positive example of what the EU can achieve.

'The European patent system, and hence the market for technology, is highly fragmented.'



Source: OECD, MSTI, 2007.

Not only does academic research feed ideas to the market, but it also attracts more funding from the business sector and promotes the setting up of scientific clusters. For instance, Abramovsky *et al* (2007) show that, in the UK, universities with a high scientific output attract significantly more local and foreign research laboratories to their neighbourhood. This question is key because gaining a technological edge is the main driving force behind foreign business R&D investment, be it in the US, in Europe, or elsewhere. In fact, large firms nowadays increasingly invest in emerging markets, which provide a high-quality labour force at much lower cost than in Europe⁹. As shown by Thursby and Thursby (2006) in their survey of US and European firms, a majority of respondents

expect to increase their technical staff in China and India, while they anticipate a substantial decrease in such staff in Europe.

'High academic research spend correlates with high business R&D spend.'

The important role played by academic research as provider of ideas to the business sector and as a driver of foreign R&D expenditure implies a need for relatively more resources to be devoted to higher education research activities. Indeed the recent Bruegel Policy Brief on European universities underlines that Europe invests too little in higher education and that 'European universities suffer from poor governance, insufficient autonomy and often perverse incentives'¹⁰. In addition to remedying these three failings, governments should also provide more funding for universities' research activities. The alternative for Europe will be to lose related business research, and ultimately to lose business.

⁵ The idea that there is a positive relationship between the size of a country and its propensity to invest in R&D is empirically and theoretically supported by Guellec (1999) and Desmet and Parente (2006).

⁶ See Philippon and Véron (2008), Bruegel Policy Brief 2008/1 'Financing Europe's fast movers'.

⁷ See van Pottelsberghe and François (2006).

⁸ Guellec and van Pottelsberghe (2004) provide evidence suggesting that the social return to academic research is higher than the social return to business R&D.

⁹ Walsh (2007) documents evidence on more than 750 foreign-owned R&D centres in China in 2005.

¹⁰ Philippe Aghion, André Sapir, Mathias Dewatripont, Caroline Hoxby and Andreu Mas-Colell, Bruegel Policy Brief, 2007/4, 'Why Reform Europe's Universities?'



REFERENCES:

Abramovsky L., R. Harrison and H. Simpson, 2007, University Research and the Location of Business R&D, *The Economic Journal*, 117 (519), pp. 114-141.

Aho Group, 2006, *Creating an Innovative Europe*, Report of the Independent Expert Group on R&D and Innovation appointed following the Hampton Court Summit, available at <http://europa.eu.int/invest-in-research/>. Last accessed 25 January 2008.

Desmet K. and S. L. Parente (2006), Bigger is better: market size, demand elasticity and resistance to technology adoption, *CEPR Discussion Paper*, 5825, September, 36p.

Guellec D. (1999), A la recherche du tant perdu, *Revue Française d'Économie*, 14(1), pp. 117-169.

Guellec D. and B. van Pottelsberghe de la Potterie (2004), From R&D to productivity growth: do the institutional settings and the sources of funds of R&D matter? *Oxford Bulletin of Economics and Statistics*, 66(3), pp. 353-376.

European Commission 2007, *Key Figures 2007 – Towards a European Research Area – Science, Technology and Innovation*.

Knowledge for Growth Group, *Report on the EU's R&D Deficit & Innovation Policy*, 2007 http://ec.europa.eu/invest-in-research/pdf/download_en/rdd_deficit_report0207.pdf; (Rapporteur: Mary O'Sullivan). Last accessed 25 January 2008.

Mathieu A. and B. van Pottelsberghe de la Potterie, 2008, A note on the drivers of R&D intensity, *CEPR Discussion Paper* 6684.

Thursby J. and M. Thursby, 2006, Here or there? A survey of the factors in multinational R&D location, *National Research Council of the National Academies*, Washington D.C.

van Pottelsberghe de la Potterie B. and D. François, 2006, The cost factor in patent systems, *CEPR Discussion Paper* 5944.

Walsh, K.A., 2007, China R&D: a high-tech field of dreams, *Asia Pacific Business Review*, 13(3), 321-365.

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