Working Paper
Research Division EU Integration
Stiftung Wissenschaft und Politik
German Institute for International
and Security Affairs

Nora Albu

Research and Development spending in the EU: 2020 growth strategy in perspective

Ludwigkirchplatz 3–4
10719 Berlin
Phone +49 30 880 07-0
Fax +49 30 880 07-100
www.swp-berlin.org
swp@swp-berlin.org

Working Paper FG 1, 2011/Nr. 08, December 2011
SWP Berlin

Table of Contents

Abstract:

Spending on research and development (R&D) in the European Union (EU) diminishes as we move from the North-West to the South-East. Considering great differences in both the investment and the output of innovative goods across the EU, the feasibility of R&D convergence can be questioned. Thus, goals like those of the 'EU 2020'[1] growth strategy proscribing a spending of 3% of the national GDP on R&D are put to the test. On the one hand, the achievement of the set targets is a challenge for an economically unified Europe and requires more effort for some of the Member States. On the other hand, setting achievable targets calls for a confrontation with their actual industrial R&D infrastructure. At this stage, the discrepancies between the bigger and the smaller spenders indicate an amelioration of R&D efforts within the Euro zone, specifically for Greece, Ireland and Portugal, and a divergence within the Non-Euro zone. Thus, an increasing dispersion between the most and the least innovative countries within the EU is the result.

Introduction

The subject matter of this paper is the private and public Research and Development (R&D) spending on innovation, which constitutes the source of long run endogenous economic growth. In particular, we are analysing the divergence between the R&D spending target as outlined in the Europe 2020 strategy (3% of GDP) and the actual spending of EU Member States (on average below 2% of GDP [1.39% in 2007[2]]). In order to investigate the feasibility of convergence towards the set target, we focus primarily on the less than 1% of GDP on R&D from private spenders, a group consisting of mostly Mediterranean and Central and Eastern European countries, even though some Western European countries are also failing to meet the target. We assume that an investigation of a bigger group such as the less than 2% of GDP on R&D from private spenders will distract from the far greater difficulties in achieving the 3% of GDP on R&D target shared by the less than 1% of GDP on R&D from private spenders due to their poor industrial line of business. Furthermore, by contrasting the investment patterns of the stronger countries and that of the more challenged ones, we will differentiate between the sources of R&D spending and show existing institutional inefficiencies that stand in the way of the desired goal. Thus, this paper aims at providing a deeper understanding of the actual performance, the obstacles towards achieving the desired growth target and the long run prospects of R&D convergence within the EU.

Our results can be summarised in three points: firstly, the difference in strength of business investment in research between countries of the Euro zone and the New Member States is wide; secondly, the percentage of full-time researchers between those two groups mirrors the private R&D effort, exposing the latter, most vulnerable group; thirdly, the number of signed

[1] Online brochure: http://ec.europa.eu/europe2020/index_en.htm

[2] The European average is calculated based on the latest full dataset for the EU 27 pool from Unesco and Eurostat, see Figure 2 in the appendix.

patents depends on the R&D diversity in the industrial line of business, which is missing for most of the New Member States.

This paper is structured as follows: the first section outlines the strategic guidelines towards sustainable and inclusive growth as stated both by the Lisbon Strategy and the Strategy of Europe 2020 and points at institutional inefficiencies. The second section provides the theoretical framework to explain the core implications to endogenous growth necessary to reach the strategic R&D target. The third section presents the databases and compares the target performance of the 2007 R&D expenditure further distinguished by business, government and higher education sources of spending for the Member States, the Euro zone and the Non-Euro zone. The fourth section analyses the different R&D investment compositions using the 2007 data sample which shows a clear distinction between strong private[3] sources of R&D investment and predominantly public[4] and higher education[5] R&D funding. A fifth section presents two perspectives for the analysis of target performance: the first perspective considers the Euro zone in contrast to the Non-Euro zone and the second perspective contrasts the Mediterranean group of Greece, Italy, Portugal and Spain (GIPS) with the New Member States which joined the EU in 2004. The sixth section concludes with a discussion of the prerequisites necessary for successful achievement of the Brussels target, while also providing a list of arguments in favour of a relativisation of the 3% of GDP on R&D set target leading towards a more realistic approach to recommendations and long term prospects.

1. Lisbon Strategy target of 2002 and the Europe 2020 strategy

This section explains the origin and the development of the growth Strategy that yields the 3% of GDP on R&D target and reflects on the inefficiencies within the outline of the institutions to produce the desired results.

In 2000, the EU drafted a growth strategy called “Lisbon Strategy”. In the following years, the strategy was adjusted several times, including a significant step in 2005 that involved a refocus on growth and employment and a clearer breakdown of responsibilities. In 2002, the European Council defined the objective of 3% of GDP allocated to R&D[6] spending, 2/3 of which ought to be realised by private funding. In analogy to this Council decision, also the EU’s latest growth strategy, Europe 2020, called ‘A European strategy for smart, sustainable and inclusive growth’ contains targets for public and private R&D investment: 3% of the EU’s GDP (which is currently below 2%) should be invested in R&D.

[3] Private and business will be used interchangeably as a source of investment in R&D

[4] Public and state will be used interchangeably as a source of investment in R&D

[5] Higher Education and academic will be used interchangeably as a source of investment in R&D

[6] UNESCO Statistical Yearbook 1980 defines R&D as including fundamental and applied research, as well as experimental development.

In order to achieve this goal, the EU2020 strategy contains seven flagship initiatives. The first aim is to achieve an 'Innovation Union,'[7] which ensures that innovative ideas can be translated into goods and services that create growth and jobs. Another one is to establish an 'Industrial Policy for the globalisation era'[8] in order to improve the business environment for small and medium-size enterprises and to ensure the support of a strong industrial base able to compete globally. The strategy clearly stresses that a 'stronger economic governance will be required to deliver results'[9] but acknowledges that it can only provide an outline of priorities, headline targets and country specific recommendations; thus leaving Member States to develop their own strategies to return to sustainable growth and public finances. The European Commission defines Europe's *structural weaknesses in the last decade* as among the primer causes for the widening 'productivity gap'[10] between Europe and its main economic partners (e.g. 2.6% in the US and 3.4% in Japan). The reason being differences in business structures combined with lower levels of investment in R&D and innovations, along with insufficient use of information and communications technologies[11].

Even though the European Commission simply adopted the same 3% of GDP spending on R&D target as set by the European Council, the institution is aware of the required efforts to steer progress. For example, inefficiencies such as too much attention on 'input and not on impact'[12] have been pointed out. In addition, the Commission recognises that the conditions for private R&D spending in the EU need to be improved and suggests that R&D investment and innovation intensity should be looked at together in order get a broader range of expenditures, which would also be more relevant for business in operations and for productivity drivers.

Another important observation concerns the difficulty to contribute to the R&D target for governments that are engaged in budgetary consolidation programmes after having accumulated debt. Thus, the massive indebtedness after the Euro crisis in the case of Greece, Ireland and Portugal represents a real challenge for any R&D investment, especially on the public side.

Moreover, the Commission invited Member States to prioritise 'growth-enhancing items'[13] such as education and skills, R&D and innovation and investment in networks, for example high speed internet, energy and transport interconnections. In order to reach the desired result, however, the Council should provide further guidance and necessary impulses to key themes like research, innovation and skills.

A further weakness impeding the achievement of the targets could be

[7] Europe 2020, p. 3; http://eunec.vlor.be/detail_bestanden/doc014%20Europe%202020.pdf
[8] ibid, p.4
[9] ibid
[10] Europe 2020, p. 5; http://eunec.vlor.be/detail_bestanden/doc014%20Europe%202020.pdf
[11] Ibid
[12] Ibid, p.8
[13] Ibid, p.24

the diffusion of knowledge occurring between the different institutions: the European Commission, which monitors and the Council, which produces the strategy. Although the Commission, besides monitoring the situation, offers to help Member States to set priorities and to make hard choices, the empowerment of the Council in the form of how much it can weigh into the decision-making process of the national sovereign is central for the realisation of the growth strategy.

Now that the head has figured out the strategy, the question remains as to whether the limbs are capable of performing accordingly.

2. Theoretical explanation for the 3% R&D target

This section explains the relationship between R&D investment and economic convergence by providing an insight into the theoretical side of the endogenous growth process which relies both on human and physical capital investment. Statistics show that, although the returns to R&D investment are stronger for developing countries, their institutional attributes are weaker.

So why do we need growth and how do we generate it? A consumerist take would be that we constantly seek to improve our standard of living. An economic approach would be that growth offsets the Bermuda triangle of debts, demographic decline and increasing welfare costs. However, the basic logic of growth, as pointed out by Baldwin and Wyplosz[14], rests with the decision to invest in new physical capital (machines), new human capital (skills) and new knowledge capital (innovations). Whereas, *with time, the factors of production machines and labour exhibit still positive but diminishing returns to capital invested*, *both skills and innovations offset the effect of diminishing returns and define the long run growth rate of output*.

The exogenous growth model by Robert M. Solow (1956) suggests that in the long run, the equilibrium growth rate of an economy depends exclusively on the rates of population growth and labour augmenting technical progress. Thus, as long as the demographic as well as the efficiency of labour are exogenously defined, steady-state growth will also be exogenous. The new endogenous growth theory has resolved the unsatisfying feature of the neoclassical model: it has rectified the process by which technical change is generated emphasising knowledge and human capital formation. Paul M. Romer (1986) introduces knowledge externalities that promote accelerating knowledge, acquisition and growth. Thus, endogenous growth emerges when the aggregate stock of human capital is allowed to have an external effect as in Romer (1990). However, a different take on endogenous growth is the emphasis of investment in physical capital. Kaldor (1957), Kaldor and Mirlees (1962), and Scott (1989) suggest that endogenous growth operates through the effects of investment spending on the flow of technological innovation,

[14] Baldwin, R. and Wyplosz, C. "The economics of European Integration" McGrew-Hill Education Ltd.: Berkshire, 2004, p. 166.

with technical progress being the endogenous product of capital accumulation. Investment generates technical progress and therefore opens possibilities for further technical advances.

The technical progress in question, as defined by Josef Schumpeter, 'is increasingly becoming the business of teams of trained specialists who turn out what is required and make it work in predictable ways'[15]. However, investment in R&D also involves a non-negligible risk: uncertainty of innovative output. Therefore, there are several quantitative indications available for the investor as well as for a general assessment to estimate the amount of risk involved. These parameters include indications for R&D effort like general R&D intensity, which measures the share of GDP spent on R&D, or other examples like the number of firms investing in R&D, the number of researchers, and the number of registered patterns.

Whereas the former figures do not necessarily explain all cross-country differences in R&D effort, intuitively the economic level of development is positively linked to R&D effort. Lederman and Saenz have generated a regression of the log of the ratio of total R&D expenditures to GDP on log GDP per capita using a sample of 99 countries and 1386 observations[16] to show that R&D expenditure rises exponentially with the level of development measured by GDP per capita. The wealthier a country is, the more capital is spent on research.

At this stage the question about the return to R&D investment is posed. Primarily, the social return to R&D investment is much higher than the private rate of return, since innovation is a proximate source of productivity growth[17]. Although there is controversy surrounding the exact empirical estimates[18] concerning the rates of return to R&D between the G7 and the remaining 15 OECD countries[19], there is agreement that the 'returns to R&D in developing countries are above those for industrialised countries'[20].

Surely if the returns are higher in poor countries, why do rich countries not invest more in R&D as a share of GDP in these countries? The institutional cross-country differences are pointing towards the existence of stronger incentives for investment in some countries rather than others. Acemoglu, Robinson and Johnson argue that 'some way of organising society encourages people to innovate, to take risks, to save for the future,

[15] Schumpeter, J. "Capitalism, Socialism and Democracy" Routedge: New York, (2003[1943]), p.132.

[16] Lederman, D. and Saenz, L., "Innovation and development around the world, 1960-2000," Policy Research Working Paper Series 3774, The World Bank, 2005, Figure 1a p. 26.

[17] Helpman, E. "The mystery of economic growth", Belknap Press of Harvard University Press: London, 2004, p. 43.

[18] Coe, D. and Helpman, E. "International R&D Spillovers," NBER Working Papers 4444, National Bureau of Economic Research, Inc., 1995.

Guellec, D. and van Pottelsberghe de la Potterie, B. "R&D and Productivity Growth: Panel Data Analysis of 16 OECD Countries," OECD Economic Studies, OECD Publishing, vol. 2001(2), pages 12.

[19] Lederman, D and Maloney, W., "Research and development (R&D) and development," Policy Research Working Paper Series 3024, The World Bank, 2003, p. 3.

[20] ibid

and to find better ways of doing things, to learn and educate themselves, solve problems of collective action and provide public goods'[21].

Whereas we will shed light onto the relevant institutions in the section six, we can already presume that rich countries tend to have better institutions and therefore allow for more R&D effort.

3. Empirical analysis of R&D performance

This section presents the database used and then stresses that the substantial differences in R&D spending and the performance of individual countries represent a challenge for meeting the target, but more importantly for a convergence between the stronger and the lesser spending countries.

3.1. Method and databases

We have mostly used the database provided by Eurostat as a source for our empirical study of R&D spending in the EU. In addition, data from the Unesco database have been used. Although the figures were available for the year 2008, 2009 and even 2010 for some countries, the complete dataset for all 27 EU Member States is only available for 2007, as data for Greece has not been made available for the subsequent years. In particular for 2007, we have compared data from Eurostat and Unesco in figure 2 in the appendix to see whether there is a discrepancy between the sources, which we can disclaim due to minor decimal differences only. Although there have been some developments[22] in R&D expenditure from 2007 to 2010 among the stronger spending countries and especially for Ireland and Portugal from 2007 to 2009, it should be stressed that the country-specific increase on R&D investment over the past four years will not substantially alter the core argument of this paper.

3.2. Empirical analysis for 2007

Based on the actual spending on R&D by the business, the government and the higher education sectors for the year 2007[23] as well as the Gross Domestic Expenditure on R&D (GERD: including the private, public and academic expenditure), we point out that with the exception of Finland and Sweden, *none of the EMS comply with the 3% R&D target set by the Lisbon Strategy*. Furthermore, a differentiation between the Western, the Mediterranean and the New Member States will prove useful for analysing the potential for convergence for the lesser spending countries.

[21] Acemoglu, D. and Johnson, S. and Robinson, J. "Institutions as the Fundamental Cause of Long-Run Growth," CEPR Discussion Papers 4458, C.E.P.R. Discussion Papers. 2004, p. 12.

[22] See figure 1 below: 'GERD/GDP spending development for EU 27 beyond 2007'

[23] See Annex: Table 1

Table 1[24] shows that the average GERD expenditure for the Euro zone countries compared to the Non-Euro zone countries is higher, except for the government share of total GDP on R&D. From the total average of Gross Domestic Expenditure on R&D per GDP (GERD/GDP), the Euro zone's public spending share is 13.25% compared to 21.77% for the Non-Euro zone. Furthermore, we can differentiate between the 3% GDP on GERD + 2/3 private R&D compliance and those who do not meet the target. Finland, belonging to the Euro zone, and Sweden, which does not, are the only Member States meeting the 2020 growth target, whereas *all other member states miss the target*. Due to non-adherence by the majority of the countries, this paper suggests a further distinction between countries over and under a 1% of GDP on private R&D compliance. The latter distinction allows us to form four groups:

For the Euro Zone:		For the Non-Euro Zone:	
over 1% of GDP on private R&D	Finland, Austria, Germany, Belgium, France, Luxemburg	over 1% of GDP on private R&D	Sweden, Denmark, United Kingdom
under 1% of GDP on private R&D	Netherlands (0.97%), Slovenia, Ireland, Spain, Portugal, Italy and Greece (0.15%)	under 1% of GDP on private R&D	Czech Republic* (0.95%), Estonia*, Hungary*, Malta*, Lithuania*, Romania*, Latvia*, Slovakia*, Poland*, Bulgaria* and Cyprus* (0.1%)

As shown in the over- and under- 1% of GDP on private R&D group for the EU countries, the under-1% group includes the Mediterranean countries Greece, Italy, Portugal, Spain plus Ireland and the New Member States[25] that joined in 2004. On the one hand, the dichotomy between the over- and under- 1% of GDP on private R&D group could be translated in terms of the political weight carried by these Member States within the decision-making process of the European Council. On the other hand, the four groups are also an indication for the heterogeneity within the EU. The latter is an important aspect that should be taken into account with regards to the feasibility of converging towards the same steady-state growth path.

[24] Table 1 in the appendix

[25] Marked with a * in the table.

Map 1. Map of Europe displaying business R&D expenditure in 2007 according to the 2/3 business R&D target

3.3. Business expenditure analysis in volume

This subsection first analyses the industrial provenance of private R&D per GDP expenditure for the two target complying countries, then moves on to the over 1% of GDP on private R&D group for the Euro zone and the Non-Euro zone, and finally looks at the under 1% of GDP on private R&D group also for the Euro zone and the Non-Euro zone.

The quantitative data has been extracted from the 2007 EU Industrial R&D Investment Scoreboard [26] using the R&D ranking of the top 1000 companies by Member States and rearranging the table to display industrial sector specific R&D expenditure. For example in the Finnish case, where we observe a compliance with the 3% of GDP on GERD as well as

[26] http://iri.jrc.ec.europa.eu/research/scoreboard_2007.htm

with the 2/3 private R&D target, we can read on Table 2[27] below that 78.55% of the total R&D expenditure by the top 1000 companies is on telecommunications and equipment. Unsurprisingly, the Finnish top spender on R&D in 2007 is Nokia[28] with € 5 281 million. Similarly for Sweden, 38.69% of GERD spent by the top 1000 companies comes from the telecommunications and equipment sector. The top Swedish spender on R&D in 2007 was Ericsson[29] with € 2 911.03 million.

Moving on to the over 1% of GDP on private R&D group within the Euro zone: Austria, Belgium, France and Germany have evenly spread specialisation with the exception of the automobile industry in Germany and France, which produces an equivalent of 48.51 % and 24.62% respectively of the total R&D spent by the top 1000 companies. Another example is the focus on the pharmaceutical industry in Luxembourg and Belgium with respectively 46.09% and 30.38% of the total R&D spent by the top 1000 companies. Within the Non-Euro zone: Denmark and the UK have an equally diversified R&D investment spending, not disregarding a focus for both economies on the pharmaceutical industry, with respectively 45.62% and 39.64% of the total R&D spent by the top 1000 companies. With regards to the target complying duo and the over 1% spending group, and also taking into account the country-specific industry focuses, the Euro zone as well as the Non-Euro zone display a rather *even distribution of R&D investments*. This indicates a developed industrial infrastructure and a competitive market structure.

Comparing the over 1% group with the under 1% group, with the exception of the Netherlands, Italy[30] and Spain, the contrast both in volume and diversity of R&D investment is pointing at micro- and macroeconomic differences within the business R&D infrastructure. Furthermore, the scarce and in some cases missing business R&D investment such as for Greece, Slovenia, Bulgaria, Cyprus, Estonia, Latvia, Lithuania, Malta, Poland, Romania and Slovakia, which can be seen in the Scoreboard, Table 2[31] , are an indication for insufficient investment going hand in hand with uncertainty about the long run prospects of the status quo in research. For example, the aggregate business R&D investment of the above mentioned eleven EMS make *up less than 1% of the total German private R&D expenditure*, whereas the GIPS group, including Ireland, adds up to a share of just *under 18% of the German R&D expenditure by businesses.*

[27] Annex: Table 2

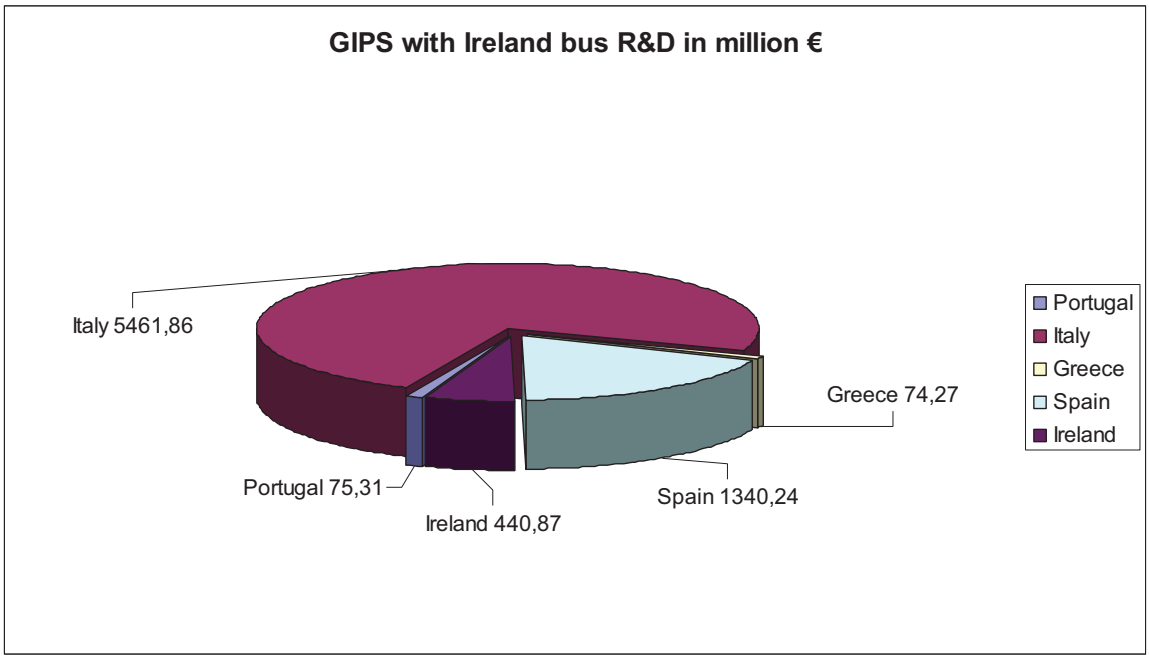
[28] ibid, top 10 companies 2007, UNESCO.

[29] Ibid, top 10 companies 2007, UNESCO.

[30] Graph 1 shows that in volume Italy is misplaced within the GIPS with Ireland group.

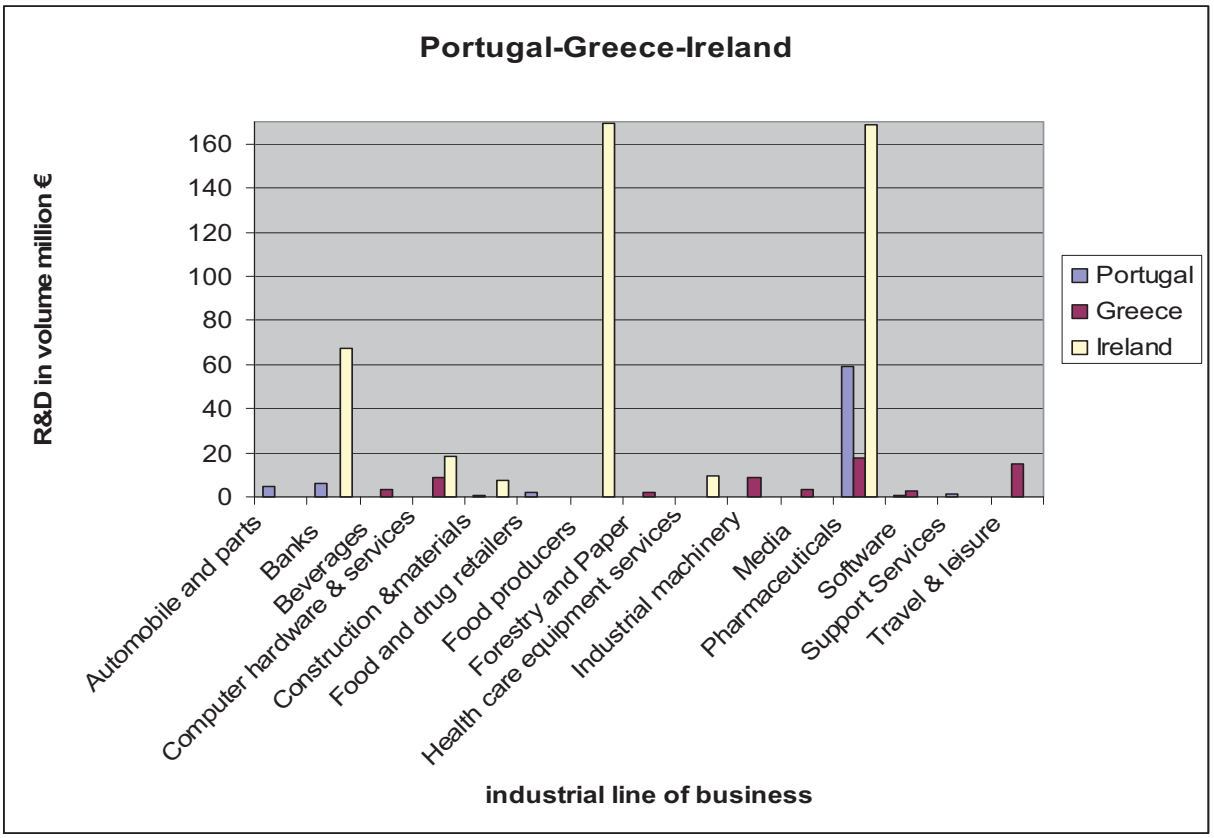
[31] See Table 2 in Annex

Graph 1. Greece, Italy, Portugal and Spain including Ireland business R&D expenditure in 2007

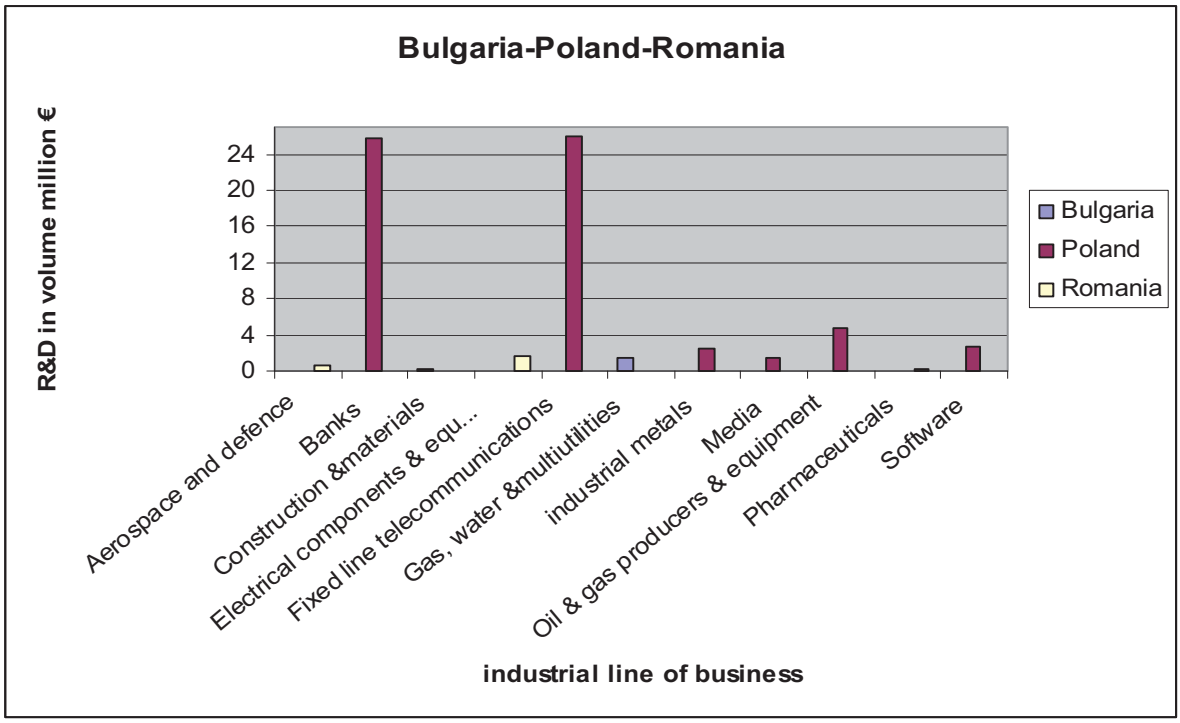


Another aspect is the stark difference within private R&D investment according to the industry in the R&D-challenged countries of the EU. Thus, we find that despite some similarity between the country size and the industrial capacity, the differences in the industries could be explained by the geographical proximity to a bigger spending country. For example, if we compare Portugal, Greece and Ireland in the Euro zone, as shown below in Graph 2, with Bulgaria, Poland and Romania in the Non-Euro zone, as displayed below in Graph 3, we can assume that the geographical proximity to a country with more important business spending, like the UK in the case of Ireland and Germany for Poland, must be an important factor explaining the differences with regards to the investment in specific lines of business. In section four we will further elaborate on the importance of regional R&D spill over-effects in the case of employment of full-time private researchers.

Graph 2. Industrial line of business and R&D expenditure in 2007 for Portugal, Greece and Ireland



Graph 3. Industrial line of business and R&D expenditure in 2007 for Bulgaria, Poland and Romania



4. Typological differentiation of investment composition within the EU27 pool

The following section will split GERD into its sectoral spending source (private, public and higher education) and classify the EU Member States in three different categories depending on their deviation from the investment composition of the target-complying Member States, Finland and Sweden. Although the investment pattern for most of the countries matches the 'Finland-Sweden' type for the Euro zone, the intensity of the R&D share within the private sector among the Non-Euro zone still differs greatly.

The categorisation with regards to the country-specific composition between sources of R&D investment in private, public and higher education allows us to differentiate between two types of investment patterns: the strong privately funded over 1% of GDP on GERD group and the predominantly publicly and higher educational funded under 1% of GDP on GERD group. Taking into account the heterogeneous nature of the EU27 pool in industrial infrastructure, market competition and the diversification in goods and services produced, we intend to generate a performance-based classification with respect to the set EU strategic goals. Furthermore, since both Finland's and Sweden's R&D spending complies with the EU target, we will use their investment composition of private, public and higher education as a bench mark in order to compare the

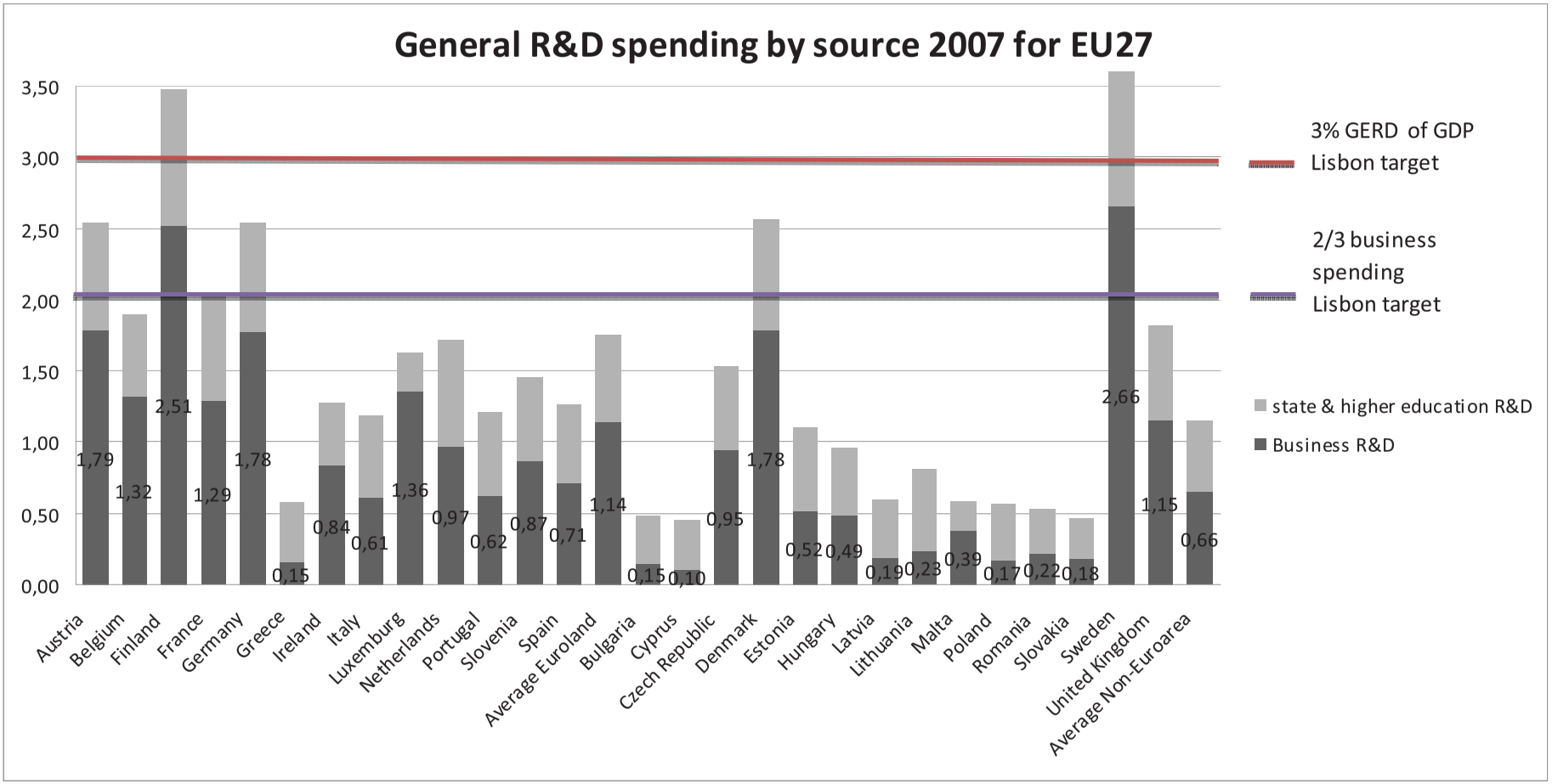
investment pattern of the remaining EMS. Consequently, when turning to the R&D investment data specific to the sectoral source of the investment, table 1 shows that Finland is displaying a 72.3% on private R&D investment share of its GERD, a further 21.13% on higher education R&D investment share, and a remaining 8.07% on public R&D investment share[32]. Similarly, Sweden is presenting a 73.74% on business R&D investment share of its GERD, a further 21.29% on higher education R&D investment share, and a remaining 4.8% on public R&D investment share[33].

The notable abundance in business R&D and target compliance enables a categorization of three types according to their actual R&D investment composition: the first category implies that the predominant R&D investment is made by the business sector; the second category implies that the predominant R&D investment is made by institutions for higher education, and the third category implies that the predominant R&D investment is made directly by the state:

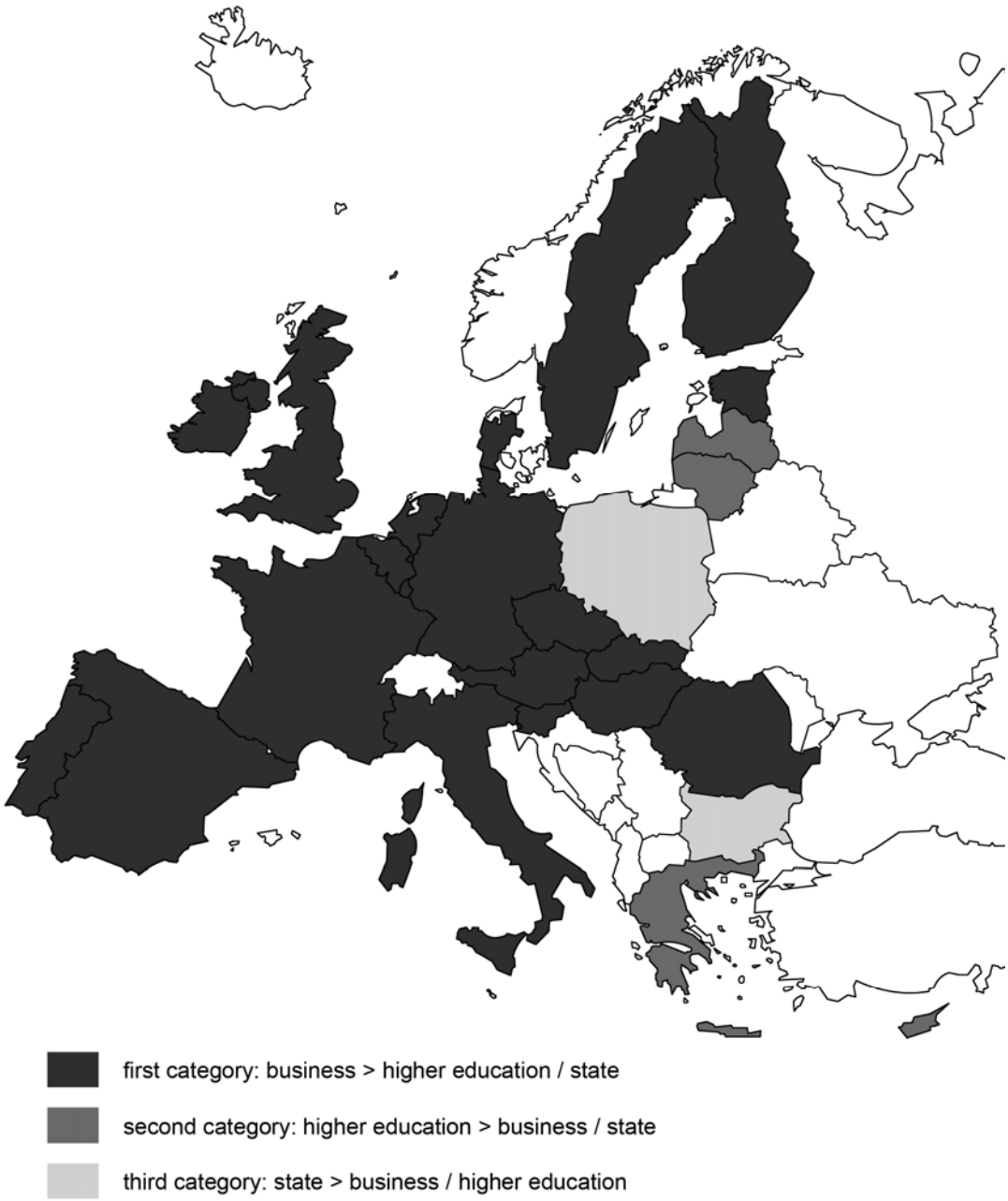
First Category: business > state / higher education
Second Category: higher education > business / state
Third Category: state> business / higher education

[32] Annex: Table 1
[33] ibid: Table 1

Graph 4: Gross Domestic R&D spending by source in 2007 for EU27



Map 2. Map of Europe displaying R&D classification according to highest spending sector



The sketched typology into categories and the R&D compliance with the EU target can be combined as displayed in Table 3 below. At first glance, we can depict a homogenous gathering within the Euro zone. Both the over and under 1% of GPD on private R&D groups, as defined in the previous section, are situated in the First Category with a predominant share of privately funded R&D. Slovenia and Ireland show a higher

business R&D investment share than state and higher education funded R&D. Concerning the GIPS countries, Italy, Portugal and Spain, which are situated under the 1% of GPD on private R&D mark, show a business investment that is almost equally as strong as the public and higher educational investment together. However, for Greece, being the only Euro zone country that does not belong to the First Category group, the share of the business sector is smaller than both the higher education and public sector investment in R&D. Considering the Non-Euro zone, we can see in Table 3 that the over 1% of GPD on private R&D group, i.e. Sweden, Denmark and the UK, belongs to the same R&D investment Category as the majority of Euro zone countries.

Table 3: Typology according to investment composition and business R&D performance[34]

Performance 2007 (GDP/business R&D) and (number of patents)	Business Predominance: First Category	Academic Predominance: Second Category	Public Predominance: Third Category
Euro zone: over 2% GDP/business R&D	**Finland (1323)**		
Euro zone: over 1% and under 2% GDP/business R&D	Austria (1797); Luxemburg (110); Germany (23929); Belgium (1472); France (8421)		
Euro zone: under 1% GDP/business R&D	Netherlands (3656); Ireland (288);Spain (1451); Portugal (121); Italy (5107); Slovenia (103)	Greece (109)	
Non-Euro zone: over 2% GDP/business R&D	**Sweden (2719)**		
Non-Euro zone: over 1% and under 2% GDP/business R&D	Denmark (1057); UK (5422)		
Non-Euro zone: under 1% GDP/business R&D	Estonia (23); Malta (8); Czech Republic (162); Hungary (173); Romania (21); Slovakia (42)	Latvia (19); Lithuania (8); Cyprus (9)	Bulgaria (29); Poland (145)

For the rest of the Non-Euro zone with the exception of the Czech Republic (0,95 % of GDP/business R&D) all of the New Member States show a very

[34] Source Table 3: own elaboration using R&D data from UNESCO and number of signed patents from Eurostat uploaded on the 2nd of August 2010.

low percentage of business R&D spending. Thus, even though Estonia, Hungary and maybe Malta are in slight contrast[35] to the others, consisting of Bulgaria, Cyprus, Latvia, Lithuania, Poland, Romania and Slovakia, the majority of the New Member States have two factors in common: first, a higher state plus higher educational funded rather than private R&D sourcing; second, extremely weak business investment into R&D coupled with weak business R&D infrastructure[36]. Consequently, the Non-Euro Zone has more diversified R&D investment patterns compared to the homogenous Euro zone, showing a private predominance in R&D funding with the exception of Greece.

When comparing the less than 1% of GERD on business R&D groups within the Euro zone and the Non-Euro zone, the private R&D intensity of Ireland, the Netherlands, Slovenia and the Czech Republic is very similar, and is almost identical [37] in the case of Italy, Portugal and Spain. However, the rest of the Non-Euro countries that joined the EU in 2004 and 2007 along with Greece greatly differ from the over groups. For example Bulgaria and Romania, with respectively 0,48% and 0,53% of GDP on GERD in 2007 and which both joined the EU in 2007, only spend a little less on R&D than, for example, Greece with 0,57% of GDP on GERD. But they differ with regard to the composition of the investment: in Bulgaria, the largest part of research is paid for by the state, in Romania most R&D investment is made by businesses and in Greece the majority comes from institutions of higher education.

However, in order to pin down the inefficiencies responsible for the divergence between the under 1% of GDP on private R&D groups within the Euro zone and the Non-Euro zone, we will inquire into the number of researchers in the different sectors and their performance with regards to the number of patents singed by the European Patent Office (EPO).

5. Detailed analysis of the under 1% of GERD on private R&D investment profile

The following section focuses on the micro-level, revealing the incentives for spending on research by businesses. Thus, we elaborate on shortcomings such as too little employment of researchers in the market and few signed patents which are disincentives to R&D spending.

Helpman[38] stresses that the private rate of R&D depends on institutional features, such as the length of patent protection, the coverage of trademark protection, the efficiency with which the legal system protects the intellectual property rights, and the nature of the regulatory framework within the business, but the assessment of the quality of the institutions is difficult due to missing data. We have chosen two institutional features

[35] See Graph 4

[36] See Appendix: Table 2

[37] See Appendix: Table 2

[38] Helpman, E. “The mystery of economic growth”, Belknap Press of Harvard University Press: London, 2004, p. 44.

that are quantifiable: the allocation of researchers and their performance measured in the number of patents signed. These shall serve as an indication for the improvement of institutional inefficiencies.

Table 4 below is plotting the percentage of full-time (FT) researchers in the private sector in a given country against the employment of researchers according to the prevailing sector (private, public or higher education). Whereas in the EU27 predominantly full-time researchers are being employed in the private sector, the intensity of full-time private researchers varies from over 60% in cases like Austria, Luxembourg, Sweden and Denmark to a low of 12,94% for Slovakia. Moreover, the researcher intensity (above 50% of FT researchers) is strongest within the private sector compared to the higher education and public ones, and additionally the share of researchers is asymmetrical to the R&D investment pattern of Table 3 above.

Countries like the Netherlands and Ireland, belonging to the less than 1% of GERD on business R&D group, are showing a more efficient allocation of researchers with less resources, as they have a lower private spending pattern than the over 1% of GERD on business R&D group. Belgium, on the other hand, although being only slightly below a 50% allocation of private researchers when contrasted with the Netherlands, produces less than half of the former's patent output[39]. In analogy to the modest private R&D spending of the Mediterranean group (Greece –Italy – Portugal – Spain) the percentage of private researchers is relatively low even though it exhibits a mainly private investment in R&D pattern.

Table 4: Full-time researchers in the private sector in percentage and classification according to typology of investment pattern[40]

Employment predominance 2007 and % of researchers business sector	Business Sector Predominance	Higher Education Sector Predominance	Public Sector Predominance
Euro zone: over 50% of FT researchers	Austria (63,32%); Luxemburg (69,16%); Denmark (63,45%); Germany (59,93%); Ireland (57,32%); Finland (56,42%); France (54,95%); Netherlands (52,19%)		
Euro zone: over 20% and under 50% of FT researchers	Belgium (49,74%); Slovenia (41,14%)	Italy (35,35%); Spain (34,33%); Portugal (30,09%); Greece	

[39] View Table 3 and 4

[40] Source: own elaboration using UNESCO data downloaded on the 13th of September 2010. http://stats.uis.unesco.org/unesco/TableViewer/tableView.aspx

		(29,25%)	
Non-Euro zone: over 50% of FT researchers	Sweden (64,74%)		
Non-Euro zone: over 20% and under 50% of FT researchers	Malta (48,79%); Czech Republic (43,87%); Hungary (40,17%); Romania (41,23%);	UK (35,96%); Estonia (26,04%); Cyprus (22,78%)	
Non-Euro zone: under 20% of FT researchers		Poland (16,04%); Lithuania (15,37%); Slovakia 12,94%); Latvia (10,96%)	Bulgaria (11,76%)

Turning to the Non-Euro zone, we can further differentiate between the under 1% of GERD on business R&D group since they feature big discrepancies not only in private R&D effort, but in the allocation of full-time private R&D researchers as well. On the one hand, we can identify an amalgam between the Czech Republic, Romania and Hungary, all three belonging to the First Category investment type and exhibiting more than 40% full-time private researchers. On the other hand, another category type independent group made up of Slovakia, Lithuania, Latvia, Poland and Bulgaria show lower shares of private researchers, lying between 16,04% for Poland and 10,96% in the case of Latvia. Thus, we can assume that the relatively scarce allocation of private researchers can be explained by market inefficiencies such as an insufficient industrial R&D infrastructure.

However, taking another quantitative institutional factor into account like the number of patents signed per country [41] in Table 3 above allows for further information about the profile of the less than 1% of GERD on business R&D group. Within both the Euro zone and the Non-Euro zone, the number of signed patents is higher in countries exhibiting a diversified industrial R&D infrastructure as described in section three. Furthermore, Germany leads with almost 24 thousand patents signed at the EPO in 2007, followed in decreasing order by France, the UK, Italy, the Netherlands, Sweden, Austria, Finland and Denmark, for which the number of patents is greater than one thousand.

This subsection contrasts the patent output against both the R&D effort and the industrial R&D infrastructure. Within the Euro zone, a smaller group of countries consisting of Ireland (288 signed patents), Portugal, Luxembourg, Slovenia and Greece (only 109) have secured a relatively lower number of patents. Within the Non-Euro zone, the two groups are again category-independent: one rather efficient group consisting of

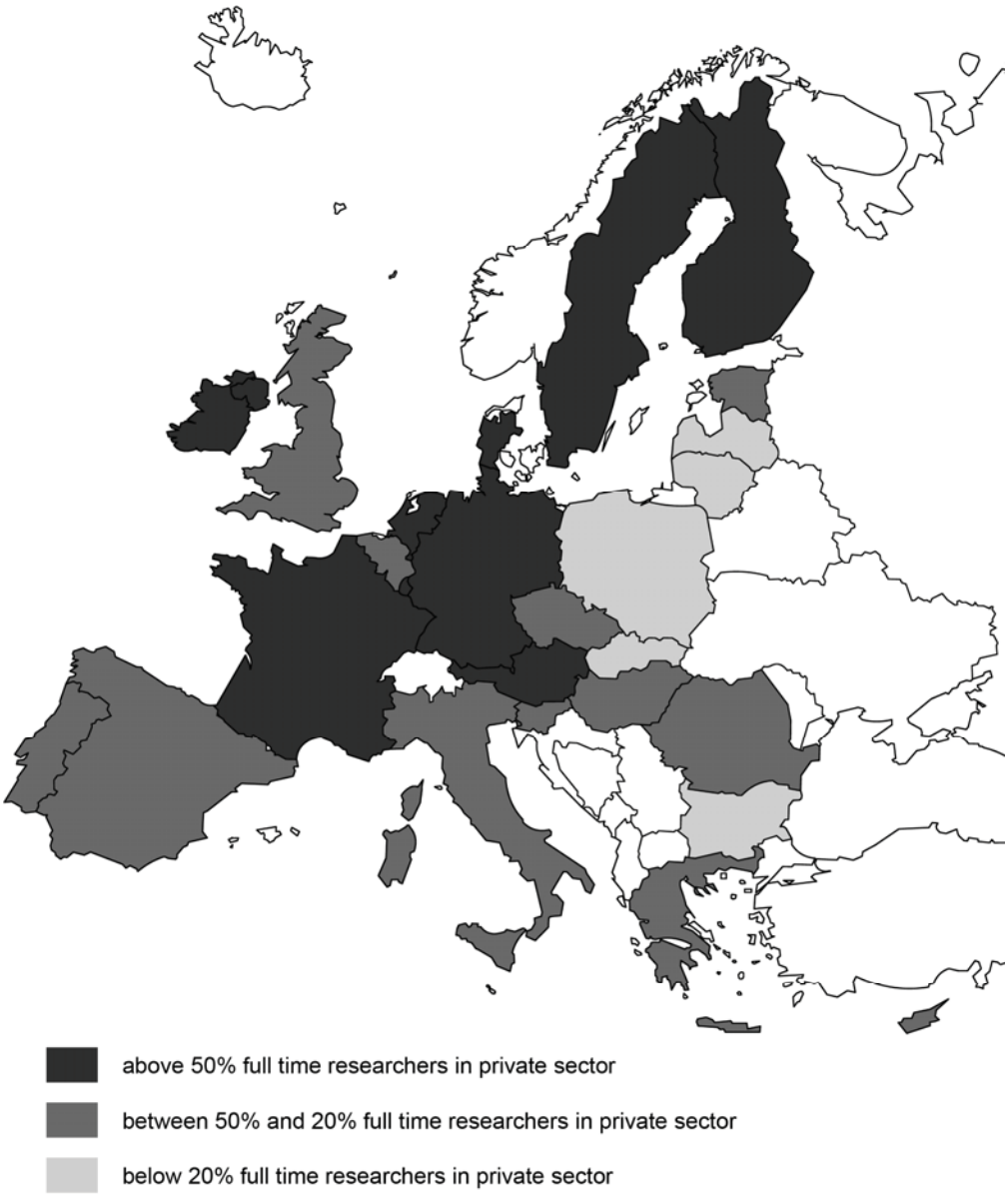
[41] Indicated in brackets behind the country name in Table 3

Hungary (173), the Czech Republic (162) and Poland (145) being slightly more productive than the Portugal, Luxembourg, Slovenia and Greece group within the Euro zone; the second rather inefficient group comprises Slovakia (42), Bulgaria (29), Estonia (23), Romania (21), Latvia (199), Cyprus (9) and Malta and Lithuania (8) holding only a modest number of patents in 2007 with a differing percentage allocation of private researchers for each country. Lastly, the UK (5422) and Italy (5107) show a comparable amount of signed patents with an equal allocation of 35% of private researchers, despite being situated respectively over and under the 1% of GERD on business R&D mark.

Thus, two important channels of productivity can be identified. First, the market size effect as stressed by Helpman,[42] which implies that the access to a larger market raises the profitability of inventive activities and encourages investment in R&D. The second effect is that of competition. Although there are firms like Nokia and Ericsson, as noted in section three, which make up a big share of the overall private R&D effort, we can nevertheless conclude that *for more than 1% of GERD on business R&D performers, the R&D activities are spread between a variety of fields*[43] as opposed to the scarcity of firms and fields for most of the under 1% spenders. This observation underlines that the competition effect[44] is another channel of productivity even if competition hurts profits, and consequently investment in R&D can decline because lower profits provide a lower stimulus for future R&D.

[42] Helpman, E. "The mystery of economic growth", Belknap Press of Harvard University Press: London, 2004, p. 65-7.
[43] Annex: Table 2
[44] ibid

Map 3. Map of Europe displaying the percentage of full time researchers employed in the private sector



6. What will become of Europe?

In the two previous sections we have seen that the gap in the intensity of the R&D investment by businesses between the majority of both the Euro zone and the Non-Euro zone is wide; further, we have established that the convergence of mostly state and higher education funded research towards more privately funded R&D depends on the political determination of the government to fix a budget in order to achieve long term economic growth implied by the 3% Lisbon target. Then, we have also seen that the discrepancy in R&D input and output between the majority of the New Member

States plus Greece and the rest of the Member States mirrors the R&D effort of the private investors for these countries. Lastly, we have identified the number of signed patents depends on the industrial R&D diversity, which is simply lacking for the majority of the New Member States where R&D funding depends on the state and the universities.

6.1. Measures to be taken on the EU level

From a national perspective, a first conclusion to be drawn would be that Europe needs to overcome its institutional inefficiencies in order to achieve convergence on the level of R&D expenditure. However, from a supra-national perspective, another important disincentive for the firms within countries experiencing less efficient economic and political institutions would be the costs and complexities of registering a patent with the EPO.

Research into the relationship between economic growth and institutional features has found that 'countries with stronger property rights and greater constraints on the executive have higher income per capita'[45]. A European Patent validated in 13 countries, for example, costs as much as € 20 000, of which nearly € 14 000 is due to translation. In contrast, the European Patent is more than ten times more expensive than the US Patent according to a press release of the EU Commission in July of this year[46]. In July of last year, the Commission proposed a Council Regulation that consists of decreasing the costs of a patent valid for the 27 European countries down to € 6 200 of which 10% would be translation costs. Furthermore, the Commission suggested an agreement upon an authentic text (patent) to be granted and published in one of the official languages of the EPO: English, French or German. Thus, not only will the costs be more affordable for the modest R&D spenders, but by simplifying the European patent procedure, the amount of administration will be reduced as well. This serves as an example of much needed simplification of the bureaucratic procedure, which creates a further incentive for more technology transfer through foreign direct investment (FDI) from one European country to another.

Whereas the simplification will have a great impact on technological exchange and cooperation within the EU, a special report in the Economist entitled 'Smart Work'[47] suggested a more imaginative incentive for national governments to boost innovation: offering prizes to firms that come up with breakthrough innovations in addition to encouraging private R&D spending through more traditional ways such as tax credits

[45] Acemoglu, D. and Johnson, S. and Robinson, J. "Institutions as the Fundamental Cause of Long-Run Growth," CEPR Discussion Papers 4458, C.E.P.R. Discussion Papers. 2004, p. 126-7.

[46] http://europa.eu/rapid/pressReleasesAction.do?reference=IP/10/870

[47] The Economist, October 9th 2010: Special report on the world economy: 'Smart Work: Faster productivity growth will be an important part of the rich economies' revival' p. 22-28

and subsidies. Thus, greater efforts to remove barriers as well as to create tailored conditions for small and medium size enterprises (SME) could result in a multilateral approach, instead of just picking winners and raising the R&D investment bar to what is, for some countries, currently an unrealistic sum of money to be spent as well as an unachievable output to be produced.

Nevertheless the main concern still remains the question: how to deal with economies spending less than 1% of GDP on business R&D? We have mentioned that technological innovation can only be sustained if supported institutionally. The fact is that these countries are exhibiting different R&D investment patterns, as stressed above, but, most importantly, they are still under-spending. At this point we need to abandon the polarised view juxtaposing the market to the state because the question as to what works best for the struggling countries - an abundance in either private or public research - is superfluous, as there simply is a lack of research full stop, despite potentially large social benefits and a high return on R&D investment. Even if basic scientific research may often seem unprofitable, governments have a special responsibility coupled with an opportunity if the market is debilitated by uncertainty and scarcity. Not to mention that private firms benefit from public knowledge as well.

Another issue is the impediment in form of the obligations tying the more challenged R&D spending countries to the Euro zone. The distinction drawn earlier between the Euro zone and the Non-Euro zone is crucial at this point. The less than 1% of GDP on private R&D spenders in the Euro zone are caught between a rock and a hard place. On the one hand, their market is not providing the necessary amount of investment to produce further growth such as in the case of Spain, and on the other hand, their governments are unable to raise more taxes or take up more debts for a necessary R&D injection into the country, like in Greece, Portugal and Italy. Thus, facing both constraints and possible sanctions from the side of the Stability and Growth Pact, which is an important feature of the Lisbon Treaty responsible for securing the Euro zone by limiting the amount of public indebtedness, the governments of the modest spending countries within the Euro zone have to prioritise between the stability of the single currency and the long term growth of their national economy.

Thus, the 3% R&D target as expressed in the Europe 2020 strategy stands in conflict with the ceilings of 60% public debt and the 3% budget deficit as stated in the Stability and Growth Pact. Directing our attention across the boarder of the Euro zone, the governments of the modest spending countries have, in comparison, more leeway to use both fiscal and monetary policy to their own advantage. The modest spenders of the Euro zone and the Non-Euro zone have different means by which the 3% R&D target can be reached. We therefore suggest either reconsidering the 3% target for the Euro-zone given the conflicting priorities especially in times of budget consolidation and debt reduction, or imposing a minimum private R&D investment through possible sanctions to which the single currency adherent countries must abide. As for the majority of countries in the Non-

Euro zone that are not even meeting the less than 1% of GDP per GERD, we suggest that the EU Council make a plan on how to create incentives for the governments to prioritise R&D projects.

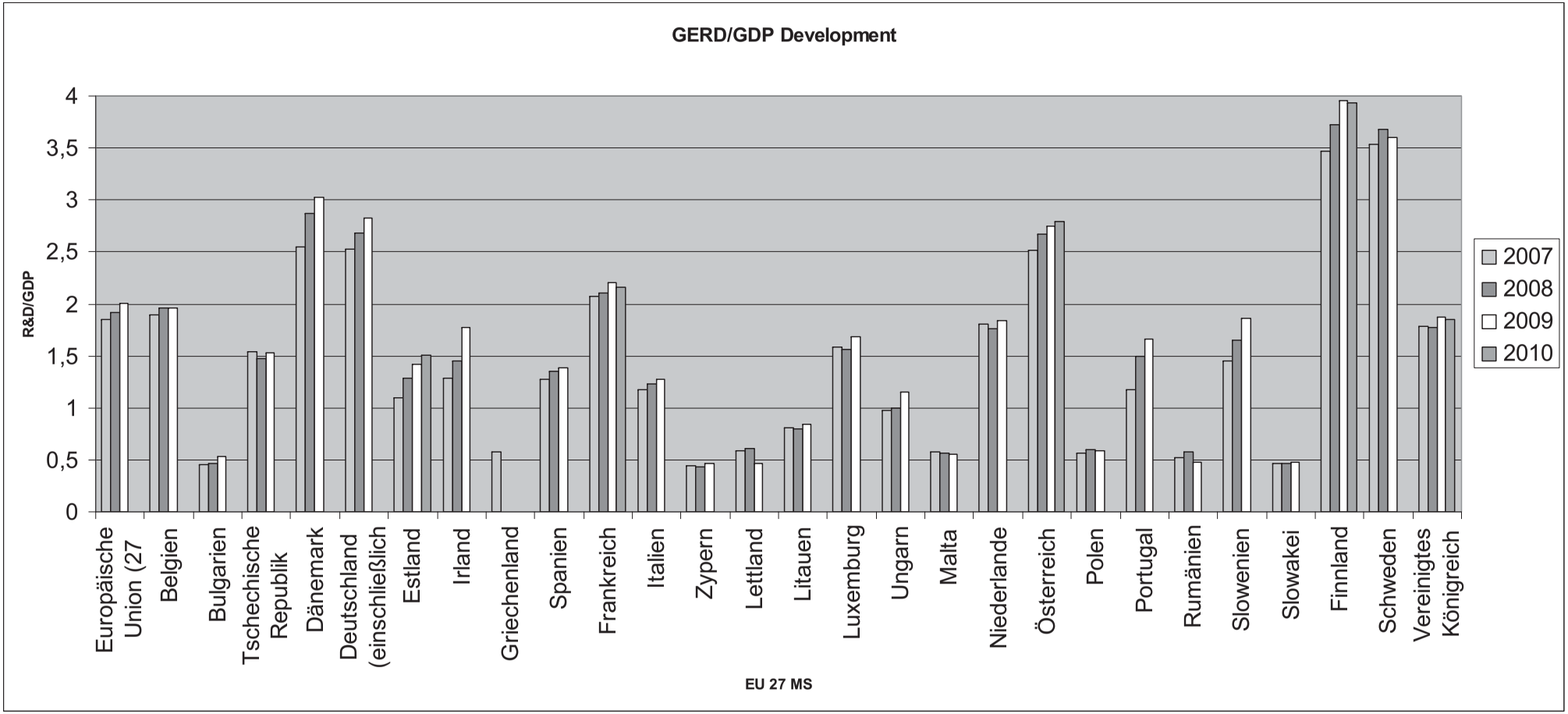
At this stage, the asymmetry in the R&D effort between the Euro zone and the Non-Euro zone is impeding the much desired EU goal, which is convergence between the 27 countries.

6.2. R&D spending trends beyond 2007

Due to missing or incomplete up-to-date data, the conclusions advanced by this paper could not have been based on a trend analysis over time. However, some trends beyond 2007 can be identified in Figure 1 below. For example, during the last four years Germany, Estonia, Ireland, Portugal, Slovenia, Denmark and Finland have continuously increased their R&D performance from 2007 to 2009. A slight improvement in spending has also been made for the EU 27 average, Bulgaria, Spain, Italy, Luxemburg (2009), Hungary (2009), UK (2009) and Sweden (2008). Whereas, Belgium, Cyprus, Lithuania, Poland, Slovakia and Netherlands have witnessed no difference in R&D effort, the Czech Republic (2008 and 2009), Latvia (2009), Romania (2009) and Malta have decreased their GDP on R&D.

Thus, as an overall image, there are tendencies of con- and divergence with regards to R&D performance over the past four years. Interestingly, the Mediterranean EU Member States - Portugal, Italy and Spain – and Ireland, which have all been closely monitored since the Greek bail-out, are all showing increased efforts in R&D spending, with the exception of Greece. Meanwhile, most of the New Member States have either decreased or maintained their R&D spending levels.

Figure 1: GDP on GERD spending development for EU 27 beyond 2007



Conclusion

This paper has investigated in how far EU Member States comply with the R&D investment targets set by the Europe 2020 strategy, i.e. a total amount of 3% per GDP, two thirds of which should come from the private sector. The analysis has shown that the actual general and source specific investment on R&D differ greatly from the target for the vast majority of Member States. Since most of the Member States fail to meet the 3% target, we have selected the group of countries that have a business R&D investment of less than 1% of GDP to get a more in-depth picture of their industrial infrastructure. The challenged groups have been identified as the Mediterranean quintet referred to as 'GIPS plus Ireland' for the Euro zone, and as the majority of the New Member States for the Non-Euro zone. Whereas both groups own a weak industrial R&D infrastructure, there is little to no R&D funding from a diversified industrial line of business for the latter with regards to the group sharing the single currency.

In terms of the sources of R&D spending (private, public or higher education), the New Member States group displays an investment pattern in which the state and the universities are major contributors to research. This finding matches the low number of signed patents and the very low percentage of full-time researchers employed in the private sector. Conversely, the troubled group within the Euro zone owns a slightly higher percentage of the research force occupied in the market, and the signed patents and investment composition reflect a more efficient private sector.

Centralised decision making such as in the case of uniform target setting is a matter of agreement in Brussels, however, the greater task still ahead is political integration and economic convergence. The trend analysis of the R&D data shows that, whereas the more vulnerable Member States within the Euro zone are additionally challenged to keep their budgets in line, they nevertheless benefit from the monetary as well as the political union to which they belong. In contrast, the New Member States have weaker shoulders to lean on, and those are mainly government funded, higher educational ones.

Thus, simplifying the patent system is one way to create incentives. However, missing R&D investment is a sign also standing for the difficulty for competing within the innovation business and of long-term planning with regards to the development of current projects for the more challenged countries.

In addition, a matter that has not been discussed within the framework of this paper is the accessibility and availability of a financial buffer for uncertain profitable outcomes of innovative research and development.

Finally, we conclude that given the data for the actual R&D investment, the innovative gap between stronger and weaker performing countries in the Non-Euro zone is wider than within the Euro zone. Consequently, target setting such as in the case of the Europe 2020 strategy is an important guideline, but the question of feasibility should be taken into consideration when setting the benchmark according to the performance of the best two countries.

Annex: Data and Tables

Table1: General R&D expenditure per GDP and share of businesses, governments and higher education in 2007

country\2007 dataset	*total GERD % GDP*	*business RD points per tt GDP*	*business % of total RD*	*government RD points per tt GDP*	*government % of total RD*	*Higher education RD points per tt GDP*	*Higher education % of total RD*
Austria	2,54	1,79	70,56	0,14	5,35	0,60	23,84
Belgium	1,90	1,32	69,54	0,15	8,07	0,40	21,13
Finland	3,47	2,51	72,30	0,29	8,46	0,65	18,66
France	2,04	1,29	63,25	0,32	15,80	0,40	19,76
Germany	2,54	1,78	69,99	0,35	13,89	0,41	16,11
Greece	0,57	0,15	26,94	0,12	21,40	0,29	50,37
Ireland	1,28	0,84	65,86	0,09	7,02	0,35	27,11
Italy	1,18	0,61	51,86	0,17	14,50	0,36	30,14
Luxemburg	1,62	1,36	83,67	0,22	13,35	0,05	2,97
Netherlands	1,72	0,97	56,50	0,22	12,94	0,52	30,56
Portugal	1,21	0,62	51,24	0,11	9,35	0,36	29,75
Slovenia *	1,45	0,87	59,83	0,36	24,47	0,23	15,56
Spain	1,27	0,71	55,87	0,22	17,60	0,33	26,37
Average €zone	1,75	1,14	61,34	0,21	13,25	0,38	24,03
Bulgaria *	0,48	0,15	31,15	0,28	58,46	0,05	9,66
Cyprus *	0,45	0,10	22,89	0,11	24,15	0,20	45,28
Czech Republic *	1,54	0,95	61,93	0,32	20,83	0,26	16,87
Denmark	2,56	1,78	69,50	0,07	2,56	0,68	26,74
Estonia *	1,11	0,52	47,15	0,10	8,66	0,46	41,80
Hungary *	0,96	0,49	50,33	0,23	24,15	0,23	23,35
Latvia *	0,59	0,19	32,55	0,14	24,26	0,26	43,19
Lithuania *	0,82	0,23	28,53	0,17	20,84	0,41	50,63
Malta *	0,59	0,39	65,69	0,02	2,57	0,19	31,73
Poland *	0,57	0,17	30,36	0,20	35,43	0,19	33,91
Romania *	0,53	0,22	41,63	0,18	33,95	0,13	24,10

Slovakia *	0,46	0,18	39,55	0,16	35,36	0,11	24,99
Sweden	3,61	2,66	73,74	0,17	4,80	0,77	21,29
United Kingdom	1,82	1,15	63,37	0,16	8,80	0,47	25,64
Average Non€area	1,15	0,66	47,03	0,17	21,77	0,31	29,94

*enlargement process since 2004

Source: UNESCO downloaded on the 24th of August 2010 http://stats.uis.unesco.org/unesco/TableViewer/table View.aspx

Table 2: Scoreboard: 2007 EU Industrial R&D Investment Scoreboard using the R%D ranking of the top 1000 companies by Member States

2007 Industry\country	**Austria**	*%*	**Belgium**	*%*	**Finland**	*%*	**France**	*%*
R&D Investment in million €	**595,97**	*100,00*	**2596,50**	*100,00*	**6746,32**	*100,00*	**25512,49**	*100,00*
Aerospace and defence					**50,60**	*0,75*	**1631,19**	*6,39*
Alternative energy								
Automobile and parts	**69,22**	*11,61*			**11,50**	*0,17*	**6280,27**	*24,62*
Banks			**367,00**	*14,13*	**15,00**	*0,22*	**315,00**	*1,23*
Beverages			**20,00**	*0,77*				
Biotechnology	**33,34**	*5,59*	**73,29**	*2,82*	**8,12**	*0,12*	**71,15**	*0,28*
Chemicals			**747,12**	*28,77*	**95,60**	*1,42*	**472,00**	*1,85*
Commercial vehicles & trucks	**7,04**	*1,18*			**127,81**	*1,89*	**39,82**	*0,16*
Computer hardware & services					**66,90**	*0,99*	**106,79**	*0,42*
Construction & materials	**8,23**	*1,38*	**34,01**	*1,31*	**19,70**	*0,29*	**599,20**	*2,35*
Electrical components & equipment	**22,95**	*3,85*			**19,58**	*0,29*	**791,70**	*3,10*
Electricity	**9,00**	*1,51*			**60,84**	*0,90*	**945,00**	*3,70*
Electronic equipment	**33,35**	*5,60*	**288,33**	*11,10*	**87,58**	*1,30*	**309,92**	*1,21*
Fixed line telecommunications	**52,02**	*8,73*	**41,00**	*1,58*	**7,50**	*0,11*	**900,24**	*3,53*
Food and drug retailers			**20,20**	*0,78*	**90,00**	*1,33*	**47,00**	*0,18*
Food producers	**10,54**	*1,77*	**5,87**	*0,23*	**44,83**	*0,66*	**278,54**	*1,09*
Forestry and Paper					**180,60**	*2,68*		
Gas, water & multi-utilities	**6,28**	*1,05*					**276,50**	*1,08*
General industrials	**9,13**	*1,53*			**17,30**	*0,26*	**19,41**	*0,08*
General retailers			**9,00**	*0,35*			**12,00**	*0,05*
Health care equipment services			**17,27**	*0,67*	**5,02**	*0,07*	**286,12**	*1,12*

Household goods					**7,40**	*0,11*	**71,30**	*0,28*
Industrial machinery	**102,61**	*17,22*	**20,80**	*0,80*	**277,97**	*4,12*	**573,81**	*2,25*
Industrial transportation					**22,70**	*0,34*	**81,61**	*0,32*
Industrial metals	**92,90**	*15,59*	**56,70**	*2,18*	**46,00**	*0,68*	**37,00**	*0,15*
Internet								
Leisure goods					**56,20**	*0,83*	**4,94**	*0,02*
Life Insurance								
Media					**18,30**	*0,27*	**749,60**	*2,94*
Mining								
Non-life insurance	**4,46**	*0,75*						
Oil & gas producers & equipment	**15,46**	*2,59*			**28,00**	*0,42*	**695,50**	*2,73*
Other financials			**19,16**	*0,74*			**52,40**	*0,21*
Personal goods	**8,14**	*1,37*	**6,81**	*0,26*	**4,48**	*0,07*	**645,70**	*2,53*
Pharmaceuticals	**5,52**	*0,93*	**788,77**	*30,38*			**4821,88**	*18,90*
Semi-conducters			**39,00**	*1,50*			**17,20**	*0,07*
Software	**19,21**	*3,22*	**11,56**	*0,45*	**51,13**	*0,76*	**880,88**	*3,45*
Support Services	**58,61**	*9,83*			**22,00**	*0,33*	**28,71**	*0,11*
Telecommunications equipment			**30,61**	*1,18*	**5299,06**	*78,55*	**3438,11**	*13,48*
Tobacco								
Travel & leisure	**27,96**	*4,69*			**4,60**	*0,07*	**32,00**	*0,13*
TT	**595,97**	*100,00*	**2596,50**	*100,00*	**6695,72**	*100,00*	**23881,30**	*100,00*

2007 Industry\country	**Germany**	*%*	**Greece**	*%*	**Ireland**	*%*	**Italy**	*%*
R&D Investment in million €	**41628,61**	*100,00*	**61,77**	*100,00*	**440,87**	*100,00*	**5461,86**	100,00
Aerospace and defence	**112,42**	*0,27*					**2012,95**	36,85
Alternative energy	**17,20**	*0,04*						
Automobile and parts	**20194,07**	*48,51*					**2029,60**	37,16
Banks	**52,40**	*0,13*			**67,00**	*15,20*	**180,53**	3,31
Beverages			**3,59**	*5,81*				
Biotechnology	**173,98**	*0,42*					**23,69**	0,43
Chemicals	**4689,71**	*11,27*					**9,71**	0,18
Commercial vehicles & trucks	**524,47**	*1,26*					**70,37**	1,29

Computer hardware & services	**152,60**	*0,37*	**8,91**	*14,42*	**18,38**	*4,17*		
Construction & materials	**150,93**	*0,36*			**7,48**	*1,70*	**7,77**	0,14
Electrical components & equipements	**3495,19**	*8,40*					**59,02**	1,08
Electricity	**53,94**	*0,13*					**29,00**	0,53
Electronic equipment	**171,78**	*0,41*					**52,89**	0,97
Fixed line telecommunications	**548,00**	*1,32*					**122,00**	2,23
Food and drug retailers								
Food producers	**109,94**	*0,26*			**169,39**	*38,42*		
Forestry and Paper			**2,36**	*3,82*				
Gas, water & multi-utilities	**204,00**	*0,49*						
General industrials	**1217,94**	*2,93*					**7,28**	0,13
General retailers	**339,50**	*0,82*					**4,35**	0,08
Health care equipment services	**754,42**	*1,81*			**9,79**	*2,22*	**63,51**	1,16
Household goods	**661,77**	*1,59*					**73,89**	1,35
Industrial machinery	**1034,36**	*2,48*	**8,58**	*13,89*			**158,42**	2,90
Industrial transportation	**159,72**	*0,38*					**25,97**	0,48
Industrial metals	**326,53**	*0,78*						
Internet	**20,19**	*0,05*						
Leisure goods								
Life Insurance								
Media			**3,29**	*5,33*			**4,60**	0,08
Mining								
Non-life insurance	**46,59**	*0,11*						
Oil & gas producers & equipment							**217,10**	3,97
Other financials	**116,24**	*0,28*						
Personal goods	**164,86**	*0,40*					**105,54**	1,93
Pharmaceuticals	**3018,18**	*7,25*	**17,50**	*28,33*	**168,83**	*38,29*	**57,21**	1,05
Semi-conducters	**1238,72**	*2,98*						
Software	**1635,33**	*3,93*	**2,78**	*4,50*			**9,15**	0,17
Support Services	**167,64**	*0,40*						
Telecommunications equipment	**48,49**	*0,12*					**103,41**	1,89
Tobacco								
Travel & leisure	**27,50**	*0,07*	**14,76**	*23,90*			**33,90**	0,62

TT	**41628,61**	*100,00*	**61,77**	*100,00*	**440,87**	*100,00*	**3448,91**	100,00

2007 Industry\country	**Luxemburg**	*%*	**Netherlands**	*%*	**Portugal**	*%*	**Slovenia**	*%*
R&D Investment in million €	**574,56**	*100,00*	**9080,25**	*100,00*	**75,31**	*100,00*	**68,31**	*100,00*
Aerospace and defence			**2701,00**	*29,75*				
Alternative energy								
Automobile and parts			**13,30**	*0,15*	**5,07**	*6,73*	**8,17**	*11,96*
Banks	**6,13**	*1,07*	**159,00**	*1,75*	**6,13**	*8,14*		
Beverages					**0,19**	*0,25*		
Biotechnology			**136,85**	*1,51*				
Chemicals	**105,00**	*18,27*	**652,00**	*7,18*				
Commercial vehicles & trucks								
Computer hardware & services			**151,61**	*1,67*				
Construction &materials			**28,01**	*0,31*	**0,72**	*0,96*		
Electrical components & equipements			**9,58**	*0,11*				
Electricity								
Electronic equipment			**403,37**	*4,44*				
Fixed line telecommunications			**16,00**	*0,18*				
Food and drug retailers					**2,15**	*2,85*		
Food producers			**113,00**	*1,24*				
Forestry and Paper								
Gas, water &multiutilities								
General industrials			**8,50**	*0,09*			**0,20**	*0,29*
General retailers								
Health care equipment services			**22,57**	*0,25*				
Household goods								
Industrial machinery			**63,87**	*0,70*				
Industrial transportation			**5,00**	*0,06*				
industrial metals	**146,37**	*25,48*						
Internet			**21,01**	*0,23*				
Leisure goods			**1614,50**	*17,78*				

Life Insurance			**26,00**	*0,29*				
Media			**33,99**	*0,37*				
Mining								
Nonlife insurance								
Oil & gas producers & equipment	**42,20**	*7,34*	**26,14**	*0,29*				
Others financials								
Personal goods	**10,06**	*1,75*	**7,10**	*0,08*				
Pharmaceuticals	**264,80**	*46,09*			**59,07**	*78,44*	**59,07**	*86,47*
Semiconducters			**2814,47**	*31,00*				
Software			**35,18**	*0,39*	**0,57**	*0,76*		
Support Services			**18,20**	*0,20*	**1,41**	*1,87*	**0,87**	*1,27*
Telecommunications equipment								
Tobacco								
Travel & leisure								
TT	**574,56**	*100,00*	**9080,25**	*100,00*	**75,31**	*100,00*	**68,31**	*100,00*

2007 Industry\country	**Spain**	*%*	**Bulgaria**	*%*	**Cyprus**	*%*	**Czech Rep**	*%*
R&D Investment in million €	**1340,24**	*100,00*	**1,71**	*100,00*	**0,02**	*100,00*	**288,49**	*100,00*
Aerospace and defence	**72,47**	*5,41*					**5,38**	*1,86*
Alternative energies								
Automobile and parts	**5,34**	*0,40*					**205,31**	*71,17*
Banks							**29,94**	*10,38*
Beverages								
Biotechnology	**11,05**	*0,82*						
Chemicals	**5,70**	*0,43*					**0,71**	*0,25*
Commercial vehicles & trucks								
Computer hardware & services	**141,05**	*10,52*						
Construction &materials	**85,72**	*6,40*	**0,21**	*12,28*			**0,32**	*0,11*
Electrical components & equipements								
Electricity	**65,00**	*4,85*					**21,78**	*7,55*
Electronic equipment								
Fixed line telecommunications	**594,00**	*44,32*						

Food and drug retailers								
Food producers	**12,22**	*0,91*						
Forestry and Paper	**13,38**	*1,00*						
Gas, water &multiutilities			**1,50**	*87,72*				
General industrials	**54,59**	*4,07*						
General retailers								
Health care equipment services								
Household Goods	**5,38**	*0,40*						
Industrial machinery	**30,91**	*2,31*			**0,02**	*100,00*		
Industrial transportation							**0,01**	*0,00*
industrial metals								
Internet								
Leisure goods								
Life Insurance								
Media								
Mining								
Nonlife insurance								
Oil & gas producers	**77,00**	*5,75*					**4,57**	*1,58*
Others financials								
Personal goods								
Pharmaceuticals	**158,62**	*11,84*					**20,47**	*7,10*
Semiconducters								
Software								
Support Services								
Telecommunications equipment	**7,81**	*0,58*						
Tobacco								
Travel & leisure								
TT	**1340,24**	*100,00*	**1,71**	*100,00*	**0,02**	*100,00*	**283,11**	*100,00*

2007 Industry\country	**Denmark**	*%*	**Estonia**	*%*	**Hungary**	*%*	**Latvia**	*%*
R&D Investment in million €	**2931,96**	*100,00*	**15,62**	*100,00*	**113,48**	*100,00*	**5,94**	*100,00*

Aerospace and defence								
Alternative energies								
Automobile and parts			**1,77**	*11,33*				
Banks	**66,25**	*2,26*	**9,87**	*63,19*				
Beverages	**14,48**	*0,49*						
Biotechnology	**365,63**	*12,47*						
Chemicals	**35,75**	*1,22*			**2,81**	*2,48*	**0,15**	*2,53*
Commercial vehicles & trucks								
Computer hardware & services	**12,80**	*0,44*						
Construction &materials	**61,92**	*2,11*						
Electrical components & equipements	**166,01**	*5,66*	**0,50**	*3,20*				
Electricity			**1,90**	*12,16*				
Electronic equipment								
Fixed line telecommunications	**77,65**	*2,65*						
Food and drug retailers								
Food producers	**115,36**	*3,93*	**0,28**	*1,79*				
Forestry and Paper								
Gas, water &multiutilities			**0,01**	*0,06*				
General industrials	**12,45**	*0,42*						
General retailers								
Health care equipment services	**110,44**	*3,77*						
Household Goods								
Industrial machinery	**223,86**	*7,64*						
Industrial transportation	**22,80**	*0,78*						
industrial metals								
Internet								
Leisure goods	**99,98**	*3,41*						
Life Insurance								
Media					**0,18**	*0,16*		
Mining								
Nonlife insurance	**5,23**	*0,18*						
Oil & gas producers	**64,24**	*2,19*						

Others financials								
Personal goods								
Pharmaceuticals	**1337,49**	*45,62*			**103,65**	*91,34*	**3,45**	*58,08*
Semiconducters								
Software	**38,42**	*1,31*			**6,36**	*5,60*	**2,34**	*39,39*
Support Services					**0,48**	*0,42*		
Telecommunications equipment	**101,20**	*3,45*	**0,01**	*0,06*				
Tobacco								
Travel & leisure			**1,28**	*8,19*				
Total	**2931,96**	*100,00*	**15,62**	*100,00*	**113,48**	*100,00*	**5,94**	*100,00*

2007 Industry\country	**Lithuania**	*%*	**Malta**	*%*	**Poland**	*%*	**Romania**	*%*
R&D Investment in million €	**0,63**	*100,00*	**0,05**	*100,00*	**63,18**	*100,00*	**2,64**	*100,00*
Aerospace and defence							**0,53**	*21,54*
Alternative energies								
Automobile and parts								
Banks					**25,76**	*40,77*		
Beverages								
Biotechnology								
Chemicals								
Commercial vehicles & trucks								
Computer hardware & services								
Construction &materials								
Electrical components & equipements			**0,05**	*100,00*			**1,71**	*69,51*
Electricity								
Electronic equipment								
Fixed line telecommunications					**25,94**	*41,06*		
Food and drug retailers								
Food producers								
Forestry and Paper	**0,02**	*3,17*						
Gas, water &multiutilities								

General industrials						
General retailers						
Health care equipment services						
Household Goods	**0,56**	*88,89*				
Industrial machinery						
Industrial transportation						
industrial metals				**2,52**	*3,99*	
Internet						
Leisure goods						
Life Insurance						
Media				**1,44**	*2,28*	
Mining						
Nonlife insurance						
Oil & gas producers	**0,05**	*7,94*		**4,82**	*7,63*	
Others financials						
Personal goods						
Pharmaceuticals						**0,22** *8,94*
Semiconducters						
Software				**2,70**	*4,27*	
Support Services						
Telecommunications equipment						
Tobacco						
Travel & leisure						
Total	**0,63**	*100,00*	**0,05** *100,00*	**63,18**	*100,00*	**2,46** *100,00*

2007 Industry\country	**Slovakia**	*%*	**Sweden**	*%*	**UK**	*%*
R&D Investment in million €	**16,17**	*100,00*	**7542,00**	*100,00*	**21474,26**	*100,00*
Aerospace and defence			**147,73**	*1,96*	**1095,12**	*5,10*
Alternative energies						
Automobile and parts			**300,07**	*3,98*	**138,56**	*0,65*
Banks	**15,18**	*93,88*	**105,57**	*1,40*	**1307,43**	*6,09*
Beverages					**29,31**	*0,14*

Biotechnology			**156,21**	*2,07*	**472,78**	*2,20*
Chemicals			**23,18**	*0,31*	**230,77**	*1,07*
Commercial vehicles & trucks			**1689,91**	*22,41*	**55,84**	*0,26*
Computer hardware & services			**42,75**	*0,57*	**128,63**	*0,60*
Construction &materials	**0,45**	*2,78*	**107,95**	*1,43*	**18,71**	*0,09*
Electrical components & equipements			**5,62**	*0,07*	**171,50**	*0,80*
Electricity			**119,16**	*1,58*	**59,92**	*0,28*
Electronic equipment			**10,85**	*0,14*	**290,64**	*1,35*
Fixed line telecommunications			**213,87**	*2,84*	**1711,48**	*7,97*
Food and drug retailers					**174,27**	*0,81*
Food producers					**1028,99**	*4,79*
Forestry and Paper			**72,38**	*0,96*	**9,00**	*0,04*
Gas, water &multiutilities					**74,20**	*0,35*
General industrials			**53,76**	*0,71*	**298,45**	*1,39*
General retailers			**9,84**	*0,13*	**150,53**	*0,70*
Health care equipment services			**137,63**	*1,82*	**156,69**	*0,73*
Household Goods			**247,09**	*3,28*	**202,89**	*0,94*
Industrial machinery			**772,39**	*10,24*	**158,80**	*0,74*
Industrial transportation			**4,34**	*0,06*	**40,98**	*0,19*
industrial metals	**0,41**	*2,54*	**33,66**	*0,45*	**103,47**	*0,48*
Internet						
Leisure goods					**67,87**	*0,32*
Life Insurance					**145,69**	*0,68*
Media			**20,32**	*0,27*	**470,01**	*2,19*
Mining			**56,09**	*0,74*	**195,77**	*0,91*
Nonlife insurance					**83,44**	*0,39*
Oil & gas producers					**1238,08**	*5,77*
Others financials			**73,93**	*0,98*	**153,95**	*0,72*
Personal goods					**27,56**	*0,13*
Pharmaceuticals			**45,71**	*0,61*	**8511,63**	*39,64*
Semiconducters			**21,00**	*0,28*	**317,53**	*1,48*
Software			**121,51**	*1,61*	**1108,94**	*5,16*
Support Services			**17,96**	*0,24*	**341,71**	*1,59*

Telecommunications equipment			**2917,66**	*38,69*	**485,07**	*2,26*
Tobacco			**8,68**	*0,12*	**162,02**	*0,75*
Travel & leisure	**0,13**	*0,80*	**5,18**	*0,07*	**56,03**	*0,26*
Total	**16,17**	*100,00*	**7542,00**	*100,00*	**21474,26**	*100,00*

Source: UNESCO, own elaboration, downloaded on the 6th of September 2010.
http://iri.jrc.ec.europa.eu/research/scoreboard_2007.htm

Figure 2: Eurostat and Unesco GERD/GDP data justaposition for 2007