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EU-R&D in Services Industries and the EU-US R&D Investment Gap

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IPTS WORKING PAPER on
CORPORATE R&D AND INNOVATION - No. 04/2009

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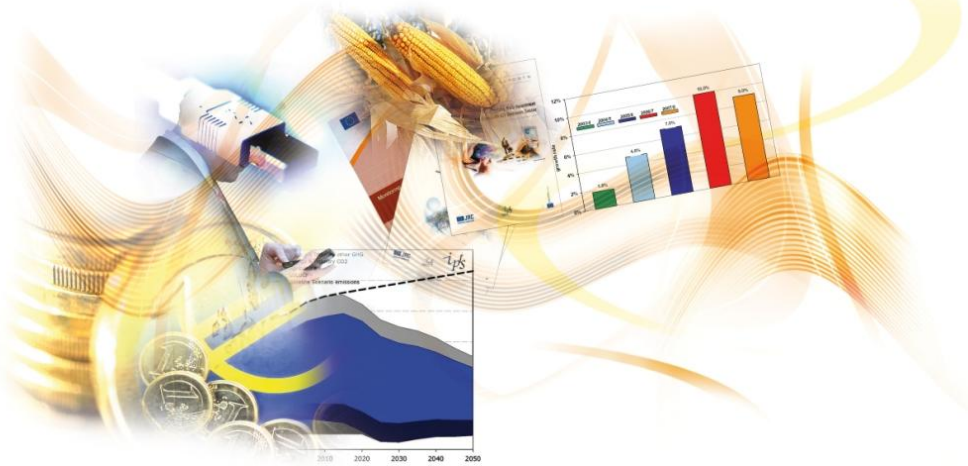
Vincent Duchêne, Elissavet Lykogianni and Arnold Verbeek



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The main authors of this report were Vincent Duchêne, Elissavet Lykogianni and Arnold Verbeek (IDEA Consult). The work has benefitted from the review of and input from Pietro-Moncada-Paternò-Castello and Andries Brandsma (JRC-IPTS) to earlier versions of the present paper.

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[1] IRMA activities correspond to the implementation of the approach set out in "Investing in research: an action plan for Europe" (COM, 2003) and in further Communications of the Commission: "More Research and Innovation – Investing for Growth and Employment – A common approach", COM (2005) 488 final, "Implementing the Community Lisbon Programme: A policy framework to strengthen EU manufacturing – Towards a more integrated approach for industrial policy", COM (2005) 474 final.

Abstract

Under the influence of the Lisbon Strategy (2000), the Barcelona '3%' objective (2002) for more investment in research in Europe and the renewed Lisbon Strategy (2005), increased attention has been paid by both policy-makers and researchers to the origin of the EU-US R&D investment gap, which lead to a blossoming of papers and studies examining sector-specific contributions to this EU R&D 'deficit'. Given their weight in the economy and relatively low R&D intensity, services industries attracted a lot of attention in this context. Many reports emphasised the importance of services –and of more adequate 'services-specific' policies- to increase the overall EU R&D intensity. A large stream of literature investigated the causes of the apparent low services R&D intensity, putting the emphasis on the inadequacies of current statistical systems and the systematic under-recording of services R&D. Recently, various papers started investigating the lack of international comparability in sector-specific R&D expenditure. Very few of them, however, examined this lack of comparability in an EU-US context. This is exactly what this paper is aiming at.

In this paper we focus on the impact of differences in practices between national statistical offices in Europe and in the US when classifying the reported R&D expenditure by industry. More in particular we examine the impact of these differences on a correct appreciation of the role of the services sector in the EU-US R&D investment gap. According to official statistics, services industries indeed appear to explain nearly the entire EU-US R&D intensity gap (US services demonstrating much higher R&D intensities than their European counterparts). We argue that this is almost entirely the result of a statistical artefact, i.e. the fact that R&D reported in the services sector is in the EU to a much larger extent redistributed by statistical offices to the corresponding manufacturing sectors (for which R&D has been executed) than in the US. Contrasting with some general beliefs in this matter, we therefore conclude that the EU R&D deficit against the US does not specifically emanate from the services sector.

JEL Classification: O33

Keywords: R&D Investments, EU-US R&D gap, services industries

1 Introduction: Increased Policy Attention to (Services) R&D

Over the past decade, increased policy attention has been paid to the level and growth of R&D investment in the various sectors of the economy, and certainly in the services industries as they represent the largest part of the economy. This increased policy concern for the level and dynamics of R&D investment finds its origin in two main trends.

On the one hand, in spite of the recent economic downturn in the US, there is evidence that the EU still suffers from a structural growth handicap. Since the mid-1990s the Union has no longer been catching up with the US in terms of productivity. Indeed, the EU's labour productivity growth rate has fallen below that of the US for the first time since the end of World War II. The fact that the EU's productivity is no longer catching up with that of the US is mainly due to the lower overall efficiency of the production process (i.e. the so-called 'total factor productivity', or TFP) (Denis e.a., 2006) . This may reflect an under-performance in the creation, diffusion, and utilisation of new knowledge over recent years.

On the other hand, with the rapid rise of –mainly Asian– newly emerging economies, a 'multi-polar world' is developing in which the sources of competitiveness, such as technology and human capital, are more evenly distributed than ever before. The EU represents a diminishing share of worldwide population, GDP and R&D investments (EU-27 accounts for 25% of global R&D expenditure compared with 29% ten years ago), and newly emerging economies are no longer competing on the basis of low-cost activities only. China is about to overtake the EU-27 in terms of world share in exports of high-tech products. Since 2003, China has become the world's main exporter of computers. Regarding electronics and telecom, China has been ahead of the EU-27 since 2004 and will probably overtake the US in 2007 (EC, 2007:56-57). Moreover, the increasing importance of newly emerging countries in globalised R&D is not only due to their rapid economic development and rising share in world GDP, but is also due to substantial increases in their R&D intensity (i.e. R&D expenditure as percentage of GDP). If current trends in R&D intensity persist, it even is expected that China will have caught up with the EU-27 by 2009.

The diverging growth patterns in the output performances of the EU compared to the US, together with the increasing challenges and new opportunities created by the new major players, have been a source of deep concern for policy-makers. This heightened level of concern has led most notably to the initiation of the Lisbon process and its efforts to encourage governments to launch employment- and productivity-enhancing reforms.

More in particular, under the influence of the Lisbon strategy (2000), the Barcelona '3%' objective (2002) for more investment in research in Europe and the renewed Lisbon strategy (2005), 26 EU-27 Member States have recently set ambitious targets to significantly increase their share of resources devoted to R&D in the coming years. These commitments to R&D (investment) are also reflected in the significantly increased budget for the 7th Framework Programme (2007-2013, +41% compared to FP6 in 2004 prices). According to the Lisbon and Barcelona objectives, the EU should approach by 2010 3% of its GDP being devoted to R&D, of which two-thirds should be financed by the private sector. If each of the 26 Member States would reach the target it has recently fixed for 2010, the EU as a whole would increase its R&D intensity up to around 2.6% of GDP in 2010 (in 2006, the EU-27 R&D intensity amounted up to 1.84%).

Recent evidence on trends up to 2006 shows, however, that the EU is not yet on track to meet these targets. Only a small number of Member States (Austria, Denmark, Ireland, Germany and Finland) have over recent years experienced rates of growth which, if they are maintained, would be sufficient to advance these countries significantly towards their targets. As a result, R&D intensity in EU-27 remains at a lower level than in most of its competitors.

This 'R&D deficit' stems mainly from the low contribution of the private sector to the financing of R&D, which explains almost 85% of the gap between the EU and the US (EC 2007:23).
In this context, the debate on the extent, origin and nature of the relative underinvestment in R&D in Europe has gained importance over recent years. For instance, many scholars have tried to determine to what extent the EU under-investment in R&D was due to differences in industrial structure (i.e. smaller R&D-intensive sectors in the EU) or to own, 'intrinsic' differences (i.e. EU sectors and companies investing less of their resources in R&D, irrespective of their share in the economy) (for a recent overview hereof, see O'Sullivan, 2007).
Key to a better understanding of the EU 'R&D deficit' is the sector-specific analysis of R&D investment. Because of their weight in the economy and their –on average- low R&D intensity (as compared to manufacturing sectors), services industries attracted a lot of attention as well. Many reports emphasised the importance of developing more adequate 'services-specific' research and innovation policies (for an extensive overview of the literature on services R&D and services research policies, see Reneser report 2007, EC 2008). A large stream of the literature examined the causes of this apparent low R&D intensity, putting the emphasis on the inadequacies of current statistical systems and surveys to monitor properly services R&D and services innovation activities as main cause for the underestimation of services R&D. According to Miles (Miles 2007), for instance, the fact that services contribute less to R&D than would be expected given their large shares of employment and output in national economies can largely be explained by three elements. Firstly, the incomplete sampling of services in national R&D surveys may lead to some underestimation of their R&D activity. Secondly, the 'technological bias' of the current official, Frascati definition of R&D and the de facto exclusion of social science research in R&D statistics reduces disproportionately the reporting of R&D by services firms (many services firms engage in R&D-like activities (business development, service improvement etc) that fall outside, or at the boundary of the classical understandings of R&D). Thirdly, R&D (innovation) activities in most services companies are often customer-driven and carried out in departments in which R&D is not the main activity. The process of managing R&D is in services companies therefore less 'formalised' than the more 'standardised approach' in industrial sectors which rely heavily on technological innovation (causing a lack of familiarity in services companies with the R&D concept and R&D management practices and consequently an under-reporting of services R&D).
These insights on the inadequacies of current statistical systems to monitor services R&D have triggered attempts to examine more in-depth services' innovation patterns and processes to better understand the nature of R&D-like activities in services industries. For instance, Srholec and Verspagen (2008), Tether and Tajar (2008) used micro-data and exploratory data analysis to identify clusters and define so-called 'distinct modes of innovation' (the relevance of which can then be tested in different industries). Tether and Tajar (2008) distinguish three modes of innovation: a product-research mode, a process-technologies mode, and an organisational-cooperation mode. The first two of these are forms of technological innovation that are well established in the literature. The third is a form of organisational innovation, about which much less is known, and which is particularly prominent in services industries. Another stream of literature puts the emphasis on a normative approach of the problem. In this regard, some papers propose amending the Frascati definition of R&D 'with the aim of reducing the influence of the industrialist and technologist inertia, which continues […] to contribute to the underestimation of the R&D carried out in service firms' (Djellal e.a. 2003:428), while others recommend revising the way in which R&D has been operationalised in surveys by reformulating specific survey questions (Gallagher e.a. 2005).
These studies tend to demonstrate the systematic under-recording of R&D activities in services in almost all countries and attempt to better define what should be measured or how to measure it. However, they do not explain why services industries demonstrate a much higher R&D intensity in the US than in the EU. Indeed, according to official statistics (Anberd), the share of R&D expenditure accounted for by the services sector is in the US

much higher than in the EU. As a matter of fact, services industries appear to represent the bulk of the difference between the EU and the US as regards R&D spending, and therefore seem to play a key role in explaining the existence of the EU-US R&D investment gap.
There is, however, a growing concern that official statistics (i.e. Anberd data as reported in OECD and national publications) are not fully comparable between countries due to some types of variation in the methods followed by national statistical offices. Recently, various papers have started documenting this lack of comparability; in particular, they shed a new light on one of its main factors, i.e. differences between national statistical offices in the way reported R&D expenditure are actually classified by industrial activity, in spite of the guidelines provided by the Frascati manual hereon (Abramovsky e.a. 2004, Golborne 2004, Lonmo 2004, DTI 2005, NSF 2005, OECD 2005, Young 2005). These papers either examined a national situation (DTI 2005 and Abramovsky e.a. for the UK, NSF 2005 for the US), provided evidence at country-level for most of the OECD countries (OECD 2005), or assessed for various OECD countries how R&D expenditure are classified in a specific industry (Young 2005 for the pharmaceutical R&D expenditure). Very few of them, however, examined this lack of comparability in a EU-US context, i.e. to what extent do differences between statistical offices in the way they classify R&D expenditure by industry affect a proper appreciation of the role of services versus manufacturing in the EU-US R&D investment gap? This is exactly what this paper is aiming at.
The remaining of this paper is organised as follows. It begins with a description of the data sources used, focusing on the OECD's Anberd database. It then provides some background information on the size and importance of services industries in the economy, with a special emphasis on the knowledge-intensive sub-sectors of the services industries. In the fourth and fifth sections, the importance of services with regard to the overall R&D intensity is looked at, in the light of the recent information collected on the different practices followed by statistical offices when classifying R&D expenditure between industries. Finally, this paper raises some outlines possible for future work.

2 Data Sources

The main reference database for examining the sector-specific distribution of R&D expenditure is the so-called 'Analytical Business Enterprise Research and Development' (ANBERD) database of the OECD. The Anberd database was set up in the early 1990s to address some of the shortcomings of the official data on R&D expenditure in the business enterprise sector as provided by the national statistical offices (Offberd), and to provide sector-level R&D data at a reasonable level of aggregation for analytical purposes. Examples of limitations of the official Offberd data were the uneven time coverage and periodicity of surveys between countries, differences in survey sampling methodologies or coverage ratios between countries, different treatment of borderline research institutions from country to country (leading to significant differences where semi-government or research bodies conduct a substantial amount of industrial R&D), differences between countries in the extent at which product field data versus principal activity data is used to classify R&D expenditure by industrial sector (see also infra), differences in the level of aggregation at which data is reported etc (OECD 2005:2-4, OECD 2006:3-5).
Initially, Anberd focused only on manufacturing sectors, but an additional breakdown for services was added in 1996-1997. The construction of Anberd involves some adjustments of Offberd and estimations by the OECD Secretariat, for instance by attempting to be closer to the 'product field' criterion in allocating R&D activities to industrial sectors, by imputing values for missing years (interpolations), or by increasing the level of sectoral detail compared to the national Offberd data. To this purpose, additional sources such as national publications, information from national experts or firm-level information (e.g. corporate annual reports) are used. Anberd currently includes 60 industries for 19 countries and an EU total (which only includes 13 EU Member States). Additional data on the remaining EU Member States (but not OECD members) available via Eurostat have been taken into consideration as well (see

infra). The latest (2005/2006) edition of Anberd covers the period 1987-2004. Due to unavailability of data for 2004 for some countries, an EU total is only possible up to 2003. The Anberd data is available in current national currency as well as in US$ PPPs. For the purpose of this paper, the data has been converted from national currencies to current ECU/Euros.

Anberd is the only internationally comparable source for data on R&D expenditure by industry and is widely used for analysis, partly due to its links with the Structural Analysis (STAN) database, which includes industry output, investment and employment, standardised input-output tables and the bilateral trade database. Anberd is also used for determining industry groupings based on technology / knowledge intensity (e.g. high-tech manufacturing).

Another source of data on R&D investment at the industry level is the 'EU Industrial R&D Investment Scoreboard', released yearly by the European Commission, IPTS-Seville (EC, 2007b). The 2007 Scoreboard collects and analyses data on 2000 companies around the world reporting major investment in R&D. The set of companies it covers comprises the top 1000 R&D investors whose registered offices are in the EU and the top 1000 registered elsewhere. However, given the purpose of this paper, the R&D Investment Scoreboard was not used for two reasons. Firstly, its data on R&D investment refers to investment by companies without any indication of the location where the investment has been actually 'consumed'. In other words, we miss the domestic character of R&D expenditure in the context of a correct appreciation of EU-US differences. Secondly, the industrial Scoreboard uses the Industry Classification Benchmark (ICB) sectoral classification while Anberd is using Isic rev3.

Finally, data from the Community Innovation Surveys (CIS), although delivering very valuable information on innovative activities of companies and sectors, were not used in this paper as they refer to a much broader set of activities than R&D only.

3 The Growing Importance of Service Industries in the Knowledge-based Economy

In both the EU and the US, services represent around three-quarters of total value added and their share is increasing, while the weight of manufacturing industry in the economy is shrinking and accounts now for less than one-fifth of total value added (Table 1). Although the increasing importance of services (and the diminishing share of manufacturing industries) is a general pattern common to all European countries and to the US, in some Member States manufacturing still represents a very significant proportion of all economic activities (e.g. in the Czech Republic, Hungary, Slovakia, Ireland, Finland and Germany, where manufacturing activities accounted for 23% to 31% of total value added in 2003), while others are more dominated by service activities (e.g. Luxembourg, the Netherlands, the United Kingdom, Belgium and France where services represented between 74% and 83% of total value added in 2003).

Table 1: %-distribution of value added by sector, EU-27(1) and US, 1997-2003

	1997	1998	1999	2000	2001	2002	2003
EU-27:							
Manufacturing(2)	20	20	20	19	19	18	18
Services(3)	68	69	70	70	70	71	72
Other(4)	11	11	11	11	11	11	11
TOTAL	100	100	100	100	100	100	100
US:							
Manufacturing(2)	23	23	23	22	20	19	19
Services(3)	74	74	74	74	76	76	76
Other(4)	3	3	3	3	4	4	5
TOTAL	100	100	100	100	100	100	100

Notes: (1) EU-27 does not include BG, EE, CY, LV, LT, MT, RO and SI; (2) Isic Rev.3 15-37; (3) Isic Rev.3 50-99; (4) Isic Rev.3 1-14, 40-45.
Source: OECD, Groningen Growth and Development Centre.

Services were long thought to be –with a few exceptions- seriously underperforming in terms of innovation. They were discounted as being mainly supplier-driven, without investing in their own innovative effort. Over the last decade, this perception has largely been overturned (Miles 2005). Knowledge-intensive services, such as the so-called 'Knowledge-intensive high-tech services'2 (KHTS), play an increasingly important role in all developed economies. KHTS cover a sector with high requirements for qualifications and the application of knowledge and this gives them a special importance for economic growth. The development of KHTS is closely linked to the growing specialisation of industries and the need for even more specialised services emanating from other service and manufacturing sectors. Very often, specialisation is conditioned by a more sophisticated demand and, as a consequence, may lead to increases in productivity.

The value added created by KHTS is an important indicator of the overall knowledge intensity of a given economy. The share of services value added accounted for by KHTS has been constantly growing in the EU in recent years. In 2003, KHTS accounted for 6.9% of the total value added in the service sector, against 6.1% in 1997. The share of KHTS in the total service sector has been growing in almost all EU Member States between 1997 and 2003. Partly under the influence of the increasing weight of knowledge-intensive services such as the KHTS, services R&D is growing rapidly since the 1990s, in most countries at levels above that of manufacturing R&D (even though the average R&D intensity of services as a whole still remains well-below that of manufacturing industries) (Miles 2005, Reneser report 2007:26)

The –growing- economic importance of services industries and knowledge-intensive high-tech services suggests that improvement in productivity and economic growth are likely to depend more on productivity increases in the services sectors than in the manufacturing industries3. Regarding the US, for instance, recent evidence shows that services sectors accounted for three-quarters of US Total Factor Productivity (TFP) growth during the post-1995 period. Services sector labour productivity and TFP grew more rapidly than and substantially exceeded productivity accelerations in the manufacturing sector (Bosworth and Triplett, 2007:3).

Although the economic weight of the services sector and its contribution to overall productivity gains have been recognised since many years, the statistical base needed to monitor and analyse in-depth this sector remains problematic, especially as regards a correct appreciation of the level and growth of R&D investment across countries.

[2] 'Knowledge-intensive high-tech services' (KHTS) re-group the following three sectors: 1) post and telecommunications (Isic Rev3 64), 2) computer and related activities (Isic Rev3 72), 3) research and development (Isic Rev3 73).

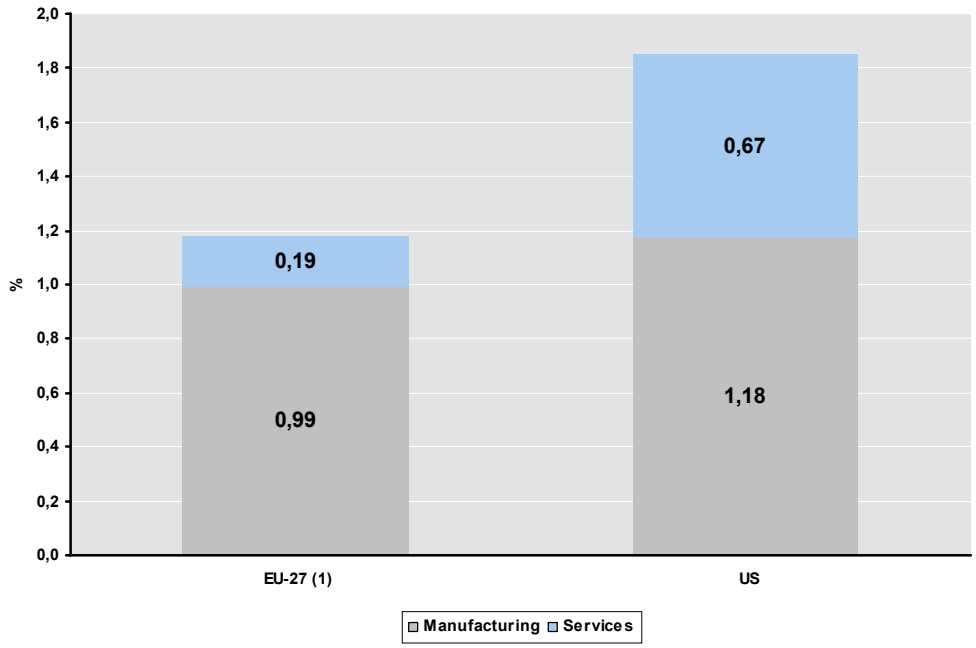
[3] Even though one should bear in mind that manufacturing sectors and services industries are not isolated from each other but tightly intertwined and co-evolving.

4 The Role of Service Industries in the EU-US Business R&D Gap: the 'Official' View

As previously mentioned, EU business sector expenditure on R&D (as % of GDP) remains at a significantly lower level than its main competitors. The significantly lower contribution from the business sector in the EU also accounts for almost 85% of the overall EU R&D deficit as compared to the US. Figure 1 below shows business R&D expenditure performed in the services sector and in manufacturing industry (expressed as a percentage of GDP) in the EU and the US.

Compared to the US, the EU has a much lower level of R&D performed in the services sector. At first sight, this could lead us to conclude that the EU R&D investment deficit with the US is almost exclusively located in the services sector, which justifies a further investigation of services R&D expenditure. However, a further breakdown of R&D expenditure per sub-sector of the services industries in the EU is only possible for 10 out of the 13 EU-27 Member States covered by the OECD and for which Anberd data are available, namely Belgium, The Czech Republic, Denmark, Spain, Ireland, Italy, The Netherlands, Poland, Sweden and The United Kingdom .

Figure 1: Business Enterprise Expenditure on R&D (BERD) in the services and manufacturing sectors as % of GDP, 2003



Source: EC 2007:28 (based on OECD, Eurostat).
Notes: (1) EU-27 was estimated and does not include MT. Due to the unavailability of 2004 data for some EU Member States, EU-27 refers to 2003.

Table 2 below shows the percentage distribution of services R&D expenditure and value added over various sub-sectors of the services industry. In both the EU and the US the bulk of services R&D is situated in two groups of sectors: respectively 75% (EU) and 82% (US) of services R&D is conducted in trade services industries and in the knowledge-intensive, high-tech services (KHTS). Especially the latter group is of great importance: while KHTS account for only 7% of the services value added in both the EU and the US, they generate about half to two-thirds of the services R&D. Trade services industries appear to account for a large part of services R&D in the US, but not in the EU. While their size in the economy is very similar

in both the EU and the US, they account for more than one-third of total services R&D in the US, against only 7% in the EU (in the majority of EU Member States accounted for by Anberd data it is even below 5%). Therefore, trade services industries play a key role in explaining differences between the EU and the US as regards the role played by the service sector in the R&D investment gap. Could these differences in the contribution of trade services to the services R&D be explained by drastic differences in research-intensity at both sides of the Atlantic? Or should the origin of these differences be sought elsewhere?

Table 2: %-distribution of Services R&D expenditure and Services value added by sub-sector, 2003

	Services R&D			Services value added		
2003	Total Services(2)	Trade(3)	KHTS(4)	Total Services(2)	Trade(3)	KHTS(4)
Belgium	100%	5%	54%	100%	17%	9%
Czech republic	100%	8%	73%	100%	20%	15%
Denmark	100%	6%	57%	100%	16%	6%
Germany (5)	100%	3%		100%	16%	6%
Spain	100%	9%	44%	100%	16%	6%
France (6)	100%	0,0%		100%	14%	7%
Ireland	100%	0,5%	96%	100%	17%	15%
Italy	100%	12%	57%	100%	18%	6%
The Netherlands	100%	25%	49%	100%	17%	7%
Poland	100%	0,05%	42%	100%	30%	7%
Finland (7)	100%	0,3%		100%	16%	9%
Sweden	100%	0,2%	75%	100%	15%	8%
The United Kingdom	100%	4%	85%	100%	16%	8%
EU (1)	100%	7%	68%	100%	17%(16%)	7%(7%)
US	100%	36%	46%	100%	16%	7%

Source: OECD, Anberd database (services R&D); Groningen Growth and Development Centre, 60-Industry database (services value added).

Notes: (1) The EU-aggregate is based on the values of ten Member States: BE, CZ, DK, ES, IE, IT, NL, PL, SE, UK, except for the figures between brackets which refer to EU-19 (BE, CZ, DK, DE, EL, ES, FR, IE, IT, LU ,HU, NL, AT, PL, PT, SK, FI, SE, UK). (2) 'Total Services' refers to ISIC Rev3 50-99. (3) 'Trade services' refers to ISIC Rev3 50-52. (4) 'Knowledge-intensive High-Tech Services' (KHTS) refers to ISIC Rev3 64, 72 and 73. (5) No data available for KHTS in Germany because sector ISIC Rev3 64 has been included into 'Transport and Storage' (ISIC Rev3 60-63). (6) and (7) No data available for ISIC Rev3 73 in France and Finland. See also Annex 1 for the definition of the Isic sectoral codes.

5 A Revision of the Importance of Services in Explaining the EU-US R&D Investment Gap

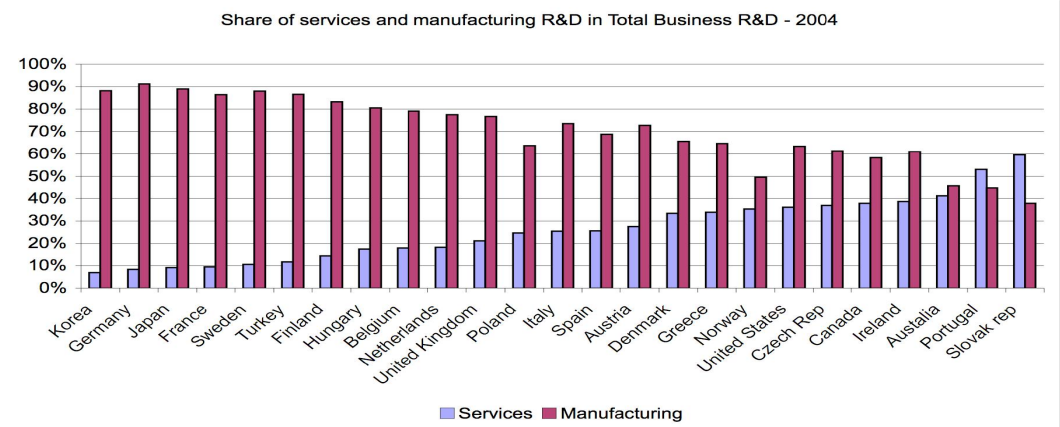
Recent studies have revealed comparability problems with industry-level data on R&D expenditure (for a recent overview, see OECD, 2005). In particular they tend to show that services R&D expenditure is significantly overestimated in the US compared with the EU, most notably in the trade services industries.

One of the main factors that limit comparability across countries is differences in the methods used to classify R&D by industrial activity. Although the Frascati Manual provides some guidelines, it appears that countries follow different practices in their national surveys when it comes to classifying large, multi-activity enterprises or firms with R&D as their main activity.

As regards the classification of multi-activity companies, the Frascati Manual recommends using the principal activity of the firm as the classification criterion, but to subdivide its R&D when the activities are heterogeneous, therefore using product field information (i.e. nature or

use of the product for which the R&D is conducted) in order to re-distribute the R&D activities to the manufacturing industry concerned.

Figure 2: Share of manufacturing and services R&D in total business R&D, 2004 (selected OECD countries)



Source: Reneser Report (2007).

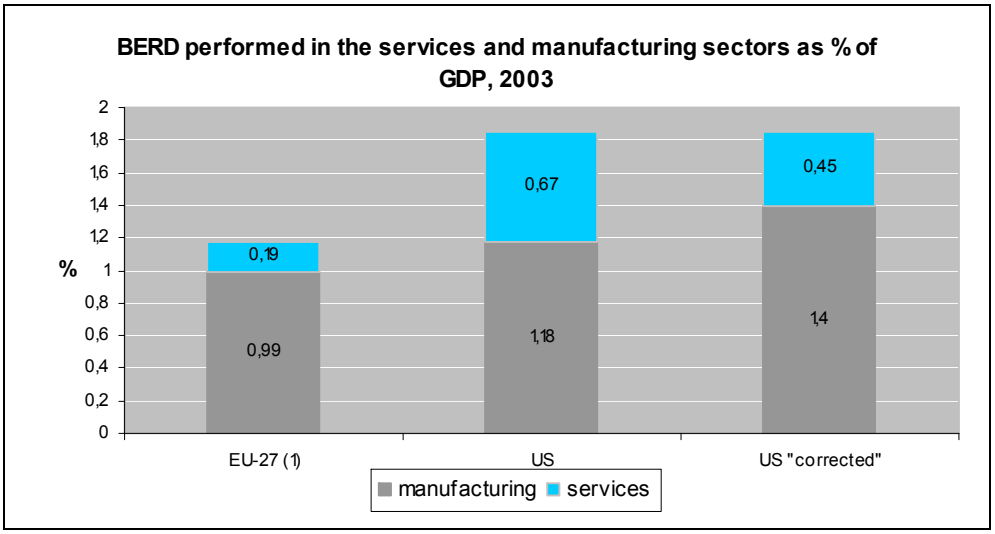
However, not all countries use product field data to the same extent to reclassify R&D, which, according to the OECD, 'may result in similar R&D expenditure being categorised in different industries across countries, thus partially explaining the wide range of values for the shares of services in BERD across countries' (OECD, 2005:5; see also Figure 2 above). While, in the US, firms are classified by principal activity only, the majority of EU Member States use product field information to re-allocate R&D expenditure. According to a survey executed by the OECD among NESTI delegates in 2005, eight out of the 13 EU-27 Member States covered in the OECD's Anberd statistics use product field information to some extent to re-allocate industry-level R&D expenditure (BE, DK, DE, FI, FR, NL, SE, UK) and five use the principal activity criterion (CZ, ES, IE, IT, PO) (OECD, 2005:5, 14-16). The former group of eight countries represent 86% of total EU-27 BERD as covered by the OECD in the Anberd statistics. Therefore, any comparison between the EU and the US based on Anberd is likely to be significantly biased because at the EU level a larger share of services R&D has been reallocated to the manufacturing industry than in the US.

This may explain a large part of the difference between the EU and the US in the share of services in total R&D expenditure, and this is certainly the case for the services R&D imputed to the US trade services. Indeed, according to the NSF, the classification of much of the R&D expenditure allocated to the Trade services industry (ISIC Rev3 50-52) in the US is a statistical artefact due to the US classification of companies according to their principal activity. Because the sale and marketing of goods and services is a trade activity, a large pharmaceutical firm or electronics manufacturer (including its R&D expenditure) would be classified in the trade services industry if the payroll associated with its sales and marketing efforts outweighed that of any other industrial activity in the company.

Based on the analysis of the micro-data underlying published R&D estimates at the industry level in the US, the NSF estimates that 93% of the R&D expenditure recorded under the US trade services industry (i.e. 33.5% of total services R&D expenditure in the US) should be re-allocated to the manufacturing industry. Using the assumption that "the R&D reported in a trade industry is more closely aligned with the manufacturing of the product being sold than the trade activity itself", the NSF redistributes almost all of the R&D recorded under trade services industries into their corresponding manufacturing sectors, namely 1) the 'pharmaceuticals and medicines manufacturing industry (North American Industry Classification System –NAICS- 3254), 2) the 'electrical equipment, appliances, and components manufacturing industry' (NAICS 335), 3) the 'computer and electronic products manufacturing industry' (NAICS 334) (NSF, 2005:25-30). The effect of this re-allocation is substantial: it increases business R&D expenditure in the manufacturing sectors concerned

by respectively 80% ('pharmaceuticals' and 'electrical equipment') and 20% ('computers'). After the redistribution, the total R&D in the 'computer manufacturing industry exceeds all nonmanufacturing R&D combined.
We applied these NSF estimates to re-allocate US trade services R&D to their corresponding manufacturing sectors in the Anberd database. As shown on Figure 3 below, the 'corrected' figures significantly modify the manufacturing-services distribution of BERD in the US, as well as the EU-US comparison in this regard.

Figure 3: BERD performed in the services and manufacturing sectors as % of GDP, 2003



Source: OECD, Eurostat, own calculations based on NSF, 2005:25-30.

Official Anberd figures on the manufacturing–services breakdown of R&D intensity showed that services industries were responsible for the largest share of the gap between the EU and the US. However, correcting for the 'misallocation' of trade services R&D in the US changes the picture. After redistribution, it appears that the EU deficit in R&D intensity is not exclusively a result of less R&D in the services sector: the differences among the services and the manufacturing sector appear to be more in proportion to the overall difference in total R&D between EU and the US. Even though this is not documented, we cannot exclude that part of the trade services R&D may be misallocated in some EU countries as well, and therefore may be subject to a similar redistribution. However, such a redistribution into the corresponding manufacturing sectors would have at the EU level a much smaller effect than in the US (trade services R&D represents only 7% of services R&DS in the EU, see Table 2 above).
Moreover, the methodological differences between the classification of R&D expenditure in the EU and the US may also apply to other services industries such as 'Computer and related services' (ISIC Rev3 72), an important component of the 'knowledge-intensive, high-tech services' (KHTS). The case of IBM, for instance, is well-known. Because of the increasing weight of its services activities, the company switched in 1992 from being a manufacturing company to being a services company, which caused a significant –artificial– increase in US services R&D expenditure. In the US, 'Computer and related services' (ISIC Rev3 72) represented 27% of total services BERD, twice as much as in those EU countries for which comparable data are available. Any redistribution may thus alter the EU-US comparison in this regard, with possibly a sharper re-allocation of services R&D to the manufacturing sector in the US than in the EU.
Finally, firms with R&D as their main activity ('scientific R&D services industry', ISIC Rev3 73) are also treated differently across countries. The scientific R&D services industry comprises companies that specialise in conducting R&D for other organisations, such as biotechnology companies. Although these companies and their R&D activities are classified as non-manufacturing because they provide business services, many of the industries they serve are

manufacturing industries. This implies that the R&D activities of a research firm that services a manufacturer would be classified as R&D in manufacturing, if the same research firm were a subsidiary of the manufacturer. Part of the services R&D recorded under this industry may therefore reflect a more general pattern of manufacturing's reliance on outsourcing and contract R&D.

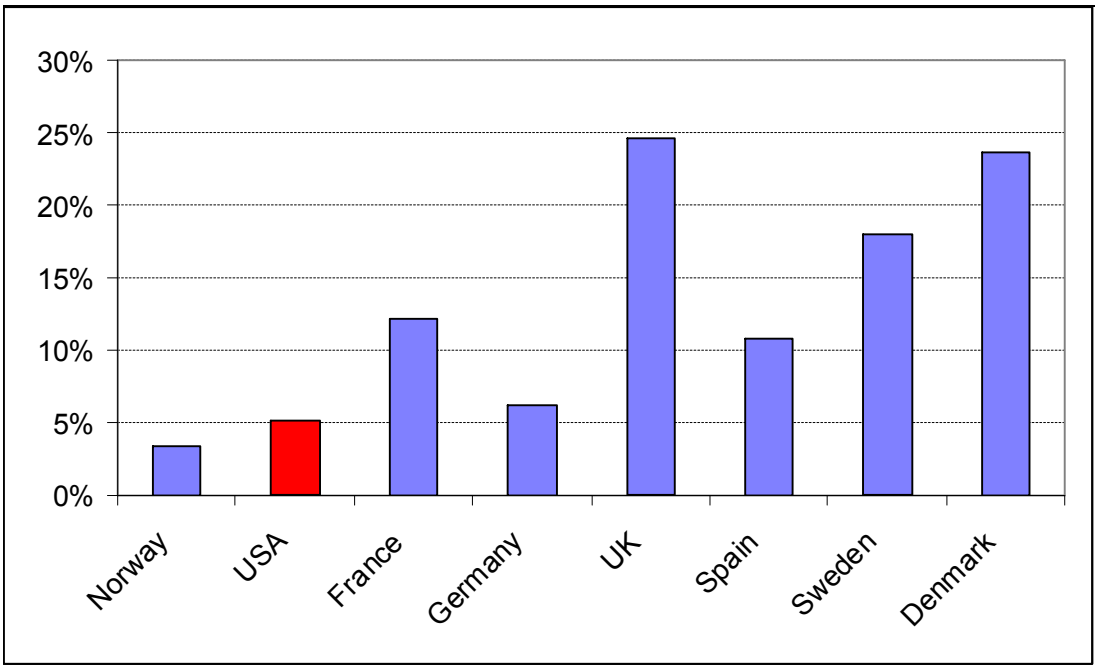
In some EU Member States such as France, the United Kingdom, Germany, Belgium, Finland and Denmark (accounting for three-quarters of Anberd-recorded EU-27 BERD), the R&D performed by these service companies is at least partially re-distributed to the manufacturing sector for which the R&D has been conducted. For instance, in both France and the United Kingdom, Offberd is essentially compiled by product field. In France, the branch Isic Rev3 73 is not used and the R&D carried out by R&D services companies is fully redistributed to their corresponding manufacturing sectors. In the US, the R&D expenditure of these companies is included under the sector 'Scientific R&D services' (ISIC Rev3 73). Here again, a comparison between the EU and the US based on Anberd is likely to be biased too since at the EU level a larger share of services R&D recorded under the 'Scientific R&D services' industry has been reallocated to the manufacturing industry than in the US. In 2003, the 'Scientific R&D services' sector represented 6% of total BERD in the US compared with 2.5% in those EU countries for which comparable data are available. According to the OECD, redistributing the R&D of this sector could significantly alter the overall manufacturing/services distribution in total BERD (OECD, 2005:6).

An illustration of the impact of this different treatment of services R&D between EU countries and the US is given by Young (2005). Young examined how differences in classification of R&D by industry across OECD countries affect the comparability of data on R&D expenditure in the pharmaceutical manufacturing sector. In order to obtain a more accurate estimate of total pharmaceutical R&D, the author carried out two main adjustments on the official industry-based data combining various data sources (official R&D data –Offerd, Anberd, national R&D publications, private sector data): 1) remove from R&D performed by the pharmaceutical industry the part that does not relate to pharmaceuticals (usually a very small percentage), and 2) add pharmaceutical R&D performed by other industries, mainly in the services (in particular two services sectors: Scientific R&D Services (Isic rev3 73) and 'Trade Services' (Isic Rev3 50-52)).

These adjustments allowed the author to re-estimate R&D expenditure in the pharmaceutical manufacturing industry according to both the 'product field' criterion and the 'principal activity' criterion. The results are shown on the lower graph in Box1. It is obvious that for some countries such as the UK, France, the US or Denmark, the use of the classification criterion has a significant impact on the distribution of R&D expenditure. The above-graph in Box 1 shows for some European countries and the US the R&D expenditure in the pharmaceutical industry (as % of BERD), according to the official Anberd figures. It appears very clearly that the official R&D expenditure data for most of the EU countries such as the UK, France and Denmark rely much more on product field approach than on the activity approach, while in the US the opposite is true. In EU countries, pharmaceutical R&D reported under services industries has been classified under the manufacturing sector to a much larger extent than in the US. This confirms once more that services R&D in the US is artificially over-estimated in comparison with most EU countries.

Box 1: R&D in the pharmaceutical industry

R&D expenditure in the pharmaceutical industry (Isic rev3 2423) in some OECD countries, 2001 (as % of BERD)



Source: OECD, Anberd 2005/2006.

R&D expenditure in the pharmaceutical industry (Isic rev3 2423) (2001) (as % of BERD), according to the product field versus industry classification criterion

Source: Young 2005.

Nevertheless, the extent of the misallocation in the 'Computer and related Services' and 'Scientific R&D services industry' is not enough documented to allow for any correction, as we did for the trade services. However, it appears from the analysis of differences in classification practices between the US and some EU Member States that in the US a larger part of R&D is still recorded under the services sectors 'Computer and related Services' and 'Scientific R&D services industry' than in the EU. This reinforces our statement that it would be unsafe at this stage to conclude that the EU/US R&D deficit mainly emanates from the business services sector.

6 Conclusion

Over the past decade, the level and growth of R&D investment has been under increasing scrutiny in the EU. Under the influence of the Lisbon Strategy, all EU Member States have committed themselves to substantially increase their R&D intensity, as a mean for improving their productivity levels and growth. Increased efforts have been made to reinforce the mix of policy measures to foster R&D investment (mainly by the private sector) and, more generally, to better address the perceived weaknesses of their innovation systems. In that context, the debate on the causes of the relative under-investment in R&D and its weak growth performance in Europe has gained importance, which lead to a blossoming of studies assessing sector-specific contributions to the EU R&D 'deficit'. Given their weight in the economy and relatively low R&D intensity, services industries attracted a lot of attention in this context. Many reports emphasised the importance of services –and of more adequate 'services-specific' policies- to increase the overall EU R&D intensity. A large stream of literature investigated the causes of the apparent low services R&D intensity, putting the emphasis on the inadequacies of current statistical systems and the systematic under-recording of services R&D. Recently, various papers started investigating the lack of international comparability in sector-specific R&D expenditure. Very few of them, however, examined this lack of comparability in an EU-US context.

In this paper we focused on the impact of differences in practices between national statistical offices in Europe and in the US when classifying the reported R&D expenditure by industry. More in particular we examined the impact of these differences on a correct appreciation of the role of the services sector in the EU-US R&D investment gap. According to official statistics, services industries indeed appear to explain nearly the entire EU-US R&D intensity gap (US services demonstrating much higher R&D intensities than their European counterparts). We argue that this is almost entirely the result of a statistical artefact, i.e. the fact that R&D reported in the services sector is in the EU to a much larger extent redistributed by statistical offices to the corresponding manufacturing sectors (for which R&D has been executed) than in the US. Contrasting with some general beliefs in this matter, we therefore conclude that the EU R&D deficit against the US does not specifically emanate from the services sector.

This does not mean that the attention paid to services R&D by scholars and policy-makers is not justified. On the contrary, given the high interest in sector-specific R&D data and in the contribution of services to productivity gains, it is crucial that sustained efforts are being made to further improve the international comparability of Anberd data and other international sector-specific data on R&D expenditure. Countries (and their national statistical institutes) should be encouraged to use to a larger extent product field information on the R&D conducted. In co-ordination with the OECD and Eurostat, this would lead to better harmonised re-allocation practices of sector-specific data. At the same time, the researcher's community should be encouraged to intensify the analysis of services' innovation patterns and processes, in order to establish what types of R&D-like activities are underway in these sub-sectors. This, however, requires the availability of micro-data from R&D surveys and Community Innovation Surveys (CIS). While some modification in R&D measurement might be desirable to capture a larger spectrum of services R&D activities, it is also important to understand better the non-R&D elements of services innovation.

7 References

Abramovsky e.a. (2004), 'Increasing Innovative Activity in the UK? Where Now for Government Support for Innovation and Technology Transfer?", Institute for Fiscal Studies, Briefing note 53, November.

Arundel, A., M. Kanerva, A. van Cruysen, H. Hollanders (2007), 'Innovation Statistics for the European Service Sector', UNU-MERIT.

Baumol, W (2002), 'Services as leaders and the leader of services', in Gadrey and Gallouj (editors) (2002), "Productivity, Innovation and Knowledge in Services (Edward Elgar, Cheltenham UK, Northampton USA).

Bosworth, B.P. and Triplett, J.E., 'The Early 21st Century US Productivity Expansion is *Still* in Services', International Productivity Monitor, 14, Spring 2007, p. 3-19.

Davies, A. (2003) 'Integrated solutions: the changing business of systems integration' in Prencipe, A. Davies, A. and Hobday, M. (Eds.) The Business of Systems Integration, Oxford University Press, Oxford, 333-368.

Denis, C., Havik, K. and Mc Morrow, K (2006), *'EU Growth Trends at the Economy-Wide and Industry Levels'*, (DG Ecfin paper submitted to the EPC meeting of April 2006), Brussels, 2006).

Department of trade and Industry (DTI)(UK)(2005), 'R&D intensive Businesses in the UK', DTI Economics paper nr 11, March (http://www.dti.gov.uk/economics/economics_paper11.pdf).

Djellal, F. Francoz, D., Galouj, C., Gallouj, F. and Y Jacquin (2003) 'Revising the definition of research and development in the light of the specificities of services', Science and public policy, 30, no. 6, pp.415-429.

European Commission (2006), 'The future of R&D in services: implications for EU research and innovation policy', a report commissioned by the Science and Technology Foresight Unit of DG Research, Brussels

European Commission (2007), 'Key Figures 2007 on Science, Technology and Innovation. Towards a European research Area', (EUR 22572), Brussels.

European Commission (2007b), 'Monitoring Industrial Research: the 2007 EU Industrial R&D Investment Scoreboard', (EUR22928 EN), Brussels.

European Commission (2008), 'R&D in services – review and case studies', paper submitted for the CREST – R&D in Services Working Group, Brussels.

Gadrey, J., Gallouj, F. and Weinstein, O. (1995), 'New modes of innovation, How services benefit industry', International journal of service industry management, Vol. 6, No. 3, pp.4-16.

Gallagher, M., Link, A. and Petrusa, J. (2005), 'Measuring Service-Sector Research and Development. Final Report, Planning Report 05-1', National Science Foundation and National Institute of Standards and Technology, VA, US.

Golborne, N. (2004), 'R&D in services – does sector analysis tell the whole story?', Room document prepared for the meeting of the TIP group, 7-8 December.

Hipp, C. and Grupp, H. (2005), 'Innovation in the service sector: the demand for service-specific innovation measurement, concepts and typologies', Research Policy, 34 (4), May 2005, 517-535.

Howells, J. (2004), 'Innovation, consumption and services: encapsulation and the combinatorial role of services', The Services Industries Journal, 24, 19-36.

Lonmo, C. (2004), 'A note on Possible Contributing Factors to Differences in Industrial Performance in Services Sector Between OECD Member Countries', DSTI/EAS/STP/NESTI/RD(2004)6, June.

Miles, I. (2004) 'Innovation in services', in Fagerberg, J., Mowery, D. and Nelson, R. (eds.) The Oxford handbook of innovation, Oxford: Oxford University Press, 433-458.

Miles, I. (2007), 'Research and development (R&D) beyond manufacturing: the strange case of services R&D', R&D Management 37 (3), 249-268.

National Science Foundation, Division of Science Resources Statistics (2005), "National Patterns of Research and Development Resources: 2003", NSF 05-308, Brandon Shackelford (Arlington, VA 2005).

O'Sullivan, M., 'The EU's R&D Deficit and the Innovation Policy', (report to the 'Knowledge for growth' Expert group of EU Commissioner for Research J. Potocnik), April 2007 (http://ec.europa.eu/invest-in-research/pdf/download_en/rdd_deficit_report0207.pdf).

OECD (2005), 'Business enterprise R&D data by industry – A review of Anberd and other issues', (DSTI/EAS/STP/NESTI(2005)12), Working Party of National Experts on Science and Technology Indicators, Reykjavik, Iceland, May.

OECD (2006), 'Research and Development Expenditure in Industry (ANBERD) 1987-2004. 2005/2006 Edition', Paris.

Reneser report (2007) 'Research and Development needs of Business-Related Service Firms – Reneser Project, European Commission, DG Internal Market and Services, Brussels, Belgium.

Srholec, M. and Verspagen, B. (2008), 'The Voyage and the Beagle in Innovation Systems Land, Explorations on Sectors, Innovation, Heterogeneity and Selection', TIK Working Paper on Innovation Studies 20080220.

Tether, B.S. and Tajar, A. (2008), 'The organisational-cooperation mode of innovation and its prominence amongst European service firms', Research Policy 37 (4), May 2008, 720-739.

Young, A. (1996) 'Measuring R&D in Services' STI Working Papers, OECD/GD(96)132, OECD, Paris

Young, A. (2005) 'Measuring pharmaceutical R&D expenditure: some classification issues', unpublished mimeo, OECD, Paris.

Annex 1: The International Standard Industrial Classification (Isic), Rev3 of Industrial sectors

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Author(s): Vincent Duchêne, Elissavet Lykogianni and Arnold Verbeek (IDEA Consult)

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2009

Technical Note

Abstract
Under the influence of the Lisbon Strategy (2000), the Barcelona '3%' objective (2002) for more investment in research in Europe and the renewed Lisbon Strategy (2005), increased attention has been paid by both policy-makers and researchers to the origin of the EU-US R&D investment gap, which lead to a blossoming of papers and studies examining sector-specific contributions to this EU R&D 'deficit'. Given their weight in the economy and relatively low R&D intensity, services industries attracted a lot of attention in this context. Many reports emphasised the importance of services –and of more adequate 'services-specific' policies- to increase the overall EU R&D intensity. A large stream of literature investigated the causes of the apparent low services R&D intensity, putting the emphasis on the inadequacies of current statistical systems and the systematic under-recording of services R&D. Recently, various papers started investigating the lack of international comparability in sector-specific R&D expenditure. Very few of them, however, examined this lack of comparability in an EU-US context. This is exactly what this paper is aiming at.

In this paper we focus on the impact of differences in practices between national statistical offices in Europe and in the US when classifying the reported R&D expenditure by industry. More in particular we examine the impact of these differences on a correct appreciation of the role of the services sector in the EU-US R&D investment gap. According to official statistics, services industries indeed appear to explain nearly the entire EU-US R&D intensity gap (US services demonstrating much higher R&D intensities than their European counterparts). We argue that this is almost entirely the result of a statistical artefact, i.e. the fact that R&D reported in the services sector is in the EU to a much larger extent redistributed by statistical offices to the corresponding manufacturing sectors (for which R&D has been executed) than in the US. Contrasting with some general beliefs in this matter, we therefore conclude that the EU R&D deficit against the US does not specifically emanate from the services sector.

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