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Trends in R&D policies for a European knowledge-based economy

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Contact information
Address: Edificio Expo. c/ Inca Garcilaso, 3. E-41092 Seville (Spain)
E-mail: jrc-ipts-secretariat@ec.europa.eu
Tel.: +34 954488318
Fax: +34 954488300

IPTS website: http://ipts.jrc.ec.europa.eu
JRC website: http://www.jrc.ec.europa.eu
DG RTD website: http://ec.europa.eu/research/

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Executive Summary

This report provides an assessment of policies put in place by EU Member States to reach the objectives set out in the Lisbon Strategy. Changes in policies, rather than the specific value of some short-term indicator, are the chosen method for tracking progress in the spirit of Lisbon. In other words, are we observing structural changes towards a more R&D-based economy? It emerges that:

Member States' R&D policies have become increasingly articulated.

Whereas some countries have been designing and implementing R&D strategies for a number of years, some countries have only just begun to formulate overarching R&D strategies on a national level. New governance arrangements under the Lisbon strategy called for the elaboration of National Reform Programmes that had to include, among others, specific measures in the area of research and development. This in turn had an impact on national strategy formulation, on its implementation and on structural elements of the governance system that is even more evident in the case of some of the newer EU Member States.

National policies for R&D evolved towards more coherent and complex policy mixes, with new strategies that cut across different Ministries and changes in the institutional settings for R&D policy. Almost all Member States employ complex policy mixes to stimulate high-tech sector development and promote regions as key actors in national innovation policies. Moreover, they are also increasingly developing new programmes aiming to achieve specific Research, Technological Development and Innovation (RTDI) policy goals. These "mini-mixes" involve policy instruments that often go beyond the boundaries of R&D policies.

The number and diversity of approaches adopted by Member States constitutes an important result in itself. It facilitates the exploration of innovative policy measures, the acquisition of information on what works and what does not work, and the progressive emergence of best practices. In this respect, the revamped Lisbon process has shown its usefulness by providing common policy orientations and a limited number of quantified targets but at the same time leaving Member States free to experiment and design specific policies and measures suited to their economic structure, institutional features and national priorities. This also increases the Member States' ownership of the whole process, thus putting reforms on a firmer basis and increasing the likelihood that the momentum will be sustained well after 2010.

Legal frameworks have been reformed to allow for more autonomy and accountability of research organisations.

All Member States acknowledge the relevance of an excellent research base in terms of the scientific quality and the relevance of research with regard to its potential economic use or societal relevance. The post-2000 period has seen widespread policy activity in pursuit of reforms to foster the excellence of the public research base, particularly in the university sector. These reforms have included developments at the national and organisational levels, including:

- Introduction of legislation to create more autonomous research organisations, with increased management autonomy and reduced central management by the State.
- Introduction of national research policies with explicit thematic and procedural strategies and a commitment to increasing social and economic benefits.
- Introduction of more competitive funding models and a shifting balance of funding in favour of performance-related income and mission-oriented funds.

Governments are not withdrawing from their responsibilities or from influencing the public research base but are using new methods – such as performance contracts – to steer the research base and align it with policy priorities. Member States show a growing interest in performance monitoring and evaluation, which is a corollary of the increasing autonomy of public research organisations and the need for budget holders to be able to demonstrate efficient and productive use of public funds. Several countries have created new institutions with a quality control mission. Several of them have recently implemented measures to support centres of excellence.

EU universities have been at the centre of major policy changes concerning their governance, funding and human resources policies. Increasing competition has driven universities to develop consistent strategies to attract students, researchers and funds and to raise their scientific profile. In most countries the institutional autonomy granted to universities is being reinforced. This involves more competitive and output-oriented modes of coordination between the state and higher education institutions and among the higher education institutions themselves. It also includes a corresponding reorganisation of decision-making processes within institutions. University funding, including all the budgetary elements – revenues and expenditures – is characterised by new patterns: a decline in block grants and line item budgets and a rise in competitive funding and money from contracts. Human resources are in a transition phase characterised by an increasing market orientation, a growing "managerialisation" of academic work, and an increasing flexibility of career paths. Also, the growing internationalisation of higher education and research is reflected in policy initiatives aimed at attracting foreign researchers and national researches working abroad.

Member States have adopted sophisticated policy mixes to foster investment in R&D by the private sector.

Because of the high immediate costs and rewards paying off only on a longer term, firms are prone to under invest in R&D. Although there is a long tradition of public policy intervention to tackle this market failure, there has been a recent shift in Member States' policies in this area: The relative weight of public funds for Business Expenditures in R&D (BERD) has declined constantly and government funding of private R&D is nowadays increasingly taking place through indirect measures, such as tax incentives.

Despite the theoretical soundness of many of the measures adopted, it still has to be seen if they will be enough to sustain R&D investment, especially in the current adverse economic environment. R&D expenditures and policies are indeed at risk of being downsized or dropped altogether due to the enormous strains on both public and private budgets. The current budget corrections in some Member States seem to confirm the reality of this danger. On their side, firms are confronted not only with a tightening of their budgets, but also with a credit crunch that is likely to hit risky investment first. Also, fiscal incentives have a limited impact when companies' balance sheets are already loaded with losses.

As this report will show, there is still room for improvement and renewed emphasis on some policy dimensions (e.g. private investments in R&D). It is also important to keep urging Member States to build on their successes and tackle weaknesses, in order to sustain current positive trends and to project them beyond 2010. As highlighted by the examples provided throughout the various sections, *all* Member States have undertaken institutional reforms and changes in policies, albeit with different paces, foci, and designs. The fact that also those countries that were farthest away from the Lisbon objectives are showing progress and are adopting concrete measures should be a further reason for optimism.

1 Introduction

In 2005, five years after having set the strategic goal for Europe to become the most competitive and dynamic knowledge-based economy in the world[1], the European Council reiterated the importance of research and development (R&D) policies[2]. Following the mid-term review adopted that year, the whole governance of the Lisbon strategy for growth and jobs was overhauled to facilitate the implementation of a limited and more focused set of priorities and targets. This new approach included the adoption of a series of policy orientations, the so-called 'integrated guidelines', aiming to provide a common policy framework to Member States' National Reform Programmes.

With the 2010 deadline approaching, the temptation to engage in early assessment is hard to resist. Critics might point to the fact that EU does not appear to be more knowledge-intensive today than in 2000, given that investments in R&D have grown roughly at the same rate as GDP. Others might instead point to an increase in the number of researchers and their share in the labour force and take an opposite stance.

This report, however, builds on the premise that drawing conclusions by simply looking at these trends would be misplaced. R&D policies are, by they very nature, oriented towards the medium- to long term, implying that only over such an extended time horizon can a proper assessment be made. A corollary is that the data most relevant to the assessment of progress towards the R&D goals foreseen by the Lisbon agenda are of a structural kind, and thus available only with considerable delay (provided they exist at all). As a consequence, it is simply not possible to assess progress by looking at some sort of coincident indicator.

In such a case, it is important to assess whether policies have been put in place that are geared towards reaching those objectives (even if, of course, to assess their effectiveness more time is needed). The Lisbon strategy of the EU has become an important driver of R&D policy development over the last years. For the first time, EU Member States report in a coherent manner about their priorities and activities in R&D, which are embedded into a more general policy framework, notably aiming at the creation of economic growth and more and better jobs. The fact that R&D as well as innovation plays a prominent role in the Lisbon strategy's Integrated Guidelines for Growth and Jobs (IGLs) reflects on the one hand Member States beliefs, but on the other hand puts pressure on them in order to translate their beliefs into action. IGL number 7 in particular is a useful reference for any report dealing with this subject[3]. All its dimensions are reflected in the structure of this report, albeit with some

1 Presidency Conclusions, Lisbon European Council, 23-24 March 2000.

2 Presidency Conclusions, Brussels European Council, 22-23 March 2005.

3 Integrated Guideline No. 7 confirmed an overall objective for 2010 of 3 % of GDP, with an adequate split between private and public investment. Member States would define specific intermediate levels and should further develop a mix of measures appropriate to foster R&D, in particular business R&D, through: improved framework conditions and ensuring that companies operate in a sufficiently competitive and attractive environment; more effective and efficient public expenditure on R&D and developing public-private partnerships (PPPs); developing and strengthening centres of excellence of educational and research institutions in Member States, as well as creating new ones where appropriate, and improving the cooperation and transfer of technologies between public research institute and private enterprises; developing and making better use of incentives to leverage private R&D; modernising the management of research institutions and universities; ensuring a sufficient supply of qualified researchers by attracting more students into scientific, technical and engineering disciplines and enhancing the career development and the European, international as well as inter-sectoral mobility of researchers and development personnel.

qualifications, given that some of them partly overlap and that this report will put more emphasis on a review of trends on R&D policies.

The objective of this report is to present to the reader a summary of relevant information on R&D policies in Europe, supported by statistical and other quantitative and qualitative information. In doing so, the report contributes to a better understanding of the European Research Area (ERA) going beyond the mere overview of Member States efforts in the R&D domain, by distilling some more general trends out of the available information. The focus is on activities in the most recent years, even though in some cases the lack of updated statistics makes it necessary to refer to older data. Also, due to the diversity of Member States, sometimes the identified trends are either very general or not applicable to all EU countries. For this reason, throughout the report we present also some concrete insights into the diverse stances adopted by Member States.

With the National Reform Programmes (NRPs) published in autumn 2005, where Member States stated their R&D policy goals and measures, and the corresponding Progress Reports from autumn the following year, detailed and comparable information on R&D policies is available for the first time. Also, the report uses information collected through a number of activities undertaken by the Joint Research Centre – Institute for Prospective Technological Studies (JRC-IPTS), such as ERAWATCH, Integrated Information System on European Researchers (IISER) and the EU Industrial R&D Investment Scoreboard. The ERAWATCH research inventory proved to be an invaluable source of information for compiling this report. If other sources have been used, they are referenced accordingly.

The report is structured as follows: Chapter 2 presents the general trends in R&D expenditures and R&D priorities and policies. Chapter 3 deals with the public science base, notably its management, policies to strengthen science-industry links and policies to foster the excellence of public research. Chapter 4 presents the policy measures used to leverage private R&D engagement, namely government funding of business R&D and tax incentives for R&D. Chapter 5 highlights the main trends that are changing European universities. The last chapter deals with human resources in R&D and presents insights into the mobility of European researchers and the policy measures to improve both mobility and career development.

2 General trends in R&D investments and policies

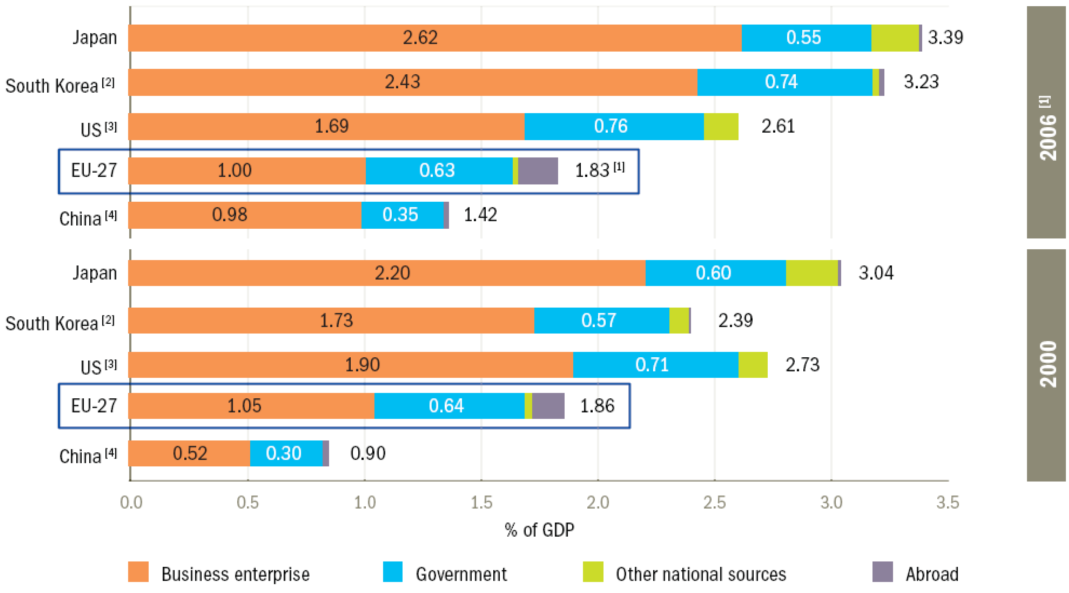
2.1 R&D investments

Since the 1990s major new players have emerged in science and technology – notably in Asia. The result is an increasingly multi-polar world where science, technology and patent applications are more widely distributed throughout the world. This is reflected by a declining world share of Gross Domestic Expenditure on R&D (GERD) and patent applications, both for the US and for the European Union. Asian economies have increased their patents under the Patent Cooperation Treaty (PCT) even more rapidly than their investments in research as compared with EU-27. The high cost of patents in Europe is a likely explanation of this striking result[4].

EU-27 is also lagging behind the US, Japan and South Korea in terms of overall R&D intensity (R&D expenditures as a percentage of GDP), due to a lower level of R&D funded (and performed) by the business sector (see Figure 1). At EU-27 level, the intensity of business funding of R&D has slightly declined between 2000 (1.05% of GDP) and 2006 (1.00% of GDP). In the US, the decline was much more significant, although from a substantially higher level.

4 Patent applications under the international PCT have a different direct cost than patent applications to national patent offices. However, the decision to use the PCT procedure is linked to anticipation by economic actors of the potential future costs of their applications, which are determined by national patent application procedures. The upfront cost of a patent application to the European Patent Office (EPO) covering 12 Member States and Switzerland is over 20 times higher than the corresponding cost for a patent application to the US and 13 times higher than in the Japanese patent office, while the costs of maintaining a patent protection in the 27 Member States are over 60 times higher in the EU than in the US. The European Commission has invited Member States to reduce by up to 75 % the fees for patent application and maintenance (see Communication of the European Commission 'A European Economic Recovery Plan', COM(2008) 800, 26.11.2008, page 13).

Figure 1 - R&D intensities for the four sources of funds, 2000 and 2006 [1]



Source: DG Research
Data: Eurostat, OECD
Notes: [1] EU-27: 2005 (2005 is the latest year available for GERD by source of funds)
[2] KR: R&D in the social sciences and humanities is not included
[3] US: Most or all capital expenditure is not included; Abroad is included in business enterprise
[4] CN: The sum of the sectors does not add to the total

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Across the world, two-thirds to three quarters of all R&D activities are carried out in the business enterprise sector[5]. Therefore, the business sector is not only the principal financing sector of R&D, it is also by far the main performer of R&D activities. The involvement of the business sector in research-driven activities is thus crucial for Europe's future economic growth and competitiveness. In the EU-27, the R&D intensity of the business sector was equal to 1.00% of GDP in 2006 compared to 1.05% in 2000. In comparison, business R&D intensity decreased in the US from 1.90% of GDP in 2000 to 1.69% of GDP in 2006.

Despite differences between countries, in general at least three quarters of total business R&D is concentrated in manufacturing industries. A comparison of the distribution of manufacturing R&D across industrial sectors according to their level of technology-intensity shows that in the US manufacturing R&D is more concentrated in high-tech sectors than in the EU. This is due to the fact that high-tech industry in the US is both about 20% more research-intensive than in the EU and has a larger share of the economy. European industrial R&D is almost equally concentrated in medium-high-tech manufacturing.

The progressive international re-localisation of R&D facilities is fast becoming a key element in the overall process of economic globalisation. One of the reasons why R&D intensity is lower in the EU than in the US is that large European companies decide to carry out their R&D activities in the US rather than in the EU. EU companies tend to invest more in R&D in the US than do their US counterparts in the EU. Although there is evidence to show that EU companies might benefit from this "technology-sourcing" thanks to knowledge spillovers to the parent company resulting in increased marginal productivity at company level in the region of origin, such a net, increasing outflow also reflects the relatively stronger attractiveness of the US research and innovation systems compared to those of the EU. Moreover,

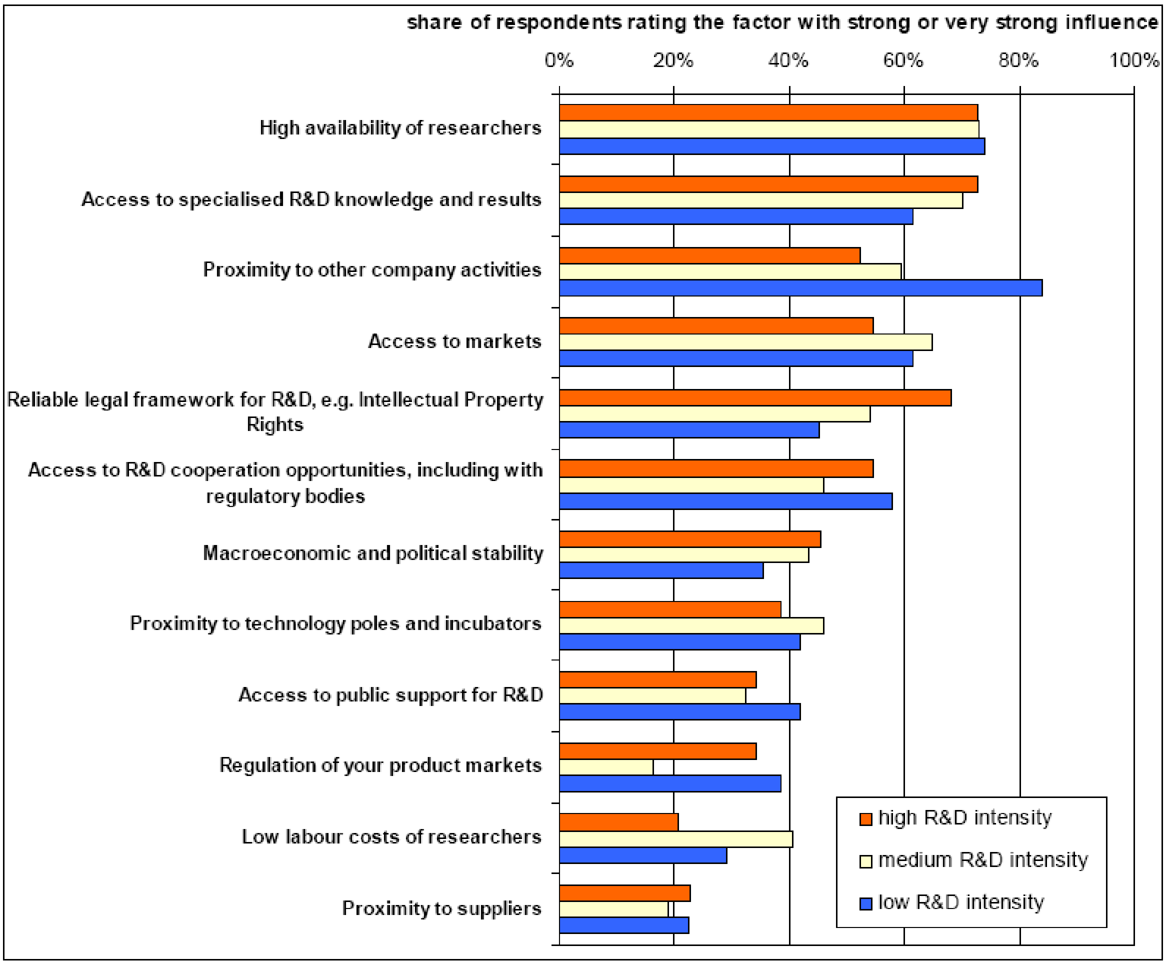
5 Part of them are financed from public sources.

internationalisation of R&D is no longer limited to the intra-Triad flows; more recently, this phenomenon has become more truly global. This more global focus for R&D spending can be seen in the increasing diversification of the US's own outward R&D investment. US firms are targeting all major regions of the world and especially Asia, with as result that the EU-15's share in the total US's outward R&D spending is decreasing significantly since the mid-nineties. This trend is expected to continue as the new, emerging market players continue to build up their Science and technology systems and to open up their markets to foreign entrants.

Up to 2008, in all ERA countries for which the data are available, a significant part of business R&D (more than 20%, except in Finland and up to 70% in Ireland) is performed by affiliates of foreign parent companies. In some countries, foreign affiliates are even the main performers of business R&D. In the ERA countries for which data are available, more than 50% (up to 93% in Portugal and Austria) of R&D expenditure by foreign affiliates in the manufacturing sector is by affiliates of an EU or EFTA parent company. Only in Ireland is most R&D performed by foreign affiliates of US companies.

In any case, there is a widespread concern among Member States policy makers that the globalisation of private sector R&D reduces the positive societal spillovers from public R&D efforts, as these spillovers are realised elsewhere. Background is the observation that due to the globalisation (especially of the financial markets) an increasing share of companies are becoming foreign affiliates. Today, about 70% of BERD in Ireland and Hungary is actually realised by companies being a foreign affiliate. The share of BERD executed by foreign affiliates is growing everywhere, so the arising policy question (for national policy makers) here is, how to manage the risk that public support to foreign affiliates is used by the mother company to create growth and jobs elsewhere.

Figure 2 - Factors for R&D location in the country considered the most attractive



Note: The factors are sorted by average importance. The figure refers to 112 out of the 118 companies in the sample.
Source: European Commission JRC-IPTS (2008)

According to the 2007 Survey on R&D Investment and Business Trends, factors considered being of some importance for R&D location decisions were access to markets, proximity to other company activities, a reliable legal framework for R&D, access to R&D cooperation opportunities, macroeconomic and political stability, proximity to technology poles and incubators and access to public support for R&D. The factors which were of less importance include regulation of the company's product markets, low labour costs of researchers and proximity to suppliers.

An overview of the main trends in R&D investments and intensity trends helps to have a clearer picture of this shifting ground, this is presented in the next section. IGL7 clearly states the main objectives concerning investment in R&D, that is to increase investment in R&D (the well-known 3% target), to attain an adequate split between its public and private components (1% and 2% respectively), and that Member States adopt appropriate policies to foster R&D.

The most recent evidence on the first two goals is assessed in the following of this subsection, while the issue of appropriate policies is addressed in section 3.2 and all over the following sections of this report.

In 2006, Gross Domestic Expenditure on R&D (GERD) in EU-27 amounted to € 213 billion[6]. Between 2000 and 2006, GERD in EU-27 has increased by 14.8% in real terms. Over the same period, GDP in EU-27 has grown at almost the same rate as R&D expenditure, 13.7% in real terms between 2000 and 2006. The result is a slight decline in EU-27 R&D intensity from 1.86% in 2000 to 1.84% in 2006[7], indicating that there has been no structural change leading to a greater weight of R&D in the EU economy over the period. In comparison, R&D intensity in 2006 was 2.61% in the US (down from 2.72% in 2000), 3.23% in South Korea and 3.39% in Japan (up from 3.04).

The stability of EU-27 R&D intensity at EU-27 level disguises quite different situations and developments across Member States. If ranked according to the **level** of their R&D intensity, the EU-27 Member States and the Associated States can be roughly subdivided into a group of Member States with *high R&D intensities* (close or above the 3% target): Finland, Sweden, Denmark, Austria and Germany. Of the Associated States, Switzerland, Iceland and Israel have similar or higher R&D intensities. 21 Member States find themselves instead below the EU-27 average), of which ten countries with less than 1% of GDP.

An equally mixed picture emerges when analysing the **trends** in R&D intensity for the EU-27 Member States and the Associated States over the 2000-2006 period: ten Member States (representing about 47.1% of EU-27 GDP) have seen *their R&D intensities decrease*. These include Sweden, Luxembourg, France, Belgium, the United Kingdom and the Netherlands, as well as four countries with very low R&D intensities (Poland, Slovakia, Bulgaria and Greece) which, therefore, have fallen further behind. Among the Associated States, R&D intensity also decreased in Norway and Croatia. Five Member States (Denmark, Italy, Malta, Germany and Finland), representing about 36% of EU-27 GDP) have *increased their R&D intensities by up to 10%*. Of the Associated States, Israel and Iceland have increased their R&D intensities to a similar extent. Twelve Member States (Lithuania, Spain, Austria, Hungary, Romania, Ireland, Czech Republic, Slovenia, Estonia, Cyprus, Latvia and Portugal, representing about 16.9% of EU-27 GDP) have had *R&D intensity increases of between 10% or more*. Of the Associated States, Turkey and Switzerland have experienced comparable increases in R&D intensity.

It is important to note that the annual R&D intensity growth in the 12 new Member States has changed remarkably since 2003. Even if this had almost no impact on the annual R&D intensity growth of EU-27 – due to the relative weight of national economies – this witnesses the substantial contribution made by Cohesion Policy. The EU Structural Funds contributed an average annual total of € 157.4 million to research investment in the ten new Member States over the period 2004-2006, an investment which triggered an average annual total of € 69.6 million in national R&D investment (or about 8% of the total national public R&D investment). In the period 2007-2013, such investments in the 12 new Member States are expected to reach an average annual total of € 2.9 billion[8].

In conclusion, R&D expenditure has grown in real terms in all EU Member States over 2000-2006, but with the exception of Austria, substantial increases in R&D

6 That is 183 billion PPS€2000.

7 Eurostat estimates for 2007 show a further marginal decline to 1.83%.

8 See Annual Report on research and technological development of the European Union in 2007, COM (2008)519 final.

intensity have almost exclusively taken place in those of countries with lower initial R&D intensities.

Since the re-launch of the Lisbon Strategy in 2005, each Member State has set a national R&D intensity target. The national targets may differ from the 3% target for the EU as a whole, depending on the particular situation of each Member State regarding R&D expenditure. This was meant to provide much needed flexibility given the structural differences between Member States' economies, their different starting points. As a consequence, by having more realistic targets for R&D intensity, this would have increased the probability of advancing regularly and effectively towards the target. The majority of the Member States used this option to set a target lower than 3%, with some putting forward a date later than 2010. Only two Member States, Finland and Sweden, raised their target upwards, to 4%. If all Member States reach their respective R&D intensity targets, EU-27 will have an R&D intensity of 2.5% in 2010. While being below 3%, it would still be a substantial improvement on the current level.

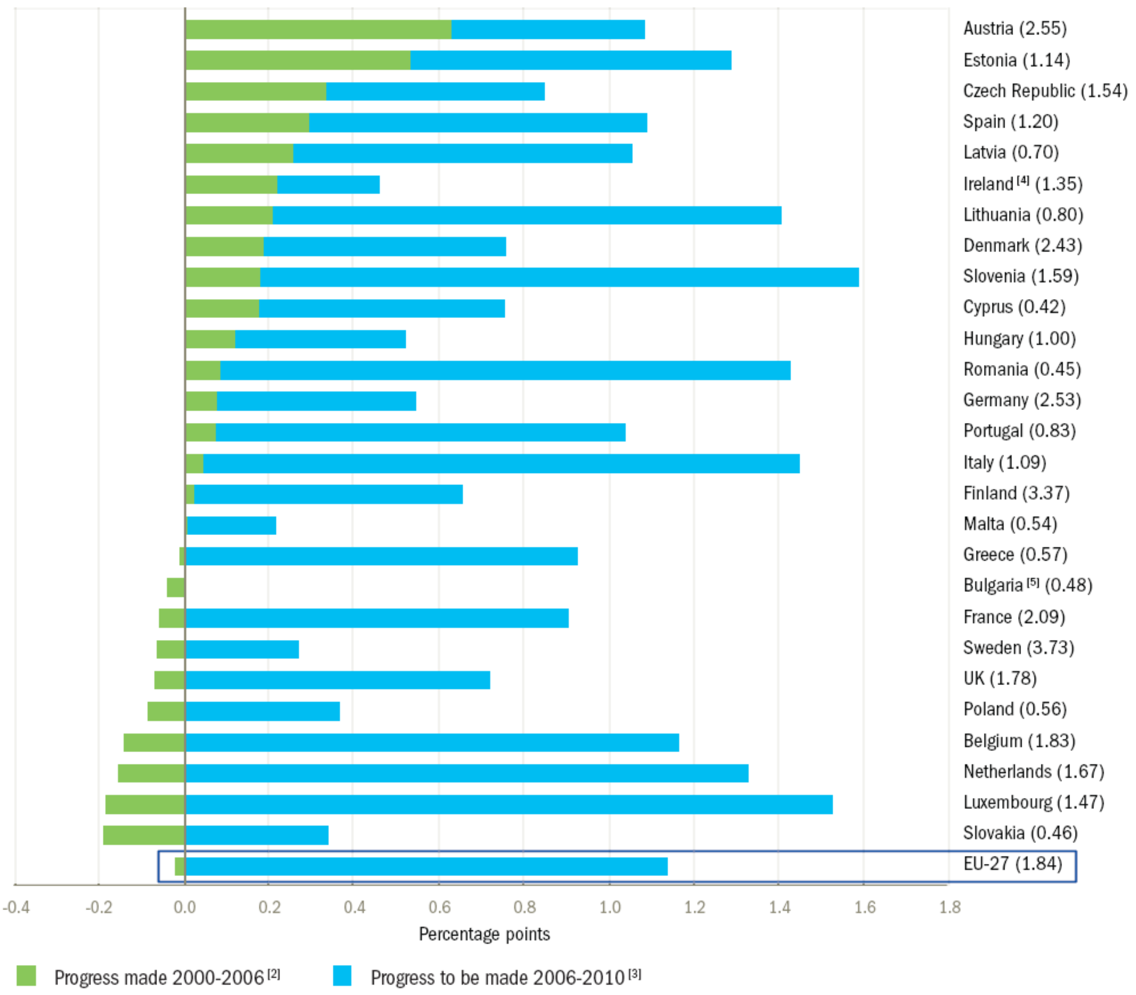
Figure 3 shows in green for each Member State the difference between its R&D intensity for the latest available year[9] and its R&D intensity in 2000. For instance, R&D intensity in Austria was 0.64 percentage points higher in 2007 (at 2.55%, shown in brackets on the graph) than in 2000 (at 1.91%). The blue bars show for each Member State the distance separating its latest[10] R&D intensity value and its R&D intensity target for 2010. Austria's R&D intensity target for 2010 of 3% is 0.45 percentage points higher than its 2007 R&D intensity of 2.55%. In other words, in the period 2000-2007, Austria has progressed more than halfway towards its 2010 target.

In 10 Member States, R&D intensity was higher in 2000 than in 2006 (negative green bars). These Member States are therefore further away from their national R&D intensity targets in 2006 than in 2000. Austria, Estonia and the Czech Republic are the Member States that have achieved the most substantial progress towards their targets. However, in the 13 remaining Member States (Bulgaria has not set an R&D intensity target for 2010), the progress made towards their respective R&D intensity targets is only a small part of the progress that is required to meet them. Given past trends and the challenges raised by the current economic environment, it is highly unlikely that a radical change will occur over the next few months. This area of the Lisbon agenda will thus have to undergo a deep scrutiny when outlining plans for the post-2010 period.

9 2005, 2006 or 2007 according to the latest data available for each country.

10 2005, 2006 or 2007 according to the latest data available for each country.

Figure 3 - R&D intensity — progress towards the 2010 targets (in percentage points) in brackets: R&D intensity, 2006 [1]



Source: DG Research
Data: Eurostat, Member States
Notes: [1] IT: 2005; IE, AT, SK, FI: 2007
[2] IT: 2000-2005; IE, AT, SK, FI: 2000-2007; EL: 2001-2006; FR, HU, MT: 2004-2006; SE: 2005-2006
[3] IT: 2005-2010; FR: 2006-2012; UK: 2006-2014; EL: 2006-2015; IE, AT, SK: 2007-2010; FI 2007-2011
[4] IE: The R&D intensity target for 2010 was estimated by DG Research
[5] BG has not set an R&D intensity target

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2.2 R&D policies

(1) EU Member States are increasingly becoming aware that enhancing their economic performance and responding to societal needs will require R&D policy to be placed in a broader context and to be developed in coherence with other policy fields. The most apparent approach is the link with the innovation policy, but other policy domains are also taken into consideration by national policy makers, such as industrial policy, education policy or fiscal policy.

Recently, national policies for R&D continued to evolve towards more coherent and complex policy mixes. With the view of addressing key drivers of economic growth, Member States were building up policy mixes by developing new strategies that cut across different Ministries or by changing the institutional settings used for R&D policy. For example, almost all Member States employ a complex policy mix to stimulate high-tech sector development and promote regions as key actors in national innovation policies. Moreover, member States are increasingly developing new policy programmes aiming to achieve specific RTDI policy goals. These can be called "mini-mixes" of policy instruments and often go beyond R&D policy.

Box 1 - Examples of policy mix approaches

UK

The UK has always had a holistic approach in terms of planning and implementing measures for science, technology and innovation policy. One of the earliest policy documents indicative of this approach was the 1993 Science White Paper, *Realising our Potential*, which was the first major review of science for over twenty years. This White Paper clearly indicated that science and technology policy could not be separated from the concept and process of innovation. As a consequence, all subsequent policy statements dealt with science and technology as an integral part of the UK innovation system.

Netherlands

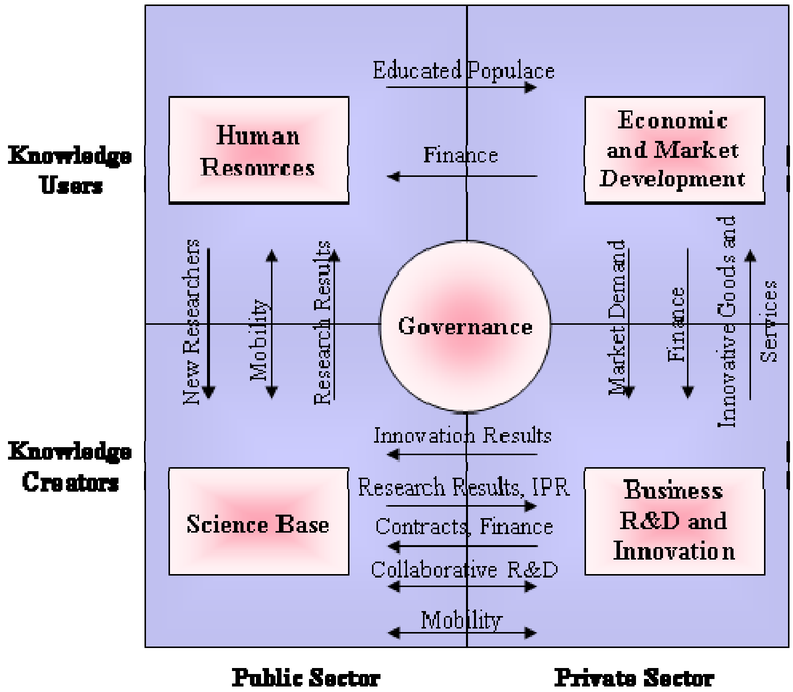
Another example has been the establishment of the Dutch Innovation Platform (September 2003). This was mainly in order to bring the "Innovation policy field" to the inter-ministerial level of "horizontal" policy involving several existing policy making fields and several stakeholders (public and private). The aim of the Innovation Platform is to propose strategic plans to reinforce the Dutch knowledge economy, based upon an integral perception of the Dutch knowledge economy and the role of its actors. On the one hand, it functions as a booster for innovation by stimulating business enterprises and organisations in the knowledge structure to work together and achieve concrete results. On the other, it functions as a partner with the Cabinet for the development of policies to stimulate the production and transfer of knowledge and to stimulate innovation in the Netherlands.

In the frame of increasing the quality of public research, institutional restructuring of the research performers is an ongoing process in several Member States, generally driven by the need to assure that public research performed in the respective countries can compete on a world scale. Since 2005, a CREST-OMC expert group is realising reviews on national R&D policy mixes[11]. Until now, nine EU Member States have been reviewed based on a "light peer-review process". The overall remit of the group is to encourage mutual learning amongst Member States concerning the policy mixes needed to improve overall R&D and innovation system performance. This is seen as a necessary step if the targets set by Heads of State at the European Council meetings of Lisbon (2000) and Barcelona (2002) are to be met. The aim of the peer review process was to help countries better understand the policy mixes needed to raise R&D intensity by improving overall innovation system performance. In contrast to conventional, resource-intensive peer reviews aimed at producing critical and judgemental conclusions based on exhaustive analyses, the emphasis in this "light" exercise was to encourage the sharing of information about policy-related issues between senior policymakers and to generate generic lessons for the formulation and implementation of effective policy mixes.

11 See: http://ec.europa.eu/invest-in-research/coordination/coordination01_en.htm

The CREST-OMC expert group uses a simple analytical framework to link the different domains of an innovation system to structure both discussions and reports. Policy mixes were conceived as the aggregate of policies affecting four major domains: Human Resources; the Science Base; Business R&D and Innovation; and Economic and Market Development. The governance system linking policies in all these domains was also of central interest. Figure 4 depicts all these domains and some of the more important links and flows between them.

Figure 4 - A simple model of an Innovation System.



Source: Ken Guy (2007), Policy Mix Peer Reviews: Synthesis Report.

Although innovation systems are typically much more complex than depicted here, this simple model provides a convenient way of visualising some of the more important domains within an innovation system and the relationships between them. Obviously, the potential R&D system's contribution to future economic growth and jobs depend to a considerable extent on the given socio-economic context of the country, or even of a particular region in which the public science base is embedded. The way, how R&D can contribute through innovation to economic development and jobs, depends notably on the composition of the economy.

The observed weak organisational integration of, for example, R&D, innovation and education policies, can be an effect of policy failures, but it can also result simply from complexity. This has a number of dimensions. On the one hand there can be complex divisions of political authority, such as the different responsibilities of the Federal and State levels in Germany. Many Member States have mechanisms that link the various levels to ensure that each knows what the other is doing and that this is not the same. On the other hand, most of the R&D/innovation systems involve a wide range of agents, of very different types: publicly-funded labs, research institutes, consulting organisations, universities, standards organisations etc. It is important to note that a significant element in organisational complexity is the existence of specialised research units with some specific technical function – animal health and safety, geological surveys, radiation safety, and so on. The more developed European economies possess such institutes in very large numbers, and it is difficult to see how these institutes can be coordinated more effectively, or whether indeed this is even desirable.

Besides, the aim to develop a more coherent policy mix has not generally led to institutional integration, or shifts in organisational structure, although many Member States use formal bodies either to coordinate or advise the policy process. In some cases these bodies are only advisory; in other cases they are only coordination, as is the case with some the inter-ministerial committees; finally, in some cases, they are a mixture of advisory and coordination and combine the use of experts with the coordination of different ministries and/or parts of the policy system.

The influence of EU policy on the national level is of relevance to each Member State but to varying degrees. The EU's influence can be seen on a number of different levels: the influence of the Lisbon Strategy, the influence of the Framework Programme and the influence of the structural funds. These can have an influence on national strategy formulation or on the implementation or on more structural elements of the governance system such as evaluation.

Box 2 - Examples of initiatives to better coordinate R&D-related policies

Germany

In September 2006, the German cabinet approved the High Tech Strategy that for the first time presents an overarching strategy of the German government as a whole and not only from the Research ministry. In order to monitor the implementation of High tech strategy, new advisory councils have been established at two level, one directly under the responsibility of the chancellor (Rat fuer Innovation und Technologie) and one on the level of the Federal ministry for education and research (Forschungsunion Wirtschaft und Wissenschaft).

Ireland

The Strategy for Science, Technology and Innovation 2006-2013 outlines in some detail how the Government proposes to achieve the 3% R&D target. The document has very close parallels with the national 3% action plan, "Building Ireland's Knowledge Economy". The strategy represents the first comprehensive approach undertaken by policy-makers that represents a whole-of-government approach (previously, individual government departments had developed their own science strategies). Accordingly, the Inter Departmental Committee on Science, Technology and Innovation, taking direction from the Cabinet Sub-Committee on Science and Technology, plays a key role in assuring a "joined up Government" approach to science and technology.

Estonia

Estonia has established the Coordination Commission of the Estonian Research, Development and Innovation Strategy to coordinate different aspects of R&D policies and of programmes implementation. The Commission is chaired by the representative of the Ministry of Research and Education and its members are appointed from all government bodies who have their sectoral R&D programmes. Also the implementing agencies and other public institutions are represented.

Lithuania

The law on the restructuring of Lithuanian Science Council into the State Office was approved by Lithuanian Parliament at the end of 2007. The key function of the restructured Lithuanian Science Council is to develop and implement the programmes of competitive funding for R&D, achieve better concentration of R&D efforts and improve research performance of both institutions and individual scientists. The Science Council will be responsible for the development of R&D performance standards, evaluation of State science Institutions, and of individual researchers. In the same time, it will continue the advisory function to the Ministry of Education and Science on Science policy making.

Moreover, the establishment and development of Integrated Science, study and business centres was approved by Lithuanian government on 21st March 2007. The selected initiators of the centres were officially invited to submit extended proposals to establish and develop five Science, study and business integrated centres in the selected priority areas of Lithuania on the 1st February 2008.

Latvia

During the first half of 2007 research policy issues have been addressed as part of the preparations for the first medium-term government budget for 2008–2010. The rationale of the introduction of budget planning beyond annual cycles is to provide stability for the planning and implementation of investments with a longer time horizon, of which R&D is a prime example.

Some of the newer EU Member States are orientating their national R&D strategies heavily towards EU policy. This can be seen either through the focus on the Lisbon strategy in their national policy documents or their orientation towards the EU Framework Programme. This harmonisation enforced by EU membership not only assures continuation of the effort (contrary to the rule that new coalitions break previous initiatives) but also reinvigorates research policy in the new Member States.

EU accession resulted in passing new legislation, creation new policy bodies, and publication of new strategic documents. Only in 2005 Hungary, Latvia, Poland and Slovakia passed new legislation on research; Hungary and Poland also on higher education and innovation; in previous years new legislation on research was also introduced in Lithuania and Slovenia. New advisory bodies (sometimes also with coordination task) were created in 2005 in Poland (*The Council of Science* subordinated to the Ministry of Education and Science and the *Council for Science and Technology Development*, board of the Council of Ministers and the Prime Minister) and in Slovenia (*The National Science and Technology Council*) and in earlier years also in Hungary (*Science and Technology Policy Council*, 2003, *Research and Technological Innovation Council*, 2004) and in Czech Rp. (*Council for Research and Development*, 2002). Hungary, Lithuania and Slovakia have recently created implementation research and technology agencies, usually responsible for administration and coordination of the EU programs, such as Lithuanian *Agency for International Science and Technology Development Programmes* (2002) and Slovakian Minerva (2004). Also majority of countries publish new strategic documents referring to the Lisbon Strategy and the aim of building knowledge society.

The issues that emerge as policy priorities at national level can be grouped under the following categories:

- <u>Building coherent policy mixes for R&D</u>

(2) The need to build coherence with other policy fields starts is increasingly reflected in changes in the institutional settings used for R&D policy development, such as mergers between Ministries dealing with research, education, employment, trade and industry. For example, in 2007 the UK Department of Trade and Industry (DTI) has been replaced with a new Department of Innovation, Universities and Skills (DIUS) which brings together policy on skills, higher education, science and innovation. In the same line, the Finnish Ministry of Trade and Industry (main R&D funding ministry) was merged with parts of the Ministry of Interior and the Ministry of Labour, the new ministry being called the Ministry of Employment and Economy.

(3) National strategies developed recently fully reflect this cross-cutting approach (e.g. Cyprus: 2007-2013 National Development Plan, Spain: Research, Development and Innovation Plan 2008-2011, Greece: Strategic Development Plan for Research, Technology and Innovation 2007-2013, Hungary: Science, Technology and Innovation policy strategy 2007-2013, Portugal: a new National Strategic Reference Framework, Romania: National Research, Development and Innovation Strategy 2007-2013, Slovakia: Long term Objective of the State Science and Technology Policy up to 2015).

(4) Stakeholders are being increasingly involved in policy making processes, fact revealed by the broad, co-participative foresight exercises organised in the last years by numerous Member States with the view of establishing thematic priorities for research funding.

(5)

- <u>Development of policy programmes ("mini-mixes") to achieve specific RTDI policy goals</u>

An increasingly popular approach has been the construction of comprehensive policy programmes ("mini-mixes"[12]) that explicitly use different types of policy instruments together (e.g. human resource initiatives, fiscal exemptions, grant schemes, regulation) to achieve a specific RTDI policy goal (e.g. R&D investments in bio-tech) or support a specific target group (e.g. new technology-based firms). These policy instruments can be related to non-R&D policies – regulation, fiscal, and innovation oriented – as well.

12 Term introduced by the Policy Mix Project "Monitoring and analysis of policies and public financing instruments conducive to higher levels of R&D investments", commissioned by the DG RTD.

One can distinguish three types of mini-mixes: 1) the cluster or *Pôle de Competitivité* approach, 2) the packages of measures for high-tech starters and 3) packaged R&D programmes with flexible/multiple support mechanisms. In some cases there are different geographic governance levels involved (local, regional, national and international) with pre-defined divisions of labour. A number of Member States have adopted such "mini-mixes"[13] Netherlands has developed the Technopartner programme, which is a package of measures to support new technology start-ups, as well as the Innovation Programme - a flexible policy support framework that focuses on a specific technology domain; France has launched a multi-annual inter-ministerial research and innovation programme on Transportation (PREDIT); also the national *Pôle de Competitivité* approach has some characteristics of mini-mixes; in Belgium, a *Pôle de Competitivité* programme combines different policy domains and includes packaged approaches.; in Germany, bundling and simplifying existing SME policies by the Ministry of Industry (BMWi) could also be seen as a mini-mix.

- <u>Structural Funds in R&D</u>

Structural Funds have an important role in supporting the regions in taking the Lisbon strategy forward. For the new programming period 2007-2013, the Member States have drawn up national strategic reference frameworks and operational programmes in partnership with national, regional and local authorities and the Commission. These are based on the Community Strategic Guidelines for Cohesion Policy, which focus increasingly on the Lisbon priorities including research. Through the operational programmes, available budgets are distributed over the different priorities. An analysis of all approved operational programmes shows that almost 29% (99.4 billion Euros) of the total EU Structural Funds 2007-2013 are foreseen for R&D and innovation. Of this amount are 49.9 billion Euros for research and technological development which means a massive increase compared to the 2000-2006 period. The priorities are supporting RTD in and for SMEs, technology transfer, R&D capacity building, regional cross-border and transnational research cooperation.

(6)

- <u>Increasing the quality of public research</u>

(7) Having an excellent public research base is broadly recognised by Member States as an essential factor in attracting private investments in R&D. The reasoning for actions geared towards increasing the quality of public research systems is related to the growing awareness of the globalisation of R&D. However, the new Member States are at different stage of development comparing to the old Member States. Whereas for the last ones the driver has been a willingness to ensure that public research performed in their respective countries can compete on a world scale, a number of new Member States are struggling to move towards the quality of public research performed in the old Member States. Some Eastern European countries still have to cope with a

massive restructuration of their research system and with changing of institutional roles of research performers.

(8) Recently, the most visible strategies were related to the institutional restructuring of research performers, setting up evaluation bodies aiming to assess research activities of R&D performers, and a shift towards an increased proportion of competitive funding.

(9) For instance, Denmark is restructuring its public research performers, aiming at the establishment of internationally more competitive universities. Finland has also launched a revision of its public research base, attempting to cut down the number of universities and pursuing a regional reallocation of research centres. France has passed a law modernizing the governance of universities and giving them more autonomy. An independent Evaluation Agency for University and Research has been set up in Italy. The Lithuanian Science Council has been restructured and the evaluation of public research institutions and universities is one of its new tasks. The shift towards competitive funding of research comparing to block institutional funding continues in the new Member States, the establishment of a new funding agency in Poland (National R&D Centre) being a relevant example in this respect.

Increasing human resources in R&D is a critical factor for the quality of public research. It is being addressed through measures such as increased funding aiming to develop human resources (Austria and Netherlands) or improving the recruitment of researchers by establishing transparent procedures in line with international standards (Italy).

- Developing High-Tech sectors

Almost all Member States employ a complex policy mix to stimulate high-tech sector development, even though they have different policy approaches. Many mini-mixes mentioned above are part of this effort. In particular, attention to new technology-based firms has become the focus of increasing attention across Europe. Examples of this dedication to high-tech sectors in Member States are: Biotechnology and BioPharma Programmes in Germany, ICTRegie in the Netherlands, introduction of thematic programmes and technology-focussed schemes in Austria, competitive clusters in France, building-up of a public biotechnology research infrastructure in Belgium.

In some New Member States, the tendency is sometimes to put all efforts on the development of high-tech sectors to the detriment of innovation in traditional low technology sectors that nevertheless make the bulk of their industry. Due account should also be taken of traditional and low-tech sectors which are important in many Member States' economies, but where growth potential is hampered by low levels of innovation.

- Regional involvement: towards commercialization in specific sectors

Regions have become key actors in innovation policies of Member States. Many regions have developed their own innovation strategies, relying on local strengths and potential. Regions concentrate on selected areas or technologies to strengthen specific sectors. They complement national opportunities and generic support by measures that are more thematic and take the existing local industrial structure into account (this does not exclude however targeted support offered also at national level). The main goal of regional involvement is to promote technology transfer, innovation and commercialization. Networking and linking with other parts of the industrial fabric is considered their responsibility. The national and regional layers can therefore produce complementary effects.

- Internationalising

  Although the challenge of globalisation is literally mentioned in all recent strategic R&D policy documents of Member States, only a few policies can be found in Member States which explicitly deal with the growing internationalisation of R&D, such as the Austrian *"Headquarter Strategy*" programme, supporting companies in establishing their R&D headquarters in Austria, or the Finnish LIIKE 2 programme, aiming at supporting companies to position themselves in a globalised economy, or the Portuguese "*Projectos de Investigação, Desenvolvimento Tecnológico e Inovação em Cooperação Europeia e Internacional*", aiming at supporting cooperative research projects with European and International partners, which may contribute to foster new research fields in Portuguese research centres as well as to encourage the internationalisation of the research activities of those centres.

3 Trends in steering the public science base

The post-2000 period has seen widespread Member State policy activity in pursuit of research reform, and particularly in the university sector. Only Greece, Ireland, Malta, the Netherlands and the UK have not introduced significant new legislation in that time, although the relative calm in the Netherlands and the UK reflects a much earlier adoption of these principles and goals. This modernisation process has been driven on the one hand by EU-level policies, to establish a European Research Area (ERA) and a European Higher Education Area (the Bologna process), and on the other hand it is the result of a more general commitment to introduce the principles of new public management and member states' ambitions to increase the social and economic return from public investment in research.

These reforms have included developments at the national and institutional levels, including:

- Introduction of legislation to create more autonomous institutions, with increased management autonomy and reduced central management by the state;
- Introduction of national research policies with explicit thematic and procedural strategies and a commitment to increasing social and economic benefits, and a competitive economy in particular;
- Introduction of more competitive funding models, and a shifting balance of funding in favour of performance-related income and mission-oriented funds.

Governments are not withdrawing from their responsibility or influence for the public research base but are using new methods of steering the research base to align with policy priorities. A handful of countries have followed the New Public Management approach of writing performance contracts with the universities.

Member States report a growing interest in performance monitoring and evaluation, which is a corollary of the increasing autonomy of public research institutions and a need for budget holders to be able to demonstrate efficient and productive use of public funds. Several countries have created new institutions external to the universities with a quality control mission.

A growing number of European Member States has published national policies to promote and facilitate international research cooperation, and in particular to increase and strengthen links to leading scientific nations and emerging economies outside the EU. There is a growing strategic interest in the subject at the university and institute level too. International relationships are coming to be seen as a vital means by which to drive research excellence, attract students and staff and sustain the institution in the longer term.

Increased interaction between universities and industry is a long-standing policy objective in all Member States and many have long-running programmes that promote both "pair wise" research cooperation between companies and universities as well as the formation of more extensive networks to facilitate diffusion and valorisation. There is evidence of renewed efforts to promote industry engagement and not simply through project level cooperation, but also through – for example – the direct engagement of the private sector in the governance and leadership of universities and the encouragement of strategic research partnerships with individual companies.

Apart from some notable exceptions, there is little evidence of systematic rationalisation and concentration of research institutions, and few member states are actively looking to intra-EU cooperation as a means by which to improve coordination and reduce fragmentation. On the funding side, intra-EU joint research programmes are in a minority and have very small funds at their disposal, the significant boost provided by ERA-NET and Article 169 initiatives notwithstanding. Researcher mobility and career enhancement is developing only slowly, and the opening up of national programmes is not an evident priority, although there are exceptions and increasing experience of how to reconcile domestic agenda with internationalisation.

Overall, the process of reform is widespread if still rather uneven and suggests that there is an important and continuing role for the European Research Area, through more and better information sharing about reform and support for EU-wide research and experimentation into the various aspects of reform that have proved to be particularly challenging, from novel funding models to new governance structures to new ways to encourage internationalisation.

This chapter deals with the recent trends in the public science base, starting with a quick overview of trends in public R&D expenditures and then turning to the main policy issues in steering the public science base, notably current efforts to reform the public science base, to strengthen science-industry links and finally ensuring the excellence of the science base.

3.1 Public R&D expenditures

Even if the intensity of government funding of R&D has increased in a majority of Member States, at EU-27 level this intensity has remained stable (0.63 % of GDP in 2006) due to the stagnation and decrease in Member States with a high share of EU-27 GDP.

Compared with the late Nineties, in EU-27 R&D expenditure in the higher education sector has increased only very slightly as a percentage of GDP (to 0.40% in 2006), while the intensity of R&D performed in government institutions has slightly decreased to 0.25% in 2006, i.e. at a much lower level than the intensity of R&D performed in the higher education sector. At EU level therefore, if the overall level of public R&D expenditure has remained very stable, its centre of gravity has been more and more directed towards the higher education sector over that period of time.

Three main groups of countries may be considered in this respect. The three Nordic countries of Sweden, Finland and Denmark, as well as Austria, still stand out with the highest intensity of higher education R&D and the public R&D expenditure of these countries is largely university-oriented. This choice has been confirmed over the years. On the other hand, in a majority of European countries R&D intensity has not changed much since 2000, neither in higher education nor in governmental research organisations. Government R&D maintains a remarkably strong position in France and Germany, whereas in the two other largest Member States, the United Kingdom and Italy, university R&D prevails. Finally, in a third group of countries, composed mostly of new Member States, public R&D is mainly conducted in the government sector, even if a modest shift has taken place since 2003 in all of these Member

States, with a slow convergence towards a more widespread breakdown of public R&D.

Beside the actual expenditures of the public sector (Higher Education and Government), there are data on Government Budget Appropriations or Outlays for R&D (GBAORD) available. A growing share of R&D budget in general government expenditure demonstrates increased commitments by a large majority of Member States. In 2006, GBAORD[14] amounted to 1.62% of general government expenditure in EU-27.

The share of the R&D budget in general government expenditure has increased between 2000 and 2007 in 20 Member States. In nine Member States, this share increased by 5.5% or more per annum. These high growth rates to some extent reflect the initial low or very low levels of the R&D budgets in these Member States, but they also indicate a commitment to increasing public investment in R&D. In these Member States, the Lisbon Strategy and the associated target for R&D intensity has clearly led to a step change in the political importance attributed to research.

The structure of GBAORD at EU level has stayed remarkably similar to that of 2000 and the distribution of government appropriations across the various socio-economic objectives has remained stable for a majority of countries in Europe since 2000. For the majority of Member States "Research financed from General University Funds" (GUF) is the most important one. For some, though, (Belgium, Spain, Hungary, Romania and Finland) the most important GBAORD objective is "Industrial production, and technology". In most of the new Member States, the most important GBAORD objective by far is "Non-oriented research". The major part of the European budget allocated to "Defence" is to be found in the United Kingdom and France and, to a much lesser extent, in Spain. In fact, for the United Kingdom and for France, "Defence" is the first priority in terms of GBAORD, followed by GUF and "Non-oriented research". For all other EU Member States, "Defence" is a relatively minor priority.

As the improvement of science-industry cooperation is a key R&D policy priority, it is interesting to look at the share of public R&D (higher education and government) which is financed from the private sector: This has remained substantial in EU-27, amounting to 6.4% of the total in 2005. The largest shares (more than 10%) are found in Latvia, Romania, Slovenia, Hungary, Belgium and the Netherlands. For all other countries, business support for public R&D ranges from 3% to 10%, with a cluster of countries at around 5-7% (Cyprus is an exception with less than 3%). Half of the countries had a positive – and half a negative – annual average growth rate in the level of private funding of public sector R&D over the 2000-2005 period, with an annual average growth rate within the range of -5% to +5%.

3.2 Managing the science base

The reform of the public research base is another key step towards the achievement of the Lisbon objectives and, as such, it is further put forward in the Integrated Guidelines. The goal of reforms of the public research system should be to facilitate

14 For the purposes of GBAORD, the Frascati Manual recommends that central or federal government should always be included; provincial or state government should be included when its contribution is significant; local government funds (i.e. those raised by local taxes) should be excluded.

and enhance cooperation with the private sector and/or to become a more demanded partner for private sector R&D activities. The recent fourth Community Innovation Survey (CIS4) showed that public sector R&D organisations and universities are highly important partners for less than 5% of innovating companies.

Public sector R&D organisations share a considerable number of reform issues, such as:

- An increased role for stakeholders;
- The progressive professionalization of management;
- Changes in organisation to become more outward facing;
- An increased ability to define and implement strategy;
- An increased autonomy from the State;
- The "contractualisation" of relations with funders/customers via various kinds of performance contracts, often accompanied by performance indicators;
- Increased external quality controls (explicitly through agencies in the case of the universities; more implicitly in the case of institutes, where arguably there is still an evaluation deficit).

Most Member States have launched policy initiatives within the above-mentioned reform areas. How these initiatives are actually implemented, depends largely on the historical and cultural context in which the public research base is operating. For instance, for those Member States with a high level of regional autonomy, such as Belgium, Germany and Spain, priorities between the regions might differ. For Member States with a strong non-university public research system such as France, Germany, the new Member States and their Academy of Sciences system, Spain, Italy and the UK, priorities might be different from those where the Higher Education sector is the main public R&D performer like the Nordic Countries, Ireland, Netherlands or Belgium.

Recently, a number of policy initiatives to reform the public research base have been launched in the EU Member States. Often, these initiatives are presented in form of national R&D strategies, sometimes within the context of national development programmes. The legal nature of these initiatives and strategies is not always obvious, as they contain long term objectives and goals without being necessarily precise on their concrete legal implementation. On the other hand, National Reform Programmes present a number of legal initiatives in this regard as well. For instance, the Slovenian resolution on the National Research and Development plan for 2006-2010 includes a legally binding obligation to assure continuous monitoring and evaluation of set targets. The French 2006 Law for research provides new legal tools to encourage cooperation between public research organisations and the university system. In addition it gives new emphasis on evaluation of research procedures.

The principal trends regarding Member States' policies on research reform are post-legislative policy measures to press forward with greater levels of institutional autonomy within the university sector. Even if reforms are still in progress, there appears to be a reduction in the level of prescription and direct management of the university sector by the state, although there is growing policy interest in university performance, and related efforts to incentivise increasing excellence and connections to social and economic end games. Similarly, there is evidence of a reduction in the extent to which policies and priorities are decided by academics alone. Other stakeholders are playing a more prominent role, albeit typically working with an academic majority.

With the drive towards autonomy, Member States appear to have few active policies to promote improved terms of employment and careers for researchers. Conditions of employment differ markedly too, with a broad split between Member States where university researchers are to all intents and purposes civil servants with protected posts, pensions and other benefits and those where a majority of researchers are not tenured, but must work within the context of successive short-term contracts linked to specific grants.

There is a clear evolution in research funding models, with many member states beginning to increase project funding relative to institutional funding, and in some cases linking institutional funding to objective reviews of past performance. There has been an extension of research funding instruments with new measures to reinforce legislative changes and to help to secure policy objectives, in particular with respect to newer commitments.

On balance, the process of reform appears to be rather uneven, with just a minority of Member States that have arrived at a situation where their public research organisations are independent, internationally competitive research organisations, alive to changing research priorities, but with broadly based funding sources and flows of students and faculty from around the globe.

Box 3 - Examples of initiatives to reform the public research base

Spain

To improve management and reduce bureaucracy for R&D and innovation, a new Regulation under the General Subsidies Act makes the administrative procedures for funding R&D and innovation more flexible, and a new Agencies Act enables public research institutes such as the Higher Council for Scientific Research and Carlos III Health Institute to adopt legal forms that are in line with their procurement and contracting needs.

Italy

A national council for university and research assessment (ANVUR) is being established. The council will have the task of assessing the results of teaching and research carried out at Italian universities, public entities and private entities in receipt of public funds, in accordance with principles of impartiality and independence. The results of such assessment activity shall form the basis for allocation of state funding in the future.

Portugal

In 2006 the Government approved an extensive Reform of the State Laboratories with consultation and monitoring provided by an International Scientific and Technical Committee. The legal status of State Laboratories was reviewed so as to ensure proper conditions to operate, the ability to render services, autonomy, the renewal and mobility of staff, competitive attraction of high quality human resources, and greater raising and effective use of own income.

3.3 Strengthening science-industry links

The national policy and legal environment has evolved in the past 5-10 years and has become increasingly concerned to improve and increase industry engagement in public research. The Lisbon agenda has reinforced this trend, with universities at the forefront of national and regional initiatives to attract inward investment from leading global technology companies. All Member States recently launched activities in order to improve the linkages between the public R&D base and the business sector. In principle, business can engage with public research institutions through several channels, such as the recruitment of researchers, the purchase of research outputs, the appointment of business people to governing bodies or the appointment of academics to external posts, the privatisation of elements of the research delivery system, endowments given to research institutions, executive education, student projects in companies, and so on.

According to the ERAWATCH study "The Activities of EU Member States with Regard to the Reform of the Public Research Base", industry engagement is a major focus for research reform across EU Member States. This subject has been explored in more detail in three cases (Austria, Netherlands and UK). In all of them, national research strategies are evolving into what might be called research and innovation strategies, where a commitment to deliver research excellence sits alongside a parallel commitment to increase the benefits to the national economy deriving from this significant public investment and social activity. Equally, there is evident involvement of the private sector in strategic planning exercises, as architects and consultees. Moreover, there is an increasing industry engagement at the institution level in appointments to governing bodies, the involvement / consultation with private sector around university strategies, public-private strategic research partnerships and the outsourcing of key "innovation" functions.

In the Netherlands, the Association of Universities in the Netherlands (VSNU) reports a doubling of research income from the private sector, in the 10-year period from the mid-1990s. Similarly, in the UK data show long-run, year-on-year growth in private sector involvement across higher education in governing bodies, co-publications, research income, licence income, and so on. These trends appear to be echoed in industrial research, with a growing commitment to open innovation on the one hand and a growing sense that international comparative advantage is no longer rooted in the close and proprietary control of basic technology.

Box 4 - Examples of initiatives to improve science – industry links

Austria:

A variety and a large number of policy measures in support of collaboration, networking and clustering have been designed and implemented, the "centres of excellence" (or "competence centres") programmes being the most visible and – in terms of budget - largest activity. The K-plus and K-ind/K-net programmes promoted the long-term strategic R&D cooperation between companies and research institutions in so-called "competence centres" that are funded for a maximum of 7 years. In 2007, a follow-up programme has been launched: like its predecessors, COMET ("Competence Centres for Excellent Technologies") supports long-term strategic R&D collaboration between science and industry in "competence centres" for durations of 7 or 10 years, and in "competence projects", i.e. multi-firm research projects lasting 3-5 years.

France:

Amongst the main recent instruments put into force to increase public/private partnerships are the Competitiveness Clusters, which have put the emphasis on private research organisations involvement, and the Agency for Industrial Innovation, which supports large programmes for industrial innovation. Another instrument has been put into force to enhance relations between public research actors and private ones: the Carnot Award. The Carnot award is a label rewarding a limited number of public research entities or private research organisation with general interest goals for their implication with the socio-economic partners (enterprises). Carnot institutes receive funding up to 40 €M for a four year period.

Netherlands:

Main instruments in this category are the funding of programmes and projects in which partners from both public and private organisations are a requirement. A prominent example is the introduction of innovation vouchers, which stimulate the exchange of knowledge and connections between SME's and knowledge institutes in order to facilitate innovation. Also, the Leading Technological Institutes stimulate scientific excellence on research areas that are of relevance to the industry and several initiatives are taken to promote universities to develop a professional policy on patenting.

Poland

The INNOVATOR programme, launched by the Foundation for Polish Science (FPS), plans to support young researchers in applying their innovative projects involving state of art technologies, products and services into economy. The main objective of the programme is to prepare young researchers – doctoral candidates and postdocs – to work at the junction of science and business and to assist them in implementation of their ideas into market. This new programme is directed to young scientists under 35 working in any field of science. Applicants are selected taking into account innovative character of the project and its potential application. The programme foresees three stages:

- Selection of 20 to 25 innovative projects (in technology or services). Subsequently, selected scientists are to be invited for a 2- to 4-months practical training on managing business activity. At the end of the course the participants are required to create business plans with regards to the project implementation.
- The FPS covers the expenditures concerning project implementation for selected candidates, following business plans submitted by the authors, and offers financial and organizational support at the launching stage.
- The FSP directs successful applicants to external financial institutions and provides assistance concerning further project funding.

3.4 Fostering excellence of public research

It is widely accepted that excellence in research is a prerequisite to its societal spillovers in form of technology development or other innovations. Also in this case, all Member States acknowledge the relevance of an excellent research base in close accordance with the spirit of the corresponding Integrated Guideline. Excellence is often meant as including two dimensions: the scientific quality and the relevance of research with regard to its potential economic use or potential societal relevance. Most EU Member States launched activities to foster the excellence of their public research base.

The year 2006, for instance, saw the official launch of "National Institutes of Technology" in Italy and Austria to develop a national R&D-excellence flagship. Other Member States like Belgium, Estonia, Sweden or Malta launched new initiatives regarding the creation of centres of excellence, such as the Platforms of strategic importance (PSI) in Malta or the Linnaeus grant system in Sweden. In Germany, the "excellence initiative" for universities provided the first funds for five selected universities.

For a number of countries, especially the new Member States but also Portugal or Belgium, the achievement of R&D excellence is closely linked with an increased internationalisation of the public R&D system, notably through participation in the EU Framework Programme. Increased international linkages of the national research system are seen as key tools in achieving R&D excellence at the international level.

A handful of countries have followed the New Public Management approach of writing performance contracts with universities. Austria, France and Denmark have all introduced performance contracts since 2003. In the Austrian case, 20% of the income from the Education Ministry is dependent upon the performance indicators specified in the contract. In Germany the first performance contracts were signed between the government of Baden- Wurttemberg, Berlin and Lower Saxony with universities. Since then, this kind of instrument has been introduced or is in preparation in all German States. In Spain, regional governments such as Catalonia have developed multiannual programme-contracts with public universities since 1997. Public funding is then provided according to progress in the chosen area. Specific objectives are established regarding university management, technology-transfer, and relations with society.

Governments are thus not withdrawing from their responsibility or influence for the public research base but are using new methods of steering the research base to align with policy priorities. Performance contracts are used increasingly in connection with applied institutes' core funding. In France, setting a performance contract with CNRS paralleled the "contractualisation" of relations with the universities. As with the universities, however, it is not clear that there is a strong feedback loop from performance against contract to the amount of state money the institutes get.

Member States report a growing interest in performance monitoring and evaluation, which is a corollary of the increasing autonomy of public research organisations and a need for budget holders to be able to demonstrate efficient and productive use of public funds. Several countries have created new institutions external to universities with a quality control mission, including the Evaluation Agency for Higher Education and Research (AERES) created by France in 2007, National Research and University Assessment Agency (ANVUR) in Italy, Lithuania's Centre for Quality Assessment in Higher Education that has a remit that covers not only education but also research. In the Netherlands, university quality control is instead mostly handled internally by universities themselves, supported by Quality Assurance Netherlands Universities (QANU). Spain has whole range of such institutions, including the Centre for the Development of Industrial Technology (CDTI), the National Agency for Evaluation and Prospective studies (ANEP) and the National Commission for the Evaluation of Research Activity (CNEI).

The research quality control system that stands out as distinctly different is the UK's Research Assessment Exercise (RAE), which has been in place since 1986. The goal was to drive up the quality of research and to bring about a degree of concentration of research performance. Although the system has evolved over time, it basically uses a combination of bibliometrics and international peer review to assess and rate the research of every university department in the country (that chooses to submit). The resulting ratings are used to allocate around 30% of the national science budget across the period until the next RAE. Most importantly, the funding credits are heavily skewed in favour of the best performing departments and as a result the stronger research universities have seen substantial growth in their research income in the period, while those universities with a weaker research base have seen their income shrink, leading to a situation where some 50% of block funding is awarded to the top 10 research universities. These leading institutions account for around 30% of total university research capacity. Having established the principles and practice of performance-related income, the UK government has decided to simplify the RAE, placing more weight on bibliometric analyses. Outside the UK, there has been little enthusiasm for this type of quality control or such a strong feedback loop from evaluation results to resource allocation, with the exception of Denmark.

Box 5 - Examples of National Institutes of Technology

Italy

The Italian Institute for Technology (IIT) is a Foundation created to promote excellence in research in Italy. IIT was established jointly by the Ministry of Education, Universities and Research and the Ministry of Economy and Finance. It is open to the active participation of private organizations in order to encourage technological development and training in high technology. In particular, the Foundation's scientific programme includes the launch of research programmes on three different technological platforms: Robotics, Nanobiotechnology and Neuroscience. These three platforms will develop synergic and highly interdisciplinary research activities with the common objective of studying and developing humanoid technology. The Foundation has its headquarters in Morego (Genoa).

Denmark

The restructuring of the public research performers is one of the cornerstones and the first highly visible outputs in the research domain of the general reform process started with the Globalisation Strategy of 2006, to profile Denmark as a leading knowledge society in international perspective. Based on the merging of resources of the existing 25 universities and public research institutes, 11 new research institutions have been established since 1 January 2007. Most significantly has been the establishment of three large universities with clear research profiles which locate the main R&D actors in their respective fields:

- Copenhagen University will house the main chemical and biological research performers.
- Aarhus University will cover a broad range of fields with a specialisation in sciences covering environmental issues and natural resources, nanoscience, economy and social sciences.
- Denmark's Technical University has merged with five public research institutes, e.g. the Research Centre Risø, and has the goal of becoming a leading international university for the development and application of research-based technology.

4 Trends in leveraging private R&D investments

There is a long tradition of specific measures aimed at tackling market failures leading to suboptimal levels of private sector R&D. There is, however, an ongoing debate about the most effective policy instruments to overcome them. On one hand, direct financial support runs the risk of "crowding out" private-sector investments rather than enhancing them. Indirect measures such as tax incentives, on the other hand, bear the risk that companies improve their tax breaks by changing their R&D reporting and accounting practices.

The Lisbon strategy recognises the importance of all these factors and asks Member States to design and execute the different policies in a more coordinated and integrated manner. A variety of policies is currently applied across the Member States in order to achieve this goal. Typically, they include direct funding of business R&D, competitive and collaborative R&D programmes, and incentive schemes for public sector R&D organisations to cooperate with the private sector, tax incentives and other financial incentives for business R&D efforts, such as tax cuts for private sector researchers[15].

Although different national and sectoral settings might require different "policy mixes" and the same policy instruments might have a different impact according to the respective national setting[16], R&D policies typically belong to the following types[17]:

- Direct Financial R&D measures: these include all direct transfers of financial support for R&D from the public to the private sector via grants or conditional loans;
- Indirect fiscal R&D measures: these include all forms of reduced tax requirements from companies for approved R&D investment behaviour;
- Catalytic financial R&D measures: these include all measures enabling and/or facilitating access to external financial resources for R&D performing companies, usually in the form of venture capital or loan and equity guarantees.

Most Member States have policies in place that cover the whole spectrum described above. According to the specific national situation and to the existing governance structures, however, the concrete design of these measures varies widely and measuring the impact or the relative importance of the instruments used by these policy initiatives in each national setting can be very difficult[18]. Moreover, although Member States developed over the last decade quite sophisticated policy mixes, the level of private R&D expenditures remained remarkably stable.

15 For an overview on fiscal incentive schemes in the EU see the Report of the CREST OMC expert group on Evaluation and design of R&D tax incentives.

16 UNU-MERIT (2006), Monitoring and analysis of policies and public financing instruments conducive to higher levels of R&D investments, The policy mix project.

17 EUROPEAN COMMISSION (2003), Raising EU R&D Intensity: Improving the effectiveness of the mix of public support mechanisms for private sector Research and Development, Report to the European Commission by an independent expert group.

18 See for example: EUROPEAN COMMISSION (2005), Policy, Indicators and targets: Measuring the impact of innovation policies, by Anthony Arundel and Hugo Hollanders, TrendChart. The need to develop respective indicators has been raised in a number of recent publications; see for example EUROPEAN COMMISSION (2004), Improving institutions for the transfer of technology from science to enterprises, expert group report, BEST project.

This chapter presents a brief overview of private R&D investments before turning to a more detailed analysis of measures of direct governmental support to business R&D and indirect leveraging of private R&D investments, notably tax incentives. The measures described are limited to R&D policies aiming at directly or indirectly influencing private R&D investments. Measures from other policy domains are only covered when they play a key role within the respective national policy mix.

4.1 Private R&D expenditures[19]

In nominal terms, EU-27 GDP grew at a similar rate to EU-27 Business Expenditures on R&D (BERD) between 2000 and 2006 respectively. As a result, business R&D intensity in EU-27 (BERD as percentage of GDP) declined from 1.20% in 2000 to 1.17% in 2006. The intensity of business funding of R&D has increased almost exclusively in those Member States where this intensity was already low or very low. Except for Austria, EU Member States with medium and high levels of business funding have not been able to increase substantially their business R&D funding intensities.

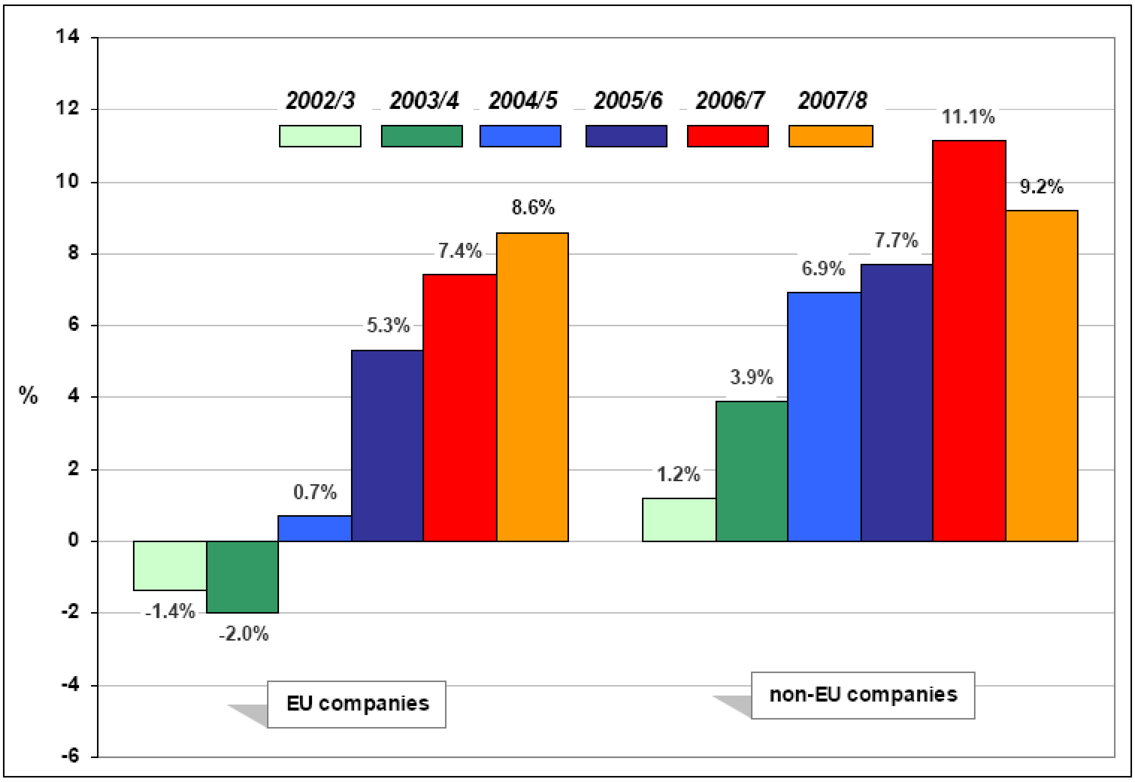
The EU Industrial R&D Scoreboard, comparing R&D investments pattern between the largest EU and non-EU companies, is a key resource when dealing and comparing internationalisation of R&D. According to the 2008 Scoreboard, the regional distribution of the companies in the top 50 has not changed. The EU accounts for 18 companies among the top 50 R&D investors, the US for 20 and Japan for 9. Five out of the top 10 R&D investors are from the US, of which three are the world's top R&D investors: Microsoft (€5.58 bn), General Motors (€5.54 bn) and Pfizer (€5.53 bn). There are three EU companies among the top 10 R&D investors: Nokia, the top EU company, invested €5.28 bn, Volkswagen, €4.92 bn and Daimler, €4.89 bn. Among the top 10, there is one company from Japan (Toyota Motor, €5.45 bn) and one from Switzerland (Roche, €5.01 bn).

The 1000 EU companies in the 2008 Scoreboard increased their R&D investment by 8.6%, an improvement on the previous year's 7.4% growth. At 9.2%, the R&D investment growth of the 1000 companies in the non-EU list was less pronounced than the previous year's 11.1% growth. Therefore, the difference in growth of R&D investment between the EU and non-EU groups of companies has decreased significantly (see Figure 5). Also, this was fifth year running in which the growth rate by EU companies has beaten the previous year's figure.

The EU companies in the top 50 have a lower average R&D intensity (4.7%) than their non-EU counterparts (6.7%). The overall lower average of R&D intensity of EU companies is due to their large share of low R&D-intensive sectors (with much higher sales) as compared to the similar group of non-EU companies.

19 Two data sources are used: The first is the EUROSTAT / OECD databases on Business Expenditures on R&D (BERD); the second is the EU Industrial R&D Scoreboard which is compiled by the European Commission, notably DG-RTD and JRC-IPTS. Although both data sources deal with R&D efforts by the private sector, they present a different but complementary view on the issue, mainly because they use different methodologies for compiling the data.

Figure 5 - Growth of R&D investment the Scoreboard companies.



Source: The EU Industrial R&D Investment Scoreboards (of 2004, 2005, 2006, 2007, 2008), European Commission, JRC/DG RTD.

R&D investment remains highly concentrated by sectors: the top three – pharmaceuticals & biotechnology, technology hardware & equipment and automobiles & parts – account for more than 50% of the total. At the same time, the top 3 sectors by R&D intensity – pharmaceutical & biotechnology, technology hardware & equipment and software & computer services – accounting for more than 40% of the overall R&D investment, have had double digit R&D growth over the last three years. For the pharmaceuticals & biotechnology and IT sectors, the combination of high R&D intensity and high R&D investment share underlines the role of these sectors for R&D investment.

4.2 Government funding of business R&D

Direct public support of private sector R&D (GBERD), i.e. the public funds spent on business R&D, is the most obvious instrument used by Member States to support business R&D. However, this no longer corresponds to the actual public support for private R&D, since direct funding of private R&D is increasingly being replaced in a number of Member States by indirect measures, notably tax incentives. In smaller economies in particular, tax incentives make up a considerable fraction of all government support to business R&D, often exceeding direct government funding[20]. However, as they are not targeted to specific sectors, an analysis of GBERD data still provides useful information on the sectoral priorities of public action.

Governments usually use competitive R&D programmes, for the direct funding of private R&D, requiring that applicant companies cooperate with public research activities, either in universities or other public research organisations. Cooperation programmes are often directed towards the needs of SMEs. Another frequently used instrument, in particular for defence-related research, is contract research, whereby governments buy research services from a company. Here, no formal cooperation with public research is required.

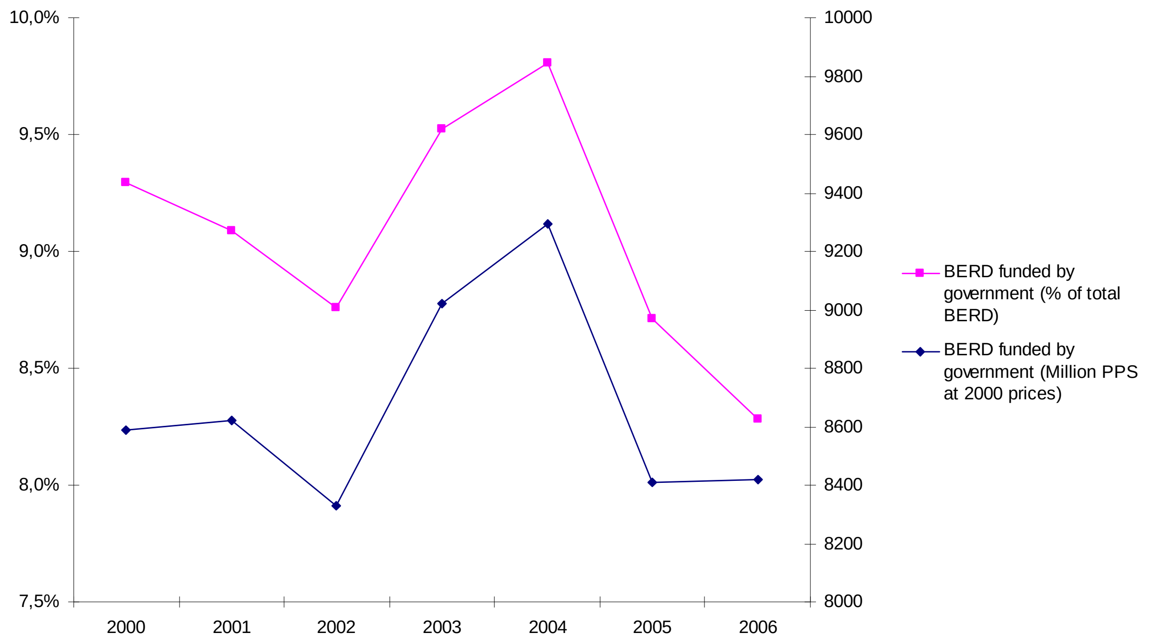
As regards the direct funding of private sector R&D, information is available on both the sectors benefiting most from public support and on the relative importance of this support as a percentage of business expenditures on R&D (BERD) in the respective sectors. Over the last two decades, the relative weight of public funds for BERD has declined constantly[21], reflecting on the one hand (at least for Europe) the declining importance of defence-related research and on the other a change in the governance of public R&D. Two changes should be mentioned here: a shift towards more technology-oriented and less sector-oriented R&D policy[22] on the one hand and the substitution of direct funds with indirect schemes – namely tax incentives – on the other.

20 OECD (2006), OECD Science, technology and industry outlook 2006

21 OECD (2002), STI Review – Special issue on new Science and technology Indicators, pp 147-181

22 See also: Dosi, G., Llerena, P., Labini, M.S., Evaluating and comparing the innovation performance of the United States and the European Union, Expert report for the TrendChart Policy workshop 2005

Figure 6 - BERD funded by government in the EU

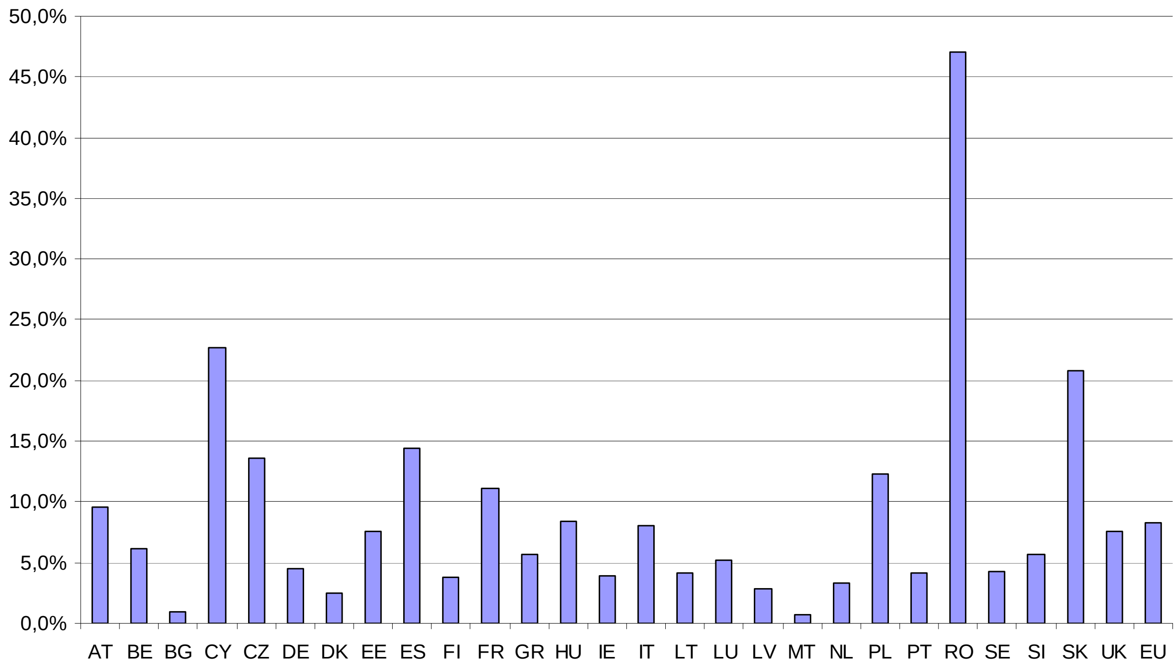


Source: Eurostat.

Note: EU total was calculated based on the data for 19 countries (BE, BG, CY, CZ, DE, EE, ES, FI, FR, HU, IE, IT, LT, LV, PL, RO, SI, SK and UK).

Figure 6 shows the declining role of governments in funding BERD. The rebound in 2003 might indicate a temporary decline in industrial R&D funding during the economic slowdown; however, it is mostly due to a very pronounced increase in the UK. At national level this indicator has performed in a variety of ways, ranging from, e.g., a substantial decrease in Poland to a marked increase in Spain. The end result of these differences in progress and in past policies is a wide diversity of government contributions to BERD in the different Member States, as shown in Figure 7. This indicator varies substantially, ranging from less than 5% in countries such as Denmark, Finland, Ireland or the Netherlands, to over 15% in some new member states (Cyprus, Romania and Slovakia).

Figure 7 - Share of BERD funded by governments by EU Member State (%), 2006



Source: Eurostat.

Note: Figures refer to 2005 for GR, LU, SE; to 2004 for DK; to 2003 for NL.

An equally wide range of experiences is reflected in the evolution of public funding of BERD over the 2000-2006 period: for instance, Germany decreased its direct support by almost 30%, whereas Spain more than tripled it. Again we find some opposite trends even between the New Member States, more than doubling in Hungary while being reduced to less than half its initial size in Poland. France, Germany and the UK have continued to provide well over half of total EU government support for BERD, yet a disproportionate share goes to defence and/or aerospace.

4.3 Tax incentives for R&D

Tax incentives and direct measures have different roles within a policy mix aimed at leveraging business R&D. Direct measures are best suited to encourage high risk projects and to meet specific policy goals, and are usually allocated based on a competition between firms. This ensures that resources from the state budget are invested in the best projects within the topics defined by the political authorities – and not according to what firms or market conditions would give grounds for. Such allocation mechanisms might be relatively costly to administer, but make it possible to target financing according to what society at large has decided are vital goals for R&D.

Tax incentives reduce the marginal cost of R&D, so that firms are stimulated to increase their R&D volume. Tax incentives are usually available for a wide range of firms; they therefore encourage an increase of R&D across the whole spectrum of firms without giving them clear directions as to what kind of R&D should be given priority. The firms themselves decide what kind of R&D should be given priority. Also because of this, the tax incentives are generally also the least burdensome way of increasing R&D in the business sector from an administrative point of view – firms are already obliged to deal with the tax system anyway – and this may explain why tax incentives are popular among firms.

The following descriptive overview is based on evidence for a total of 23 national tax incentives for business R&D in 15 EU/CREST countries in 2005. Among the countries which do not use tax incentives for business R&D in the strict sense, there are some which use tax incentives only for fostering the market introduction and uptake of new products and processes, e.g. Israel and Romania, and some countries such as Greece, Latvia and Malta which include R&D as one of many possible items for a general investment incentive scheme. Among the countries which do not use tax incentives for R&D at all are countries with high R&D intensity such as Germany, Sweden, Finland and Switzerland as well as countries with low R&D intensity such as Cyprus and Slovakia.

The generosity of tax incentives vary considerably across countries, even if robust comparisons of national tax incentive schemes are problematic, as it is not possible to take account of the all the detailed differences in designs[23]. A tax incentive can be more or less generous depending on what type of R&D is covered and whether outsourcing of R&D falls under the scheme. Most countries have used the OECD (Frascati Manual) definition of R&D in their schemes for tax incentives. Usually all types of R&D according to this definition are eligible for the tax incentives: Basic and applied research as well as development. Concerning development a usual condition is that there is some element of novelty and resolution of some sort of scientific or technological uncertainty in the project. An important design issue is whether only in-house R&D is eligible or also R&D subcontracted to other businesses and organisations is included, and whether the commissioner or the subcontractor is the one who benefits. In some countries there are also restrictions as to which types of organisations are acceptable as subcontractors.

An important choice for R&D tax incentives is whether all R&D expenditures are eligible (so-called volume-based schemes) or if only additional research is supported (incremental schemes). Among the measures in use the first option is increasingly favoured. One repeatedly reported reason for this is that business strongly argues in favour of this design option.

Table 1 compares incremental and volume based incentives by showing the advantages concerning the two. In brief, the figure shows that volume based incentives are the most advantageous seen from the business perspective, while seen from the government perspective this can be a more expensive system. Incremental designs are, however more complicated and costly to operate and may discriminate between firms – because only firms that increases their R&D efforts are beneficiaries. There is no guarantee that this promotes the most profitable projects or that an incremental tax incentive has a higher additionally effect than a volume-based system.

23 However, some insights give the so called 'B-index'. The B-index measures the relative attractiveness of a corporate income tax system in terms of its R&D tax treatment. The B-index is based on as the present value of before-tax income that a firm needs to generate in order to cover the cost of an initial R&D investment and to pay the applicable corporate income taxes: The lower the index, the greater the incentive for a firm to invest in R&D. More briefly it can be explained by how much own effort that is needed in the firm for financing 1 Euro of R&D. Another approach is the percentage rate of tax relief chosen by governments, either as a tax credit (a reduction in payable tax) or as an allowance (the deduction of expenses from taxable income).

Table 1 - Advantages of volume and incremental designs

	Business perspective	Government perspective
Volume	Easy to comprehend Low application costs Provides no incentives for distortions in or between firms Apply to a wide range of firms	Low administrative costs
Incremental	Target R&D start-ups and firms with fast growing R&D	Limited costs Target new R&D

Source: Based on presentation of Bruno van Pottelsberghe to the Working Group 6th September 2005

A design choice with a variety of options is the type of R&D costs covered. Basically, three general types of costs can be distinguished: wages and social charges, other current expenses and capital expenditures. The tax incentive can be designed in a way that includes all types of costs, or exclude some of the costs, i.e. capital cost, market surveys and administrative overhead costs. As part of the general tax treatment of R&D, most of the surveyed countries allow for a 100 percent deduction of current expenses. Also, in all the schemes for business R&D in use current expenses are eligible, even if some schemes (for instance in Belgium and the Netherlands) restrict the eligible costs to the most important subcategory, the salaries of the researchers.

The treatment of capital expenditures for R&D, which constitutes typically only about 10% of all R&D expenditures, is less homogenous. About half of the tax incentives covered allow for certain types of capital expenditures, usually machinery and sometimes also buildings. A number of countries accept accelerated depreciation of R&D related capital expenditures, of which the formula and restrictions vary considerably in detail. Some countries allow even 100% depreciation of the capital expenditures in the first year (OECD 2002a). Finally, schemes differ to what extent categories such as software, patent purchase and licenses are eligible. Theoretical arguments suggest that all R&D outlays should be treated as (intangible) assets instead of current expenses (on this topic see the report of the independent EU expert group chaired by Bruno van Pottelsberghe, European Commission 2003), and be depreciated according to appropriate principles. However, all EU countries seem to accept the treatment of R&D as current expenses.

About three quarters of the tax incentive schemes are open to all types of firms. In about half of the schemes this general openness is somewhat limited by an upper ceiling of eligible R&D expense – a cap. This makes the tax incentive schemes less interesting for large firms because of lack of a marginal incentive for R&D expenses above the cap. About one third of the tax schemes provide specific incentives for SMEs, and two schemes in France (the young innovative company) and the United Kingdom only target SMEs (although in the latter case formally the SME scheme has been extended to other firms). A growing number of schemes try to provide for young innovative or less profitable firms. In France there are even specific conditions and schemes for these target groups. Incremental tax incentive schemes might, in general, favour SMEs and young companies who are about to increase their R&D expenses from a fairly low level. There might be reasons for arguing that "mature" firms in general will have more stable R&D investment patterns.

Box 6 - Examples of tax incentive schemes

Belgium

Belgium has introduced a special tax deduction of 80% on the tax base for patent income in April 2007. As a result, patent income is subject to an effective tax rate of 6.8% in Belgium (i.e., one-fifth of the Belgian statutory tax rate) as of tax year 2008. This 6.8% effective Belgian tax rate on income derived on beneficially-owned (and even certain licensed) patents is substantially lower than the rates available for patent income in most other European jurisdictions, even those with a very favourable status[24]. There is no cap on the amount of deduction that can be claimed and it can be combined with other important features of Belgian domestic tax law.

France

The Research Tax Credit (Crédit d'Impôt Recherche - CIR) is a key measure in supporting R&D investments within companies which underwent significant changes in the past years, in particular in 2008. The CIR is a horizontal measure, non-discriminatory across sectors of activity, aimed at supporting corporate R&D investments through tax incentives. From 2008 on, companies could benefit from a tax credit corresponding to 30% of R&D expenses for expenses up to 100 million €. Beyond this threshold, the tax credit is equal to 5%. The total value of tax incentives is expected to reach €3b per year.

Italy

The Italian system of support to enterprises has been thoroughly revised and reformulated recently. As a result, a new policy approach has been developed along two major strategic lines: a generalised support instrument combined with sectoral interventions in selected key areas. The tax incentive is the horizontal support instrument chosen to target all companies that invest in research and pre-competitive development. The 2007 budget law foresaw a bonus of 10% of eligible expenditures (15% if research contracts are assigned to universities and public research centres) for a maximum of 15 million euro/year. The 2008 budget law has raised the ceiling from 15% to 40% for research contracts assigned to universities and public research centres and the maximum amount from 15 million € to 50, with the objective of promoting closer networking between the business and science communities.

Poland

In 2005 the Polish Parliament decided on changes in the tax systems regarding R&D through a new law which enter into force 2006. The main ingredients were:

- deduction from the tax base of expenditures on a purchases of new technologies for amounts no greater than 50% (SMEs) or 30% (other than SMEs);
- shortening of the depreciation period off the finished experimental developments from 36 months to 12 months; and

24 See Ernst and Young (16 March 2007), International Tax Alert.

- imposition of a 22% VAT rate for scientific-research services. Under the previous law these services were exempted from VAT, which created a barrier for cooperation of research units with enterprises, as VAT could not be deducted.

In addition, R&D intensive private enterprises were given the status of Research and Development Centre. These have the right to apply for grants from the science state budget, and can have a monthly deduction of 20% of revenues from their research and innovation funding and are exempted from real estate, agriculture and forest taxes. A mechanism of technological credit was also introduced: a new instrument for entrepreneurs that are purchasing or implementing new technology. At least 25% of the value of the purchase or implementation of a new technology must be provided by the entrepreneur, and the government contribution has a limit of 2 million Euros.

5 Trends in shaping EU universities

Universities are key actors in the transition to a knowledge-based economy and society. Universities' role has, for instance, been highlighted in the three communications from the European Commission on this topic since 2003[25]. The same policy priority also appears in three large Member States: Germany, the UK, and France have all embarked on a modernisation plan for their higher education system in order to strengthen their national knowledge base. This chapter presents the main changes currently underway and the key drivers and trends which will shape EU universities in the future. It looks in turn at funding, centres of excellence, the "third mission", governance, and human resources [26].

5.1 *Funding*

EU University funding[27], including all the budgetary elements – revenues and expenditures – is characterised by new patterns: a decline in block grants and line item budgets, a rise in competitive funding and money from contracts. At the same time, various new ways of costing research are being implemented throughout the EU, such as full economic costing of research and various levels of overhead ratios. The stabilisation of the number of students due to demographic changes, with the consequent levelling off of the enrolment rate, is another important factor, meaning that in the long term universities will lose a key mechanism for their growth. In terms of the composition of funding, there is a diversity of funding structures (national, regional budget subsidies, EU, national, regional grants, fees) both across and within countries ("old" and "new" mechanisms co-exist).

Box 7 - Examples of schemes for university funding

Austria

Recent reforms established a "performance agreement" negotiated between the federal government and each university for a duration of three years, regarding the services to be provided by the university, including teaching, research, mobility of researchers and students, cooperation, strategy, specialisation, etc. 20% of the budget is based on indicators and the remaining 80% on a set of criteria based on requirements, demand, performance and societal goals. University revenues, such as tuition fees, now go directly to the university budgets instead of being integrated in general federal revenues, but Austrian universities are required to publish financial statements. Universities are encouraged to raise more funds from contract research, from the EU or the Austrian Science Fund. Universities are thus expected to direct their research activities partly towards the demands of the regional innovation system

25 These are: The role of the universities in the Europe of knowledge, COM(2003) 58 final; Mobilising the brainpower of Europe: enabling universities to make their full contribution to the Lisbon Strategy {SEC(2005) 518} COM(2005) 152 final; Delivering On The Modernisation Agenda For Universities: Education, Research And Innovation, COM(2006) 208 final.

26 This section builds on the exchanges held with all the participants in the "Observatory of European University" project. It also uses the results of the workshop "Future of the EU University" organised by the IPTS (European Commission - Directorate General Joint Research Centre) in Brussels on March 23rd and 24th 2006.

27 Based on Benedetto Lepori (2006), Funding patterns and costing structures, "Future of the EU University", IPTS meeting, March 2006.

and the needs of the economy and society. In recent years, special funding from the government has been directed towards promoting organisational change and specialisation at universities and improvements in infrastructure.

Belgium

The Federal Government has created a new fiscal instrument that offers a partial exemption from tax withholdings in favour of employers who employ researchers under certain conditions. Through this instrument, the Federal Government supports universities, public research institutions and companies in an indirect manner. The tax exemption is applied with different modalities to different research organisations.

In the Flemish Community, the Special Research Fund (BOF) supports fundamental research at universities. The funding that a university gets is calculated according to a fixed allocation formula, depending on the number of second cycle (higher) degrees, the number of doctorate degrees, the total number of employees, and the number of publications and citations. The allocation of the BOF fund is under the authority of universities themselves. In general, all research themes and disciplines are relevant but some universities might decide to prioritise certain themes for the use of BOF funds.

Denmark

As of 2008 universities' basic funding is distributed according to the quality of research, with universities delivering high quality research getting more funding, and is also based on an evaluation of each institution's ability to achieve the objectives stated in the development contract (the funding contract between the university and the ministry).

Greece

The new framework for the higher education system introduced in 2007 by Law 3649 reformed the mechanisms for the mobilisation of resources at the ministry and university levels, by linking the institutional funding of each university with a four year development plan negotiated with the Ministry of Education. Thus, the existing one year budget has been replaced by a medium-to-long term financial and development mechanism.

Portugal

Annual bulk funding to universities is allocated based on the number of students and covers both teaching and research activities. There are also lines of competitive funding: The Pluriannual Funding Program (PFP) provides basic funding to research units on the basis of assessments provided by international peer reviews. In addition to the PFP, competitive calls are published with a certain regularity to support research projects, their selection based on advice formulated by international peer review committees. Over the last decade, units granted the category of "excellent" in the context of the PFP have been assigned the "Associate Lab" status, which has provided them with more generous funding conditions.

5.2 Centres of excellence

A centre of excellence is a structure where research and technology development (RTD) is performed of world standard, in terms of measurable scientific production (including training) and/or technological innovation. Even if this concept is interpreted and used in many different ways in Europe, it seems possible to list some common features:

- a "critical mass" of high level scientists and/or technology developers;
- a well-identified structure (mostly based on existing structures) having its own research agenda;
- capable of integrating connected fields and to associate complementary skills;
- capable of maintaining a high rate of exchange of qualified human resources;
- a dynamic role in the surrounding innovation system (adding value to knowledge);
- high levels of international visibility and scientific and/or industrial connectivity;
- a reasonable stability of funding and operating conditions over time (the basis for investing in people and building partnerships);
- sources of finance which are not dependent over time on public funding.

Centres of excellence in RTD evolve continuously. Together with a well-educated workforce, they are essential for endogenous economic growth as well as to attract private investment; the argument of proximity to excellent research centres is becoming a major element in decisions by multinational companies to locate production sites. RTD activity itself more and more attempts to capture and make best use of frontier knowledge in multidisciplinary dimensions (global change, food safety, learning, ageing, etc). Although physical concentration of excellent researchers is still a key factor in RTD productivity, advanced ICT tools progressively allow effective interaction in networks. Several European countries have recently implemented measures to give reinforced support such Centres of Excellence.

Box 8 - Examples of policies on centres of excellence

Belgium

The Interuniversity Attraction Poles (IAP) programme aims to provide support for teams of excellence in basic research that belong to Belgium's various (linguistic) Communities. The programme is aimed at research units from higher education institutions and intends to provide additional human and material resources in order to ensure sufficient critical mass, to encourage collaborations between teams from different institutions belonging to the different Belgian linguistic communities, to promote complementarities and interdisciplinarity between these teams, to enable young teams to benefit from the environment of excellence provided by a network and its international influence, and to enable Belgian research teams to link up with European and international networks.

Czech Republic

In 2005 the Government introduced the "Centres of Basic Research" aid scheme, aimed at higher education institutions and private non-profit centres, which allocates grants with a view to supporting cooperation between top level research establishments, increasing the competitiveness of national research and fostering the training of young researchers. Centres must comprise at least two top level research institutions (and at least one of them must offer study programmes accredited by the Ministry of Education, Youth and Sport) with a view to accelerating and promoting their research activities at the level of fundamental research. Support takes the form of grants up to 100% and the duration of the scheme is until 31 December 2011.

Estonia

The Excellence Centres programme is aimed at higher education institutions' research units and is intended to develop a small number of centres of excellence in the areas considered a priority for economic growth by rewarding those which perform well and consolidating and restructuring the Estonian research landscape. The budget for the programme is significantly larger for 2007-13 than before and the number of new centres selected is smaller (seven against the 10 in the previous programme period). The main scientific fields - biotechnology, ITC, medical research - are now more concentrated.

Finland

In 2006 a national strategy was adopted to create Strategic Centres of Excellence in Science Technology and Innovation (CSTI), international high level centres in fields that are crucial to the future of the Finnish business sector and society. The operation of the clusters draws on strong commitment from businesses, universities, research institutes and funding organisations. Priority is to be given to the following thematic areas: energy and environment; Metal products and mechanical engineering; Forestry cluster; Health and wellbeing; Information and communication industry and services.

France

In France the Law on Research of 2006 established the possibility for higher education institutions and research centres (public and private) of combining their activities and resources in two formats:

- Research and Higher Education Clusters, which have the aim of gathering top class partners on a common theme at a common physical location to enable them to cooperate in a more integrated way, such as by defining a common training strategy, a common human resources policy, setting up common services, and strategic orientation committees). Their legal form can be flexible and their status and activities are not limited in time.
- Thematic Advanced Research Networks (TARN), a scheme for supporting Research and Higher Education actors who decide to engage in a specific scientific project, in one or more scientific areas, whose quality and international visibility give them a global scope. These networks will have the dedicated status of Foundations for Scientific Cooperation, in order to give them the necessary

flexibility and ability to respond in the context of international competition, and recognition of public interest, which gives them the opportunity to engage other financing sources. The criteria for the creation of a TARN are: (i) a critical mass of very high-level researchers, superior or equal to the best world research centres in a given field; (ii) Plurality of specialisation within a given theme; (iii) a strong international dimension; (iv) openness to other disciplines and/or the socio-economic sectors; and, (v) definition of a common strategy.

Germany

The Initiative for Excellence was launched in 2005 to improve the quality of academic research. It has three dimensions:

- The creation of Research Schools for young scientists that will provide structured PhD programmes within an excellent research environment and a broad area of science;
- The creation of Excellence Clusters in cooperation with non-university research institutions, universities of applied science and industry;
- The funding of up to ten selected universities under the heading of "Future concepts for top class research at universities", selected on account of their having at least one excellence cluster, one research school and an overall strategy for them to become an internationally recognised "beacon of science".

This programme will run until 2011 and is 75% Government funded. Universities submit their applications which are then evaluated by an independent jury. In 2008 the German Research Foundation and the Science Council have presented a joint position paper on the further development beyond 2011, assessing the interim results positively and arguing for a continuation along the existing lines with increased funding to ensure sustainability of the desired structuring effects.

Sweden

In Sweden the Government bill 2004/05:80 Research for a Better Life established a line of funding for Centres of Excellence in all scientific fields, managed by the Research Councils. This was implemented through the Linneaus Grant in 2006, with a second round in 2008: a new type of long term support for strong basic research environments for which only Higher Education Institutions (HEIs) can apply (not individual researchers or research groups). In order for an application to be considered, the research environment must form part of the applicant HEIs strategic planning and the application must show how the HEI intends to stimulate the development of the research environment, support its management and make use of the grant. Co-funding must match at least 50 per cent of the amount applied for. Other instruments playing an important role are collaborations between the public and private sectors in strong research environments, such as the VINN Excellence Centres and the Berzelii Centres (both implemented in 2006).

5.3 The "third mission"

Universities' so-called "third mission"[28] encompasses the relations between universities and their non-academic partners. It goes beyond the mere transfer of knowledge to economic actors (through patents, licenses, spin-offs, etc.) and reflects the richness of the relations between the university and society at large. The third mission thus encompasses:

- The transfer of "competences trained through research" to industry;
- The ownership of knowledge (patents, copyright, etc.), the use of that knowledge (university spin-offs) and contracts with industry and public bodies;
- The participation of academics in policy making, including advisory boards;
- The development of activities serving the community (museums, law shops…).

Universities have social and economic roles; they are economic and political forces. They are usually important employers in their region and are stakeholders in urban planning and public transport. Universities are also providers of services. Teaching output – qualified knowledge workers – is the bulk of the universities' third mission.

The universities' third mission is highly dependent on the mix of activities deployed: For institutions providing basic vocational higher education - e.g. for "vocational bachelors" – the third mission aims mainly at shaping and proposing adequate curricula tailored to local employment needs. For the growing number of institutions providing specialised professional higher education – e.g. professional masters – the third mission aims mainly at developing an "industry relevant" research portfolio and masters degrees which fit industry's needs. For the institutions providing academic training and education – i.e. those that focus on PhDs – the third mission relates to the joint development of research activities with large firms, the strategic management of new intellectual property rights and of spin-off companies and the participation in public debates.

Box 9 - Examples of "third missions"

Estonia

In Estonia, the SPINNO programme makes funds available for universities and research centres to create a favourable environment in R&D and higher education institutions for the transfer of knowledge and commercialisation of the results of R&D activities. This may include the creation and development of a set of administrative rules necessary to regulate the business activities and intellectual property of members; The creation and development of motivational systems for members; And the development of competences, structures and networks relating to knowledge and technology transfer. Funding is also available to increase awareness and develop researchers' knowledge and skills concerning the commercial exploitation of ideas deriving from R&D activities and the opportunities for cooperating with business (organising competitions, seminars, forums and conferences for raising awareness and enhancing entrepreneurial abilities; organising training for the development of knowledge necessary to engage in business; distributing general information on business support services and funding possibilities). The results of the 2007

28 Based on: Philippe Laredo (2006), Third mission, "Future of the EU University", IPTS meeting, March 2006. Universities are important players in the local economy and their social context.

evaluation of the programme gave good grounds for a renewal and the new round (2008-2013), called SPINNO+, was launched in August 2008.

France

Technology Platforms (TPs) support and institutionalise the promotion of innovation and technology transfer. This measure is geared both to education institutions and SMEs and aims at making the two parties mutually aware and open to cooperation. TPs have three main guidelines, organised around SMEs needs:

- To provide resources and competences of higher education institutions, training institutions, but also secondary technical education institutions (vocational high schools) and lifelong learning professional training organisms, for the benefit of SMEs;
- To create a common space for training and technological services;
- To develop a network gathering various technology transfer structures.

Only the TPs that have received a certification label in 2007 from the ministry in charge of research can benefit from its financial support. The juridical status of a TP is defined on a case by case basis; it often takes the form of a Public Interest Group.

Latvia

In Latvia**,** in 2005, the Ministry of the Economy launched a programme providing support for the establishment of technology transfer contact points at research institutions and since then six technology transfer offices have been set up. The aim of these establishments is to promote cooperation between scientists and entrepreneurs in order to support the commercialisation of research results obtained at public research organisations. The main tasks of the contact points are to check opportunities at the respective universities and research institutes, to provide research and product development services according to entrepreneurs' needs, to clarify companies' demand for research results and cooperation opportunities, to promote cooperation among entrepreneurs and researchers in order to attract co-funding from the private sector, to ensure patenting of intellectual property, and to encourage the establishment of new high technology companies.

Portugal

Since 2001 the GAPI network (Support Offices for Industrial Property Promotion) has several small offices located on the premises of universities, R&D facilities and business associations that provide information and carry out activities relating to the promotion of industrial property. Within universities they have operated as "technology licensing offices" and they have encouraged patenting.

Spain

The 2008-2011 sub-programme in support of the transfer function of research organisations substitutes a similar instrument of the previous national R&D plans and offers backing (for up to four years) to the action of the Transfer Offices of Research

Results (TORRs). Its aim is to encourage the valorisation of knowledge produced by universities and other research organisations, by reinforcing and consolidating TORRs and other similar units. Among the activities that can be financed, Strategic Transfer Plans are to be executed individually through the TORR of the organisation that applies for the support. The instrument finances a maximum of 50% of the total budget during the first phase of the project (2 years). After this first phase, the TORR has to present a progress report in which it explains the level of goal achievement. This report will be reviewed by an evaluation commission especially nominated. During the second phase (maximum 2 years), financing amounts to up to 50% of the budget, depending on the level of goal achievement during the first phase.

UK

The Knowledge Transfer Partnership (KTP) programme involves Research Organisations, Higher Education Institutions, companies, graduates, and Further Education Colleges in collaborating towards the aim of build up successful businesses though technology transfer (among the partners of the projects). Staff from research organisations gain ideas and business support for further research and consultancies, deepening collaborations with developing businesses; higher education institutions are able to apply their wealth of knowledge and expertise to important business problems; and recently qualified graduates (known as KTP Associates) are given the opportunity to work in companies managing challenging projects central to the development needs of participating companies. All approved Knowledge Transfer Partnerships are part funded by the Government.

5.4 Governance

Increasing competition has put university governance under considerable strains[29]. Institutions are driven to develop consistent strategies to attract students, researchers and funds and to raise their scientific profile. In most countries the institutional autonomy granted to universities is being reinforced, giving greater latitude to the governing bodies of higher education institutions to develop their strategic capabilities.

Across most European countries various forms of multi-level governance are taking the place of the state bureaucracy. This includes more competitive and output-oriented modes of coordination between the state and higher education institutions and among the higher education institutions themselves. It also includes management-type mechanisms at the institutional level and a corresponding reorganisation of decision-making processes within institutions. Policy makers expect that the introduction of management structures and managerial forms of decision-making will make it possible to provide high quality education to more people and to enable more relevant research output at the same or lower cost. Monitoring of output and fulfilment of duties by academic staff is increasing. Apart from setting up incentive structures, performance-based contracts with individual academic staff members and departments also lead to greater pressure to achieve (e.g. output of doctorates and publications, attracting third-party funding for research projects, monitoring presence at the workplace and fulfilment of teaching duties, issues of

29 Based on: Barbara Kehm (2006), Governance and strategy, "Future of the EU University", IPTS meeting, March 2006.

intellectual property rights, etc.). Intervention within the core of academic affairs is still seen as being difficult, however. Universities are expert organisations and depend on the expertise of their academic staff. This expertise needs a certain degree of freedom and autonomy. However, it has been observed that "poorer" departments, i.e. those which attract less external research funding, are more threatened by managerial intervention and more prone to lose legitimacy than "richer" departments which might become too independent ("little fiefdoms"). As a consequence, competition between departments has increased. Mergers, closures, reduced allocations of money or a reduction in research funds might be the consequences if performance is deemed inadequate.

Traditional collegial governance has declined in favour of a managerial approach and thus a more hierarchical form of decision-making that also includes an increasing number of external stakeholders (through boards). The decision-making powers of boards or university councils vary considerably. In principle, however, a mixture between forms of collegial governance and managerial governance is chosen in most cases.

Box 10 - Examples of universities' governance structures

Austria

The 2002 University Act 3 gave universities complete autonomy, with new control instruments such as global budgets and performance agreements. The universities were divested from the federal administrative system and transformed into independent legal entities under public law. The Universities Act conferred "full legal capacity" to universities, allowing them to access new funding sources in addition to the money received from the federal government. The major aim of the Universities Act was to improve Austrian universities' research profile by giving greater support to their research activities. More strategically governed universities should be able to specialise and exploit synergies, both internally and with other universities, so as to improve their research outputs. Universities also have to regularly define research priorities, research strategies and development plans, taking into account the needs of society and industry.

Denmark

The new University Act published in 2003 increased universities' autonomy and self regulation, while at the same time aiming at promoting R&D quality and links with industry. A substantial part of universities' financial base was transferred to direct productivity management in the form of performance measurement-based grants. Universities are obliged to sign development contracts with the Ministry of Science, Technology and Innovation.

Finland

The Education and Research Development Plan 2003-2008, defined objectives for universities – to be then implemented autonomously by universities themselves – with biannual negotiations regarding their results, directions and funding. The law on universities was reformed in 2005, increasing the financial autonomy of universities in order to promote national and international networking and expertise at the highest level. The law also increased the opportunities and responsibilities of universities in regional development. More generally, universities are expected to operate in interaction with the rest of society and to increase the societal impact of their research.

France

In 2007 France passed a law aimed at granting more autonomy to French universities which determines the reform of higher education over the following five years, and aims at:

- Granting universities more autonomy to decide their budget and staff, allowing them to create foundations to collect money and put in place their own recruitment processes;
- Giving universities more competence in opening their administration to external staff, allowing for example representatives of the business world to take part in university governance;
- Strengthening the State's legal control.

Netherlands

In the Netherlands, the new Higher Education and Research Act reinforces universities' autonomy and also raises the status of knowledge institutes (research centres, mainly in universities), which are made responsible for looking after specific interests (such as quality of education and research, how employee and management representation is organised), anticipating or acting on new social developments. A bigger role is given to stakeholders (students, professionals and employers).

Slovakia

Higher Education Institutions have been given the status of non-profit, rather than public, organisations, in order to allow for more flexible budgetary management and easier access to other sources of funding.

5.5 Human resources

EU universities' human resources are in a transitional phase, as institutions in the higher education system are being profoundly transformed. This change is characterised by four main trends:

- Increasing market orientation, resulting from competitive access to scarce resources – researchers, funds and students – directly linked with changing funding patterns.
- A growing "managerialisation" of academic work, which is subject to ever stricter requirements for accountability, relating particularly to universities' main resources, namely the academic time devoted to teaching and research. In the past, this division of labour was mainly defined by universities on the basis of institutional factors, e.g. an educational orientation vs. research

universities. There is nowadays a growing division of labour within institutions themselves. Professional specialisation has been introduced to increase effectiveness and efficiency. However, many analysts feel that this new management model may tend to make the academic environment a less attractive place to work.

- Flexibility is increasing, as career paths are becoming more diversified. Recruitment criteria are no longer exclusively limited to academic visibility. Teaching excellence and knowledge-transfer experience are already explicitly used as alternative criteria on which to judge candidates when recruiting for posts. While reputation remains a university's predominant asset, it is increasingly complemented explicitly by other factors such as economic capital (i.e. its ability to raise or to compete for funds), and social capital (its integration in networks). Even senior researchers may be offered fixed term positions for professorship in European universities. This "flexibilisation" may conflict with universities' efforts to reinforce staff loyalty to the institution.
- Internationalisation of higher education and research: Attracting foreign students has become crucial both as a way of raising funds and of making the academic labour market international. Mobility is therefore a very important issue. However, there have been only a limited number of incentive schemes in the EU university landscape (e.g. adapting salaries) to date. In most countries, current career paths and salary systems do not differentiate between academics.

6 Trends in fostering human resources

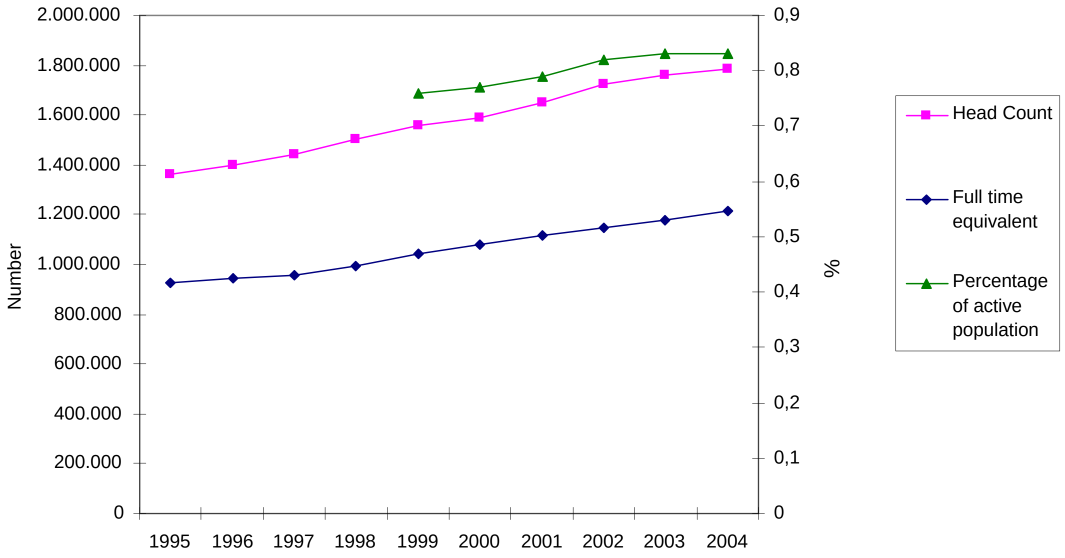
Over the last few years, human resources received increasing attention in the R&D policy debate. Triggered by the target of 3% R&D intensity, the number and stocks of researchers in both the private and the public sector have been thoroughly analysed in a number of EU Member States. In addition the EU set up the Integrated Information System on European Researchers (IISER) system, informing about the stocks and flows of researchers across the EU. Across Europe, a common goal of R&D policy makers is to make R&D careers more attractive. In order to boost the number of researchers in the private sector, a number of Member States introduced tax incentives or other subsidy schemes to facilitate employment of researchers.

There is a general perception that "excellence in research" is closely linked to the attraction of the best researchers. With a growing mobility of researchers, a number of EU Member States launched initiatives to either attract foreign researchers or to support the repatriation of national researchers working elsewhere. This chapter will first present a statistical background on the number of researches in the EU and on policy measures to increase it and then address the topic of the international mobility of researchers by presenting evidence and policy initiatives in this area. Due to the structural nature of these data and to the delay with which they are available, the 1994-2005 decade will usually be considered.

6.1 Increasing the number of researchers

The number of researchers in the EU increased from 1.36 million – in headcount (HC) terms, which amounts to 927 000 in full time equivalent (FTE) – in 1995 to 1.79 million (1.22 million in FTE) in 2004. This represents an annual growth rate of 3% and corresponds to an increase of about 50 000 researchers (in HC) per year. The percentage of researchers (in HC) in the active population also shows an upward trend, having risen from 0.76% in 1999 to 0.83% in 2004 (Figure 8).

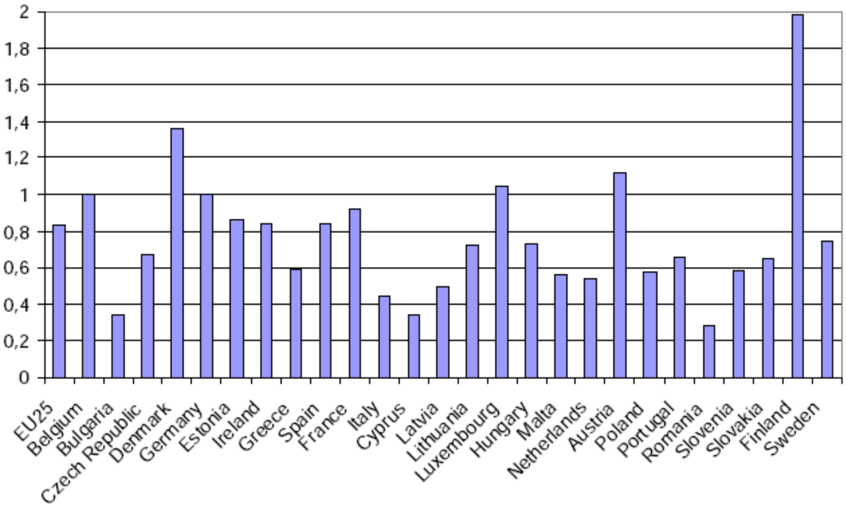
Figure 8 - Number of researchers (HC, FTE) and number of researchers (HC) as percentage of active population in the EU-25, 1995-04



Source: JRC-IPTS with Eurostat data.

This growth in the number of researchers is matched by a slightly lower growth in expenditures (2% a year, in constant prices). The slight mismatch between the increase in researchers and in expenditures can be explained by a more rapid growth in scientific disciplines (e.g. the social sciences) and industrial sectors (e.g. services) that are more labour intensive and less demanding in terms of equipment. However, these figures for Europe are based on very diverse national settings. Regarding the percentage of researchers in the active population, some countries in 2004 were still below the 0.5% level (Bulgaria, Italy, Cyprus, Latvia and Romania). The only countries above 1% were Denmark, Luxembourg, Austria and Finland (Figure 9).

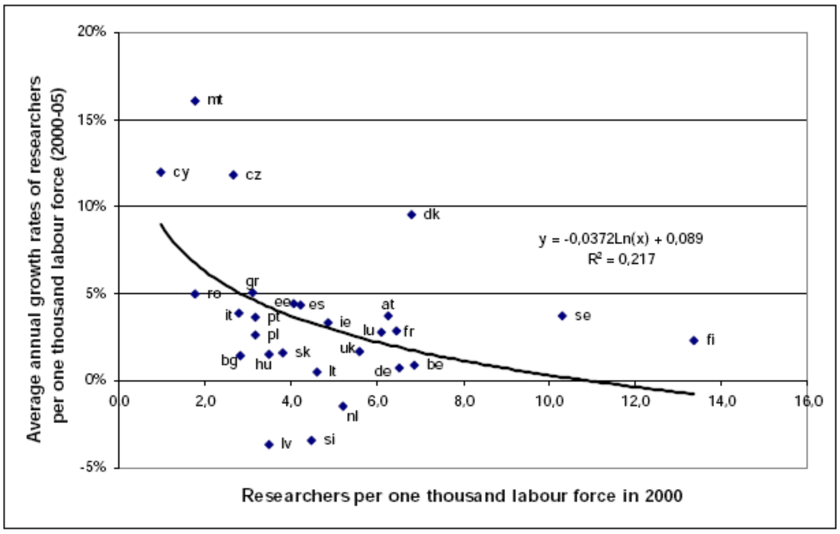
Figure 9 - Number of researchers (HC) as percentage of the active population by country, 2004



Source: JRC-IPTS with Eurostat data. Note: data from 2003 for Belgium, Germany, Greece, Luxembourg, Netherlands, Portugal and Sweden.

Over the 2000-05 period, the number of full-time equivalent researchers in the EU-27 has increased by 3.6% per year. Within EU-27, the strongest average annual growth rates have been observed in Malta, Cyprus, Czech Republic and Denmark. Slight decreases have taken place in Latvia, Lithuania, Netherlands and Slovenia. EU-27 experienced as well an increase in the number of researchers (FTE) per one thousand labour force from 4.87 in 2000 to 5.64 in 2005, which corresponds to an average annual growth rate of 3%. Many EU Member States enjoyed a significant growth in the number of researchers per one thousand labour force, in particular Czech Republic and Denmark. To the contrary, three EU Member States experienced a decrease (Latvia, Slovenia, Netherlands). For the 27 EU Member States, there is a negative correlation, but quite loose, between the initial level of the number of researchers (FTE) per one thousand labour force in 2000 and the growth observed over 2000-05 in the number of researchers (FTE) per one thousand labour force, which could be interpreted as a slight convergence (Figure 10).

Figure 10 - Average annual growth rates of the number of researchers (FTE) per one thousand labour force over 2000-05 and number of researcher (FTE) per one thousand labour force, 2000



Source: JRC-IPTS with Eurostat and OECD data.

Member States recently launched a number of initiatives to make the career of researchers more attractive. Namely, measures are often geared towards addressing the uncertainty faced by researchers in their career development, which can deter talented individuals from entering/staying in the R&D sector. This can mean providing enough opportunities to brilliant young researchers at the beginning of their career or providing financial support to research groups to integrate unstable project-based financing.

Box 11 - Examples of policies to facilitate research careers

Belgium (Flemish Community)

The Methusalem programme is a sum of money (lump sum) that is divided between universities based on calculations by the Special Research Fund. The grants are meant to give a structural 5-year support to researchers. The structural support should allow these researchers and their research groups to become leading authorities in their field. The Methusalem programme is a new type of financial support that should fill the gaps of existing project-based financing by providing a more stable type of financing that is long-term and project independent.

Hungary

In order to create more favourable conditions for research and development and to provide motivation and acknowledgement for outstanding research activities, the Bolyai Janos Research Scholarship provides financial support for young (under the age of 45 years) researchers for the duration of one, two or three years. Applications may be submitted in all fields of research. The measure supports the following activities: preparation of studies or other scientific research work of equivalent quality, and research performed in order to obtain advanced scientific degrees and qualifications.

6.2 Taking advantage of mobility

Fostering the mobility of R&D personnel at the European and international level is another important goal within the broader realm of the Lisbon strategy. Although mobility has already increased in recent years, due to better communication, transport and liberalisation of travel and immigration in many countries, policies should be aimed at making the most out of it, both inward and outward. Debates at national level are usually focused on the more restrictive concepts of brain drain (some countries experience structural and sizeable net outflows of talented students and qualified workers) and brain gain (some countries are instead prime destinations), implying a zero-sum interpretation of mobility.

Reality is much more nuanced however: as it has been argued elsewhere in this report, specialisation of research has increased in recent years and will further continue, creating focused centres of excellence and innovation poles. Most of the EU Member States do not have the size and/or the resources to excel in all fields, so that mobility can be seen as a way of sourcing competences that could be accumulated domestically only at prohibitive costs. Moreover, enhanced mobility increases global welfare by deepening the labour market for researchers and allowing a better match between research organisations with their specific strengths, traditions and missions on one side, and research personnel with their interests and career paths on the other.

Unfortunately, data coverage in this area is still far from comprehensive; in what follows, instead of presenting a collection of all possible data from different sources we will mainly focus on data on the mobility of doctoral candidates. These are the most complete and can be seen as a proxy for the mobility of research personnel, while allowing covering most of the relevant dimensions (stocks, within-EU flows, flows to and from third countries).

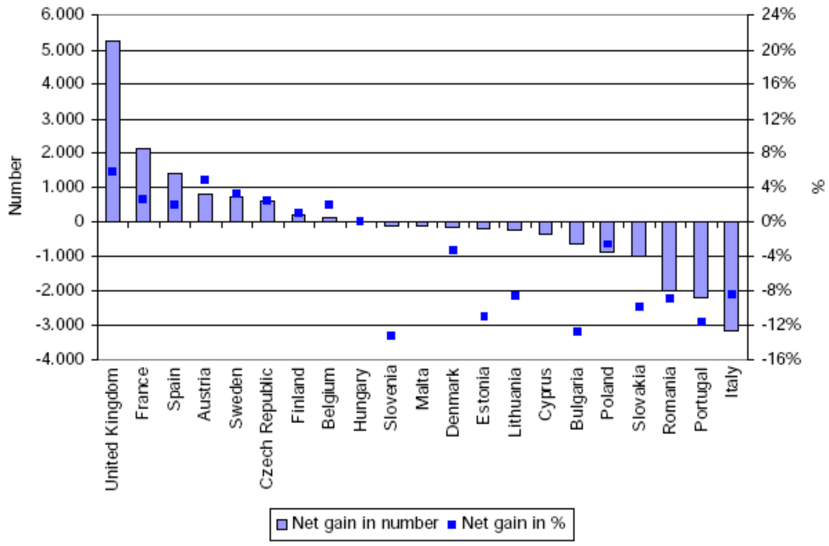
In the European Union (based on 21 EU countries having reported data to Eurostat), in 2005, among the 487 000 doctoral candidates, 79.5% were citizens of the country in which they work, 5.8% had the nationality of another Member State (accounting for about 28 000 doctoral candidates) and 14.1% came from third countries: 5.3% were from Asia, the Middle East and Oceania, 3.7% from Africa, 3.1% from South and central America, 1.1% from other European countries (outside the EU-27) and 0.9% from North America. 0.5% was of unknown citizenships.

In absolute terms, Greeks, Germans and Italians are those pursuing doctoral studies in a Member State other than their country of citizenship in greater numbers. The ratio of the number of expatriate doctoral candidates to the total number of doctoral candidates in the considered country is the highest for Ireland (25.7%), Greece (17.8%), Slovenia (14.8%) and Portugal (13%)[30]. It is the lowest (below 3%) in the UK, the Czech Republic, Finland, Sweden, Austria, Spain and France. The percentage of doctoral candidates continuing their doctoral education in an EU country other than their country of citizenship is highest in Slovenia (13.5%), Bulgaria (12.5%), Portugal (12.4%) and Estonia (11%). It is lowest (below 3.5%) for the UK, the Czech Republic, Finland, Sweden, Spain, Austria, France and Poland.

30 If we exclude Malta and Cyprus which have very high ratios, 257% and 144% respectively, due to the limited number of doctoral candidates in these two countries.

Intra-EU net gains are defined as the differences between the number of doctoral candidates of EU nationality in the reporting country and the number of its citizens' doctoral candidates in other Member States (Figure 11). The UK is the most important intra-EU net gainer, in absolute and relative terms, of the intra-EU exchanges of doctoral candidates, with a net gain of 5 300 doctoral candidates, accounting for 5.8% of the total number of doctoral candidates in the UK. The other countries with a positive intra-EU net gain are France, Spain, Austria, Sweden, the Czech Republic, Finland and Belgium, accounting for between 0.9% (in Finland) and 4.9% (in Austria) of their total number of doctoral candidates. The highest intra-EU net losses in absolute terms are found in Italy, Portugal and Romania, accounting for 8.5%, 11.8% and 8.9% respectively of their number of doctoral candidates.

Figure 11 - Intra-EU "net gain" of doctoral candidates, in absolute and relative terms



Source: JRC-IPTS with Eurostat data. The net loss in % is not represented on the figure, as it is 143% for Cyprus and 257% for Malta.

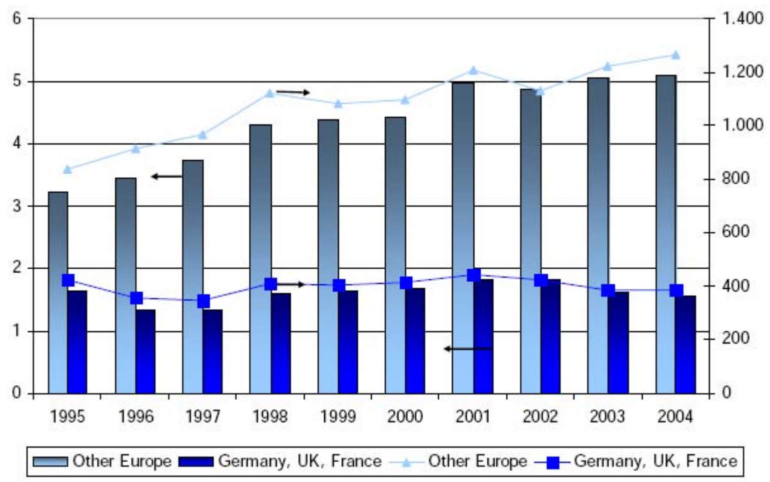
As far as doctoral candidates from outside the EU are concerned, the three major receiving countries (among the 21 countries reporting data) of doctoral candidates from third countries, were the UK, France and Spain, with 24 100, 23 000 and 11 300 respectively. While all three together account for only 51.4% of the total number of doctoral candidates, they received 84.8% of the doctoral candidates from third countries (58 400 out of 68 900). As a percentage of the total number of doctoral candidates in the reporting country, France, the UK, Belgium and Spain received the highest share, respectively 27.9%, 26.3%, 18.7% and 14.8%. All the other countries were below 10%. The share of North American citizens is below 1% in all of the 21 Member States except in the UK, where it was 3.7%. The Chinese were the most numerous, followed by Mexico, Morocco and the US. The latter, with about 3 000 individuals, accounts for about 4.4% of doctoral candidates from third countries (or 0.62% of the total number of doctoral candidates).

On the other side, the picture can be completed by looking at the outflow of researchers to the US. Of the 43,300 doctorates granted by U.S. universities in

2005[31], about 35% were to non-U.S. citizens (4% with permanent resident visas and 31% with temporary visas). Among the top 30 countries in terms of the number of doctorates awarded to their citizens, there were nearly 1 300 recipients from eight EU countries: Germany (11th, 0.61%), Romania (12th, 0.52%), Italy (14th, 0.45%), the UK (15th, 0.41%), France (17th, 0.37%), Spain (20th, 0.30%), Greece (23rd, 0.26%) and Bulgaria (26th, 0.23%). That accounts for 3.1% of the total number of doctorates with known citizenships conferred by US institutions (or 9% of the number of non-US citizens earning doctorates).

The evolution of the number and percentage of S&E doctorates conferred to Europeans (separating the "three big" countries from all the other European countries) over the period 1995 to 2004 is provided in Figure 12. The number (and percentage) of S&E doctorates conferred to citizens from the "three big" countries has tended to stay relatively stable over time, whereas the number (and percentage) of S&E doctoral conferred to citizens from all the rest of Europe has tended to increase.

Figure 12 - Number and percentage of US S&E doctorates conferred to European citizens, 1995-2004



Source: JRC-IPTS with National Science Foundation/Division of Science Resources Statistics, Survey of Earned Doctorates. Number of doctorates conferred to citizens from Germany, France and the UK, and to other European countries (right axis). Percentage: among the total number of S&E doctorates with known citizenships (left axis).

As far as foreign **scholars** in the US are concerned, among the top 10 countries of origin in the US in 2005 and 2006[32], there are four EU countries (Germany in fifth place, France in seventh, the UK in eighth and Italy in ninth place).

Member States recently launched a number of initiatives to improve the mobility of researchers. In a number of EU countries, mobility of researchers (usually implemented through grant systems), is not organized via specific programmes but embedded into the institutional setting of the national research system. For example in Germany, the DAAD (Deutscher Akademischer Austauschdienst), the Humboldt

31 Of these, about 40,700 with known citizenships and 2,600 with unknown citizenships. All the figures cited here refer to individuals with known citizenship. Hoffer, T.B., V. Welch, Jr., K. Webber, K. Williams, B. Lisek, M. Hess, D. Loew, and I. Guzman-Barron (2006). Doctorate Recipients from United States Universities: Summary Report 2005. Chicago: National Opinion Research Center.

32 These 10 countries account for two thirds of the total number of foreign scholars.

Foundation and INVENT (former Carl Duisberg Gesellschaft) are main institutions dealing with the international mobility of German researchers and with attracting foreign researchers to work in Germany. Also the DFG (German Research Foundation) has resources available for international mobility.

Box 12 - Examples of policies to foster the international mobility of researchers

Belgium (Flemish Community)

The Odysseus programme aims at attracting top researchers to Flanders with a financial incentive. The target group is Flemish and other researchers with a position at foreign universities. When hired in Flemish universities, these top researchers are expected to develop research groups and create centres of excellence.

Denmark

Niels Bohr Visiting Professorship: The Danish National Research Foundation started in 2005 a new initiative to support the invitation of high qualified and international recognised visiting researchers from all scientific fields. The goal of the programme is to strengthen the international orientation of Danish basic research. Visiting researchers have to develop their research during a longer stay of at least 1 and maximum 5 years (that can be divided in several periods of at least 6 months) in interaction with researchers at Danish universities. It is also possible to come with 1 or 2 younger researchers as well.

A number of criteria have to be fulfilled. In particular, the visiting professor should be acknowledged as being a part of the absolute elite in his/her field of research and should be affiliated with a foreign research institution. The visiting professor should participate to a research project with researchers in Denmark. The inviting research institution has to provide a suitable and focused research group and give access to all necessary infrastructures, including apparatus and other facilities. The visiting professor shall give several lectures and seminars and actively participate in the education of Danish researchers.

Finland

The goal of the Finland Distinguished Professor Programme (FiDiPro) is to further the internationalisation of Finnish research and to raise the level of scientific and technological research performed in Finland. It is also aimed at creating new kinds of international links between basic and applied research and the R&D efforts of business companies. The programme enables Finnish universities and research institutes to hire international scientists who usually work abroad. These experts will then conduct research together with Finnish research groups for 2-5 years. The experts to be recruited shall have recognised scientific merits and strong experience in researcher training. The programme is managed jointly by the Academy of Finland and the National Technology Agency of Finland (Tekes).

Hungary

The Hungarian Eötvös Scholarship provides financial assistance for outstanding young Hungarian graduate (preferably post-doc) researchers under the age of 40 to participate in training and education programmes at foreign universities, research institutes and workshops. Applications are invited from every fields of science under two sub-categories: pre-doctoral applications (PhD students) and post-doctoral applications (PhD or DLA graduates). Scholarships are granted for the maximum period of 3-8 months and can be renewed for another 6 months. The applicant is expected to prove previous excellent achievements (e.g. publications) in order to qualify for support. Applications are reviewed by the relevant scientific colleges in the various fields.

Italy

Italian Law Decree No. 269/2003 introduced a 90% tax exemption on personal income tax and total exemption from the regional tax on productive activities for three fiscal years for non-resident researchers (Italian or foreign nationals) wishing to work in Italy. The exemption applies if researchers have a first degree or equivalent qualification, reside abroad, have carried out research for at least 2 years and return/move to Italy within 5 years following the entry into force of the decree.

Netherlands

The aim of the Rubicon programme is to encourage talented researchers at Dutch universities and research institutes to pursue a career in postdoctoral research. Rubicon offers researchers who have completed their doctorates in the past year the chance to gain experience at a top research institution outside the Netherlands (for a minimum of six months and a maximum of two years). The programme also offers limited opportunities for grant-assisted research in the Netherlands, but the use of grants to spend time outside the Netherlands will be preferred. Applications are admissible only if the candidate is to conduct research at an institution other than the one that awarded his or her doctorate. Research must also be conducted in a country other than the one where the applicant graduated or obtained the doctorate. Proposals are assessed on the basis of quality criteria and certain policy criteria. The procedure involves multidisciplinary advisory committees that assess the applications, while the final award decisions are made by the boards of the relevant divisions/foundation. The Rubicon programme also offers talented researchers from abroad the opportunity to obtain grants to spend one year conducting research in the Netherlands.

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European Commission

EUR 24014 EN Joint Research Centre – Institute for Prospective Technological Studies
Directorate General Research

Title: Trends in R&D policies for a European knowledge-based economy
Authors: Giuseppe Veltri, Alexander Grablowitz, Fulvio Mulatero

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Abstract

This report provides an assessment of policies put in place by EU Member States to reach the objectives set out in the Lisbon Strategy, by presenting to the reader a summary of relevant information on R&D policies in Europe, supported by statistical and other quantitative and qualitative information. In doing so, it contributes to a better understanding of the European Research Area (ERA) and goes beyond the mere overview of Member States efforts in the R&D domain by distilling some more general trends out of the available information. The focus is on activities in the most recent years, even though in some cases the lack of updated statistics makes it necessary to refer to older data. Also, due to the diversity of Member States, sometimes the identified trends are not applicable to all EU countries; for this reason, throughout the report some concrete examples of the diverse stances adopted by Member States are also presented.