Table 3

European Patent Costs (enforced in 13 countries) relative to the USA and Japan

	Cumulated fees and translation costs[1]	Total cost for 20 years[2]
USA	11	9
Japan	14	7

[1] 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.

[2] 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.

Source: Adapted from B. van Pottelsberghe de la Potterie, D. François: The Cost Factor in Patent Systems, in: CEPR Discussion Paper No. 5944, 2006. These figures represent the simulated costs of a European patent divided by the simulated cost of an average patent in the USA and in Japan.

tion towards R&D intensive industries, as illustrated in the European Commission's Key Figures 2007. At the EU level, technological specialisation has not evolved much towards R&D intensive industries, which explains the lack of "visible progress" over the past few years.[5] 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 USA.[6]

However, several countries like Sweden, Japan or the USA display above-average R&D intensity. Something other than technological specialisation also seems to drive R&D intensity in these countries. We shall put forward tentative explanations below for the US or Swedish exceptions and draw lessons for EU and national policy.

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 the 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 Europe, in addition to the numerous innovation-related policy recommendations proposed by expert groups, such as the Aho Group report and the second report of the Knowledge for Growth Group. The stimulating effect of R&D subsidies and R&D tax credits has been illustrated by Guellec and van Pottelsberghe[7] through macroeconomic panel data analyses of 16 OECD countries.

[5] "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.

[6] "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." European Commission: Key Figures 2007 – Towards a European Research Area – Science, Technology and Innovation, p. 35.

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 USA has an above-average R&D intensity (or larger than its industrial structure would suggest). The USA benefits from a huge and homogeneous market, with one main language and one regulation. 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[8] and Desmet and Parente.[9] In Europe, sending a product from Amsterdam for sale in Brussels is still considered an "export", whereas in the USA 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 companies.[10]

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 the 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).[11] The gap is still considerable for 20-year protection. In 2004, a European patent examined by

[7] D. Guellec, B. van Pottelsberghe de la Potterie: The impact of public R&D expenditure on business R&D, in: Economics of Innovation and New Technology, Vol. 12, No. 3, 2003, pp. 225-244; D. Guellec, B. van Pottelsberghe de la Potterie: From R&D to productivity growth: do the institutional settings and the sources of funds of R&D matter?, in: Oxford Bulletin of Economics and Statistics, Vol. 66, No. 3, 2004, pp. 353-376.

[8] D. Guellec: A la recherche du tant perdu, in : Revue Française d'Économie, Vol. 14, No. 1, 1999, pp. 117-169.

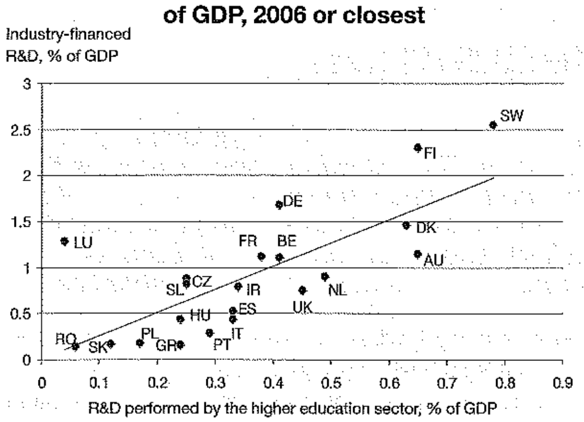
[9] K. Desmet, S. L. Parente: Bigger is better: market size, demand elasticity and resistance to technology adoption, CEPR Discussion Paper, No. 5825, September 2006, p. 36.

[10] T. Philippon, N. Véron: Financing Europe's Fast Movers, in: Bruegel Policy Brief, 2008/01, 2008.

[11] B. van Pottelsberghe de la Potterie, D. François: The cost factor in patent systems, in: Journal of Industry, Competition and Trade, forthcoming.

Figure 5

Business-funded R&D and R&D Carried Out in Institutions of Higher Education as a Percentage of GDP, 2006 or closest



Source: B. van Pottelsberghe: Europe's R&D: missing the wrong targets?, in: Bruegel Policy Brief 2008/03, February 2008, pp. 8 ff., computed from OECD, MSTI, 2007.

the EPO and validated in 13 member states cost more than €20,000, against €1,800 in the USA and €1,500 in Japan.

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 USA and Japan.

More and Better Academic Research

Market size may explain the 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 in 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 sector.[12] 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.

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.[13] 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 USA, 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 Europe. For instance, Walsh documents evidence on more than 750 foreign-owned R&D centres in China in 2005.[14] As shown by Thursby and Thursby[15] 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.

The important role of academic research as a provider of ideas to the business sector and as a driver of foreign R&D expenditure implies a need for 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".[16] 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.

[12] D. Guellec and B. van Pottelsberghe de la Potterie provide evidence suggesting that the social return to academic research is higher than the social return to business R&D. Cf. D. Guellec, B. van Pottelsberghe de la Potterie: from R&D to productivity, growth..., op. cit.

[13] L. Abramovsky, R. Harrison, H. Simpson: University Research and the Location of Business R&D, in: The Economic Journal, Vol. 117, No. 519, 2007, pp. 114-141.

[14] K. A. Walsh: China R&D: a high-tech field of dreams, in: Asia Pacific Business Review, Vol. 13, No. 3, 2007, pp. 321-365.

[15] J. Thursby, M. Thursby: Here or there? A survey of the factors in multinational R&D location, in: National Research Council of the National Academies, Washington DC 2006.

[16] P. Aghion, A. Sapir, M. Dewatripont, C. Hoxby, A. Mas-Colell: Why Reform Europe's Universities?, in: Bruegel Policy Brief, 2007/4.

Table 1
Structure of R&D Intensity across the EU and US States

(most recent figures)

	EU(27) 2006	USA(52) 2004
Maximum	Sweden 3.8%	New Mexico 8.0%
Minimum	Cyprus and Romania 0.42% and 0.46%	Wyoming and South Dakota 0.40% and 0.50%
Median across states	1.2%	1.9%
Average across states	1.4%	2.2%
90th percentile	2.5%	4.3%

Source: B. van Pottelsberghe: Europe's R&D: missing the wrong targets?, in: Bruegel Policy Brief 2008/03, February 2008, pp. 8 ff., computed from 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.

subsidies and procurement) research activities. The only countries that are close to the 1% target are Sweden, Austria and Finland.

- Second, despite the Lisbon agenda, a large number of countries have actually reduced their government funding of R&D as a percentage of GDP. The aggregate EU27 government-funded R&D intensity dropped between the mid 1990s and 2006. Interestingly, a drop also occurred in the USA 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 for R&D activity over the past ten years, the spending targets which individual countries chose to set themselves were overly ambitious. Indeed, Figure 3 illustrates a clear positive relationship between a country's distance from the 3% 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.

Table 2
Industry and Government-financed Gross Expenditure on R&D (GERD), as a Percentage of GDP

(1995 and 2006, or closest date)

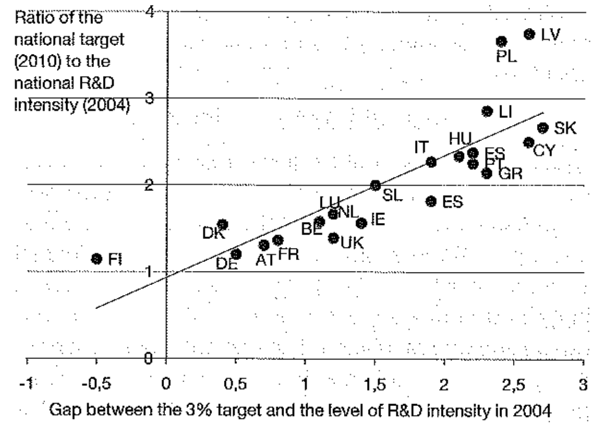
	Industry-funded GERD			Government-funded GERD		
	2006	1995	Difference	2006	1995	Difference
Sweden	2.55	2.17	0.38	0.91	0.96	-0.05
Finland	2.30	1.35	0.95	0.87	0.79	0.08
Germany	1.68	1.31	0.37	0.70	0.83	-0.13
Denmark	1.46	0.82	0.64	0.67	0.72	-0.05
Luxembourg	1.28	na	na	0.27	na	na
Austria	1.14	0.70	0.44	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: B. van Pottelsberghe: Europe's R&D: missing the wrong targets?, in: Bruegel Policy Brief 2008/03, February 2008, pp. 8 ff., computed from OECD, MSTI, 2007.

Skewed Country Rankings

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 the finance industry (e.g. 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 the tourism, fashion, services or food industries would logically have a 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 taken 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 intensity may be perceived as not being particularly high.

Figure 3
R&D Intensity Targets for 2010 Compared with the "Lisbon gap" in 2004[1]



[1] Bulgaria, the Czech Republic, Romania and Sweden are not included as we were unable to find an explicit R&D target in the National Reform Programmes of those countries.

Source: B. van Pottelsberghe: Europe's R&D: missing the wrong targets?, in: Bruegel Policy Brief 2008/03, February 2008, pp. 8 ff., computed from European Commission, National Reform Programmes (NRP) and annual reports on implementation.

The role of specialisation has received increased attention in recent European reports on innovation (see the Aho Group report (2006),[2] the second report of the Knowledge for Growth Group (2007)[3] and the Commission's Key Figures 2007). This is an important issue, 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,[4] 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 22 industrial sectors in 10 countries over the period 1991-2002. Their results lead to three observations:

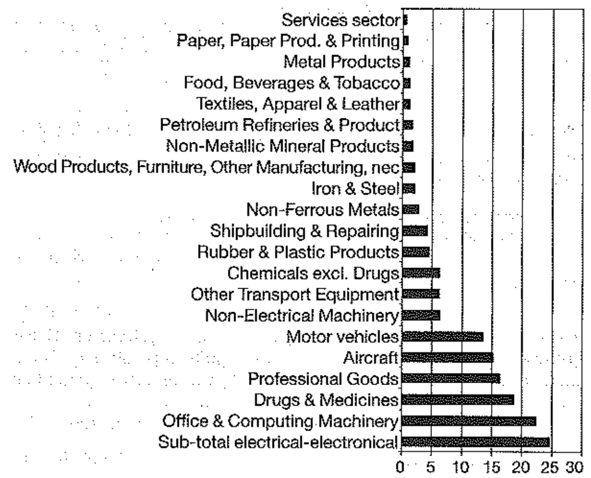
- Technological specialisation explains the variation in R&D intensity much better than any other country specificities (the adjusted R-squared is about ten times higher with industry specificities than with country dummies).
- Not taking industrial specialisation into account may lead to a somewhat skewed ranking of countries.
- When industrial specialisation is taken into account, countries like Sweden and the USA still outperform other countries.

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 R&D 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 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 specialisa-

Figure 4
R&D Intensity by Industry

(average across 10 countries in %)



Source: A. Mathieu, B. van Pottelsberghe de la Potterie: A note on the drivers of R&D intensity, in: CEPR Discussion Paper 6684, 2008, based on OECD, ANBERD and STAN databases (2005).

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

[3] 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.

[4] A. Mathieu, B. van Pottelsberghe de la Potterie: A note on the drivers of R&D intensity, in: CEPR Discussion Paper 6684, 2008.

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Bruno van Pottelsberghe de la Potterie*

Europe's R&D: Missing the Wrong Targets?

Europe is not delivering on its commitment under the Lisbon agenda to increase its R&D-to-GDP ratio to 3% by 2010. But does the European Commission's practice of benchmarking each and every member state against the headline 3% figure make sense? R&D intensity is influenced by industrial specialisation, but also by other factors such as a large integrated market for technology and a favourable environment for academic research. What can be done by the EU and by the governments of the member states to improve the situation?

One of the main goals of the EU's Lisbon agenda is to achieve a higher level of research and development (R&D) investment. 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% in the late 1990s to about 3% 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 1b, R&D intensity in the EU has been relatively stable since the early 1980s, fluctuating between 1.6% and 1.8%. In 2006, R&D intensity in the EU was still under 1.8%. The relative spend on research activities in the USA has also been stable, but on average above 2.5%. Japan exhibits an impressive performance, with a constantly increasing R&D intensity that has remained well above 3% since the early 2000s. Figure 1b also illustrates the dramatic increase in China's total R&D expenditure relative to GDP, from about 0.5% ten years ago to 1.5% in 2006. In a nutshell, the EU is not really catching up with the USA or Japan in terms of research spend, while China is catching up with the EU.

In what follows we provide a critical assessment of the R&D component of the Lisbon agenda. First, we underline 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. We also illustrate governments' sluggish, and in certain cases counter-intuitive, behaviour with regard to their own self-set agenda. We then 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 badly skewed country rankings. Finally, we investigate what can be done to improve the expected return to R&D in Europe, and hence the propensity to invest in R&D. We set out two broad policy recommendations which would improve Europe's R&D prospects.

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 of R&D intensity, especially Finland and Sweden, which several years ago leapfrogged the 3% threshold. Sweden's performance lies close to 4%. Denmark, Austria and Germany are around the 2.5% threshold, whereas France is just above 2%. However, the vast majority of countries has an R&D intensity of well below 2%, expenditure fluctuating between 0.5% and 2% of GDP, with a median of 1.2%. This broad range of intensities is also observed within the USA, 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 Mexico.[1] Seven American states have an R&D intensity that is higher than 4%, against none for the EU.

Trends in the R&D-to-GDP ratio provide an interesting insight into how active countries have been in 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%), Austria (+0.9%), Denmark (+0.6%) and Sweden (+0.5%). 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%), the United Kingdom (-0.2%), and the Netherlands (-0.2%). Their levels of R&D expenditure play an important part in aggregate EU R&D intensity. As illustrated in Table 2, this drop may be explained in part by the decrease in government-funded R&D observed in the three countries, which has not been offset by 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 currently devotes one per cent of its GDP to funding public (higher education, laboratories) or business (through

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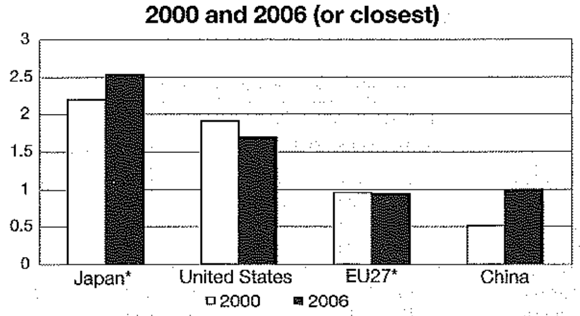
[1] New Mexico is a relatively small state, which has a remarkably high level of R&D intensity. This is largely attributable to federal support to federally funded R&D centres (FFRDCs) provided by the US Department of Energy.

Figure 1

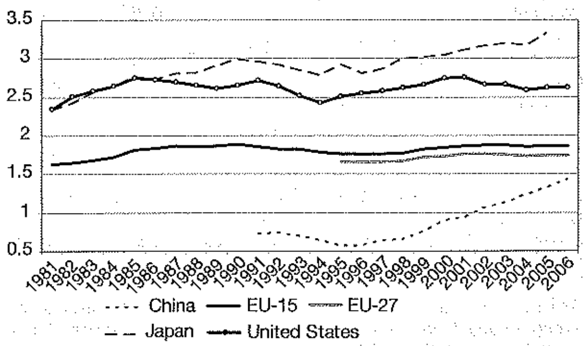
a. Business-funded R&D as a Percentage of GDP, 2000 and 2006 (or closest)



* indicates the year 2005 instead of 2006.

Source: B. van Pottelsberghe: Europe's R&D: missing the wrong targets?, in: Bruegel Policy Brief 2008/03, February 2008, pp. 8 ff., computed from OECD MSTI, 2007. Industry-financed GERD as a percentage of GDP.

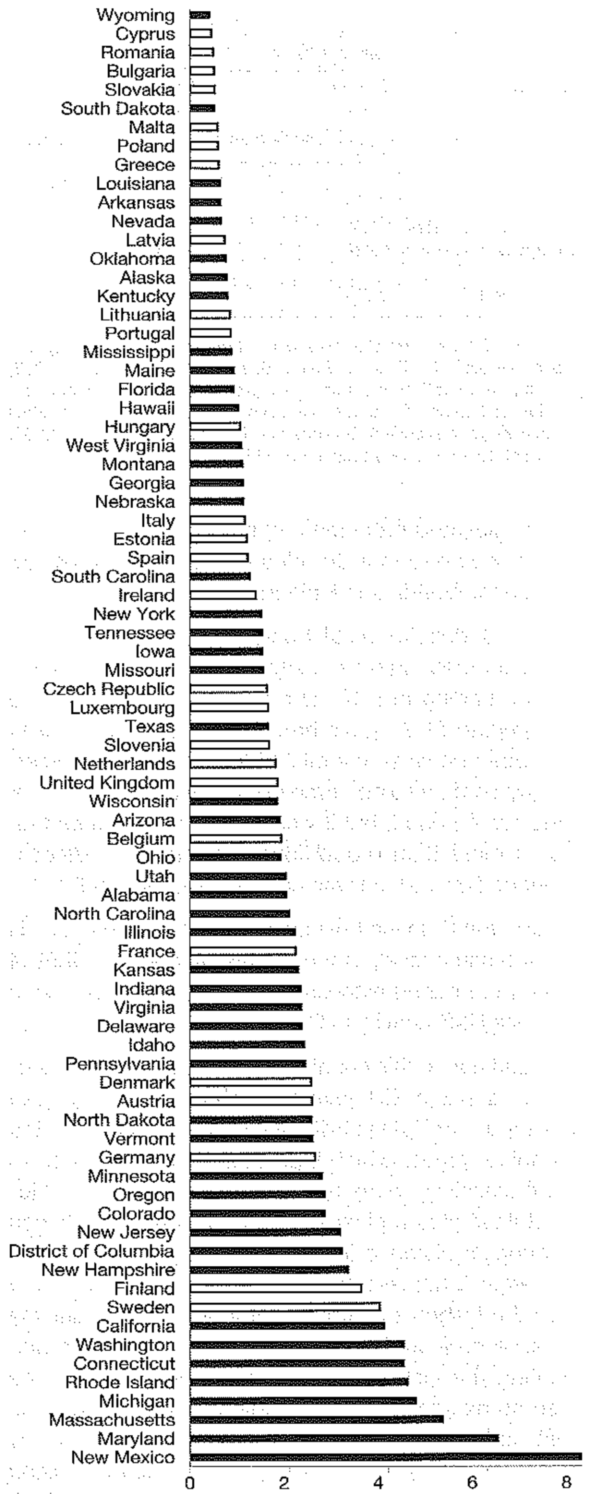
b. R&D Intensity of Selected EU and Non-EU Countries, 2006



Source: B. van Pottelsberghe: Europe's R&D: missing the wrong targets?, in: Bruegel Policy Brief 2008/03, February 2008, pp. 8 ff., computed from 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 USA.

Figure 2

R&D Intensity of the US Federal States (2004) and the EU Member States (2006)



Source: B. van Pottelsberghe: Europe's R&D: missing the wrong targets?, in: Bruegel Policy Brief 2008/03, February 2008, pp. 8 ff., computed from Eurostat, National Science Foundation, Division of Science Resources Statistics, National Patterns of R&D Resources (annual series), Science and Engineering Indicators 2007.