Research and Development Expenditure in the European Union – Chances and Challenges

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Abstract
Purpose – Research and development is nowadays a crucial global challenge. The European Union aims at building a competitive economy, however, its European Research and Development Policy, which is a common policy on increasing expenditure on this area, has not been achieved. The main aim of this article is to examine the expenses on R&D in the EU at present. The article also sets out to identify and analyse the question of investment in R&D in the European Union.
Methodology:
The comparative analysis in the following aspects:
1. Worldwide R&D investment - The EU in relation to China, Japan, US etc.
2. Expenditure on R&D in the EU
a. Public expenses
b. Private expenses (ranking of the EU companies by level of R&D investment)
3. Participation in R&D funding by the business enterprise sector.
The author examines some international reports and analyses the EU's position compared to its main competitors.
Findings:
1. Expenses on R&D are lower in the EU than in the US.
2. The European private sector is not sufficiently committed to investing in R&D.
3. The low expenses on R&D influence the low European commitment in creating knowledge and innovation.
Originality/Value:
The author explains the importance of R&D for the European Union.
The author presents the challenges for the growth of European competitiveness.
Keywords:
R&D, European Union, expenditure

Introduction

Research and development is nowadays a crucial global challenge. The European Union aims at building a competitive economy, however, its European Research and Development Policy, which is a common policy on increasing expenditure on this area, has not been achieved.

The main aim of this article is to examine the expenses on R&D in the EU at present and to focus on the main trends. The article also sets out to identify and analyse

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the question of investment in R&D in the European Union. Moreover, the following hypotheses will be verified:

- expenses on R&D are lower in the EU than in the US,
- the European private sector is not sufficiently committed to investing in R&D,
- the low expenses on R&D influence the low European commitment in creating knowledge and innovation.

The author explains the importance of R&D for the European economy. One of the additional objectives of the article is to address the question of whether the European Union after the Europe 2020 strategy has achieved a good level of R&D funding.

Methodology

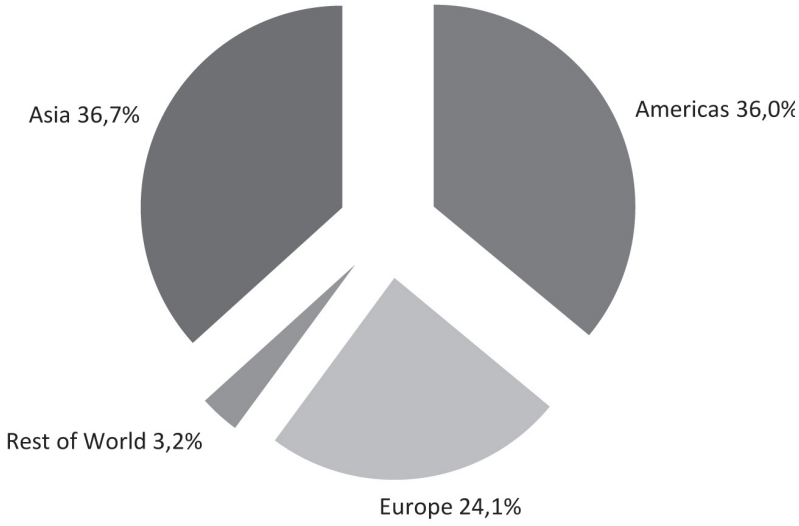
The Organisation for Economic Co-operation and Development (OECD) defines research and development as *creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications*[1]. R&D includes three activities: experimental development, basic research and applied research. Expenditure on research and development is a key indicator of private sector and government efforts to obtain a competitive advantage in science and technology. The main aggregate used for international comparisons is the gross domestic expenditure on R&D (GERD) as a share of GDP. GERD is composed of business enterprises, higher education, government and private non-profit expenditure on R&D. The main axis of investigation is a comparative analysis, which refers to the international statistical databases: the EUROSTAT and the OECD database.

R&D expenditure – the world

Knowledge is a basic element in the knowledge-based economy. Global competitiveness depends on the possession of knowledge and innovation by a country, for which reason R&D has taken on a new meaning. R&D has opened up one of the most important fields for government (activity). Global R&D spending will increase in 2012 compared with previous years. Most of the global funding (total of nearly 92% of all global spending on R&D) is being driven by Asian economies, which are expected to amount to 36.7%, European R&D is estimated to 24.1% and Americas to amount to 36% in 2012 (a forecast, Graph 1). Most R&D spending in Asia takes place in Japan, China and India. Global R&D spending is expected to grow by about 5.2% to more than $1.4 trillion in 2012. [Battelle and R&D Magazine 2011].

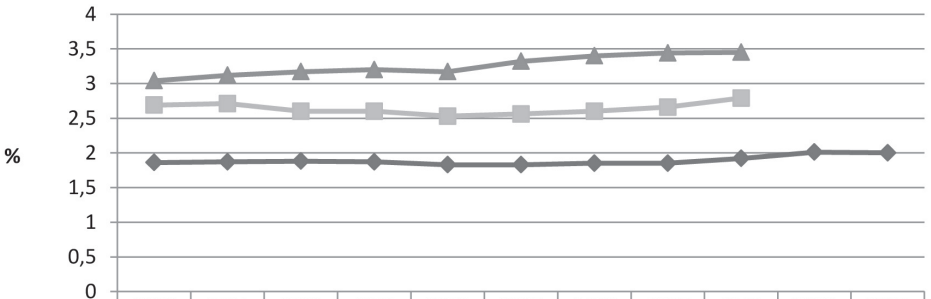
The Lisbon Strategy was a development plan devised in 2000, for the economy of the European Union between 2000 and 2010. Its aim was to make the EU *the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion*. Its goal was found to affect economic growth, including employment rates, higher education and R&D. However, most of the Lisbon Strategy goals were not achieved.

[1] § 57, Frascati Manual, OECD 2002.



Source: *2012 Global R&D funding forecast* (2011), "Battelle and R&D Magazine".

Graph 1: Share of total global R&D spending in 2012 – forecast

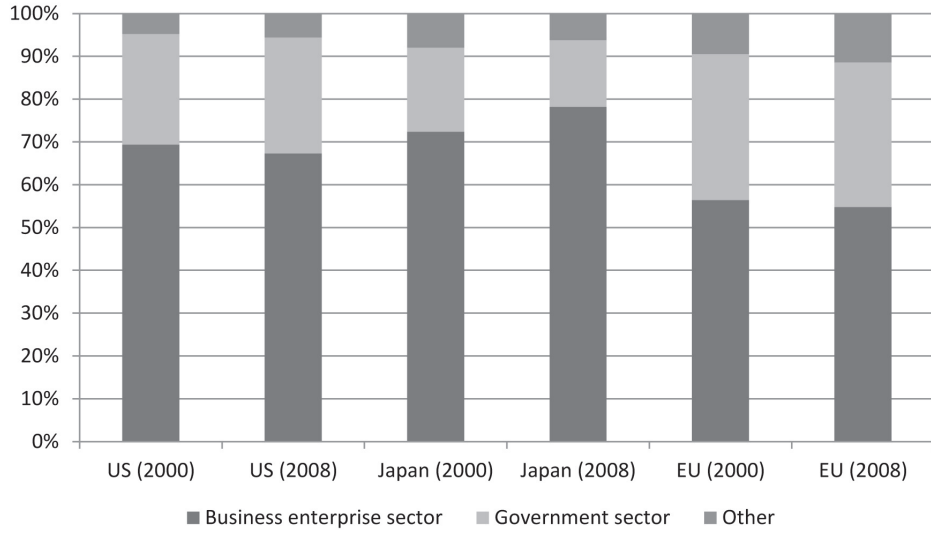


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
EU-27	1,86	1,87	1,88	1,87	1,83	1,83	1,85	1,85	1,92	2,01	2
US	2,69	2,71	2,6	2,6	2,53	2,56	2,6	2,66	2,79		
Japan	3,04	3,12	3,17	3,2	3,17	3,32	3,4	3,44	3,45		

Graph 2: Expenditure on R&D in 2000-2010 (% of GDP)

No available data for US and Japan in 2009-2010.
Source: EUROSTAT.

To focus on R&D spending, a comparison should be drawn between Europe, the US and Japan. According to the figures below, the most important problem is a wide gap between the EU, the US and Japan. The US R&D expenditure averaged 2.6% of GDP in the period 2000-2008, the Japanese 3.2%, while in the European Union it was 1.8% of GDP in the same period. In Japan the ratio rose from 3.04% to 3.45% of GDP, in the US from 2.69% to 2.79% of GDP in 2008, while the EU ratio rose from 1.86% to only 2% of GDP in 2010. The level of the European R&D expenditure in 2010 had been achieved by Japan and the US by 2000 (Graph 2). There is a marked difference between the structure of the gross domestic



Graph 3:
Gross domestic expenditure on R&D (GERD) by source of funds in 2000 and 2008

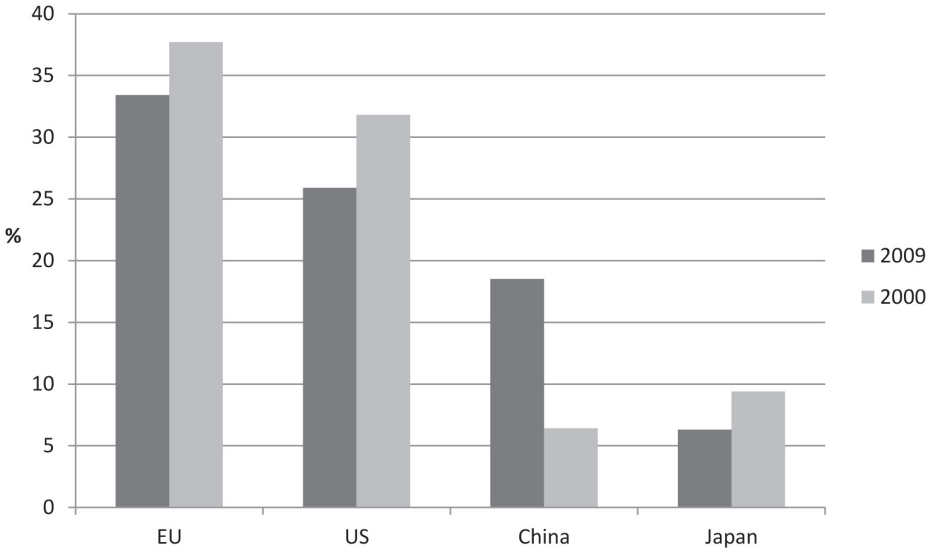
Source: EUROSTAT

expenditure on R&D (GERD) in the EU, the US and Japan; in the European Union less than 55% of R&D was funded by the business enterprise sector, while in Japan above 70% in 2000 and 2008. In the European Union the government sector is committed to funding R&D on a bigger scale than in the US and Japan (Graph 3).

An analysis of the trends in the R&D expenditure and its structure in the following years shows relatively lower expenses within the EU when compared to its main competitors. The business sector is not sufficiently committed, which is one of the most important drawbacks of the European system.

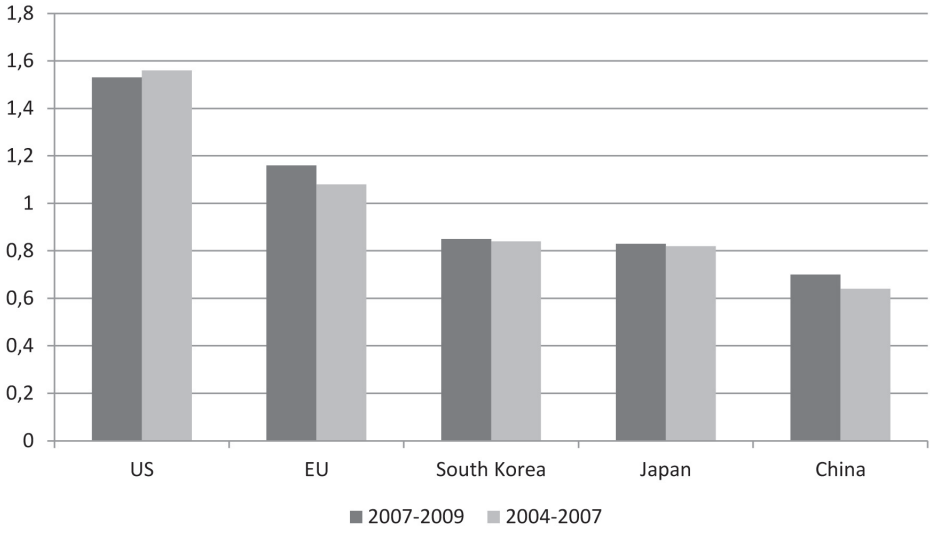
However, the EU achieved surprisingly good results in the number of scientific publications. The European Union remains the largest producer of scientific publications with 33.4% of the world's total scientific publications in 2009, followed by the United States (25.9%), China (18.5%), Japan (6.3%). The interesting fact is that China was catching up rapidly from 6.4% of the world's total scientific publications in 2000 to 18.5% in 2009, while the shares of the EU, the US and Japan worldwide were falling in the same period: in the European Union from 37.7% to 33.4%, in the US from 31.8% to 25.9%, and in Japan from 9.4% to 6.3% (Graph 4).

The European Union occupies the second place with regard to its contribution to the 10% most cited scientific publications in the world. In 2007 the scale of the EU's contribution was 1.16. *An indicator of above 1.0 means that the country contributes more to highly-cited high-impact publications than would be expected from its share in total scientific publications worldwide* [*Innovation Union Competitiveness Report 2011*]. The US performed better than the EU with its indicator above 1.5. The EU's ratio is well above those of South Korea, Japan and China. The EU also improved its scientific quality from 1.08 in 2004 to 1.16 in 2007 (Graph 5). According to this indicator, Denmark, Belgium, the Netherlands achieved the highest quality in their scientific publications in the EU [*Innovation Union Competitiveness Report 2011*].



Source: *Innovation Union Competitiveness Report 2011*, European Commission 2011.

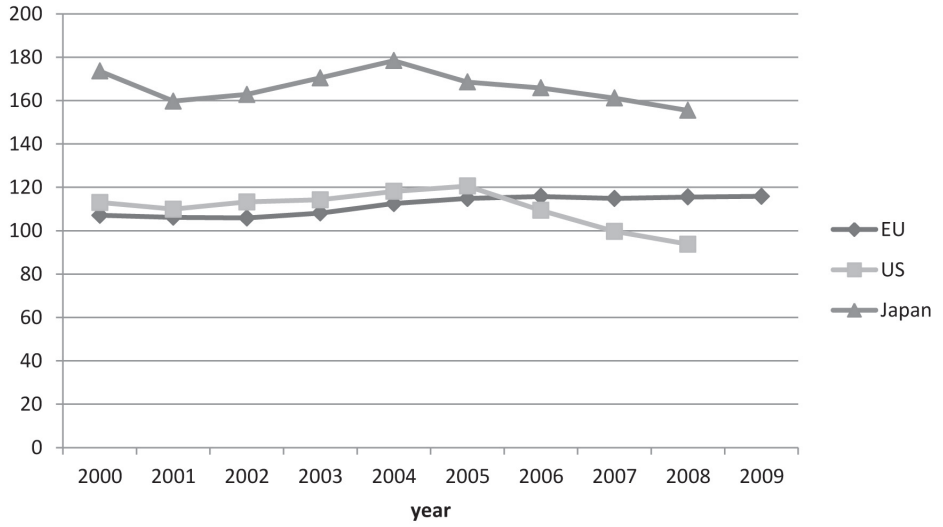
Graph 4: World shares of scientific publications in 2000 and 2009 (%)



The numerators are calculated from the total number of citations per publication for the publications published in 2004 and cited between 2004 and 2007 and in 2007 and cited between 2007 and 2009.
Source: *Innovation Union Competitiveness Report 2011*, European Commission 2011.

Graph 5: Contribution to the 10% most cited scientific publications.

Contrary to the relatively good European position in scientific publication in the world, the EU is less competitive in patent applications. Between 2000 and 2005 the EU achieved similar values to the United States in patent applications to the European Patent Office (EPO). After 2005 the EU was stagnating, while Japan and the US showed a decreasing tendency (Graph 6).



Graph 6:
Patent applications to the EPO by priority year at the national level (per million of inhabitants)

No available data for US and Japan in 2009.
Source: EUROSTAT

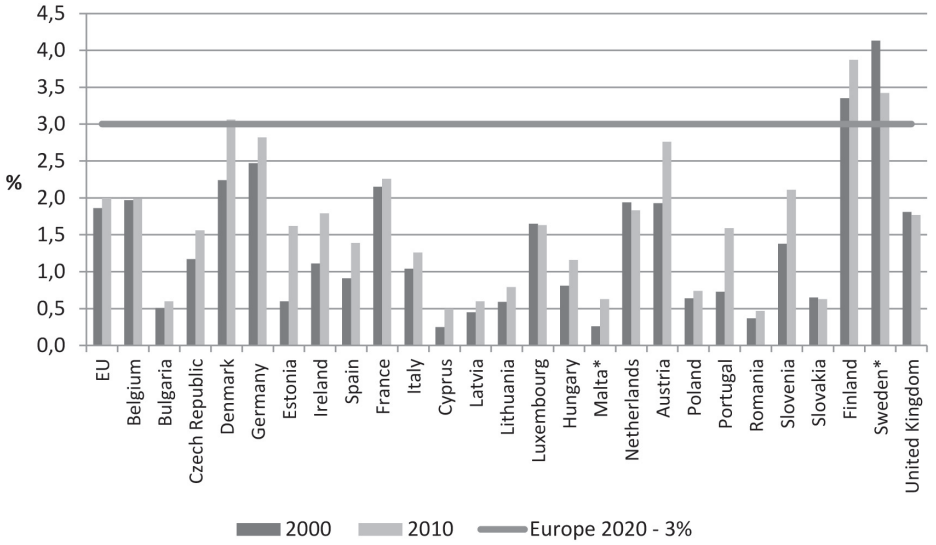
R&D expenditure – the European Union

Science and innovation are often considered as important drivers for economic development and growth in the European Union. The European Council launched the Lisbon Strategy in 2000, which aimed at transforming the EU into *the most competitive and dynamic knowledge-based economy in the world* by 2010. In Barcelona (2002) another strategic element was added, namely to spend at least 3% of GDP on research by 2010, of which two thirds were to be financed by the business sector. The main focus of the Council meetings was that the European Union and each of the Member States should invest more in knowledge and innovations. However, most of the Lisbon Strategy goals were not achieved. Its principles were endorsed in the next European Strategy, known as *the Europe 2020 strategy for smart, sustainable and inclusive growth*, including a guideline to optimise support for R&D and innovation. One of the five headline objectives in the Europe 2020 strategy is to improve the conditions for research and development, in particular with the aim of raising combined public and private investment levels in this sector to 3% of GDP.

The 2010 total expenditure on R&D in the EU amounted to 2% of GDP. In Finland, Sweden and Denmark it was over 3% of GDP; in these Member States one of the most

important aims of Europe 2020 was achieved in 2010. However, in a majority of states R&D expenses were below 2% of GDP. As shown on Graph 7, there are big differences between the EU Member States with respect to R&D funding. (Graph 7).

According to the figures above, the highest average annual growth in 2000-2010 was in Malta, Estonia and Portugal, less marked in Sweden and the Netherlands. However,



Graph 7: Total R&D expenditure in the European Union (% of GDP)

* Data for 2001 or 2003 and 2010.
No available data for Greece.
Source: EUROSTAT

some Member States made good progress as well but still remain far from the EU targets. In some Member States like the United Kingdom, Slovakia, Belgium and Luxembourg, R&D expenses were on the same (or similar) level in 2000-2010 (Table 1).

In April 2011 the National Reform Programmes (NRP) approved by the EU Member States. The NRP also refer to one of the most important EU targets – expenditure on R&D. As predicted, the EU targets will not be achieved by 2020. The European Commission estimated that in 2020 R&D expenditure would amount to 2.67-2.72% of GDP – the EU's average. One of the serious problems is that some Member States will not achieve more than 2% of GDP (Table 2). An analysis of the figures below shows that the EU target concerning R&D is too ambitious.

In a minority of Member States, the commitment of the business enterprise sector to 2009 R&D funding is estimated at less than 50%. The highest average annual growth was noted in Latvia, less so in Lithuania and Slovakia. In a majority of states, the basic source of R&D funding was the government sector. (Table 3) It is conducive to meeting the European strategy targets. Nevertheless, insufficient R&D funding by the business sector remains an issue for the EU.

Country	2000	2010	change 2000 to 2010	average annual growth 2000–2010 (%)
European Union	1.86	2	0.14	1%
Belgium	1.97	1.99	0.02	0%
Bulgaria	0.51	0.6	0.09	2%
Czech Republic	1.17	1.56	0.39	3%
Denmark	2.24	3.06	0.82	3%
Germany	2.47	2.82	0.35	1%
Estonia	0.6	1.62	1.02	11%
Ireland	1.11	1.79	0.68	5%
Spain	0.91	1.39	0.48	4%
France	2.15	2.26	0.11	1%
Italy	1.04	1.26	0.22	2%
Cyprus	0.25	0.5	0.25	7%
Latvia	0.45	0.6	0.15	5%
Lithuania	0.59	0.79	0.20	3%
Luxembourg	1.65	1.63	-0.02	0%
Hungary	0.81	1.16	0.35	4%
Malta	0.26	0.63	0.37	16%
Netherlands	1.94	1.83	-0.11	-1%
Austria	1.93	2.76	0.83	4%
Poland	0.64	0.74	0.10	2%
Portugal	0.73	1.59	0.86	9%
Romania	0.37	0.47	0.10	3%
Slovenia	1.38	2.11	0.73	5%
Slovakia	0.65	0.63	-0.02	0%
Finland	3.35	3.87	0.52	1%
Sweden	3.8	3.42	-0.38	-1%
United Kingdom	1.81	1.77	-0.04	0%

Table 1:
Total R&D expenditure in the European Union (% of GDP) – change (increase or decline) and average annual growth[1]

No available data for Greece.
[1]Malta 2002-2010, Luxembourg 2003-2010, Sweden 2003-2010.
Source: EUROSTAT

Member States	R&D in % of GDP	Member States	R&D in % of GDP
AT	3.76	IT	1.53
BE	3.0	LV	1.5
LT	1.9	LU	2,3-2,6
BG	1.5	MT	0.67
CY	0.5	NL	2.5
CZ	1 (only public sector)	PL	1.7
DE	3	PT	2.7-3.3
DK	3	RO	2
EE	3	SE	4
EL	to be revised	SI	3
ES	3	SK	1
FI	4	UK	no target in NRP
FR	3	EU target	3
HU	1.8	EU estimated	2.65-2.72
IE	approx.2		

Table 2: Europe 2020 target by National Reform Programmes (NPR) in 2011

Source: Europe 2002 targets available at: http://ec.europa.eu/europe2020/pdf/targets_en.pdf, (accessed 1March 2012).

Country	BUSINESS ENTERPRISES SECTOR			GOVERNMENT SECTOR		
	2001	2009	average annual growth 2001-2009 (%)	2001	2009	average annual growth 2001-2009 (%)
European Union	55.7	54.1	0%	34.1	34.9	0%
Belgium	63.4	58.6	-1%	22	25.3	2%
Bulgaria	27.1	30.2	2%	66.2	60.5	-1%
Czech Republic	52.5	44.6	-2%	43.6	43.9	0%
Denmark	61.4	60.2	NA	28.2	27.8	NA
Germany	65.7	66.1	0%	31.4	29.7	-1%
Estonia	32.9	38.5	2%	52	48.8	-1%
Ireland	66.7	51.2	-3%	25.6	31.3	3%
Greece	33	NA	NA	46.6	NA	NA
Spain	47.2	43.4	-1%	39.9	47.1	2%
France	54.2	52.4	0%	36.9	38.6	1%
Italy	39.7	44.2	3%	50.7	42.1	-4%
Cyprus	15.3	15.7	1%	65.5	69	1%
Latvia	18.3	36.9	15%	50	44.7	1%
Lithuania	37.1	21	-5%	56.3	53.9	0%
Luxembourg	NA	70.3	NA	NA	24.3	NA
Hungary	34.8	46.4	4%	53.6	42	-3%
Malta	46.8	51.6	3%	25.9	30	4%
Netherlands	48.2	45.1	NA	38.7	40.9	NA
Austria	41.8	47.1	2%	38.3	34.9	-1%
Poland	30.8	27.1	-1%	64.8	60.4	-1%
Portugal	31.5	44	5%	61	45.3	-4%
Romania	47.6	34.8	-2%	43	54.9	4%
Slovenia	54.7	58	1%	37.1	35.7	0%
Slovakia	56.1	35.1	-5%	41.3	50.6	3%
Finland	70.8	68.1	0%	25.5	24	-1%
Sweden	71.7	58.8	NA	22.3	27.5	NA
United Kingdom	45.5	44.5	0%	28.9	32.6	2%

Table 3: GERD by source of funds (%) in the European Union[1]

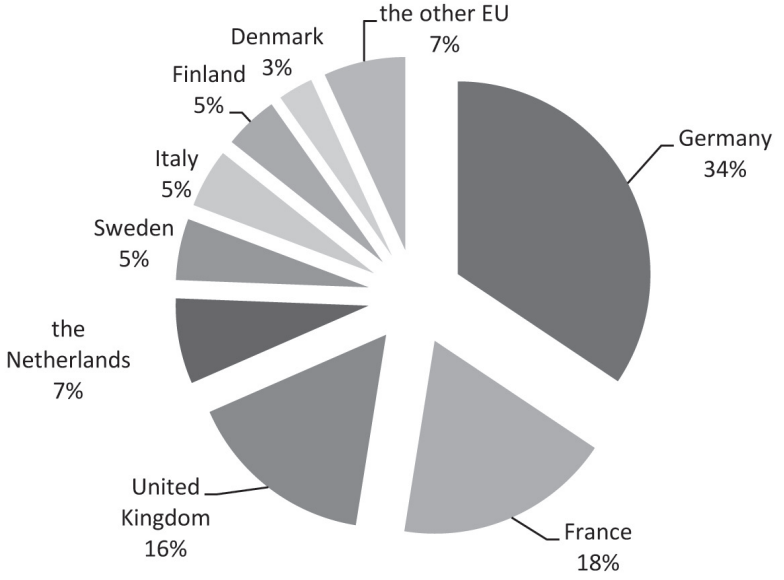
NA – No available data for each year.
[1]Italy 2005-2009, Malta 2005-2009.
Source: EUROSTAT

Participation in R&D funding by the business enterprise sector

Following the data from *The EU's Industrial R&D Investment Scoreboard,* the EU share in R&D investment by the top 1400 companies (% of total €455.9bn) amounted to 29% in 2011, while the share of the US amounted to 35.1%, of Japan 21.7% and other countries 14.2%. The last group mainly includes companies based in emerging markets such as South Korea, China, India, Taiwan [*The EU Industrial R&D Investment Scoreboard* (2011)].

The top 10 companies invested more than €5bn in R&D and account for 13.7% of the total R&D investment by the 1400 *Scoreboard* companies. In 2011 the world's top 100 group includes 29 EU firms and 71 non-EU companies. The world's top R&D investor is the Swiss company Roche. The largest EU firm in terms of R&D investment is Volkswagen (€6.26bn) in 6th position. There are five US companies in the top ten: Pfizer (€7.02bn), Microsoft (€6.74bn), Merck US (€6.40bn), General Motors (€5.19bn) and Johnson & Johnson (€5.10bn). The other firms in the top 10 are Toyota (€6.67bn) from Japan, Samsung (€6.18bn) from South Korea and Novartis (€6.02bn) from Switzerland [*The EU Industrial R&D Investment Scoreboard* (2011)].

In the European Union almost two thirds of company investment in R&D comes from Germany, France and the United Kingdom (Graph 8). At the top of the EU's companies are two enterprises from Germany (Volkswagen and Daimler) and Nokia from Finland. The top 50 group includes 13 companies from Germany, 13 companies



Source: *The 2011 EU Industrial R&D Investment Scoreboard*, European Commission.

Graph 8: R&D investment (top companies) by main country in the European Union, 2010

from France and 9 from the UK. In the Europe is low commitment company from the EU-12. (Graph 9).

The EU companies in the world's top 50 are mainly from ICT-related sectors, the Automobile & Parts and Pharmaceuticals. The non-EU companies are mostly from Pharmaceuticals & Biotechnology, IT-related sectors and Automobile & Parts sectors. [*The EU Industrial R&D Investment Scoreboard* (2011)].

The European Union should create suitable incentives to encourage to invest in R&D by company. It would be more beneficial if Member States provided tax credits or incentives to companies with actively operating R&D programs. The Member States should support cooperation between universities and industries in R&D manufacturing, as well as create R&D programs at a national level. The questions raised above may encourage companies to commit to R&D funding.

Conclusions

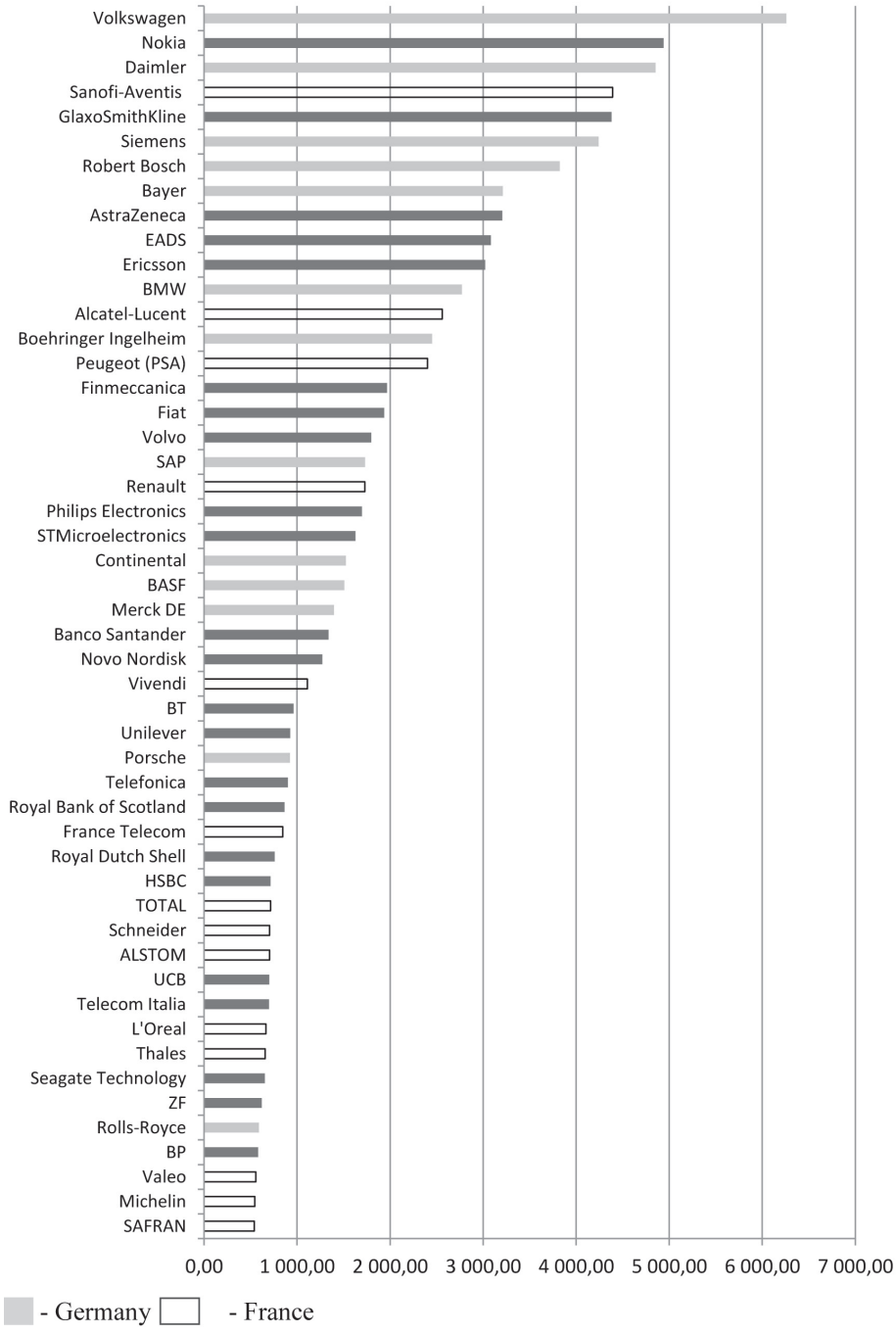
The R&D system of the European Union is far from perfect. The issues that come to the fore are:

- low expenditure on R&D compared with its major competitors (US, Japan) especially by the private sector,
- weak knowledge exchanges between Science and Industry,
- low percentage of scientific publications among the most cited publications worldwide.

R&D expenditure is relatively lower in the EU than in the US or Japan. A total of nearly 92% of global spending on R&D comes from Asia (36.9%), the US (31.1%) and the European Union (24.1%). The private sector is insufficiently committed to investing in R&D. In 2011 the world's top 100 group (R&D investment by the top companies) included only 29 EU firms and 71 non-EU companies. In spite of the fact that the European Union remains one of the largest producers of scientific publications, it should still improve its scientific quality.

The low R&D expenditure, significant differences between the public and the business sectors in R&D funding, wide disparities between the Member States in GERD, the real difficulties with meeting the Europe 2020 Strategy targets (especially regarding R&D expenses) all pose a serious problem for the European R&D policy. These issues represent a real challenge for the European Union for the near future.

The EU should introduce some structural changes in R&D, which would improve the consolidation of public finances and safeguard the resources for future growth and competitiveness. This should be done by means of investing in growth-enhancing policies, such as research and innovation. The business enterprise sector can innovate and should be encouraged to invest in R&D. Innovation creates a more knowledge-intensive world. Moreover '*the fast-growing enterprises in the most innovative sectors of the economy are the most important for the development of emerging industries and for the speeding up of the structural changes that Europe requires in order to become a knowledge based economy with sustained economic growth and high quality jobs' [Innovation Union Competitiveness Report 2011]*.



Source: *The 2011 EU Industrial R&D Investment Scoreboard*, European Commission.

Graph 9: The EU's to 50 companies by their total R&D investment in 2011 Scoreboard (euro million)

Investing in R&D will generate some advantages:

- for the EU as a global actors because it will improve economic competition,
- for the business enterprise sector because it will improve the quality of production,
- for the Member States because it will help to creating a knowledge-based economy.

"The Innovation Circle" (Chart 1) shows the links between expenditure on R&D, economy and social growth. It is a simple relationship which illustrates that R&D can involve a lot of social and economic areas. It is necessary to emphasise that an increase in R&D expenses should be combined with a structural reform in the R&I system. The reform should improve the structure of R&D funding (by the public and the private sectors), support knowledge transfer between academia and industry, as well as it should introduce a legal framework for conditional expenditure on science and innovation upon quality.

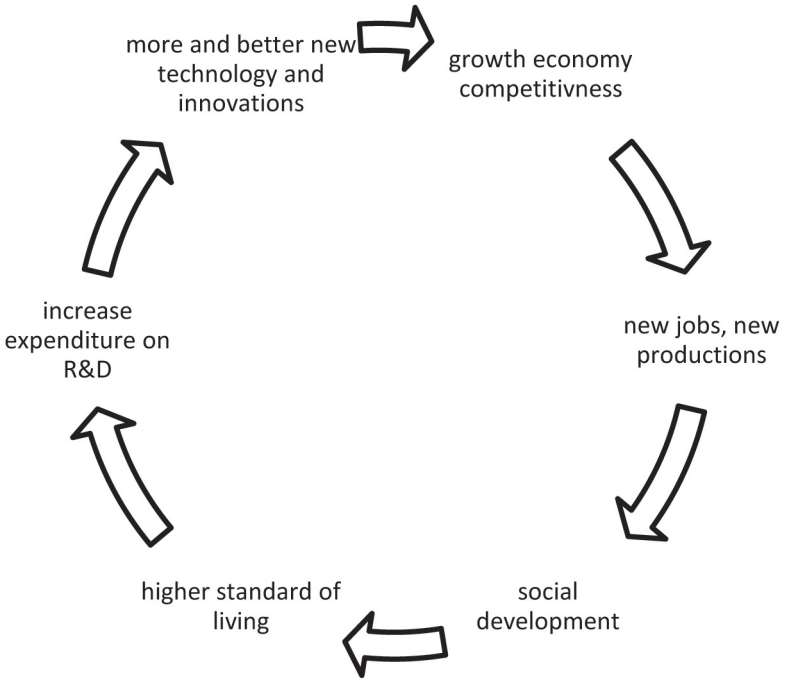


Chart 1:
Innovation circle

Source: Author's study

References

- *EUROSTAT – Science, Technology and Innovation,* available at:. http://epp.eurostat.ec.europa.eu/portal/page/portal/science_technology_innovation/data/main_tables, (accessed 26 February 2012).
- *Europe 2002 targets* available at: http://ec.europa.eu/europe2020/pdf/targets_en.pdf, (accessed 1March 2012).
- "2012 Global R&D funding forecast" (2011), Battelle and R&D Magazine, available at:. http://www.battelle.org/ABOUTUS/rd/2012.pdf, (accessed 26 February 2012).

- OECD (2011), *Main Science and Technology Indicators*, OECD Publishing, available at:. http://www.oecd.org/document/26/0,3746,en_2649_34451_1901082_1_1_1_1,00.html, (accessed 1 march 2012).
- *OECD Science, Technology and Industry Scoreboard 2011: Innovation and Growth in Knowledge Economies* (2011), OECD Publishing**,** available at:. http://www.oecd.org/document/10/0,3746,en_2649_34451_39493962_1_1_1_1,00.html#toc, (accessed 1 march 2012).
- *The EU Industrial R&D Investment Scoreboard (2011)*, European Commission, available at:. http://iri.jrc.es/research/scoreboard_2011.htm, (accessed 26 February 2012).
- *The Innovation Union Competitiveness* (2011), European Commission, available at:. http://ec.europa.eu/research/innovation-union/index_en.cfm?section=competitiveness-report&year=2011, (accessed 26 February 2012).