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Innovation Union Competitiveness report 2011

Part II: A European Research Area open to the world - towards a more efficient research and innovation system

It is not sufficient to invest more to increase research activity in Europe. We also need to improve the overall efficiency of the European research system to ensure high quality science and technology and reinforce the attractiveness of European research internationally.

A majority of the strategic objectives towards a European Research Area policy, as well as key aspects of the Innovation Union initiative - such as a single market for knowledge - are focused on this overarching objective. The present part of the report includes many of these aspects of system efficiency for research and innovation with a specific focus on the transfer and circulation of knowledge, capitalising on science and technology produced.

Part II analyses reforms made at national level to strengthen research institutions and enhance their performance, knowledge transfer in public-private cooperation, progress towards gender equality, optimisation of research programmes in Europe, a framework for pan-European research infrastructures, mobility of researchers and free circulation of science and technology across Europe and beyond. Several of these areas benefit from a specific ERA initiative, accelerating the realisation of a true European Research Area.

Part II: A European Research Area open to the world - towards a better and competitive research and innovation system

1. Strengthening public research institutions

Highlights

The public dimension of the European research system builds on two categories of research institutions, which are almost equally important in terms of public funding: Higher Education Institutions (HEIs) and Public Research-performing Organisations (PROs). According to recent estimates, Europe hosts around 3 000 Higher education institutions: one third of all HEIs worldwide. However, Europe has only 1 000 research-performing HEIs and around 170 highly research-intensive universities in terms of academic output. There is no precise figure on the total number of public research-performing organisations, but Europe counts approximately 150 large PROs.

European countries are reforming their public research institutions, focusing on their autonomy, funding schemes, management and quality assurance. European universities have in recent years received more autonomy, and developed institutional strategies covering competitive funding, research priorities, international attraction of staff and other areas. University reforms are inspired by the process of the internationalisation of education and research and by European policies and Europe-wide competitive funding opportunities. Performance monitoring and evaluation has become a demonstrator for efficient and productive use of public funds in most of the Member States. Accountability and quality assurance processes in institutions have been fostered by ranking universities. Centres of excellence have emerged in a range of European countries to sustain global knowledge competition in research and innovation. The competences of public research organisations are also broadening, including a 'third mission', which is much linked to innovation and to interaction with the surrounding society. In the last year, Member States have enhanced cooperation with industry as a key dimension of the 'third mission' of universities in support of research-based innovations. However, the reforms concerning HEIs as well as for PROs are only half achieved.

Public research institutions, in particular research-based universities, are subject to an increasing number of international ranking systems measuring mainly the research missions of these institutions. These rankings all show a strong dominance of the US universities in the top 100 in the world. European universities are present among the top 100 in the world to various extents depending on the ranking method chosen. In general terms, only around 30 European universities are considered among the top 100 research universities in the world, and this number has slightly decreased between 2005 and 2010. These highly ranked European universities are situated mainly in the United Kingdom, Switzerland and the Netherlands. European countries with a stronger emphasis given to public research-performing organisations are consequently less present in the world rankings, which are currently focused on higher education institutions.

An objective method to assess performance of all categories of European public research organisations — HEIs as well as PROs — is to consider success rates in European-wide competition for research funding. The EU is, via its Framework Programme (FP), a major funder of research. Proposals to both the Framework Programme (FP) and the European Research Council (ERC) are selected by rigorous, impartial assessment procedures by international experts. Therefore, FP7 and ERC grant winners can claim to perform excellent research. Success in EU competitive funding indicates that many of the non-university research-performing organisations are of excellent quality. In FP6, the PROs achieved both in terms of participation and budget, a larger share of the FP award than they would have comparative to their weight in the national research systems. When considering European-wide competition in basic research, as assessed by the grant allocation at the European Research Council, currently up to 41 European universities situated mainly in the United Kingdom, France, the Netherlands, Germany, Switzerland, Sweden and Israel, have shown outstanding research performance receiving equal or more than 10 grants.

Finally, the chapter has compared the 170 or so top research-intensive European universities in terms of academic output (i.e. publications) to their performance in the Europe-wide competition for research in the framework programme. In fact, only 60 % of the funds granted to higher education institutions in FP6, were allocated to one of these 170 European universities. This finding indicates the complementary nature of the EU competitive funding, going beyond publications to technology development while being open to all public and private research-performing organisations.

1. Strengthening public research institutions

1.1. What is a public research institution?

In recent years, the European Commission has made efforts to achieve higher transparency about research institutions in the European Research Area in order to focus and direct its research policy more efficiently. A research institution is an entity, such as university or research institute — irrespective of its legal status (organised under public or private law) or way of financing — whose primary goal is to conduct fundamental research, industrial research or experimental development and to disseminate their results by way of teaching, publication or technology transfer. All profits are reinvested in these activities, the dissemination of their results or in teaching.[1]

Two types of public research institutions dominate the European Research Area: Public Research-performing Organisations (PRO) and Higher Education Institutions (HEIs)

Public research in Europe is mainly performed in two types of institutions: Higher Education Institutions (HEIs) and Public Research-performing Organisations (PROs), sometimes called non-university research organisations. 'Higher Education Institution' (HEI) means a university or any type of higher education institution which, in accordance with national legislation or practice, offers degrees and diplomas at masters or doctoral level, irrespective of its denomination in the national context. A research-performing HEI means an HEI which undertakes research or technological development as one of its main objectives i.e. which is also a 'research organisation' and which delivers Ph.D.s. (research doctorates). In the HEI category it is mainly universities which perform research. A specific category is the polytechnic universities, which perform a range of missions, with only a minor part dedicated purely to research. 'Public Research-performing Organisation' (PRO) means any mission-oriented public legal entity which undertakes research or technological development as one of its main objectives.

[1] FP7 defines a *research organisation* as a legal entity which a) is established as a non-profit organisation which b) carries out research or technological development as one of its main objectives. Public research organisations include a) Public research performing higher-education institutions and b) Public research-performing organisations.

1.1.1. Public research-performing organisations

The landscape of public research-performing organisations in Europe is extensive and quite diverse. They account for almost 40 % of public research expenditures in Europe on R&D[2]. However, comparable statistical data on PROs is currently relatively undeveloped. The variation starts with their different missions: basic research (e.g. Max-Planck-Institutes in Germany) or applied research, also known as 'technology developments' (e.g. TNO in the Netherlands). As well as organisations which include a hundred institutes, we find small stand-alone entities, some of which have associated themselves in networks (e.g. Helmholtz, CARNO). PROs may form parts of ministries, or agencies, or be independent. Some PROs are charities or foundations — others are Ltd companies[3], or affiliates of, for example, the Hungarian Academy of Science or the CNRS.

Public research-performing organisations in Europe show a large diversity of profiles and missions

As described by an FP6 report[4], the first PRO was probably the Royal Botanic Garden in Edinburgh, founded in 1670. Other centres originating prior to the 20th century are usually observatories, geological investigators and meteorological laboratories, while health and agriculture PROs became more common towards the end of the 19th century. A sharp increase in the founding of new institutions could be observed after the First World War. In the second half of the 20th century 'big science' laboratories and institutions of larger scale came into existence, as well as intergovernmental or international labs such as CERN and EMBL.

In order to distinguish between different public-sector research institutes, three basic types of institutes can be mentioned[5]:

- Scientific research institutes
- Government laboratories
- Research and Technology Organisations (RTOs)

Scientific research institutes are mainly associated with basic research. The German Max-Planck-Institutes or the French CNRS, as well as large parts of Science Academies in the Eastern European countries belong to this category.

Government laboratories serve the specific needs of their respective ministries or of regional and local authorities. They are engaged in technical norms, standardisation or metrology, testing, or charged with specific missions or with public duties.

Research and Technology Organisations are the most diversified types of institutes, as they carry out mainly applied research and technical development. They may be private but they are non-profit organisations.

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[2] See the last section of this chapter as well as Arnold, E., K. Barker, and S. Slipersaeter: *Research Institutes in the ERA*, Brussels July 2010 and Arnold, E., J. Clark, Z. Járvorka*: Impact of European RTOs, A study of social and economic impacts of research and technology organisations*, Brussels October 2010.

[3] This might seem impossible. However, legal set-up as an Ltd company does not exclude being not-for-profit. A prominent example is the Forschungszentrum in Jülich, a GmbH.

[4] PREST: A Comparative Analysis of Public, Semi-Public and Recently Privatised Research Centres, project report CBSTII contract ERBHPV2-CT-200-01, Manchester, July 2002.

[5] Arnold et all, Research institutes in the ERA a.a.O.

The tables below illustrate the different tasks and missions of PROs in Germany and provide an overview on the main institutions and their tasks in this Member State. Unfortunately, data for other Member States are not available on a comprehensive scale.

Table II.1.1 The structure of Public Research performing Organizations (PROs) in Germany, 2007

Institution	R&D expenditure		R&D personnel (FTE)			
	Total euro (millions)	%	Total	%	Of which: Researchers	%
Max Planck (MPG)	1290		11785		5996	
Fraunhofer (FhG)	1319		10519		6667	
Helmholz (HFG)	2740		23283		12190	
Science Leibnitz (WGL)	966		9699		5480	
Federal research establishments (BFE)	681		8319		3675	
Regional or local research establishments	218		2990		1354	
Other	1002		10930		7138	
Science libraries and museums	325		3119		1062	
Total PROs	8540	46,1	80644	43,7	43561	37
Higher education institutions	10000	53,9	103953	56,3	72985	63
Total public research institutions	18540	100	184597	100	116546	100

Source: DG Research and Innovation — Innovation Union Competitiveness Report 2011
Data: Statistische Bundesamt. Statistische Jahrbuch 2009 from EFI report 2010.

Table II.1.2 Main activities and tasks (1) of Public Research performing Organizations (PROs) in Germany

Institution	MPG	FhG	HGF	WGL	BFE
Basic research	100	9	46	62	7
Applied research	3	91	57	48	74
Technical development	3	46	26	6	7
Metrology / standardisation	0	17	6	6	26
Information	3	3	3	23	22
Further education	22	3	34	19	7
Infrastructure supply	6	11	37	13	15
Technology transfer to enterprises	3	57	31	12	7
Knowledge transfer to society	19	0	14	23	15
Consultancy to public authorities	3	9	17	19	78
Public duties	3	3	9	10	56

Source: DG Research and Innovation — Innovation Union Competitiveness Report 2011
Data: Polt et al. from EFI report 2010.
Note: (1) Tasks have been ranked at a five-scale Likert-skala in terms of highest importance (multiple choices of high priority feasible).

According to a study made for EARTO[6], RTOs in the European Research Area may have quite a substantial economic impact[7]. This impact varies depending on the definition of economic impact — i.e. whether counting all the activities of the RTOs or only the activities involving state subsidies for research. The overall impact, including social returns, spans from EUR 25 billion to EUR 40 billion and the total return could be in the order of EUR 100 billion in a ten-year time horizon.

[6] The study refers to the RTO subgroup of PROs.
[7] Arnold et all: Impact of European RTOs, a.a.O.

Table II.1.3 Estimated economic impact of European Research and Technology Organizations (RTOs) - central estimates

	Wide definition (€bn)	Narrow definition (€bn)
Direct	12.2	9.8
Indirect	10.8	8.7
Induced	+ / - 4.6	+ / - 3.7
Social returns	12.9	10.4
Total	31.3 - 40.5	25.2 - 32.6

Source: DG Research and Innovation Innovation Union Competitiveness Report 2011
Data: EARTO, 2009

Europe has around 150 large public research-performing organisations

A study financed by the European Commission[8] identified the 150 biggest and most nationally recognised public research-performing organisations in 36 countries in Europe, in which each organisation counted more than 50 researchers or over 100 affiliated staff[9].

The inventory also showed the panoply of ways in which the PROs are organised, and the role they play in their countries. They differ widely as each one is embedded in its national system and culture. Also, the organisation may vary insofar it is a public research unit, a research agency, a foundation, or a non-profit enterprise.

When comparing the EU-15 Member States with the EU-12, the former account for the vast majority of the funding made available to PROs. In terms of the number of researchers at the PROs, the difference between EU-15 and EU-12 is less significant. Due to the tradition of the Academy in the new Member States, quite large public research-performing organisations exist. However, in the last decade, the public research-performing organisations in EU-12 have undergone profound changes.

1.1.2. Higher Education Institutions (HEIs)

HEIs, like PROs, perform different missions. In addition to teaching and research, HEIs play an essential role in innovation. Building on the so-called 'third mission', higher education institutions have increasingly taken on societal and economic roles. They are important employers in their region, and universities are providers of services, playing a crucial role in the service society. HEIs' 'third mission' is in fact a bundle of missions, touching on innovation, regional, societal and economic involvement as well as international engagement.

The HEI sector performs various missions of which the 'third mission' is least recognised

The so-called 'third mission'[10] of HEIs encompasses the relations between universities and non-academic partners. The mission goes beyond the mere transfer of knowledge to economic

[8] EUROLABS report (2009) carried out by ECORYS (NL), COWI (DK) and IDEA (BE) taking stock of the Public Research-performing Organisations (PROs) and Intergovernmental Research Organisations (IROs) in Europe. The inventory was established at the level of organisations and not of institutes. Based on 2006 figures, the PROs covered by the study received basic institutional funding amounting to at least 50.3 % of total government R&D spending (GOVERD). Overall, the organisations had a total budget of EUR 31 000 million and a staff count of 292 500.

[9] Performance related criteria like publications or patents do not yet exist in a comparable format.

actors (through patents, licences, spin-offs, etc.) and it reflects the richness of the relationships between the university and society at large. The third mission thus includes:
• Transfer of ‘competences trained through research’ to industry;
• Further education to postgraduates and adults;
• Ownership of knowledge (patents, copyright, etc.), the use of that knowledge (university spin-offs) and contracts with industry and public bodies;
• Participation of academics in governance structures, including advisory boards;
• Development of activities serving the community (museums, law shops, etc.).

The universities’ third mission is highly dependent on the mix of activities they deploy. For the growing number of institutions providing specialised professional higher education, the third mission aims mainly to develop an ‘industry-relevant’ research portfolio and masters degrees which fit industry’s needs. The industry-relevant mission has been enhanced strongly in the EU Member States (see also Part II, chapter 2).

The European Commission funds the elaboration of a mapping system of higher education institutions that considers all their major missions and tasks

The EU has started to analyse and classify the different roles and missions of higher education institutions in order to help HEIs to develop their profile and for users to orient themselves in the increasingly diversified European HEI landscape. The rationale for developing a European classification of higher education institutions lies in the desire to better understand and use diversity as an important basis for the further development of European higher education and research systems.

The aim of the European higher education classification is to draw benefits of increasing diversity of missions of HEIs in Europe. The U-Map project[11] therefore developed a classification model to map the diversity of European higher education institutions according to their various missions, such as education, research, innovation, regional involvement and internationalisation.

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[10] Based on: Laredo, P (2007), "Revisiting the third mission of Universities: towards a renewed categorisation of university activities", *Higher Education Policy*, 20.4, 441-456. Universities are important players in the local economy and in their social context.
[11] The first project was finalised in 2010: see http://www.u-map.org/U-MAP_report.pdf The aim is to design and select appropriate instruments and construct the multi-dimensional ranking of 150 pilot institutions in over 40 countries. Final results are expected in June 2011. The feasibility study is being funded by the European Commission and carried out by the CHERPA Network in association with the European Federation of National Engineering Associations (FEANI) and the European Foundation for Management Development (EFMD).
The U-Multi-rank approach is based on a number of important principles:
User-driven: the nature of a university ranking should be determined by its purpose and by the needs of its potential users.
Multi-dimensional: the importance of different dimensions and indicators vary among different user groups; a university ranking should not produce a consolidated score but should treat different dimensions separately.
Field-specific and institutional rankings: performance may vary considerably across disciplines within one university; an effective ranking should also offer field-specific information.
Diversity: ranking should respect the diversity of higher education institutions and compare only institutions with a similar profile.
Performance-orientation: ranking should focus primarily on achieved performance and not on inputs, reputation or descriptive characteristics.
Context: an international ranking must take into account the linguistic, cultural, economic and historical contexts of different higher education systems.

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The 'European Classification of Higher Education Institutions: "U-Map"' project was established to map the strength of all types of higher education and research institutions and to display comparable institutional profiles. Rankings or benchmarks may be applied when an institutional profile like this exists. Six dimensions of HEIs have been identified and these profiles have been made operational by specific indicators as follows:

- Educational profile on teaching and learning:
    - degree-level focus
    - range of subjects
    - orientation of degrees
    - expenditures on teaching

- Student profile:
    - mature students
    - part-time students
    - distance-learning students
    - size of student body

- Research involvement:
    - peer-reviewed publication
    - doctorate production
    - expenditures on research

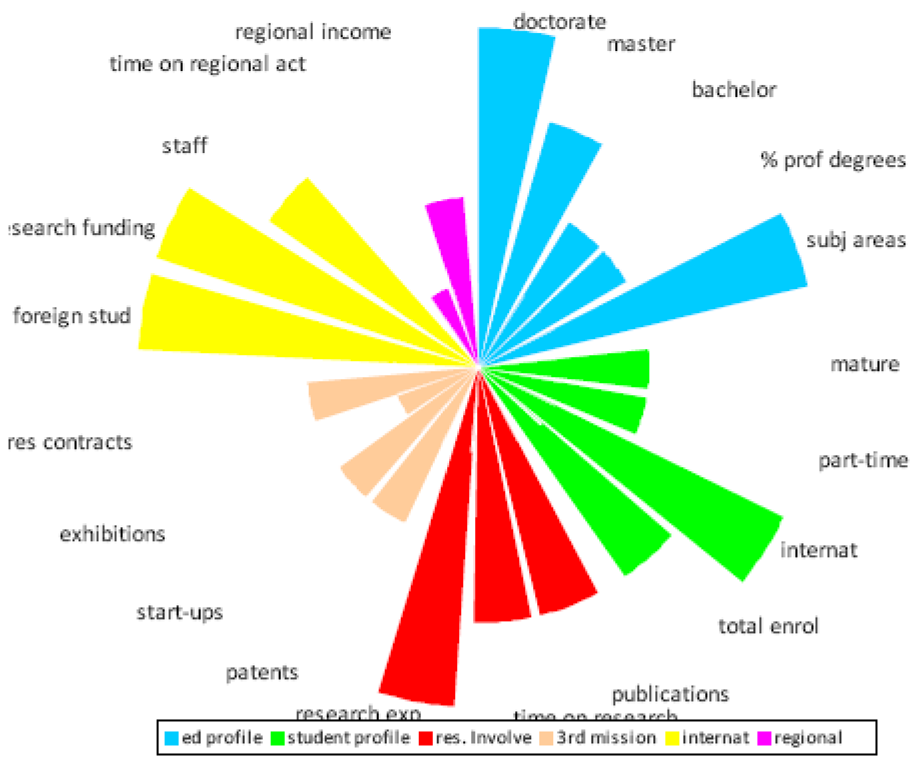
- Involvement in knowledge exchange:
    - start-up firms
    - patent applications filed
    - cultural activities
    - income from knowledge-exchange activities

- International orientation:
    - foreign degree-seeking students
    - incoming students in international exchange programs
    - students sent out on international exchange programs
    - international academic staff
    - importance of international sources of income in the overall budget of the institution

- Regional engagement:
    - graduates working in the region
    - first-year bachelor students from the region
    - importance of local/regional income sources

The six dimensions may be transformed into a profile viewer of a specific HEI, representing a strong international research university:

Figure II.1.1. Representation of future profile of a higher education institution



A mapping exercise will allow at a later stage specific rankings beyond research performance. It may contribute to the creation of a stronger profile for European higher education on a global stage and to the realisation of the goals of the Europe 2020 strategy and the Bologna Process.

Around 47 % of all higher education institutions in Europe are clearly research-active and only 6 % are highly research-intensive

In parallel, the European Commission has started to build foundations to better monitor the European research and education area. A feasibility study[12] carried out preparatory work for a regular data collection by national statistical institutes on individual higher education institutions (HEI) in the EU Member States, Norway and Switzerland. The so-called EUMIDA study focussed on HEI data in national databases, insofar as these databases are maintained by national statistical institutes, ministries, or other organisations with a public mission. It reviewed a number of issues including data availability, data confidentiality and the resources needed to create and maintain a pan-European university register.

Europe has 2 906 recognisable HEIs of which are 1 364 research-active ones

The EUMEDIA study estimated the total number of HEI in the EU[13] at 2 906. These HEIs cover 90 % of all students registered in higher education.

[12] Also known as the EUMIDA project http://www.eumida.org/.
[13] In defining the perimeter of HEI, the study excluded a number of small entities, mostly schools associated with industry or professional associations, which deliver ISCED 5B (vocational training) degrees but are not considered as 'institutions' as they do not have significant autonomy in managing staff and financial resources. The study comprised two pilot data collections: a core set of data covering all HEI in a country and an extended

Institutions fulfilling at least three of the following six criteria were regarded as research-active:

- existence of an official research mandate;
- existence of institutionally recognised research units (e.g., on an institution's website);
- inclusion in the R&D statistics (availability of R&D expenditure data), as a sign of institutionalised research activity;
- awarding doctorates or other ISCED 6 degrees;
  consideration of research in an -institution's strategic objectives and plans;
- regular funding for research projects either from public agencies or private companies.

Applying this definition, the study concluded that 1 364 of the 2 906 HEIs were 'research active' (the total numbers will grow when France and Denmark provide their full data). Of the 1 364 institutions, only 850 award doctorates, meaning that a significant number of research active institutions are found outside the traditional perimeter of HEIs, i.e. in the domain of non-university research (particularly in countries with dual higher-education systems).

Europe has 171 universities which are highly research-intensive in terms of scientific production

Articles published in referenced journals[14] are the performance measure for academia to which research universities would affiliate them. The referenced articles are the basis for scientometric analysis applied by the Leiden Ranking as a performance of a university. The total of article production by universities in a country may serve as a proxy for national scientific production. However, this ranking provides an overview of the main centres of academic production in Europe. The scientometric analysis displays the volume and visibility of scientific production over a nine year period (1997–2006). If a certain threshold of production is applied at 5 000 articles with an average impact in the fields above 0.50, the analysis results in a list of 171 universities from 21 countries. Most of these universities are located in EU-15 Member States and some EU-12 Member States (see table below). Beyond this threshold, the production of scientific articles decreases rapidly. Therefore we can assume that Europe has around 171 top research universities or research- intense universities.[15]

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set of data covering a subset of institutions defined as 'research active'. It collected data on 2 457 institutions as France and Denmark (in part) did not provide data. Norway and Switzerland were also included as case studies in the project.

[14] For details on the methodology used to assign articles to universities, including a discussion of measurement issues relating to capturing the research activity of specialised universities, see: http://www.cwts.nl/hm/bibl_rnk_wrld_univ_full.pdf. The top research universities in Europe were selected from a list compiled by CWTS in the ASSIST project. The level of scientific production was measured by the number of articles published in journals referenced in the Web of Knowledge. The visibility of publications at world level was measured by applying the CPP/FCSm indicator, the so-called 'crown' indicator of the CWTS ranking.
The selection has two limitations. Firstly, universities have been defined in a narrow sense. As a consequence a few large HEI have been excluded due to their non-university label: e.g. Politecnico di Milano or French 'Grandes Écoles'. Therefore, the total sample of HEI that have produced more than 5 000 papers within the 1997–2006 period should be slightly larger. The other limitation is related to the non-consideration of specialised universities which are in general smaller or active in scientific domains that have a lower publication pace, as is the case of social sciences and humanities, mathematics or engineering sciences, e.g. London School of Economics.

[15] For more comprehensive data and analysis of higher education institutions in Europe, see also JRC-IPTS University Observatory.

Table II.1.4 Scienific publications produced by the top European research universities, 2000-2006

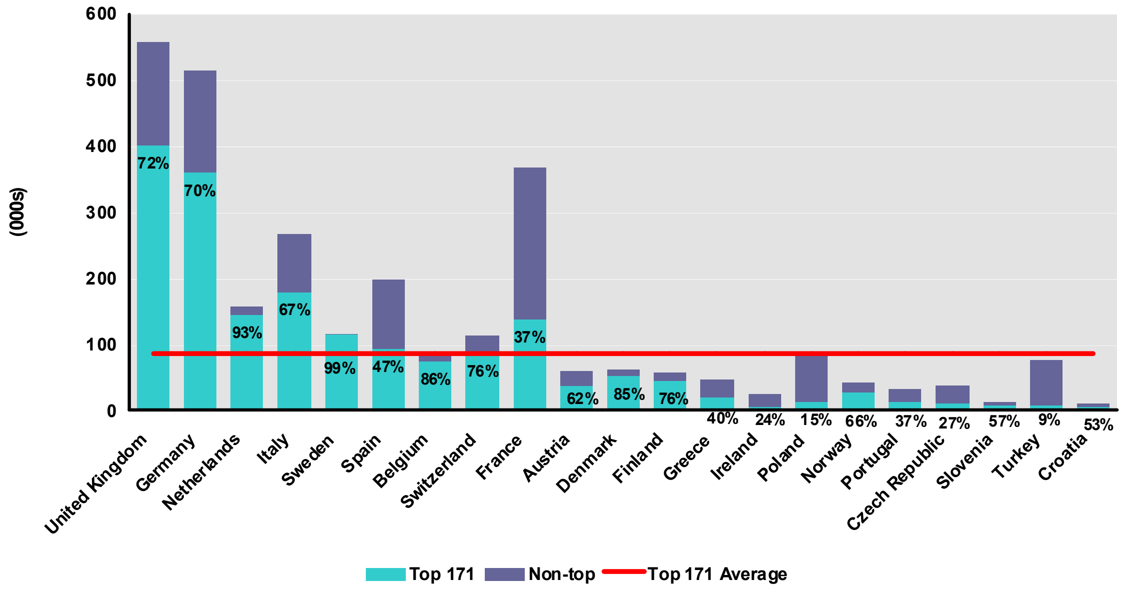
	Top European research universities		Scientific publications 2000-2006	
	Total	% distribution	Total	Share in total national scientific publications %
Germany	35	20	348469	54
United Kingdom	32	19	401967	58
Italy	18	11	180032	53
France	14	8	136921	30
Netherlands	11	6	144759	73
Spain	10	6	93493	37
Sweden	10	6	115579	78
Belgium	7	4	73883	67
Switzerland	7	4	85071	60
Finland	5	3	43804	60
Austria	4	2	37025	49
Denmark	4	2	52149	67
Norway	3	2	27023	50
Greece	2	1	19364	31
Poland	2	1	12877	11
Portugal	2	1	12100	27
Croatia	1	1	5806	43
Czech Republic	1	1	10148	21
Ireland	1	1	5914	19
Slovenia	1	1	9306	56
Turkey	1	1	7145	7
Bulgaria	0	0	0	0
Estonia	0	0	0	0
Cyprus	0	0	0	0
Latvia	0	0	0	0
Lithuania	0	0	0	0
Luxembourg	0	0	0	0
Hungary	0	0	0	0
Malta	0	0	0	0
Romania	0	0	0	0
Slovakia	0	0	0	0
Total	171	100	0	0

Source: DG Research and Innovation, JRC-IPTS — Innovation Union Competitiveness Report 2011
Data: Europe's top research universities in FP6 based on Leiden ranking.

These 171 most-productive universities in science account for 60% of the total number of international scientific articles in Europe. This holds true also for most of the Member States. Universities from smaller research systems included in the top 171 represent 60–70% of the scientific publications from their respective country. The same pattern applies for large research systems such as those of the United Kingdom, Germany and Italy. However the situation is different in Spain and particularly in France. Universities in France and Spain which belong to the top 171 account for a share of only 37% and 47% respectively of the total national scientific production (see figure below).[16]

[16] TableII.1.4. and Figure II.1.2. are from Henriques, L., Schoen, A., Pontikakis, D, 2009, "Europe's top research universities in FP6: scope and drivers of participation", *JRC Technical Notes 24006* http://ftp.jrc.es/EURdoc/JRC53681_TN.pdf

Figure II.1.2 Number of scientifc publications (thousands) and top universities' national shares of scientific publications (%), 2000-2006



Source: DG Research and Innovation, JRC-IPTS
Data: Europe's top research universities based on Leiden ranking

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1.1.3. The distribution and cooperation of top research institutions in Europe

European public research-performing organisations are more evenly distributed across Europe than the top research-intensive universities, but the academic linkages are centred in Western Europe

After having identified the most important public research-performing organisations and the most academic-research-intensive universities in Europe, it is valuable to see where they are located in Europe, as they constitute an important section of the public part of the European research system. Their location is indicated in the map below. The picture shows a distribution that has a concentration in the middle axis of Europe reaching from the United Kingdom to the north of Italy. For centuries, the 'Blue Banana' - a banana-shaped metropolitan axis running from London to Milan - has been Europe's breeding place for innovation and growth[17]. It seems that the major public research institutions are part of this configuration, both with respect for their location and for their linkages. Even though EU-12 count on important PROs, these are less connected to informational flows counting web-links to the major research centres in Western Europe.

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[17] Gert-Jan Hospers: Beyond the Blue Banana? Structural Change in Europe's Geo-Economy, Intereconomics, March/April 2003.

Figure II.1.3. Distribution of top public research institutions in Europe

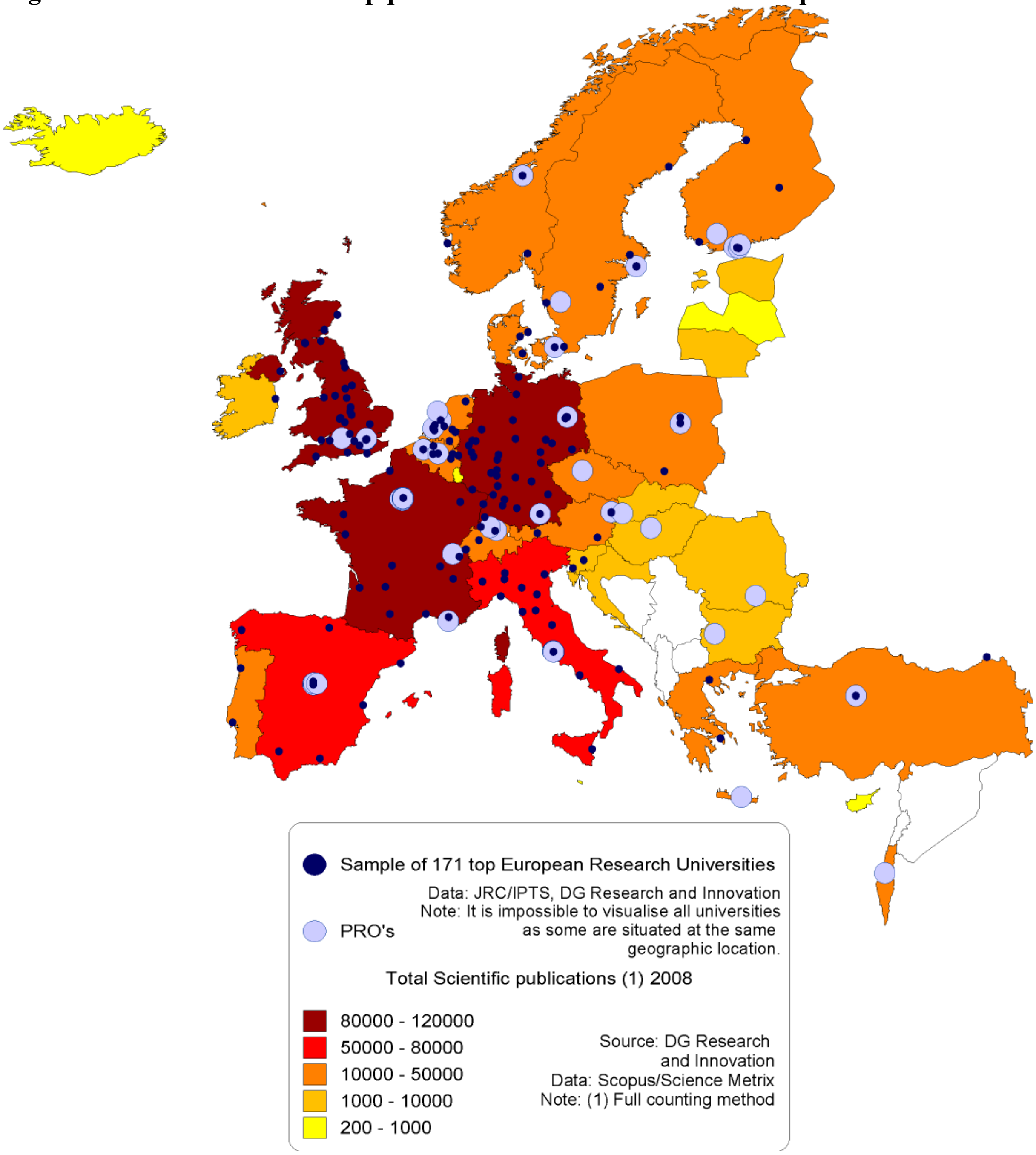
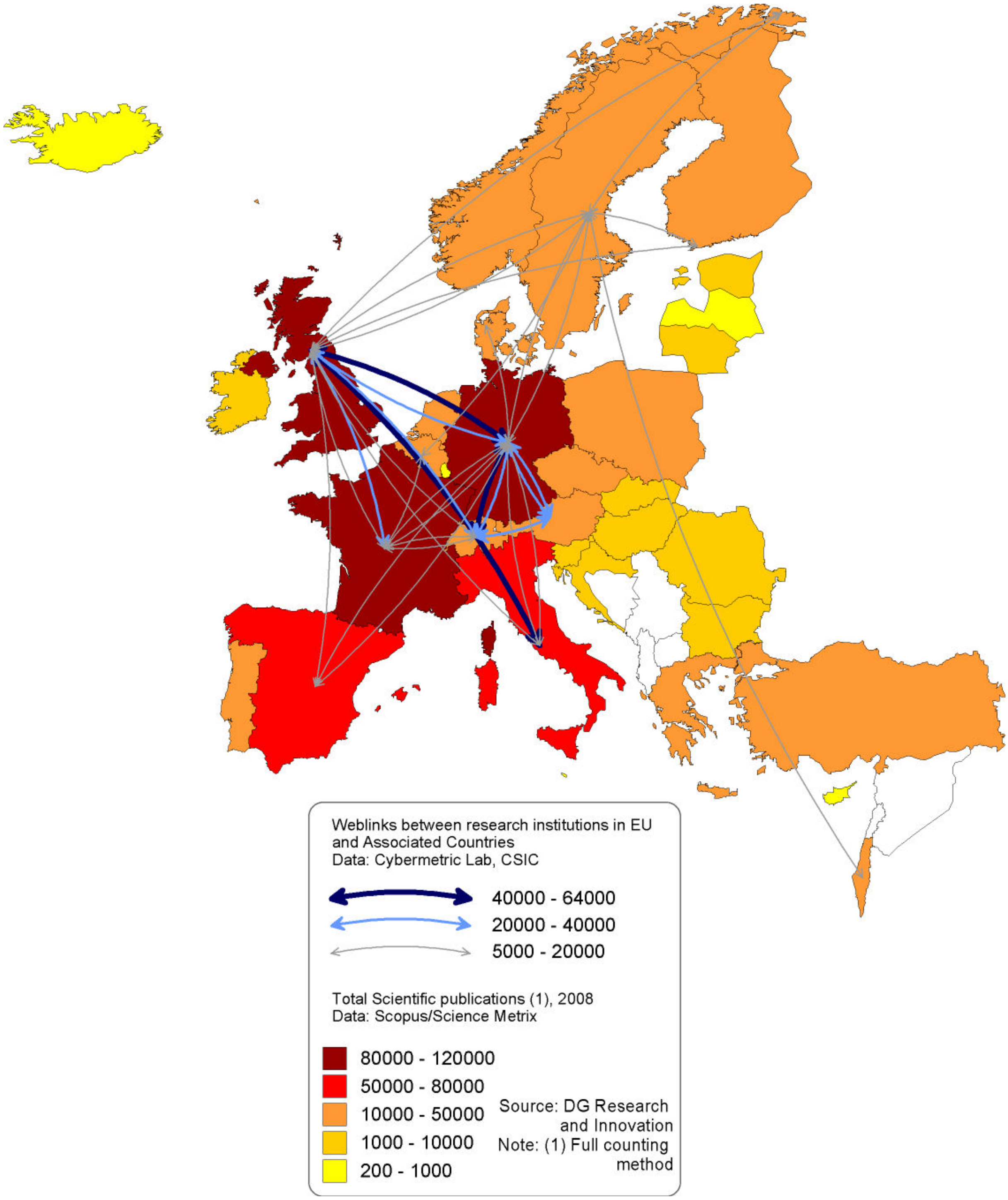


Figure II.1.4. Web-based links between the top public research institutions in Europe, 2009



1.2. What reforms are taking place in public research institutions?

European higher education systems have undergone important changes over the last few decades (Geuna, 2001; OECD, 2005, Kyvik, 2004). The changes have fostered public discussion on the Bologna reforms, which has brought higher education and universities into the reform limelight. However, PROs have also undergone restructuring, like the science academies in the new Member States or efforts in the United Kingdom to privatise government laboratories in the defence area. However, we lack sufficient statistical evidence on these reforms. Therefore, this sub-chapter will concentrate mainly on HEIs and complement the text with reforms of PROs insofar as they are available.

1.2.1. Institutional strategies in higher education institutions

Current reforms of European higher education institutions[18] are aimed at various institutional structures and they are guided by several motivations. The latest 'Trends 2010'[19] report of the European University Association (EUA) detected intensive reform of universities in Europe. Reforms of universities have several dimensions, such as implementing the Bologna Process (78 % of respondents), quality assurance reforms (63 %) — enhanced by reforms in funding allocation schemes and legal reforms for increased autonomy of the universities — and reforms adapting to the internationalisation of research and education (61 %). These are reforms which have altered institutional higher education policies and strategies. More institutions are developing an integrated internationalisation approach to teaching and research and putting focus on strategic partnerships. The report concludes that the European Higher Education Area and the European Research Area have given new opportunities to universities, and charged HEIs with new responsibilities in a close interface between education, research and innovation.

The framework for the European universities is changing: more autonomy, performance-based funding, higher share of project funding, engagement in competitive research, and international competition for staff.

The most frequent reforms introduced in the universities in European countries mentioned by the report of EUA were:

- 18 countries have introduced a reform of quality assurance for degrees and education;
- 15 countries have changed their research policies, taking into account the international competitive environment;
- 12 countries have expanded the institutional autonomy of their HEIs;
- 12 countries have fostered reforms in their funding system in order to diminish institutional funding in favour of competitive funding.

Other changes identified in the survey were: governance reforms of universities to cope with knowledge transfer, new career structures, new entry requirements to the different cycles of study, and innovation policies.

[18] The last STC Key Figures Report 2008/2009 gave an overview on reforms based on a Commission expert group grounded in findings from CHE. See Part II chapter 1, p. 92 ff. This volume takes into account more recent reports.

[19] The report is based on a longitudinal analysis of higher education institutions. The data come from 821 responses from universities and 27 responses from the National Rectors' Conferences. The recent survey compares with similar ones reported in 2005 and 2007.

While eight countries (Austria, the Czech Republic, Spain, Greece, Italy, Poland, Slovakia and Slovenia) increased their number of universities, eleven countries (Belgium, France, Germany, Denmark, Estonia, Finland, Hungary, Iceland, Norway, Sweden and Slovenia) pushed their institutions for mergers. Mergers may support better economy of scale, but in many of these countries the aim is to raise quality and strive for excellence by critical mass. The current reforms of universities often aim at autonomy, particular in view of strengthening the excellence at universities.

Table II.1.5 The most important reforms in European universities (beside the Bologna Process)

Institution	Funding	Autonomy	QA	Research policies
Belgium	●		●	●
Czech Republic	●			●
Denmark	●		●	
Germany		●	●	●
Estonia			●	
Ireland			●	●
Greece			●	●
Spain		●	●	
France		●	●	●
Italy		●		
Latvia		●	●	●
Lithuania	●	●		
Luxembourg	●	●		●
Hungary				●
Netherlands	●		●	
Austria		●	●	
Poland		●	●	●
Slovakia			●	●
Slovenia	●	●	●	●
Finland	●	●		
United Kingdom	●		●	●
Iceland	●		●	●
Norway	●	●	●	●
Serbia			●	

Source: DG Research and Innovation — Innovation Union Competitiveness Report 2011
Data: EUA: Trends 2010: A decade of change in European Higher Education

* In the original UEA survey, data on Belgium were split in the two major regions. The Commission has merged the table for reasons of comparability as countries with cultural regional diversity as Germany and Spain for example have as well different reforms in their respective regions.

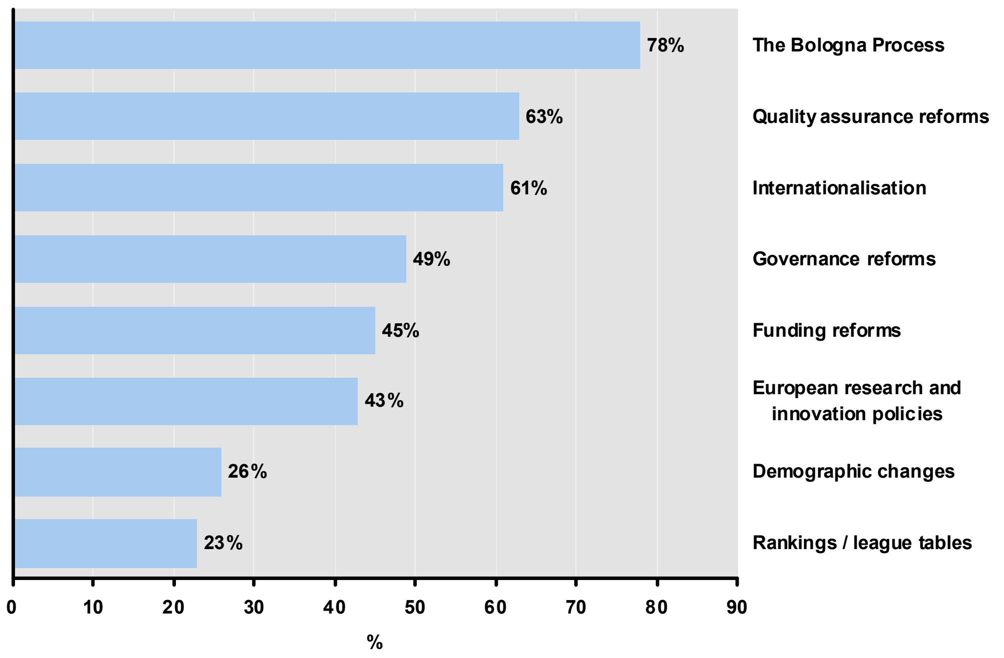
Internationalisation and European policies are among the main drivers of new university strategies and reforms

The comparison of excellence at worldwide level is a high impact exercise. In this sense, ranking activities influence strongly institutional strategies of international active universities. Moreover, efforts to achieve competitive funding at a European level have fostered the trend of profile building, international mobility and openness to non-national staff.[20]

[20] See also the chapter on researcher mobility, Part II, chapter 5.

European policy issues have had a crucial impact on university reform. The Bologna Process was and is of high importance to the reform of higher education degrees. The internationalisation of science and the Bologna Process have stipulated quality assurance reforms, along with the process of accreditation of the degrees. As the figure below shows, European research and innovation policies had a high impact on the institutional strategies of universities. Another important factor is the expanding European dimension in research, which attributes higher importance of competitive funding in comparison to institutional funding. Although ranking and lead tables play a certain role in the institutional strategies of universities, competitive European funding provides additional funds to national resources and may be considered as one proof of international competitiveness and a benchmark for scientific excellence. In this view, the Danish Ministry for Science, Technology and Innovation has applied an interesting benchmarking and ranking analysis of OECD, EU and BRIC countries based on 20 indicators. The purpose of monitoring Danish research institutions is to raise the research quality and respective features in the Danish research system.[21]

Figure II.1.5 Importance of developments for institutional strategy



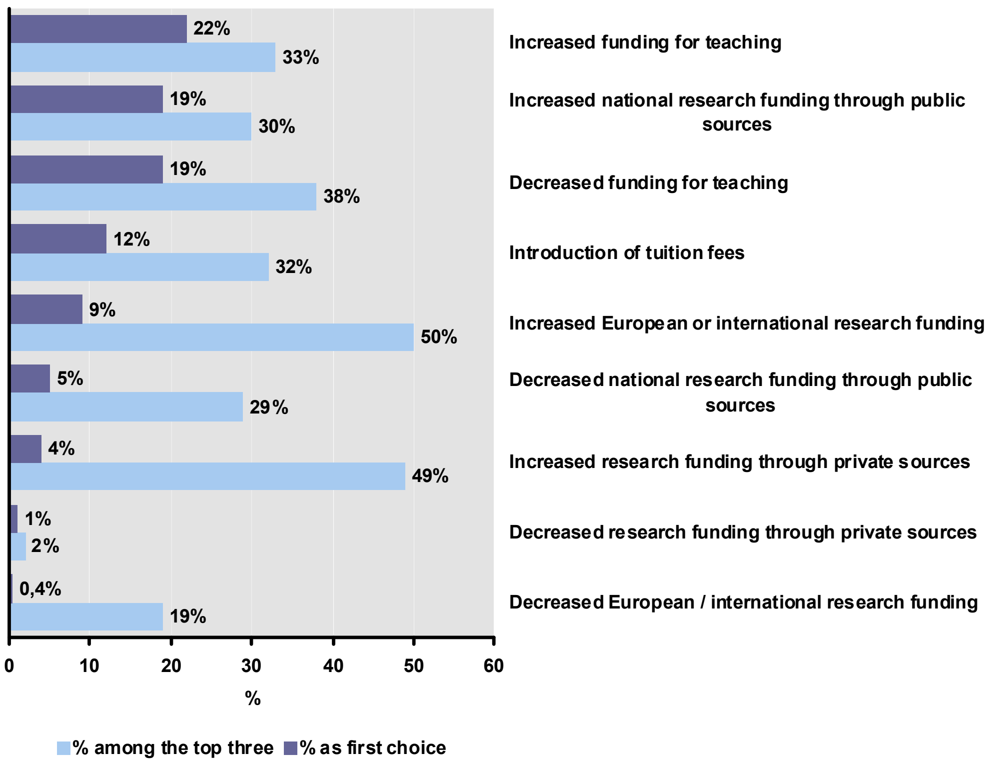
Source: DG Research and Innovation — Innovation Union Competitiveness Report 2011
Data: EUA: Trends 2010: A decade of change in European Higher Education

The current pressure to implement the Bologna Process and to assure quality of degrees catches most of the attention of university managers. However, funding remains a critical issue. As the HEIs are mostly public national or even regional institutions, increased European or international research funding figures under the top three issues, and even decreased European or international funding is a source of concern. The reflection on increased research funding through private sources indicates the new strategic thinking of

[21] Ministry of Science, Technology and Innovation: Research Barometer 2009, Danish Research in an International Perspective, Copenhagen, December 2009.

universities and the international influence that has invaded the former national public institutions, which no longer can rely on static public institutional funding.

Figure II.1.6 The three most important developments in the funding of universities in the past five years



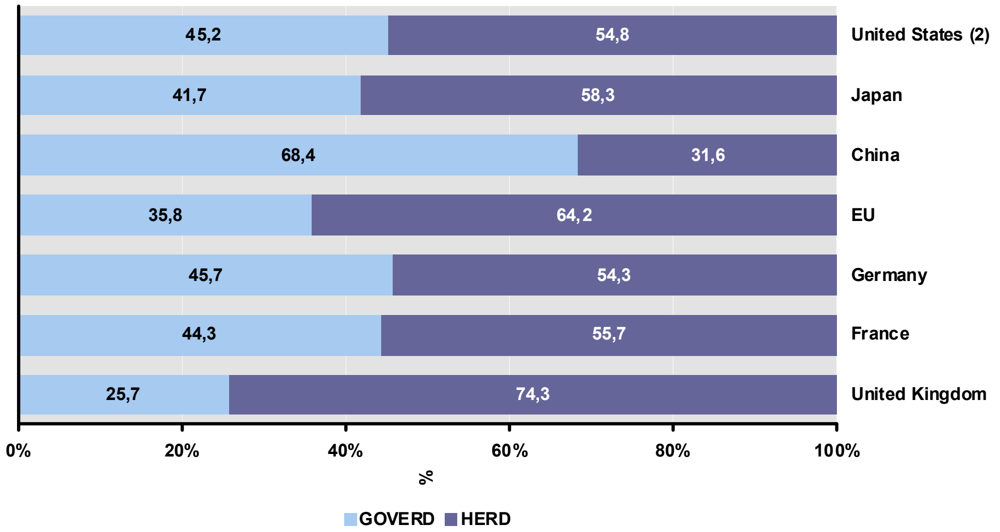
Source: DG Research and Innovation Innovation Union Competitiveness Report 2011
Data: EUA: Trends 2010: A decade of change in European Higher Education

1.2.2 Public expenditures and funding of PROs and HEIs

Over 60 % of public research funding in the EU is provided to HEIs and 40 % to PROs, with a trend of a slightly increasing share for HEIs

In the EU, 35.8 % of public R&D funds are distributed to public research-performing organisations (PROs) and 64.2 % to higher education institutes (HEIs), which shows an increase of the relative funding to higher education institutions over the last five years (in 2004, HEIs received 62% of public expenditures on R&D). In the United States, the HEIs receive 54.8 % of the public R&D funding and in China 31.6%. China and the United States have had the same trend of increase in the share of public expenditures to higher education institutions relative to the funding to PROs (in 2004, the share of HEIs in the United States was 53% and China 28%, according to OECD). Comparable distributions to that of the United States are found in France and Germany, while the United Kingdom spends much less of its R&D funding on PROs. In most of the EU Member States, it is predominantly the universities which perform public research.

Figure II.1.7 GOVERD and HERD as % of total public expenditure on R&D, 2009 (1)



Source: DG Research and Innovation Innovation Union Competitiveness Report 2011
Data: Eurostat, OECD
Notes: (1) US, JP, CN: 2008.
(2) US: (i) Most or all capital expenditure is not included (ii) GOVERD refers to federal or central government only.

When government intramural expenditure on R&D (GOVERD) and higher education expenditure on R&D (HERD) are compared in Table II.1.6., marked differences between Member States are observed. In relation to GDP, on average Member States spend half as much on PROs as they spend on HEIs. Only Bulgaria, Romania and Slovakia spend more on PROs due to the strong role of their Academy of Sciences. High relative expenditures on HEIs are done in Sweden, Denmark, Finland, Austria, and the Netherlands. In absolute terms, Germany, the United Kingdom, France and Italy hold the bulk of the total HEI spending. In absolute numbers (total euros), GOVERD spending in Germany and France alone holds at 51.4% and Germany spends up to three times as much as the United Kingdom.

Table II.1.6 Government Intramural Expenditure on R&D (GOVERD) and Higher Education Expenditure on on R&D (HERD), 2009 (1)

	GOVERD		HERD	
	Total euro (millions)	as % of GDP	Total euro (millions)	as % of GDP
Belgium	*575*	*0,17*	*1511*	*0,45*
Bulgaria	*102*	*0,29*	*26*	*0,07*
Czech Republic	448	0,33	379	0,28
Denmark	*193*	*0,09*	*2012*	*0,90*
Germany	*9840*	*0,41*	*11700*	*0,49*
Estonia	22	0,16	83	0,60
Ireland	*122*	*0,08*	*829*	*0,52*
Greece	*281*	*0,12*	*661*	*0,29*
Spain	2927	0,28	4058	0,39
France	*6879*	*0,36*	*8648*	*0,45*
Italy	*2680*	*0,18*	6049	0,40
Cyprus	*17*	*0,10*	*33*	*0,20*
Latvia	21	0,11	33	0,18
Lithuania	52	0,20	117	0,44
Luxembourg	*111*	*0,29*	*58*	*0,15*
Hungary	214	0,23	223	0,24
Malta	*2*	*0,03*	*10*	*0,18*
Netherlands	*1326*	*0,23*	*4169*	*0,73*
Austria	*403*	*0,15*	*1799*	*0,66*
Poland	719	0,23	*777*	0,25
Portugal	*206*	*0,12*	*987*	*0,59*
Romania	194	0,17	138	0,12
Slovenia	136	0,39	96	0,27
Slovakia	103	0,16	76	0,12
Finland	*645*	*0,37*	*1362*	*0,77*
Sweden	467	0,16	*2627*	*0,90*
United Kingdom	*2679*	*0,17*	*7756*	*0,50*
EU	*31251*	*0,27*	*56024*	*0,48*
Iceland	49	0,47	68	0,67
Norway	*778*	*0,29*	*1548*	*0,57*
Switzerland (2)	76	0,02	2482	0,72
Croatia	103	0,23	123	0,27
Turkey	470	0,11	1773	0,40
Israel (3)	*292*	*0,21*	*763*	*0,54*
Russian Federation	3331	0,36	785	0,08
United States (4)	*28709*	*0,29*	*34786*	*0,36*
Japan	9494	0,29	13264	0,40
China	8257	0,28	3816	0,13
South Korea	2590	0,41	2394	0,38

Source: DG Research and Innovation — Innovation Union Competitiveness Report 2011
Data: Eurostat, OECD
Notes: (1) EL: 2007; IS, CH, US, JP, CN, KR: 2008; FI: 2010.
(2) CH: GOVERD refers to federal or central government only.
(3) IL: (i) GOVERD does not include defence (ii) HERD does not include R&D in the social sciences and humanities.
(4) US: (i) Most or all capital expenditure is not included (ii) GOVERD refers to federal or central government only.
(5) Values in italics are estimated or provisional or forecasts.

Please note that Table II.1.6 is slightly changed due to change of value for Poland. I will send you this revised table as the one you have may have a different value for Poland

In several European countries a shift has emerged towards performing research in universities

Historically, a structural change between the two types of research institutions can be observed. The share of PROs fell slightly by 2.2% over nearly a decade[22] as the table on development of relative expenditure of PROs in relation to HEIs shows. In several countries, a shift towards performing publicly financed research in HEIs can be witnessed - (for example, the Czech Republic, Cyprus and Slovakia have decreased their high share of PROs following privatisation and the reduction of spending for non-civil R&D and nuclear energy). Other countries have integrated PROs into universities (like it was the case in Estonia). The most striking cases in the EU-15 may be the shift of Denmark (a decrease of almost 20%), Portugal and the United Kingdom. The share for PROs in the United Kingdom fell from 38% in 2000 to 25.7% in 2009, partly linked to the privatisation of the PROs in this Member State. In Portugal the share fell from 38.9% to 17.2%.

Countries like Bulgaria, Romania and Slovenia have kept a strong PRO sector over a decade as the research is largely performed in their Academies of Sciences. Germany and France - the countries in the EU-15 where PROs represent a large part of public research - have kept their structure at around 46% for PROs, with a slight decrease of 2% for France. In countries like Belgium and Sweden, the relative expenditures on HEIs have increased a few percentage points over the last decade, while Spain has had the opposite trend with an increasing GOVERD.

[22] In many European countries, there has been a slow shift from a public research system where PROs and teaching universities are the main knowledge institutions to a system characterised by the research centrality of HEIs. This trend is visible from the early 1990s, not only in Europe but also in Japan, South Korea and the United States.(see Foray and Lissoni, 'University research and public-private interactions', in Hall and Rosenberg (eds), Handbook of Economics of Innovation, North-Holland, 2010). .

Table II.1.7 GOVERD as % of total public expenditure on R&D [(1)], 2000-2009

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	23,7	23,8	25,3	23,6	26,3	27,3	27,4	27,6	*26,7*	*27,6*	:
Bulgaria	87,4	84,5	87,7	87,9	87,8	86,4	87,0	85,8	85,9	*79,7*	:
Czech Republic	64,1	60,2	59,5	60,5	60,3	55,0	54,0	55,2	55,5	54,1	:
Denmark [(2)]	39,0	38,4	24,2	23,2	21,9	20,8	20,2	10,9	8,7	*8,7*	:
Germany	45,8	45,6	44,7	44,3	45,3	46,0	46,3	46,3	45,7	*45,7*	:
Estonia	30,6	21,8	26,2	25,0	22,6	21,4	24,4	17,2	21,5	20,7	:
Ireland	28,6	27,1	28,0	24,0	22,0	21,4	20,0	20,6	19,4	*12,8*	:
Greece	:	32,9	:	30,3	*29,2*	29,9	*30,3*	*29,8*	:	:	:
Spain	34,8	33,9	34,1	33,6	35,1	37,0	37,6	40,0	40,5	41,9	:
France	48,0	46,6	46,7	46,3	47,7	48,6	46,2	45,6	44,3	*44,3*	:
Italy	37,9	36,1	34,9	34,1	35,2	36,4	36,3	32,5	28,4	*30,7*	:
Cyprus	65,2	63,5	58,0	53,7	50,6	45,0	41,0	34,8	34,4	*33,5*	:
Latvia	37,0	33,8	32,1	35,6	35,0	31,5	30,4	36,0	36,7	38,8	:
Lithuania	53,4	55,8	40,2	33,5	31,4	31,4	31,7	29,2	30,3	31,0	:
Luxembourg	96,7	95,6	:	96,8	89,9	88,9	84,7	81,8	72,4	*65,8*	:
Hungary [(3)]	52,1	50,1	56,6	54,0	54,6	52,7	51,0	50,8	51,5	48,9	:
Malta	:	:	21,9	10,1	7,5	14,1	12,9	*7,8*	13,1	*15,2*	:
Netherlands	31,5	33,8	32,4	28,0	28,5	26,4	26,8	26,0	24,0	*24,1*	:
Austria	:	:	17,4	:	16,1	*17,3*	17,8	18,3	*18,3*	*18,3*	:
Poland	50,6	48,9	57,3	56,2	55,0	53,5	54,4	51,1	51,2	48,1	:
Portugal	*38,9*	36,2	*33,4*	30,5	*29,8*	29,2	*26,2*	23,9	17,4	*17,2*	:
Romania	61,5	70,5	60,8	77,3	77,2	71,4	64,6	58,5	58,7	58,5	:
Slovenia	60,9	59,9	59,7	61,7	60,6	59,1	61,9	61,1	62,0	58,8	:
Slovakia	72,2	72,5	74,5	70,6	60,3	59,2	57,6	58,6	57,5	57,5	:
Finland	37,2	36,1	35,1	33,5	32,4	33,4	33,3	31,2	31,9	32,5	32,1
Sweden [(4)]	:	12,6	:	13,8	11,9	18,4	*17,8*	18,4	*17,2*	15,1	:
United Kingdom	38,0	30,7	27,7	30,2	30,2	29,1	27,7	26,0	25,7	*25,7*	:
EU	*40,0*	*38,4*	*37,3*	*36,8*	*37,3*	*37,8*	*37,1*	*36,2*	*35,5*	*35,8*	:
Iceland	*61,1*	51,7	*60,4*	53,8	:	51,7	46,2	41,5	41,5	:	:
Norway [(5)]	:	36,3	37,1	35,5	34,3	33,7	34,2	32,8	31,6	*33,4*	:
Switzerland [(6)]	5,4	:	4,8	:	4,5	:	3,6	:	3,0	:	:
Croatia	:	:	38,8	36,1	35,9	41,0	42,0	43,0	45,4	45,7	:
Turkey	9,3	11,1	9,8	13,6	10,5	17,5	18,5	18,0	21,4	20,9	:
Israel [(7)]	26,8	26,7	26,3	25,9	26,4	*25,1*	*25,8*	*27,0*	*27,2*	27,7	
Russia	84,3	82,3	81,8	80,7	82,2	81,9	81,5	82,1	81,8	80,9	:
United States [(8)]	47,4	48,2	47,5	46,9	45,9	46,0	45,7	45,2	*45,2*	:	:
Japan [(9)]	40,5	39,7	40,7	40,5	41,4	38,2	39,5	38,2	41,7	:	:
China	78,6	75,2	73,9	72,0	69,2	68,8	68,1	69,4	68,4	:	:
South Korea [(5)]	54,1	54,3	56,4	55,4	54,5	54,4	53,7	52,3	52,0	:	:

Source: DG Research and Innovation — Innovation Union Competitiveness Report 2011
Data: Eurostat, OECD
Notes: (1) Public expenditure on R&D: GOVERD (Government Intramural Expenditure on R&D) plus Higher Education Expenditure on R&D (HERD).
(2) DK: Breaks in series occur between 2002 and the previous years and 2007 and the previous years.
(3) HU: A break in series occurs between 2004 and the previous years.
(4) SE: A break in series occurs between 2005 and the previous years.
(5) NO, KR: A break in series occurs between 2007 and the previous years.
(6) CH: GOVERD refers to federal or central government only.
(7) IL: (i) GOVERD does not include defence (ii) HERD does not include R&D in the social sciences and humanities.
(8) US: (i) Most or all capital expenditure is not included (ii) GOVERD refers to federal or central government only.
(9) JP: A break in series occurs between 2008 and the previous years.
(10) Values in italics are estimated or provisional or forecasts.

Please note that Table II.1.7 is slightly changed due to change of value for Poland. I will send you this revised table as the one you have may have a different value for Poland

1.2.3 Funding of higher education institutions

One of the levers of the HEI reforms is the changes made in overall funding. The reforms brought increasing importance to project funding and other sources of funds (such as private contracts or non-profit donations) and the change of funding allocation criteria. Despite differences in the national funding systems and in the instruments used, one of the most important changes lies in the way governments allocate funds. In this context, the reforms imply a move from funding allocation criteria based on size and past input, towards more output-oriented criteria. In addition, there is a perceptible trend toward reducing core funding (institutional funding) while increasing competitive funding (contractual funding) from national and — increasingly — European funds.

The share of public funds received on a competitive basis increases with the level of financial autonomy of the institutions

A study made by the European Commission services has collected new data with comprehensive coverage throughout Europe on a large sample of universities[23] in order to investigate the structure of the university budgets. The analysis reviewed the level of financial autonomy and the share of competitive funding.

The figures below show the results on funding sources of the 200 most research-intense universities in Europe:

- 70 % of the total university income comes from government allocations. Sources from private companies represent about 6 %, around 3 % comes from the non-profit sectors and approximately 2 % is from abroad.

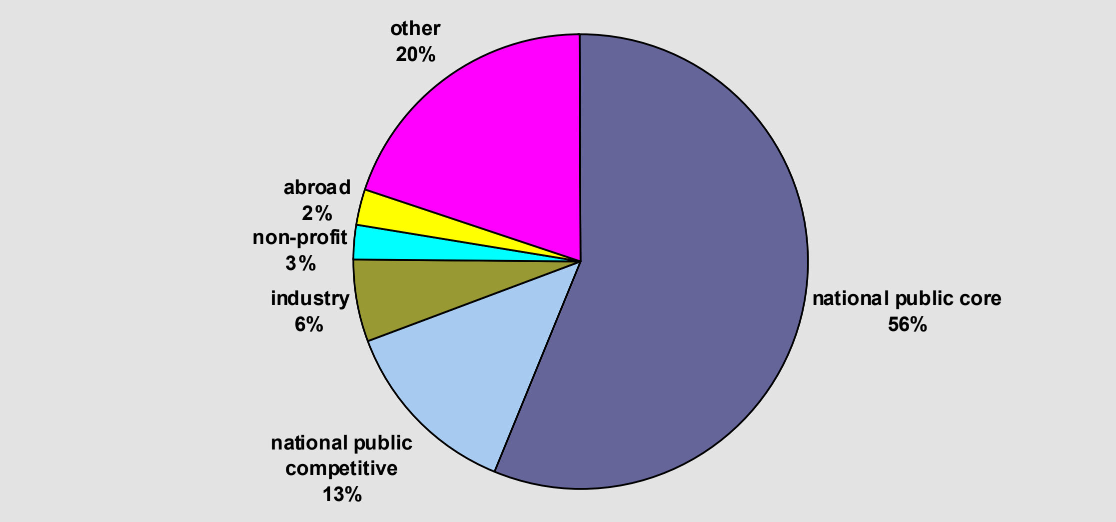
- On average about 20 % of public funding from government (national and regional) is assigned on a competitive basis, with institutions in the United Kingdom and technological universities having the highest shares of competitive funds.

- Large intra-country variability exists in the shares of government competitive funds, which could be attributed to the strategic behaviour of single institutions in acquiring funds or to their ability to compete successfully against other institutions (examples of successful institutions are the University of Cambridge in the United Kingdom, the University of Karlsruhe in Germany, the University of Florence in Italy, and the universities of Leiden and Wageningen in the Netherlands.)

- Universities with a high degree of autonomy are the ones that have the most diversified budget. Most of the institutions with a highly diversified budget are located in the United Kingdom.

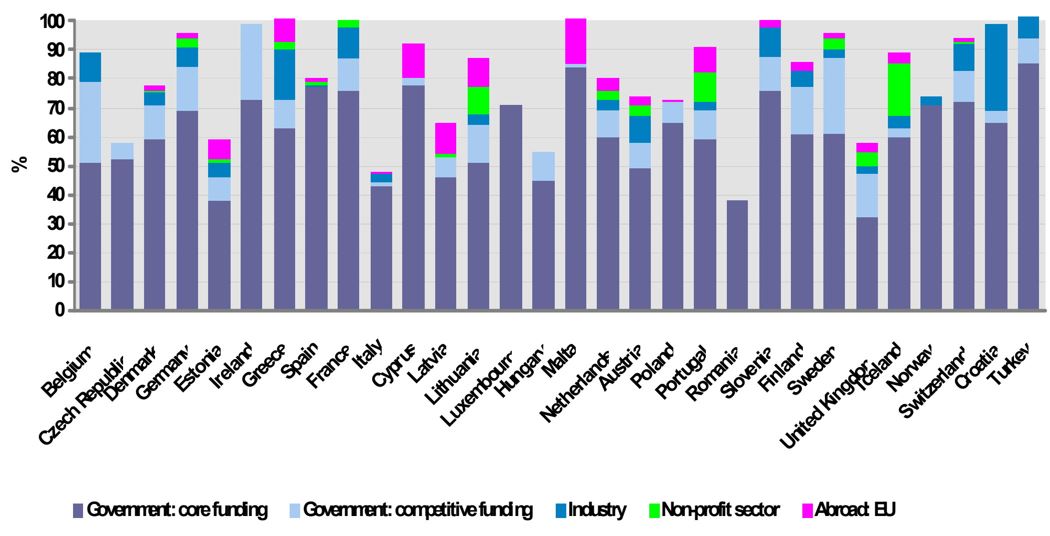
[23] The study covers 200 research-active universities from 33 European countries (the 27 Member States as well as Croatia, Iceland, Israel, Norway, Switzerland and Turkey) within the framework of the 'European Observatory of Research-Active Universities and National Public Research Funding Agencies' (UniObs). The criteria followed in selecting the universities were based on research performance and country representativeness. The UniObs monitoring is managed by the JRC-IPTS. (See De Dominicis, L., Elena Pèrez, S., Fernandez-Zubieta, A.: "European university funding and financial autonomy. A study on the degree of diversification of university budget and the share of competitive funding", JRC Scientific and Technical report nr 24761 EN, European Commission, Luxembourg

Figure II.1.8 The 200 most research intensive universities in Europe: income by source of funds [(1)] (%)



Source: DG Research and Innovation, JRC-IPTS — Innovation Union Competitiveness Report 2011
Data: UniObs: European university funding and financial autonomy
Note: (1) Average of all institutions.

Figure II.1.9 The 200 most research intensive universities in Europe: income by source of funds, averages by country



Source: DG Research and Innovation, JRC-IPTS — Innovation Union Competitiveness Report 2011
Data: UniObs: European university funding and financial autonomy.

The UniObs analysis of different sources of university income reveals the following:

- Government is still the main source of funding of European universities. For the majority of universities in the European countries, government core funds account for around 70 % or more of the total university income. The share of competitive funds allocated by government varies considerably, ranging from 1 % on average for universities in Italy to 28 % on average for institutions in Belgium.

- Funding data show that, in general, research-active universities in Europe have a proportion lower than 10 % of their budget coming from industry. In France, Greece, Bulgaria and Croatia, universities receive, on average, above 10 % of their total budget from industry. Universities studied in Croatia show the highest share of income from industry (30 %), mainly due to overall lower funding from government.

- Income from 'abroad' represents less than 10 % of the total budget for the great majority of universities in the sample, and in 83 % of them, that income falls below 5 %. Data on public funds were mostly available at institutional level and confirm that core funding is the major source of income for the selected European universities.

- Data indicate that in approximately three quarters of the countries, the universities have a share of funds coming from the non-profit sector which represents less than 5 % of their total income. The non-profit sector could be an important source of income, as proved by universities in Iceland and in Portugal, where, on average, it represents 18 % and 10 % of the total university budget.

- Philanthropic sources could potentially be an important source of income for universities, particularly for research activity. However, large-scale philanthropy not as well developed in Europe as in the United States[24].

1.2.4 Philanthropic funding for research

The most recent Ross–CASE Survey indicates that in the United Kingdom philanthropy could become a significant funding source for some universities, providing funds at the level of about 2.3 % of total institutional expenditure. However, funds remains highly unevenly distributed. 51 % of the cash income is received by Oxford and Cambridge, and a further 24 % by the leading 20 research-teaching universities in a total of 116 universities. Previous studies from the United States and the United Kingdom have noted that the vast majority of funds from philanthropic sources tend to be raised by 'elite' universities. The 'Council for Aid to Education' notes that 20 leading universities in the United States account for 26 % of all gifts in 2009 to higher education institutions.

[24] Actually, the exercise of data collection within the UniObs has shown that only half of the sample of universities was able to provide reliable data on this stream of income, which gives an indication of the low importance of this particular stream of income and the subsequent poor accountability.

Philanthropic funding for research has become a significant source for leading universities

According to a survey on philanthropic funding carried out by the University of Kent and the VU University of Amsterdam[25], funds are most likely to be raised from corporations, charitable trusts and foundations. Alumni associations are generally a less productive source of funding, although European universities accelerate their efforts in this area. The average amount varies from EUR 100000 to EUR 10 million with a few exceptions of over EUR 10 million.

Table II.1.8 Success of fundraising efforts for research purposes
Answers to a question with a number from 1 - 10, where 1 = 'not at all' and 10 = 'very'

	Median	N
Charitable trusts and foundations	6	89
Corporations	5	91
Wealthy individuals	4	77
Alumni	2.5	72
Other	2	59

Innovation Union Competitiveness Report 2011
Source: DG Research and Innovation
Data: University of Kent, VU University of Amsterdam

Table II.1.9 Average amount of philanthropic funds (euro) annually raised for research

	% (N = 112)
Less than 100,000	17
Between 100,000 and 1,000,000	27
Between 1,000,000 and 10,000,000	17
More than 10,000,000	5
Don't know	34

Innovation Union Competitiveness Report 2011
Source: DG Research and Innovation
Data: University of Kent, VU University of Amsterdam

1.2.5 International competition and strategies for excellence

As indicated in the last edition of this report,[26] Members States have put in practice different measures to foster excellence in universities and PROs: a higher share of competitive funding, more managerial governance structures ('New Public Management Approach'), higher emphasis on the selection of human resources, and strengthening of the 'third mission' of

[25] Breeze, B., I. Wilkinson, B. Gouwenberg, T. Schuyt: Giving in evidence: Fundraising from philanthropy for research funding in European universities, Brussels, September 2010.
[26] STC report 2008/2009, p. 92ff.

universities to bring public research institutions closer to the non-academic world (including science–industry links), and to establish centres of excellence.[27]

Many Member States have put in place policies to foster excellence

Over the last decade, most EU Member States have launched activities to foster the excellence of their public research base. Member States acknowledge excellence in research in two main dimensions: the scientific quality and the relevance of research with regard to its potential economic use or societal benefit.

In 2006, 'National Institutes of Technology' were launched in Italy and Austria to develop a national R&D-excellence flagship. Other Member States like Belgium, Estonia, Sweden and Malta also launched new initiatives to create 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 funds for nine selected universities.

A handful of countries have followed the 'New Public Management approach' on performance contracts with universities. Austria, France and Denmark have 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 governments of Baden-Wurttemberg, Berlin and Lower Saxony and their universities. Since then, this kind of instrument has been introduced in all German States. In Spain, regional governments such as Catalonia have developed multi-annual 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 relationships with society.

Performance monitoring and evaluation has become a demonstrator for efficient and productive use of public funds in Member States

Member States report a growing interest in performance monitoring and evaluation - a corollary which demonstrates efficient and productive use of public funds. Several countries have created new institutions with a quality control mission external to universities, including the Evaluation Agency for Higher Education and Research (AERES) created by France in 2007, National Research and University Assessment Agency (ANVUR) in Italy, and Lithuania's Centre for Quality Assessment in Higher Education (has a remit covering not only education but also research). In the Netherlands, university quality control is mostly handled internally by universities themselves, supported by Quality Assurance Netherlands Universities (QANU). Spain has whole range of 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).

A quality control system has been applied by the UK's Research Assessment Exercise (RAE) since 1986. The RAE ratings are used to allocate around 30% of the national science budget. The funding credits are heavily skewed in favour of the best performing departments and as a

[27] See also G. Veltri, A.Grablowitz, F. Mulatero: Trends in R&D policies for a European knowledge-based economy, European Commission JRC_IPTS, Luxembourg 2009.

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. This has lead to a situation where some 50 % of block funding is awarded to the top 10 research universities, which account for around 30 % of total university research capacity. Denmark has followed the United Kingdom in this type of quality control with a strong feedback loop from evaluation results to resource allocation.

Common features emerge in Europe for centres of excellence

A centre of excellence[28] performs research and technology development (RTD) at world standard, in terms of measurable scientific production (including training) and/or technological innovation. Even if this concept is understood in different ways in Europe, it has common features:[29]

- 'critical mass' of high level scientists and/or technology developers;
- well-identified structure (mostly based on existing institutions) having its own research agenda;
- integration of connected fields and associated complementary skills;
- high rate of mobility of qualified human resources;
- surrounding innovation system (adding value to knowledge);
- high levels of international visibility and scientific and/or industrial connectivity;
- 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 on public funding over time.

Proximity to excellent research centres is becoming a major element in decisions made over the location of production sites by multinational companies.[30] Although a physical concentration of excellent researchers is still a key factor in RTD strategies, advanced ICT tools progressively allow effective interaction in networks. Several European countries have recently implemented measures to give reinforced support to such centres of excellence.

Box — Examples of policies on centres of excellence

Estonia
The Excellence Centres programme is aimed at higher education institutions' research units and is intended to restructure the Estonian research landscape by developing a small number of centres of excellence in the areas considered a priority for economic growth. The budget for the programme for 2007–2013 is significantly large, and the number of new centres selected is small (seven against the ten in the previous programme period). The programme is now concentrated on fewer scientific fields — biotechnology, ITC, medical research.

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

[28] Broader evidence on technology clusters and knowledge transfer in Europe is presented in the following chapter, Part II, chapter 2.
[29] Veltrini at all, p. 46.
[30] In this context, it is also relevant to compare with the analysis of foreign R&D expenditures, see Part I, Chapter 5.2.

strong commitment from businesses, universities, research institutes and funding organisations. Priority is to be given to 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 2006 Law on Research established the possibility for higher education institutions and research centres to combine their activities and resources in two formats:

- Research and Higher Education Clusters, which have the aim of gathering top class partners on a common physical location to enable them to cooperate in a more integrated way. 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, and whose quality and international visibility give them 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.

Germany
The Initiative for Excellence was launched in 2005 to improve the quality of academic research with a substantial budget. It has three dimensions:
- the creation of Research Schools for young scientists providing 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'; each selected institution should have at least one excellence cluster, one research school and an overall strategy for becoming 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 international jury. In 2008, the German Research Foundation and the Science Council presented a joint position paper on further development beyond 2011, assessing the interim results positively and arguing for continuation along the existing lines with increased funding.

1.3. How well do European public research institutions perform?

To answer the question of how far European research institutions achieve worldwide excellence, some groundwork is required on the quantity and quality of public research institutions. As demonstrated in chapter 1.1., a range of public research-performing organisations have a mission to perform basic or applied research. Also, higher education institutions like universities are charged with a mission to perform research *and* teaching. However, PROs and HEIs are charged with a 'third mission', which includes innovation. In order to assess the performance of European research institutions advancing to excellence in research, a proper assessment has to do justice to these different types of missions. However, the statistical base, and even research on these issues is lacking and current indicators do not allow a systematic comparison across countries. In particular, data or indicators on innovation are poorly developed, as are those on technical performance, patenting, and other economic performance indicators. [31]

The present section provides an overview of the current international ranking systems of research institutions. It also analyses excellence of European research institutions based on success rates in Europe-wide funding competitions, in particular the EU research Framework Programme (FP) and grants from the European Research Council (ERC).

1.3.1. Performance in major international research ranking systems

Scientific excellence is an undisputed factor of attraction of a university. Rankings and league tables of higher education institutions (HEIs) therefore mainly relate to scientific excellence. Furthermore, these systems do not measure performance of PROs. According to the International Ranking Expert Group (IREG) of the UNESCO European Centre for Higher Education (UNESCO–CEPES) in Bucharest and the Institute for Higher Education Policy in Washington, DC,[32] rankings and league tables should contribute to the definition of 'quality' in higher education institutions within a particular country, complementing the rigorous work conducted in the context of quality assessment and review performed by public and independent accrediting agencies.

Rankings of HEIs have the potential to form the framework of national accountability and quality assurance processes. Therefore, the European Commission has carried out feasibility studies to assess the European HEI landscape in view of the European Research Area (ERA) and the European Higher Education Area (EHA).

Different types of ranking systems compete worldwide. They are either output oriented or include reputation surveys

Ranking approaches with the highest attention are:

- Academic Ranking of World Class Universities (ARWU) Shanghai Jiaotong University, since 2003;
- Times Higher Education World University Rankings (THE), since 2004;
- The Leiden Ranking, Centre for Science and Technology Studies (CWTS), Leiden University, since 2008;
- Webometrics, since 2008, Consejo Superior de Investigación Científica (CSIC) in Spain.

The most cited ranking systems in Europe are the ARWU Shanghai Jiao Tong Academic Ranking of World Universities (Shanghai) and the Times World University Ranking (THE). Both rely on a combination of objective science output and subjective assessments (opinions on reputation) of universities[33].

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[31] An interesting analysis at national level is made in the Norwegian Science and Technology indicators report 2009, www.forskningsradet.no/indikatorrapporten.

[32] IREG established a set of principles of quality and good practice in HEI rankings — the Berlin Principles on Ranking of Higher Education Institutions (Berlin, 18 to 20 May, 2006) http://www.che.de/downloads/Berlin_Principles_IREG_534.pdf.

[33] Since 2010, the THE World University Ranking has changed its provider from QS to an analysis increasingly based on Thompson Reuters Web of Sciences. However, 34.5% of the weighting scheme is still based on reputational factors.

Scientific output elements are gaining increasing importance in ranking systems

The purely output oriented ranking system is based exclusively on peer reviewed international journals (the Leiden Ranking). This ranking focuses on universities worldwide with more than 700 Web of Science indexed publications per year[34]. The fourth ranking system counts web-publications and web-links measuring attractiveness (the Webometric ranking made by CSIC in Spain).[35] It covers the most recent tool of academic communication and indicates the forefront of timely distribution of information.

Fewer European universities are ranked among world top 100 in 2010 than in 2005

The table below shows that all four ranking systems confirm the dominance of the US universities in the top 10 class. Europe accounts for 20–30 % of the top 10 universities, while the rest are mainly in the United States.

Table II.1.10 Distrbution of the top 10 universities in the world according to four academic ranking systems, 2005 and 2010

Ranking	Europe		United States		Asia		Others	
	2005	2010	2005	2010	2005	2010	2005	2010
Shanghai	2	2	8	8	0	0	0	0
Times	3	3	7	7	0	0	0	0
CWTS Leiden	1 (1)	2	6 (1)	6	2 (1)	1	1 (1)	1
WEBOMETRICS	0	0	10	10	0	0	0	0

Source: DG Research and Innovation — Innovation Union Competitiveness Report 2011
Note: (1) 2003-2007.

When considering a broader sample of universities — the top 100 in the world — a more differentiated picture emerges, although the lead of US universities remains. While THE and ARWU present roughly similar results in respect of the 2010 US advantage over Europe[36] and Asia, the Leiden CWTS ranking provides a slightly more positive assessment of European and Asian universities. However, Webometrics shows a clear lead by US universities in the use of electronic publication and visibility-attractiveness on the web, indicating that, according to these criteria, the EU gap is much larger. When comparing the rankings of 2005 with those of 2010, the most striking finding is that there are fewer European universities among the top 100 in 2010. This is a clear trend in all ranking systems. The presence of top

[34] About 1 000 of the largest (in terms of number of publications) universities in the world are covered. The bibliometric analysis is based on the scientific output of many hundreds of active researchers in each of these universities.

[35] Web indicators are useful for ranking purposes insofar as they show the global performance and visibility of the universities. The Web research links covers formal (e-journals, repositories) as well as informal scholarly communication. Web indicator-based ranking reflects a broad picture of activities, as many professors and researchers support their intellectual activities with a web presence. The ranking exercises of universities reflect research intensity, the publication of research results and the value of esteem of the publication based on visibility on the Web.

[36] In the THE ranking, the United States increases from 31 to 54 over 5 years, mainly due to a change in the calculation base — a reduction of reputational factors in the 2010 survey.

European universities has fallen 6–20 % (depending on the ranking system), while more Asian universities are represented in the top 100, according to some ranking systems.

Table II.1.11 Distrbution of the top 100 universities in the world according to four academic ranking systems, 2005 and 2010

Ranking	Europe		United States		Asia		Others	
	2005	2010	2005	2010	2005	2010	2005	2010
Shanghai	35	33	57	55	8	5	0	7
Times	33	29	31	54	15	10	21	7
CWTS Leiden	33 (1)	33	42 (1)	42	14 (1)	15	11 (1)	10
WEBOMETRICS	21	16	72	70	2	3	5	11

Source: DG Research and Innovation
Note: (1) 2003-2007.

Innovation Union Competitiveness Report 2011

* The values for CWTS Leiden the 100 and the 250 largest universities worldwide for the period 2003-2007
Source: http://www.universityrankings.ch/fr/methodology/leiden
http://www.cwts.nl/ranking/world_100_yellow.html

1.3.2. Performance in Europe-wide competitive funding as a measurement of excellence

The ranking systems presented above provide worldwide ranking at institutional level. However, their main weaknesses consist in their exclusive focus on higher education institutions, and the predominance of science over technology performance. The concept of excellence in research and innovation is complex, and data availability to fully assess the 'excellence' of an institution or an individual researcher is poor. However, from a ERA point of view, an interesting hypothesis suggests that the success of research institutions in Europe-wide competition for funding would present a proxy for excellence. Such an approach could not assess worldwide performance of research institutions, but it would have the advantage of including not only Higher Education Institutions, but also public research-performing organisations as well as private research institutions. Another advantage is that both scientific and technological performance would be considered when assessing excellence.

Research institutions and research teams can compete for an increasing amount of research funding available in an open and transparent way at European level. The research Framework Programme (FP) of the European Union is, by volume, the biggest research funder in Europe. The EU research Framework Programme applies competitive procedures with independent and impartial evaluation performed by international experts. Given this profile and scope, the success rates for participation in the Framework Programme are an interesting indicator measuring the ability to participate, and the quality or even excellence of research institutions in Europe. As part of the FP funding, the grant allocation by the European Research Council may be conceived of as an assessment mechanism for scientific research excellence in Europe. The success rates in the FP vary between the various specific fields, but in general the higher the competition, the lower the success rate. On average, the success rate in FP7 is around 25 %, meaning that the FP is highly selective.[37]

However, there are arguments against the approach of measuring excellence by success rates in the FP programmes. Some arguments focus on the population and the incentives. These

[37] The commonly accepted success rate of funding programmes is on average 30-33%.

arguments state that despite the economic incentives offered by the EU Framework Programme, the administrative burden for the application and execution phase may discourage many good research teams. Another argument is that research institutions active in a country with large amount of public research grant funding available (often larger countries) have a lower incentive to invest in the higher risk of an application at the EU level. Other arguments would point at the conditions for success. These arguments see high probability of success in the EU Framework Programme as less based on scientific or technological excellence, than on size and capital (as the risk of failure has to be overcome), or in the capacity to accumulate knowledge in application procedures and its networking ability. These arguments do not discard the interest in a ranking based on success in open Europe-wide competition, but they do call for a certain analytical precaution and warn against overly comprehensive interpretations. In order to assess the FP ranking approach, this section starts with an analysis comparing the success rates of research institutions in the Framework Programme with the existing world ranking of research performance of European universities.

There is a certain - but not absolutely clear - correlation between research universities with high scientific output rankings and top participants in FP7

The analysis of top research universities in Europe according to participation rate in the Framework Programme, reveals that the 171 universities identified by the methodology of peer-reviewed journals[38] have also participated intensively in the FP7. The data also show that these universities have taken part in the lion's share of the FP7 funding (60% of all the funds to HEIs). The 171 research universities provide most of the participants in collaborative projects (58% of the HEI participants), and they are also central actors in the resulting networks. Their high success rate in FP6 instruments, such as Networks of Excellence (NOE) and Integrated Projects (IP) indicate that they are key players in structuring and coordinating the European Research Area. Moreover, research output and research visibility are the key determinants for the top research universities, and this was an important motivating factor in participation in FP6.[39] A comparison between high output of academic production and the success of universities in projects in FP7, also shows a clear positive relation. The figure below compares the output-based Leiden ranking and the success in grants for FP7 research projects. Strong deviations in the list of the twenty first ranked universities are only given by four universities (Rotterdam, Lausanne, Basel and Munich).

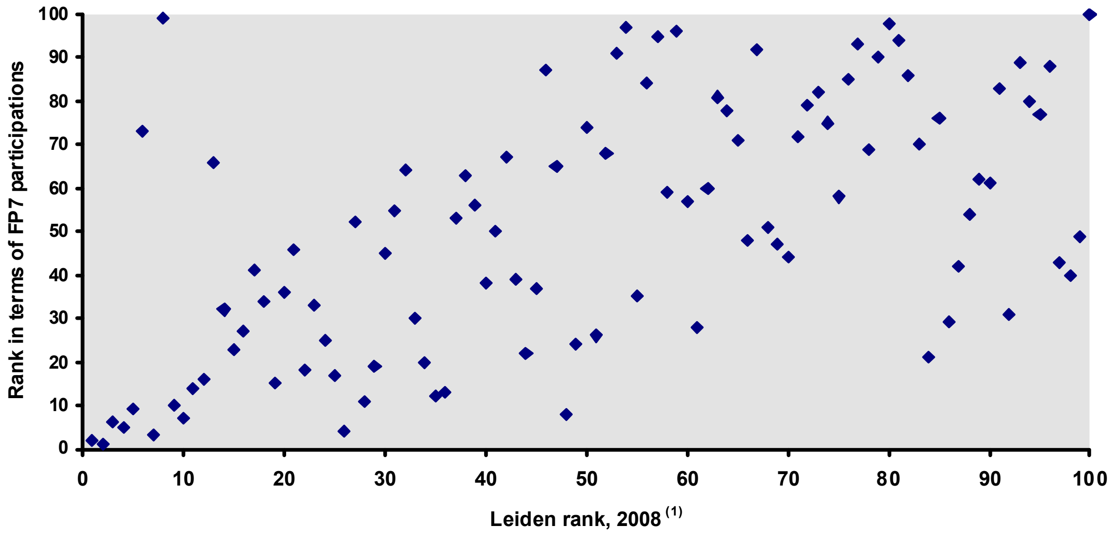
The figure below, relating the top 100 European universities in the Leiden ranking to the number of participation in the FP7, show a positive correlation, although many universities have a different pattern. However, focusing on the FP7 funding, the correlation is even clearer. The amount of EC contributions from FP7 shows a high correlation (correlation coefficient of 0.67) between the two rankings, in particular for the top 30 universities. Among the 100 top universities in the Leiden ranking, the first ranked universities are also those that have received the largest EC contributions from FP7. However, it must be noted that the FP success rate in terms of participation or received EC financial contributions is size-dependent, unlike the Leiden ranking. If a Leiden high-ranked university is relatively modest in size, it is less likely to rank as high in terms of participation or received FP funding. Vice-versa, a very

[38] See section 1.1.2. of this chapter.

[39] Henriques, L., Schoen, A., Pontikakis, D, 2009, "Europe's top research universities in FP6: scope and drivers of participation", *JRC Technical Notes 24006* http://ftp.jrc.es/EURdoc/JRC53681_TN.pdf Additional evidence on FP6 are found in Henriques, L. and Veltri, G.: "University participation in EU Framework Programme: centrality and excellence", December 2010, Seville, Draft.

large lower-ranked university in the Leiden ranking might have a higher FP rank due to advantages associated with size.

Figure II.1.10 The top 100 universities in terms of FP7 participations (ranked) versus their 2008 Leiden rankings (1)



Source: DG Research and Innovation — Innovation Union Competitiveness Report 2011
Data: DG Research and Innovation
Note: (1) The 2008 Leiden ranking by size-independent, field-normalized average impact.

A comparison of the four different ranking approaches[40] gives the following picture for European universities:
- The rank deviations stay in reasonable variations for the majority of universities, with exceptions that could be explained by structural factors.
- Subjective assessments based on surveys for reputation of universities have a stronger bias on rankings in relation to the FP ranking than those ranking systems based on output indicators.

International competitive performance in FP7 displays the top 100 European research universities

The table below on *FP7 'participation and university ranking'* displays the hundred best performing universities in Europe in FP7. The table also compares results of FP7 rankings with three other ranking systems: the Leiden Ranking (CWRS), the Webometrics ranking and the Times Higher Education ranking (THE). The highest number of universities among the top 100 universities in the FP is situated in Germany (26), the United Kingdom (17) and the Netherlands (10). These three countries cover more than half of the ranks; 13 Member States are not represented at all under the first 100. The first 50 ranks are also taken by the same three countries. However, in the first fifty ranks, the United Kingdom leads clearly (14),

[40] The 'Shanghai (ARWU) ranking' allows comparisons only for the first 50 ranks as the following ones are grouped to ranking classes.

followed by the Netherlands (7) with Germany in third place (5). Compared to the size of the country, Belgium (4), Switzerland (4), Sweden (4) and Denmark (3) are doing extremely well.

Table II.1.12 FP7 participation and university ranking

FP7 participation rank	University	Country	Leiden rank 2008	Deviation	Webometrics rank (1) 2010	Deviation	THE rank 2008	Deviation
1	UNIV CAMBRIDGE	UK	2	-1	1	0	1	0
2	UNIV OXFORD	UK	1	1	3	-1	4	-2
3	IMPERIAL COLL LONDON	UK	7	-4	83	-80	3	0
4	KATHOLIEKE UNIV LEUVEN	BE	26	-22	44	-40	21	-17
5	ETH ZURICH	CH	4	1	2	3	6	-1
6	ECOLE POLYTECN FEDERALE LAUSANNE	CH	3	3	10	-4	12	-6
7	UNIV COLL LONDON	UK	10	-3	8	-1	2	5
8	UNIV MANCHESTER	UK	48	-40	100 (273)	-92	8	0
9	TECH UNIV DENMARK	DK	5	4	(280)		64	-55
10	UNIV EDINBURGH	UK	9	1	4	6	5	5
11	KAROLINSKA INST STOCKHOLM	SE	28	-17	(495)		Not listed	-
12	KOBENHAVNS UNIV	DK	35	-23	49	-37	15	-3
13	LUNDS UNIV	SE	36	-23	57	-44	23	-10
14	DELFT UNIV TECHNOL	NL	11	3	48	-34	31	-17
15	UNIV UTRECHT	NL	19	-4	15	0	25	-10
16	UNIV HELSINKI	FI	12	4	6	10	42	-26
17	UNIV SOUTHAMPTON	UK	25	-8	12	5	37	-20
18	UNIV SHEFFIELD	UK	22	-4	80	-62	30	-12
19	WAGENINGEN UNIV	NL	29	-10	(284)		61	-42
20	UNIV NOTTINGHAM	UK	34	-14	(304)		34	-14
21	UNIV BOLOGNA	IT	84	-63	13	8	72	-51
22	UPPSALA UNIV	SE	44	-22	28	-6	28	-6
23	VRIJE UNIV AMSTERDAM	NL	15	8	(287)		67	-44
24	UNIV GENT	BE	49	-25	(291)		54	-30
25	UNIV CATHOLIQUE LOUVAIN	BE	24	1	17	8	49	-24
26	UNIV NEWCASTLE UPON TYNE	UK	51	-25	43	-17	63	-37
27	UNIV ZURICH	CH	16	11	(408)		35	-8
28	UNIV AACHEN (RWTH)	DE	61	-33	64	-36	76	-48
29	TECH UNIV DRESDEN	DE	86	-57	69	-40	124	-95
30	AARHUS UNIV	DK	33	-3	84	-54	20	10
31	UNIV ROMA SAPIENZA	IT	92	-61	62	-31	88	-57
32	UNIV GENEVE	CH	14	18	11	21	27	5
33	KINGS COLL UNIV LONDON	UK	23	10	(334)		7	26
34	UNIV AMSTERDAM	NL	18	16	23	11	14	20
35	UNIV LIBRE BRUXELLES	BE	55	-20	47	-12	80	-45
36	UNIV BRISTOL	UK	20	16	65	-29	10	26
37	LMU UNIV MUNCHEN	DE	45	-8	18	19	38	-1
38	RADBOUD UNIV NIJMEGEN	NL	40	-2	(478)		98	-60
39	UNIV LEEDS	UK	43	-4	40	-1	39	0
40	NATL & KAPODISTRIAN UNIV ATHENS	EL	98	-58	(481)		178	-138
41	TECH UNIV MUNCHEN	DE	17	24	59	-18	16	25
42	UNIV PADOVA	IT	87	-45	89	-47	137	-95
43	ARISTOTLE UNIV THESSALONIKI	EL	97	-54	(371)		200	-157
44	UNIV BARCELONA	ES	70	-26	67	-23	71	-27
45	UNIV GRONINGEN	NL	30	15	27	18	56	-11
46	UNIV GLASGOW	UK	21	25	30	16	29	17
47	EK UNIV TUBINGEN	DE	69	-22	66	-19	60	-13
48	POLYTECHNIC UNIV MILANO	IT	66	-18	(284)		126	-78
49	CHARLES UNIV PRAGUE	CZ	99	-50	26	23	101	-52
50	GOTEBORG UNIV	SE	41	9	88	-38	78	-28
51	UNIV AUTONOMA BARCELONA	ES	68	-17	95	-44	92	-41
52	LEIDEN UNIV	NL	27	25	(313)		19	33
53	UNIV BIRMINGHAM	UK	37	16	91	-38	22	31
54	UNIV FIRENZE	IT	88	-34	90	-36	169	-115
55	UNIV MAASTRICHT	NL	31	24	(688)		45	10
56	UNIV OSLO	NO	39	17	5	51	40	16
57	UNIV LIVERPOOL	UK	60	-3	(415)		55	2
58	UNIV WIEN	AT	75	-17	9	49	52	6
59	UNIV PARIS VI P&M CURIE	FR	58	1	14	45	46	13
60	UNIV WALES CARDIFF	UK	62	-2	(424)		53	7
61	UNIV NAPOLI FEDERICO II	IT	90	-29	(374)		Not listed	-
62	UNIV PISA	IT	89	-27	39	23	143	-81
63	UNIV HEIDELBERG	DE	38	25	19	44	17	46
64	JOH WOLFG GOETHE UNIV FRANKFORT	DE	32	32	78	-14	103	-39
65	UNIV BERN	CH	47	18	97	-32	82	-17

Annotations: The figures in brackets for Webometrics display the world rank. The European listing stops with the first hundred which is in the world list rank (273). In total, Webometrics ranks 12 000 Higher Education Institutions

Non-university public research organisations are performing slightly better than the HEIs in FP6

Success rates in Europe-wide competitive funding (as measured by participation in the European research FP programme) constitute a comparative measuring stick of research performance assessment of the two types of public research institutions in Europe (HEI and PRO). The shares of the two types of institutions reveal a stronger role for PROs in FP6 in comparison to their national weight - such as share of national budgets received.

The reasons for the higher success rate of PROs may be that the FP is more strongly oriented towards applied research and technology development than to basic research, which may favour higher participation rates of PROs than universities. Another possible reason may be that PROs have better administrative capabilities to participate in competition, because they rely to a higher extent on competitive funding than HEIs. PROs are also comparatively well organised in international associations like EARTO, EuroHORCs, ESF, ALLEA or EASAC[41], although European network organisations also exist among universities. However, the higher success rates of PROs in Europe-wide competitive funding could simply be an indication of the very high performance quality of many PROs in Europe.

Table II.1.13 Participation of Public Research performing Organizations (PROs) and Higher Education Institutions (HEIs) in FP6

	Paticipations			Budget		
	Total	% of FP6	% of PROs+HEIs	Total	% of FP6	% of PROs+HEIs
PROs (all countries)	22510	30,4	45,6	5093455968	30,6	44,8
HEIs (all countries)	26826	36,2	54,4	6264618165	37,6	55,2
Total PROs + HEIs	49336	66,5	100	11358074133	68,2	100
Total FP6	74137	-	-	16665265137	-	-

Source: DG Research and Innovation　　Innovation Union Competitiveness Report 2011
Data: DG Research and Innovation

1.3.3. ERC and academic excellence

The European Research Council (ERC) is striving for scientific excellence in Europe and worldwide. It is an inclusive institution that seeks excellence irrespective of nationality, gender, or location. It monitors the demographics of its applicants and grantees to optimise procedures for equitable treatment. An ERC grant winner and the institution that hosts them, can be considered an excellent scientific performer in Europe.

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[41] Associations include RTOs — the Research and Technology Organisations as a subcategory of PROs. The membership of these associations are quite diverse. There are several organisations bringing RTOs together: EARTO (350 RTOs), EuroHORCs (19 RTOs from 6 countries), ALLEA (3 RTOS) and TAFTIE; from this it can be concluded that over 50 % of the RTOs are not participating in any association[41]. There are 2 organisations bringing funders together: EuroHORCs (23 funders) and TAFTIE (20 funders). There are also organisations bringing universities together: e.g. UEA (800 higher education institutes) and LERU (20 research-intensive universities)[41]; There are a large number of academic societies bringing scientists together, often by thematic area; there are also associations of academies like ALLEA and EASAC — including a small number of academies that are also RTOs — which are not discipline oriented.

The success rate at the European Research Council is becoming a prime assessment mechanism for scientific research excellence in Europe for both universities and PROs

ERC grants are addressed to individual researchers. Over time, accumulated data on grant winners show the performance of individual countries, regions, and institutions. After six competitions and more than a thousand grant winners, a pattern of excellence of institutions emerges as a picture of the geographical distribution of institutions hosting ERC grantees across Europe. However, just as with the data on Framework Programme participation, the success rates in ERC are not size-independent, an important consideration in assessing the excellence of both the individual institutions and the country presence.

If we consider the 1762 grants allocated in the six calls and the research institutions that receive ten or more grants, the numbers show a concentration in 41 institutions. These institutions host 796 grantees or 45.2 %% of the total. The concentration is even higher in the first 10 institutions, which host 389 grantees or 22.1 % of the total.

In absolute terms, Research institutions in the United Kingdom, France, and Germany have received most ERC grants. However, individual grant winners at these institutions may come from other countries.

Dominantly, host institutions of grantees are universities. Out of the 41 institutions which have ten or more grantees, 28 are universities and 13 are PROs. However, the higher the rank or the more grantees received per institution, the larger the share of PROs. The CNRS (F) is the clear leader with 96 grantees. Among the first 20 institutions, universities are slightly more present than PROs (by a ratio 11:9). This picture is reversed if the grantees are counted.

Table II.1.14 Research institutions with 10 or more European Research Council (ERC) grantees

Rank	Host institution	Starting grants	Advanced grants	Total
1	National Centre for Scientific Research (CNRS)	62	34	96
2	University of Cambridge	25	22	47
3	Max Planck Society	22	22	44
4	University of Oxford	22	21	43
5	Swiss Federal Institute of Technology of Lausanne (EPFL)	19	20	39
6	Hebrew University of Jerusalem	20	13	33
7	Swiss Federal Institute of Technology (ETH Zurich)	9	23	32
8	Weizmann Institute	15	17	32
9	Imperial College	14	14	28
10	University College London	14	13	27
11	National Institute for health and medical research (INSERM)	14	10	24
12	Commission for Atomic Energy (CEA)	15	5	20
13	University of Edinburgh	10	8	18
14	University of Zurich	8	10	18
15	Catholic University of Leuven	15	2	17
16	Technion - Israel Institute of Technology	14	3	17
17	Karolinska Institute	8	8	16
18	Ludwig Maximillian University Munich	6	10	16
19	University of Helsinki	7	9	16
20	Leiden University	7	7	14
21	National Institute for Research in Computer Science and Control (INRIA)	8	6	14
22	University Amsterdam	8	6	14
23	University of Bristol	5	9	14
24	University of Vienna	6	8	14
25	Free University of Amsterdam	10	3	13
26	Radboud University Nijmegen	9	4	13
27	Utrecht University	8	5	13
28	Medical Research Council	6	6	12
29	University of Amsterdam	5	7	12
30	University of Geneva	4	8	12
31	Aarhus University	6	5	11
32	Ghent University	10	1	11
33	Lund University	5	6	11
34	Pasteur Institute	7	4	11
35	University of Heidelberg	8	3	11
36	Stockholm University	6	5	11
37	Cancer Research UK	3	7	10
38	National Research Council (CNR)	10	0	10
39	Technical University Munich	5	5	10
40	University of Copenhagen	6	4	10
41	University of Groningen	9	1	10

Source: DG Research and Innovation
Data: European Research Council (ERC)

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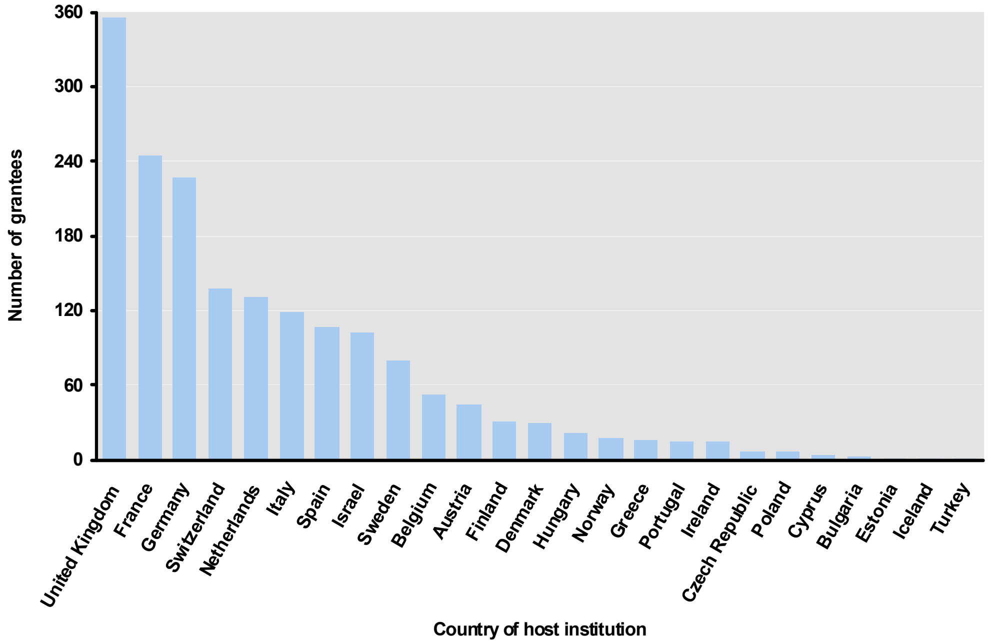
Overall, the United Kingdom is the country accounting for the most excellent research organisations concentrated in universities. France is the second country in terms of overall grants. Contrary to a tradition of concentrating research in universities in the United Kingdom, no university ranks high in France. Strong concentrations of ERC grants in France have gone to CNRS or PROs like INSERM, CEA, INRIA, and the Pasteur Institute. Other European countries showing high excellence in several of their non-university research organisations are Germany, Switzerland, the Netherlands, Italy, Spain, Israel, and Sweden.

Figure II.1.11 European Research Council (ERC) grants by host country, 2007-2010 (1)

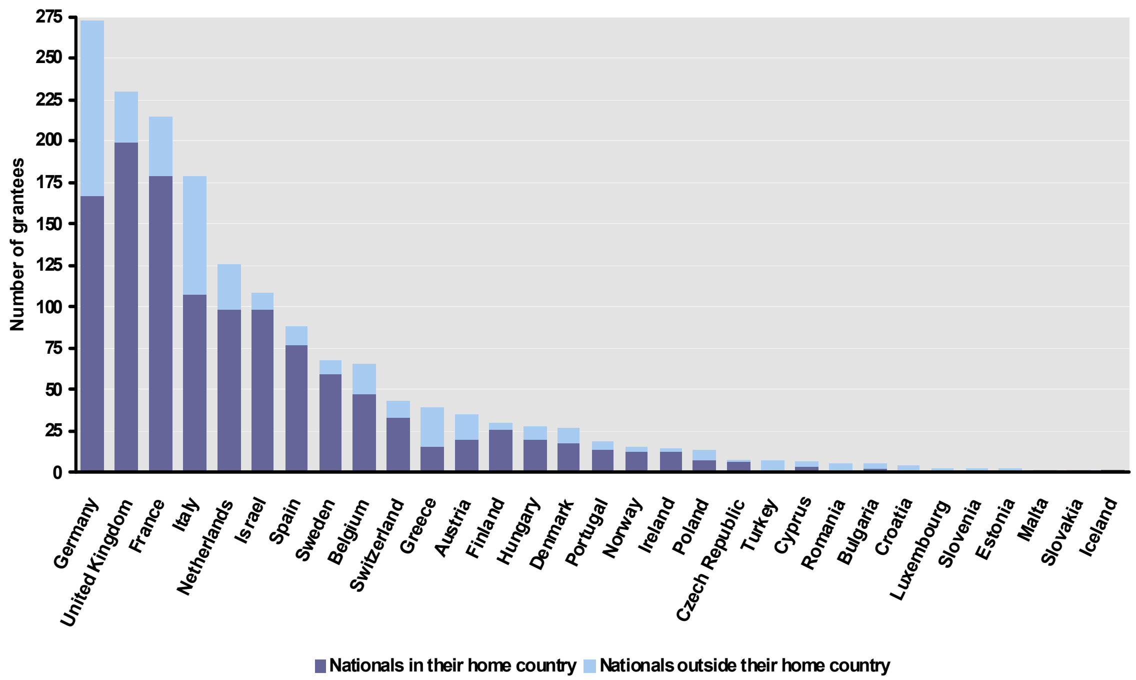


Source: DG Research and Innovation — Innovation Union Competitiveness Report 2011
Data: European Research Council (ERC)
Note: (1) Starting grants: 2007, 2009, 2010; Advanced grants: 2008, 2009, 2010.

When assessing the excellence based on individual researchers, i.e. grant winners, some countries like Germany, Italy, Greece, Austria, and Poland are better situated than when their research institutions are assessed in terms of ERC grants. A higher proportion of top researchers of these countries have chosen a host institution in another European country.[42] This may indicate a slight mismatch between the excellence of the individual researcher and the excellence of the research organisations in these countries and the importance of mobility in the European Research Area.

[42] Since this is also an aspect of transnational mobility patterns of researchers, see also Part II, chapter 5 for a more comprehensive analysis of researchers' mobility.

Figure II.1.12 Nationality of European Research Council (ERC) grantees, 2007-2010[1]



Source: DG Research and Innovation — Innovation Union Competitiveness Report 2011
Data: European Research Council (ERC)
Note: (1) Starting grants: 2007, 2009, 2010; Advanced grants: 2008, 2009, 2010.

Scientific excellence of research institutions is not equal to scientific excellence of researchers

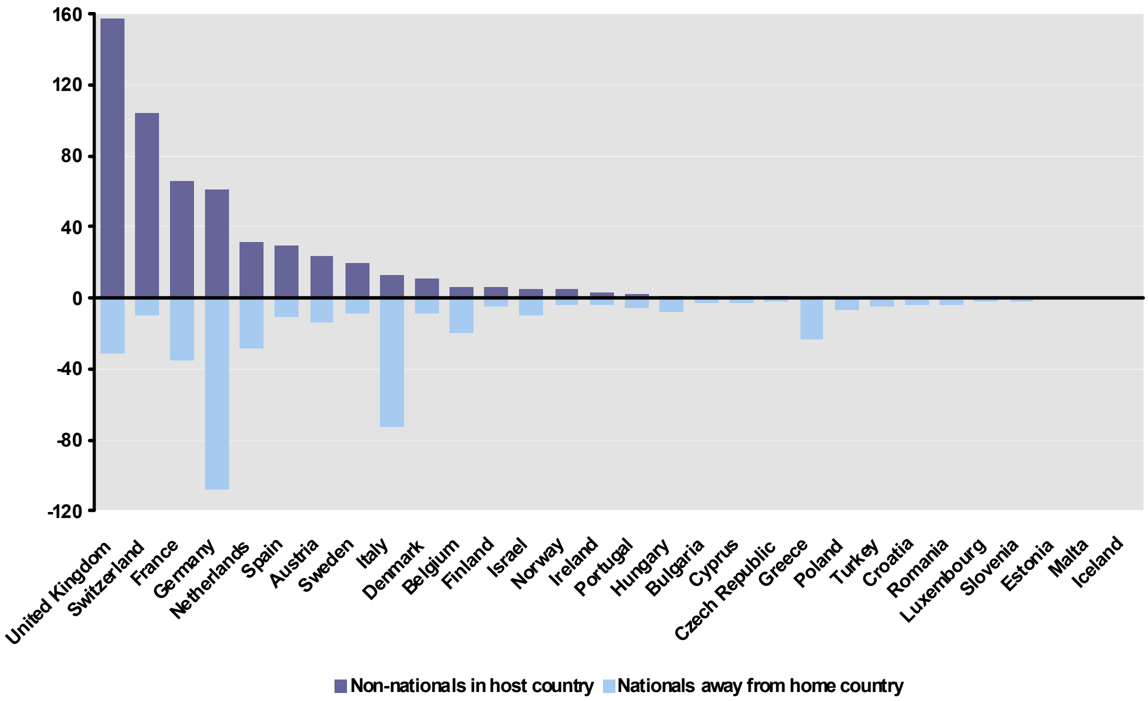
One aspect in this context is the level of research funding. The grant distribution reflects the reality of unevenly distributed national R&D investments across Europe. Regions that systematically invest strongly in their own R&D systems benefit by creating research environments that breed and attract excellent investigators. There is a strong correspondence between national investments in R&D and success in the ERC grants. The EU-12 collectively invests 2.4% of EU-27 funds in R&D and receives 4% of the ERC grants hosted by EU-27 countries. Conversely, the EU-15 collectively invests 97.6% of EU-27 funds in R&D and reaps 96% of ERC grants in EU-27 host institutions. Countries investing less in their R&D capacity are less attractive to foreign recruitment and may suffer repatriation of their nationals (e.g., Greece, Poland and Turkey all invest around 0.6% of their GDP in R&D and have large fractions of their nationals hosted in other European countries)[43].

The graph below shows the balance of non-national to national-grantees in research institutions in terms of absolute number of ERC grant holders. The balance shows that the United Kingdom harvests the largest number of grantees that have not UK citizenship, followed by Switzerland and France. On the contrary, Germany, Italy and Greece have a

[43] M. Antonoyiannakis, J. Hemmelskamp, and F. C. Kafatos: The European Research Council Takes Flight, in: Cell 136, Elsevier Inc. 2009.

strong negative balance by sending out more excellent researchers than they receive in their own institutions.

Figure II.1.13 International mobility of European Research Council (ERC) grant holders, 2007-2010 (1)



Source: DG Research and Innovation

Innovation Union Competitiveness Report 2011

Data: European Research Council (ERC)

Note: (1) Starting grants: 2007, 2009, 2010; Advanced grants: 2008, 2009, 2010.

2. Knowledge transfer and public–private cooperation

Highlights

Over the period 1995-2006, public research institutions have increased their patent applications from 834 to 2228 a year filed in EPO. However, these academic patent applications still represent only 4.1% of the total number of patent applications. Knowledge transfer policies therefore focus on enhancing public-private cooperation, cluster creation and knowledge transfer offices or platforms. In this context, knowledge transfer can take different forms: contractual arrangements, collaboration and co-development of R&D, as well as informal flows of information and movement of people between public and private institutions.

Contractual arrangements can be measured by public sector expenditure on R&D financed by business enterprises, normalised by GDP. Over the period 2000-2008, in the EU a slightly growing share of public research has been financed by business enterprises, up from 0.4% of GDP in 2000 to 0.05% in 2008. This funding level is above both the United States (0.02%) and Japan (0.015%). However, considering public-private scientific cooperation, as measured by co-publications, the EU is lagging behind the United States despite good progress in several Member States. In 2008, public-private co-authored scientific articles per million researcher was 70.2 in the United States, compared to only 36.2 in the EU. However, Sweden, Denmark and Finland had public-private co-publication rates of above 100 and Austria achieved the highest growth from a ratio of 36 in 2002to almost 66 in 2007.

One factor behind the lower public-private scientific cooperation in the EU could be that in general universities and PROs are not the main cooperation partners for innovative firms, except in Finland, Austria and Belgium. Another reason may be the lower size and intensity of researchers in the private sector in Europe, given that public-private cooperation to a large extent is made by people. A recent EU-wide study found that in 2009 only 5-6% of the researchers in the EU had moved back-and forth between public and private sector.

2.1. Is knowledge transferred in public–private cooperation?

As described in the previous chapter on public research institutions, the ‘third mission’ of higher education institutions and public research-performing organisations includes, among other aspects, an IPR management and the commercialisation of scientific and technological outputs. Given the specific structure of the European research system - with a relatively large part of R&D performed by public research institutions - the ‘third mission’ is even more relevant.

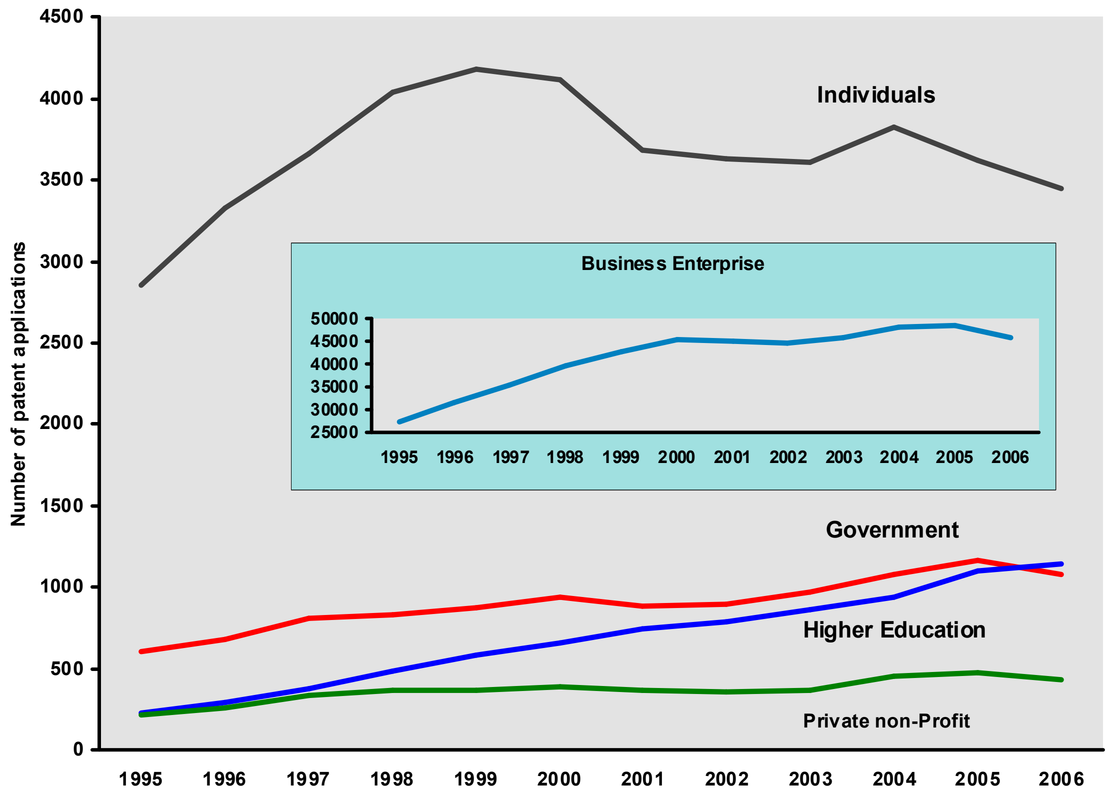
The higher education institutions, the public research-performing organisations and the private non-profit organisations have increased their number of patent applications by 9% per year in the last decade, but its overall share of patenting remains very low

Patenting is one of the most common indicators used to measure the technological output of R&D. Therefore, patent data provides one relevant way to measure if public funds are turned into technologies with potential to be commercialised. Patent statistics now offer the opportunity to collect data on the level of institutions, thereby providing more information on the 'third mission' of public research institutions.

The figure below shows that since 1995 the higher education institutions (HEIs) have increased their number of patent applications by five times, from 224 to 1150. Although patents of HEIs still represent a very small share of the total number of EPO patents, this share is growing. In 1995, HEIs patents represented less than 1% of the total EPO patent applications, compared with 2.0% for 2006. Patents applied for by PROs in the EU increased as well, passing from 610 in 1995 to 1078 in 2006, which implies that the share of patents of EU PROs in total EPO patents increased from 1.9% in 1995 to 2.1% in 2006. The graph also illustrates the role of private non-profit organisations, which, even though on a smaller scale (0.9% of total EPO patent applications in 2006), also increased their patent applications, having doubled the value they had for 1995 (passing from 216 to 437).

Individual patents represented 6.8% of EPO patent applications in 2006, government 2.1%, higher education 2.0%, and private non-profit 0.9%. However, 89.9% of patent applications to the EPO were filed by the business sector in 2006. Thus total academic patent applications (or patent application by public sector institutions) still have a very low share (4.1%) in the total number of patent applications. However, patent applications *invented* in the higher-education and government sectors are more numerous, as a number of inventions by researchers working in universities or public research institutions may then be filed by the individual himself/herself or by a company created at this occasion. Nevertheless, the share of EPO patents filed by public research organisations remains low overall.

Figure II.2.1 EU - EPO patent applications by institutional sector, 1995-2006 (1)



Source: DG Research and Innovation
Data: Eurostat
Note: (1) All values for 2006 are provisional.

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Box — Public support to technology transfer of Higher Education Institutions and of Public Research-performing Organisations[44]

Estonia

The SPINNO programme supports universities and research centres to create a favourable environment for the transfer of knowledge and the commercialisation of the results of R&D activities. This may include the creation and development of a set of administrative rules necessary to regulate business activities and intellectual property, and the development of competences, structures and networks relating to knowledge and technology transfer. Funding is also available for the commercial exploitation of ideas deriving from R&D activities and the opportunities for cooperation with business.

France

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

- 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;

44 See: ERAWATCH: national profiles — research policies http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.home.

- create a common space for training and technological services;
- 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 legal status of a TP is defined on a case-by-case basis; it often takes the form of a Public Interest Group.

Latvia

The Ministry of 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 from the private sector, and to encourage the establishment of new high technology companies.

Portugal

Since 2001 the GAPI network (Support Offices for Industrial Property Promotion) has located several small offices on university premises, 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 technology transfer function in research organisations offers backing (for up to four years) to 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.

The United Kingdom

The Knowledge Transfer Partnership (KTP) programme involves public research-performing organisations, higher education institutions, companies, graduates, and Further Education Colleges. The aim is to promote collaboration in view of building 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 collaboration for developing businesses; higher education institutions are able to apply their wealth of knowledge and expertise to important business problems; 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.

The low level of direct commercialisation of scientific output by public research institutions raises the important challenge of knowledge transfer in public–private cooperation. Knowledge transfer can take different forms: e.g. contractual arrangements where public research institutions perform R&D financed by private enterprises, collaboration between public and private R&D performers, informal flows and the circulation of researchers between public and private institutions, teaching and training in IPR management and entrepreneurial skills.

The chapter will present the existing indicators on different aspects of knowledge transfer in public–private cooperation, recognising that each indicator only describes one specific aspect of the more complex reality of public–private cooperation in R&D. However, when placing the indicators side by side, a larger understanding emerges of the Knowledge Transfer performance of different EU Member States and Associated countries.

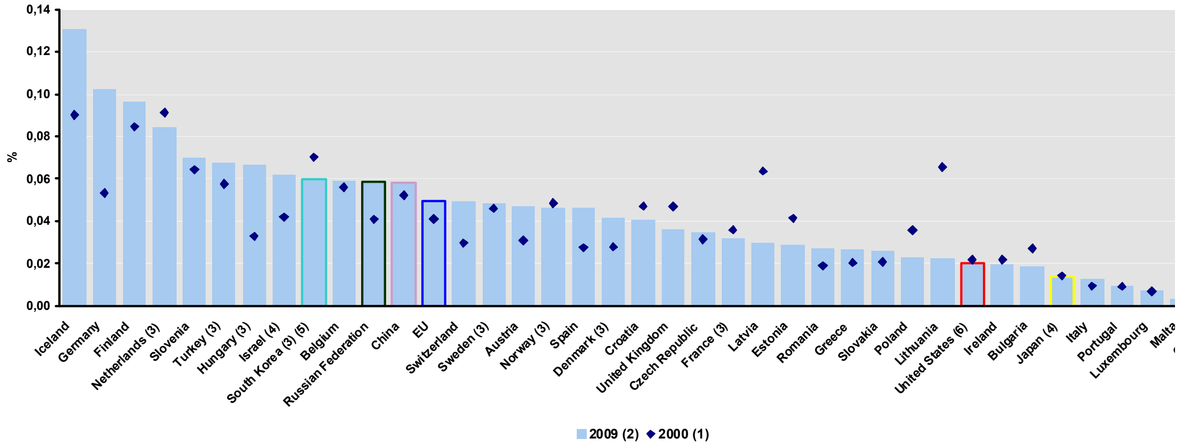
A sign of increasing knowledge transfer in public–private cooperation is the growing share of public research financed by private sector

Cooperation between public and private knowledge producers can be partly measured by the share of public sector research financed by business enterprise. Several reasons explain the motivation for the private sector to finance public research: the lack of in-house research capabilities, the interest in diversifying the scope of the firm's activities, the acquisition of external knowledge, the need to use a public research organisation (or a public university) according to rules of national funding programmes, etc. It is important to note that the use of GDP as the common denominator implies a need to refer to the size of the country as well as its economic growth. However, it is difficult to interpret this indicator, since the values also reflect the size and funding structure of public research in each country.

Business enterprise is an increasingly important source of funding for public R&D in the EU, almost 0.05 % of GDP in 2008, increasing from 2000 (0.041 % of GDP). This is higher than the same funding share in the United States (0.02 % of GDP in 2008) or Japan (0015 % of GDP in 2007), as shown in the figure below. The indicator measures contractual cooperation between public and private knowledge producers. Very different situations among the individual Member States and Associated Countries can be observed, with shares of 0.096 % for Germany and 0.089 % for Finland, the highest among the EU Member States. The intensity of contractual R&D collaboration ranges from 0.13 % of GDP in Iceland, to less than 0.005 % in Malta and Cyprus. Other countries with a very low share are Luxembourg, Portugal, Ireland and Italy, all below 0.002 % of GDP. Among the larger European countries, the intensity of Germany is around three times that of France (with 0.029 %) and the United Kingdom (with 0.036 %). While Germany has clearly increased its public–private cooperation over the period 2000–2008, France and the United Kingdom both registered a significant decrease in values for this indicator over the same period. Other countries showing a significant decrease for the period 2000–2008 are the Netherlands, Latvia, Poland, Estonia, Lithuania and Denmark.

The figure shows that China and South Korea have values slightly above the EU average, but with different trends: the former has been increasing this share, showing in 2007 a value of 0.057 % of GDP, and the latter decreased the share after 2000, reaching 0.064 % of GDP in 2007. In contrast, the United States and Japan are substantially below the EU value.

Figure II.2.2 Public sector expenditure on R&D (GOVERD + HERD) financed by business enterprise as % of GDP 2000 (1) and 2009 (2)



Source: DG Research and Innovation

Innovation Union Competitiveness I

Data: Eurostat, OECD

Notes: (1) EL, CY, SE, IS, NO: 2001; AT, HR: 2002; IT, MT: 2005.
(2) EL: 2005; BE, LU, NL, AT, NO, IL: 2007; EU, BG, DE, ES, FR, IT, CY, PT, IS, CH, US, CN, JP, KR, IL: 2008.
(3) DK, FR, HU, NL, SE, NO, TR, JP, KR: Breaks in series occur between 2000 and 2009.
(4) IL: (i) GOVERD financed by business enterprise does not include defence; (ii) HERD financed by business enterprise does not include R&D in the social sciences and humanities.
(5) KR: R&D expenditure for 2000 does not include R&D in the social sciences and humanities.
(6) US: (i) GOVERD financed by business enterprise refers to federal or central government only; (ii) HERD financed by business enterprise does not include most or all capital expennditure.

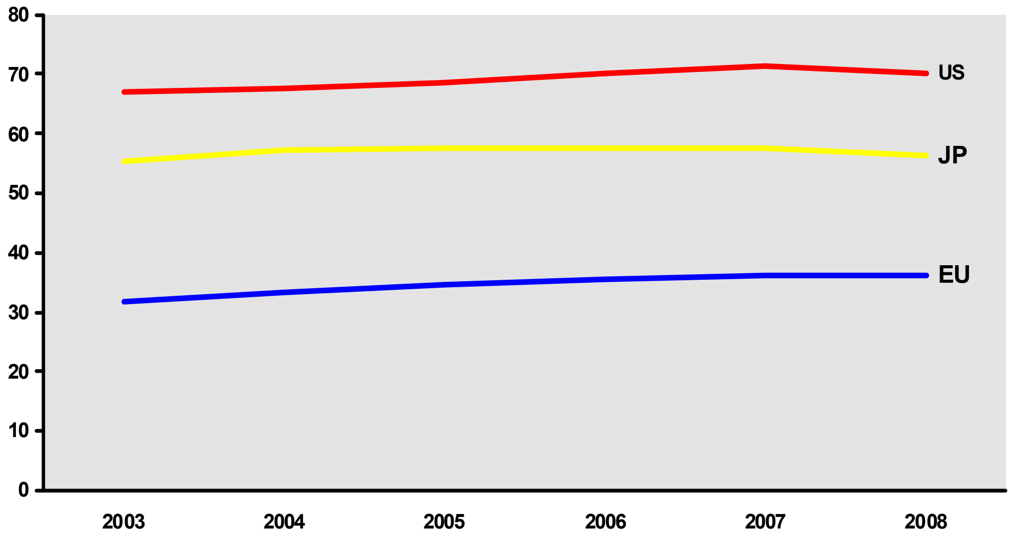
Public–private collaboration is also reflected through co-publications, where the EU is lagging behind despite good progress in several Member States

The number of public–private co-authored research publications in the Web of Science database[45] is another way of showing collaboration established between the public and the private sectors. As in Figure II.2.3 this type of partnership is more frequent in the United States than in Japan and much more so than in the EU; in this last case, the figures for the United States are more than double of those for the EU (70.2 publications versus 36.2 in 2008), even if the average annual growth registered between 2003 and 2008 is higher in Europe. Japan has remained stable over the same period, with figures between 55 and 57 publications.[46]

In the EU, the northern countries publish more strongly in public–private partnerships, with figures much higher than the EU average (see Figure II.2.4.). The Netherlands, Denmark, Finland and Sweden have reached levels of co-publications well above those for the United States and Japan. These expressive results of collaboration are also made evident through other indicators discussed in this chapter. It is, for example, the case of the choice for collaborative partners by innovative firms in Finland, and in a lesser scale, by Austria and the Netherlands. Austria has been growing strongly, putting in evidence a good performance on the link between the two sectors, and almost doubled the number of co-publications between 2002 and 2007 (from 36.1 to 65.7 co-publications).

[45] The definition of the 'private sector' excludes the private medical and health sector. Publications are assigned to the country/countries in which the business companies or other private sector organisations are located.
[46] See also Section 'Overall picture', Chapter 3.2.

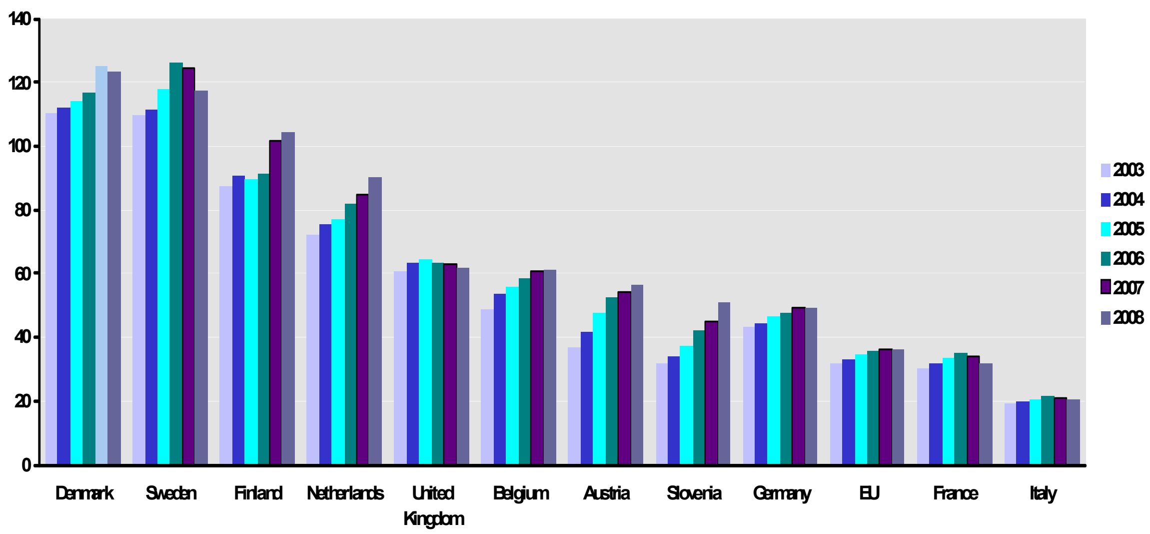
Figure II.2.3 Public-private co-publications per million population, EU, United States and Japan, 2003-2008



Source: DG Research and Innovation
Data: Innovation Union Scoreboard 2010

Innovation Union Competitiveness Report 2011

Figure II.2.4 Public-private co-publications per million population, selected Member States, 2000-2008



Source: DG Research and Innovation
Data: Innovation Union Scoreboard 2010

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Why do firms engage themselves in domestic or international collaboration? Usually the main reasons are related to the aims of 1) reducing transaction costs relative to pure market-based transactions, 2) exploring and assimilating new knowledge embedded in other firms' core competencies and 3) accessing other potential international markets. But collaboration is not without risks and failures. Innovative firms have different potential partners for collaboration within the EU, and different situations can be found when comparing countries.

BOX: Searching for the bottlenecks of public-private cooperation
The CONCORD 2010 conference, held in Seville, 3–4 March 2010, provided a forum for technical and academic discussions on the role of corporate R&D, which factors affect the relationships between corporate R&D and downstream impacts, including the collaboration of individual R&D actors with other private- and public-sector actors. Building on the papers presented at the conference, some conclusions on the Collaboration aspects were drawn:

- collaboration requires persistency over time;
- positive impact of collaboration depends on choice of partners;
- local cluster-formations to optimise collaboration evolve over time;
- support for collaboration (as FPs) has positive effect on productivity, but in a long-term perspective (5 years).

Case studies presented on strategic technology alliances and research partnerships show that when a firm envisages collaboration, it has to measure the risks and advantages of taking such initiative, one of the critical issues being the fear of knowledge leakage, even when the company needs the complementary knowledge assets. Also, when comparing domestic with international collaboration, the latter involves added degrees of uncertainty.
A good and well-established partnership for collaboration constitutes a learning experience that turns into a **repository of knowledge** (on the specific aspects of that collaboration). This can have a lock-in effect in the sense that the same actors will most probably be involved in subsequent partnerships, instead of looking for new partners and different institutional contexts. Another aspect not to be forgotten is the different motivations and perspectives of the actors involved: firms want to make profits, improve their capacity, increase their competitiveness, while universities or public research institutions give preference to the increased sharing and networking aspects (this also emerges from the analysis of the collaboration networks formed in the context of FP6, showing how industry prefers to have minor networking tasks).
From a case study on **new technology based start-ups deriving from R&D collaborations funded by EU**, over a ten year period (1994–2003), some relevant aspects on collaboration emerged: 1) FPs' (specially since FP6) played a bridging role between world knowledge sources through the collaborations created; 2) to overcome their lack of internal competencies, high-tech start-ups need to carefully select their partners through a network of alliances, bearing in mind the specialised competencies their alliance partners possess; 3) R&D alliances seem to be more fruitful if they involve industrial partners located in a variety of countries and if partners' countries are close to worldwide dispersed sources of knowledge.

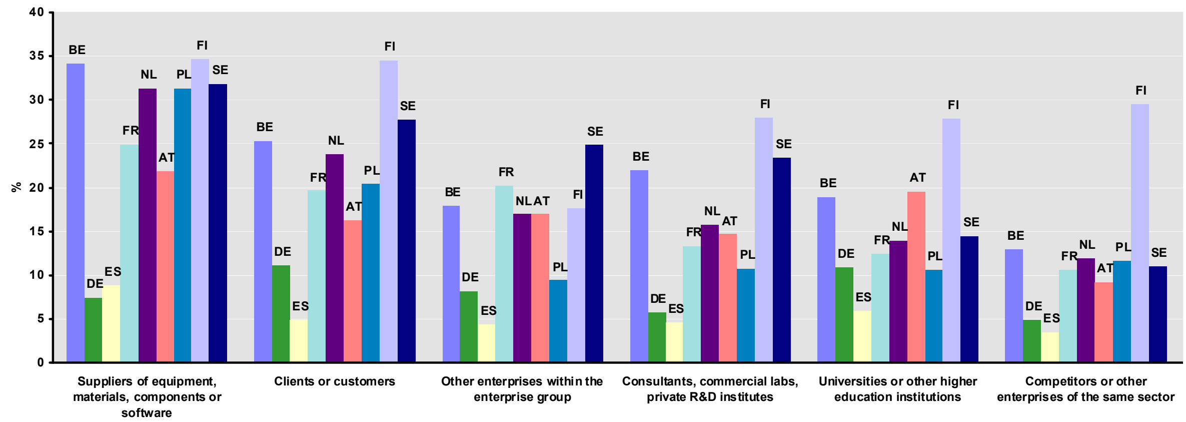
Universities and PROs are not the main cooperation partners for innovative firms. Finland, Austria and Belgium show the highest share of cooperation between public research institutions and innovative firms

The CIS (Community Innovation Survey) is a relevant tool to improve the evidence on the dynamics of knowledge transfer and to perceive the strategies enhancing the innovation performance. Some flaws related to the concept of innovation used in the survey - which reflects a wide range of activities under the same umbrella - require caution in reading and analysing the data. Another less positive aspect is that, not being a mandatory survey, for some countries the data is not available, thus reducing the scope of the analysis and benchmarking.

In general, for the period 2006–2008, suppliers of equipment, clients and customers, other enterprises within the company group, consultants and private R&D laboratories were more frequently partners of innovative companies than Higher Education Institutions or Public Research-performing Organisations (PROs), as shown in the figure below.

In Finland, 28% of the innovative firms collaborate with universities and other higher education institutions, while one in four innovative firms cooperate with PROs. Finnish innovative firms also show a high degree of external collaboration with suppliers of equipment, materials, components or software and clients or customers as is the case of Belgium, Sweden, Poland and the Netherlands; but innovative firms in Belgium use the suppliers of equipment and clients or customers as partners twice as often as higher education institutions or PROs. The Austrian innovative firms also show a relatively high level of collaboration with higher education institutions and, to a lesser degree, PROs. Polish firms use suppliers of equipment and software more frequently than the Austrian firms (31.3% against 21.9%). In Germany and Spain, innovative firms show a low degree of collaboration (only 20.7% and 18.7% respectively), including low levels of cooperation with HEIs and PROs.

Figure II.2.5 Main cooperation partners of innovative enterprises as % of innovative enterprises, 2006-2008



Source: DG Research and Innovation
Data: Eurostat

Innovation

Public–private cooperation is taking place between people

The existence of skilled personnel and human resources are key conditions for knowledge transfer. The gap in knowledge transfer is partly related to lower numbers of researchers and R&D personnel in the private sector in the EU compared to its main competitors.[47] Even though there has been an increase in the number of researchers in the private sector in the EU (from 536 785 in 2000 to 707 534 in 2008, the average annual growth rate being 3.8 %), the EU still has a lower share of business researchers (47 %) than the United States (79.6 %) and

[47] For a graphic presentation of the number (and growth) of FTE researchers in the EU, the United States, China, Japan and South Korea, see Part I, Chapter 4 as well as the initial section 'Overview picture', Chapter 2.2.

Japan (69.3 %). In general, there is a correspondence in the Member States between the shares of researchers (FTE) employed in the business sector and the shares of R&D performed by business enterprise.[48]

Researchers move mainly from public to private sector. There are low levels of circulation and mutual flows of researchers.

Alongside direct cooperation between public- and private-research performers, mutual flows of staff and researchers are at the heart of knowledge transfer. A recent study on mobility patterns and career paths of EU researchers[49] - including a survey conducted in industry - showed that there is a substantial flow of researchers from the public to the private sector, with 42 % of the respondents indicating that their career path started in the public sector and ended in the private sector. In contrast, 37 % of the industry researchers state that they have always worked in the private sector. This suggests that in many instances mobility flows are mainly oriented from the public to the private sector, with low levels of circulation and mutual flows. In fact, round-tripping between the private and the public sectors, seems to be of a lower importance. Only between 5 % and 6 % of the industry researchers have career paths that involve such round-tripping (in either direction) and less than 5 % of those interviewed have moved from the private to the public sector. The findings are equally valid for the EU-15 as for the EU-12. It is also relevant to note the substantial difference in the way individual sectors recruit industry researchers. For example, the flow of researchers in manufacturing is mainly an intra-sector flow (74 %).

Table II.2.1 Career paths of industry researchers by region of residence

Path	Respondents by region of residence			% distribution		
	EU-15	EU-12 (2)	EU-27	EU-15	EU-12 (2)	EU-27
Always private sector	723	238	961	38,2	35,1	37,4
Public to private	802	285	1087	42,4	42	42,3
Public to private and back	27	12	39	1,4	1,8	1,5
Private to public	28	8	36	1,5	1,2	1,4
Private to public and back	80	30	110	4,2	4,4	4,3
Other	189	79	268	10	11,7	10,4
Total	1891	678	2569	100	100	100

Source: DG Research and Innovation — Innovation Union Competitiveness Report 2011
Data: IDEA Consult: MORE questionnaire on industry researchers
Notes: (1) Based on question: As a summary of your career path, which one of the following career paths describes your situation best (please consider only changes of employer not research visits).
(2) EU-12: The 12 Member States that have joined the EU since 2004.

The evidence also stresses that the career paths of internationally mobile industry researchers (i.e. researchers that have at least once lived in a country other than their country of graduation) are substantially different from those of nationally located industry researchers (i.e. researchers that have always lived in the same country as their country of graduation). The former group of mobile researchers have more often moved from the public to the private

[48] See also Part I, Chapter 6.3.
[49] See the study 'More', 'Mobility Patterns and Career Paths of EU Researchers', financed by the European Commission, presented in Part I, chapter 4 and in Part II, Chapter 5.
http://ec.europa.eu/euraxess/pdf/research_policies/MORE_Industry_report_final_version.pdf.

sector than the latter group. International mobility thus seems to be closely associated with career paths from the public to the private sector.[50]

When asked about the motives for their mobility, the responses of the industry researchers express a strong parallel with the factors that motivate enterprises to locate R&D facilities in a particular region: e.g. to stay close to high quality of R&D personnel and intellectual property rights, and to benefit from quality and accessibility of research environment - like universities.

2.2. What is the current landscape of technology clusters in Europe?

Within the clusters, technology cooperation creates higher levels of efficiency, higher levels of business formation and higher levels of innovation

Knowledge transfer does not take place independently of space and geographical factors. This dimension is the basis of the development of 'clusters'. The cluster concept was first developed by M. Porter, who gave the definition of clusters (1998) in terms of spatial proximity.[51] Several other definitions can be found in literature, all involving the concentration of one or more sectors in a region, and the evidence of collaboration and networking between firms and institutions.

Clusters foster excellence through competition and cooperation between different actors, mainly when the actors share a common vision and work in partnership. Studies seem to indicate that regions with a strong, sufficiently diversified cluster have better growth conditions, are less vulnerable and more sustainable.[52] Thus Clusters have the potential to better position regions in the global competition, by valorising strengths, increasing synergies and creating new business dynamics.

- Companies can operate with a **higher level of efficiency**, drawing on more specialised assets and suppliers with **shorter reaction times**.
- Companies and research institutions can achieve **higher levels of innovation**, knowledge spill-over and close interaction with customers and other companies to create more new ideas and provide intense pressure to innovate (the cluster environment also lowers the cost of experimenting).
- The **level of new business formations** tends to be **higher** in clusters. Start-ups are more reliant on external suppliers and partners, all of which they find in a cluster (clusters also reduce the costs of failure).
- From a survey made of all EU Member States, **around half of the countries** started applying cluster policy **after 1999.**
- Almost all of the European cluster programmes have **private businesses as their target group**. The other major target group is R&D performing institutions.

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[50] *Idem.*
[51] 'Geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions (for example, universities, standards agencies, and trade associations) in particular fields that complete but also cooperate'.
[52] This data analysis has been made by the Fraunhofer Institute, financed by the European Commission, DG RTD, in the project 'Regional Key Figures', Knowledge Driven Clusters in the EU, final Report, August 2010.

Quantitative evidence on clusters in Europe has been collected since 2007 by the European Cluster Observatory[53], an online platform that aims to improve cluster mapping in Europe. The European Cluster Observatory has identified and mapped more than 2 000 clusters, in 259 regions, and classified them in 38 categories on the basis of employment data — i.e. as clusters of *economic activity* in a certain sector. One limitation of these data is that they do not directly show the innovative potential of each cluster. Therefore, a complementary approach has been developed to identify clusters based on patent data, i.e. as clusters of *inventive activity* in a certain technological field, independent of the underlying scope of economic activity. The combination of these two approaches will allow the analysis of the existing clusters in the EU, and avenues for reflection on the production versus use of technologies at regional level. However, the data on patents are based on the technological performance of regions (the number of patent applications) and do not yet distinguish patenting in individual clusters.

Identifying and measuring clusters is not a task that can be easily carried out. When measuring agglomerations delimited by industries, it is not clear *ex ante* what constitutes a cluster. We are dealing with 'value chains' of related industries. Clusters are by definition cross-sectoral and cross-technological in nature. However, there is no data available on value chains on a regional basis (or data that can be converted in a regional dimension). Nevertheless, there is comprehensive evidence-based knowledge about sectoral fields (classifiable as 3- to 4-digit NACE classes) or technological areas (classifiable by IPC classes) that can be considered related to, and thus delimiting, a certain type of cluster. It is based on such a definition that the following analysis is conducted for sectoral and technological clusters.[54]

Given the strong sector specificity of clusters, the following maps illustrate clusters in three of the key sectors for the European economy. Data on other sectors are available at the European Cluster Observatory and in the "Regional Key Figures" study. The selection made for this analysis focus on clusters linked to European competitiveness and relevant for tackling some societal challenges, as further analysed in Part III, chapter 5 of this report. Given the terms of reference for these studies, data was only collected for EU Member States, not for the Associated countries.

Major technology clusters in the IT industry are formed around large IT companies, and there is a relatively clear difference between regions that produce and regions that use these technologies

The United Kingdom, Germany and France are the three Member States with the highest concentration of large firms on IT technologies, according to the European Industrial R&D Scoreboard. Sectors such as computer software and hardware, computer services, internet and other IT services - all highly R&D research intensive - are mostly present in these three countries, gathering around a variety of small firms (the United Kingdom with more than 30 large firms, Germany and France with more than 20)[55]. Sweden, Italy, Finland and the Netherlands also count on a positive and enabler presence of large firms in these sectors.

[53] European Cluster Observatory, funded by the European Commission, is managed by the Centre for Strategy and Competitiveness (Stockholm School of Economics) http://www.clusterobservatory.eu/.

[54] See the 'Regional Key Figures', Knowledge Driven Clusters in the EU, final Report, August 2010, previously mentioned.

[55] See the 2010 EU Industrial R&D Investment Scoreboard, DG RTD /JRC IPTS http://iri.jrc.ec.europa.eu/research/docs/2010/SB2010_final_report.pdf.

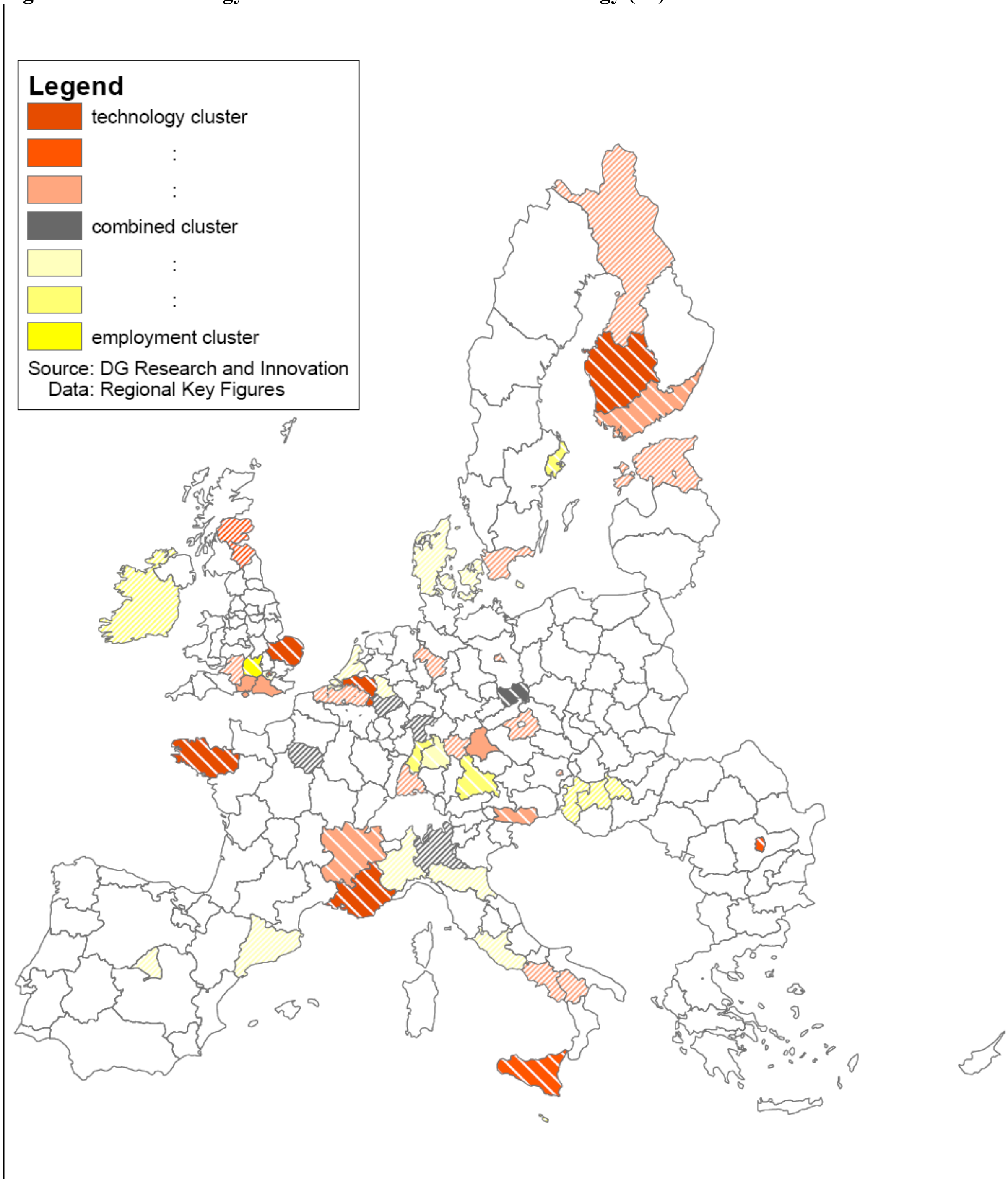
Precisely, clusters in the field of information technologies are dominated by large companies from both software and hardware industries. Examples visible in the figure below are the cluster around Nokia in Finland, the cluster in Karlsruhe region, the videogames sector in the region of Paris, or the semiconductor industry of 'Silicon Saxony', around Dresden. Both types of clusters - employment and technology - are distributed and relatively differentiated across Europe. The technology clusters are more concentrated in space. In general, clusters are more present in Central Europe, northern Italy, south-east France, the Nordic countries, the United Kingdom and Ireland. This concentration of clusters contrasts somewhat with the specialisation index in ICT (a larger category, including the Communication technologies) which is more widely spread in Europe, indicating possible growth of future clusters.[56]

A good example of a technology cluster in the field of IT is the region Provence-Alpes-Côte-d'Azur (PACA) in the south east of France. The region is widely known for its technological competences and is responsible for 40% of the manufacturing of microelectronics in France. The region hosts 41 000 employees in ICT, whereby the cluster organises 25 international groups with 13 000 employees of which 6 500 work in R&D. The region has 14 higher education institutes and is training 1 500 engineers and doctors per year. Additionally, 1 200 researchers work in public research.

One of the three Knowledge and Innovation Communities (KIC) selected in 2009 inside the European Institute of Technology (EIT), focuses on enhancing Europe's innovation capacity for the future information and communication society. The KICs are set up as very focused and European-wide clusters. The other two selected Knowledge and Innovation Communities are operational in the field of sustainable energy, and climate change mitigation.

[56] See section 'New Perspectives', Chapter 2.4. For more data on the R&D capacity in ICT, see also Part I, Chapter 5.4 and 5.5 (R&D investment and economic structure) and Part I, Chapter 6.2 (on patenting).

Figure II.2.5. Technology clusters in the Information Technology (IT) Field



Note: Based on Cluster Observatory Data; the majority of data points being from 2005;(figures may differ from claims of cluster management organisations); Categories calculated by the difference of the number of patent and the number of employment 'stars'; scaffolding indicates overall cluster strength with no scaffolding as the strongest category

Clusters in the automotive industry are widely spread across the European Union, linking large manufacturing firms with highly specialised SMEs

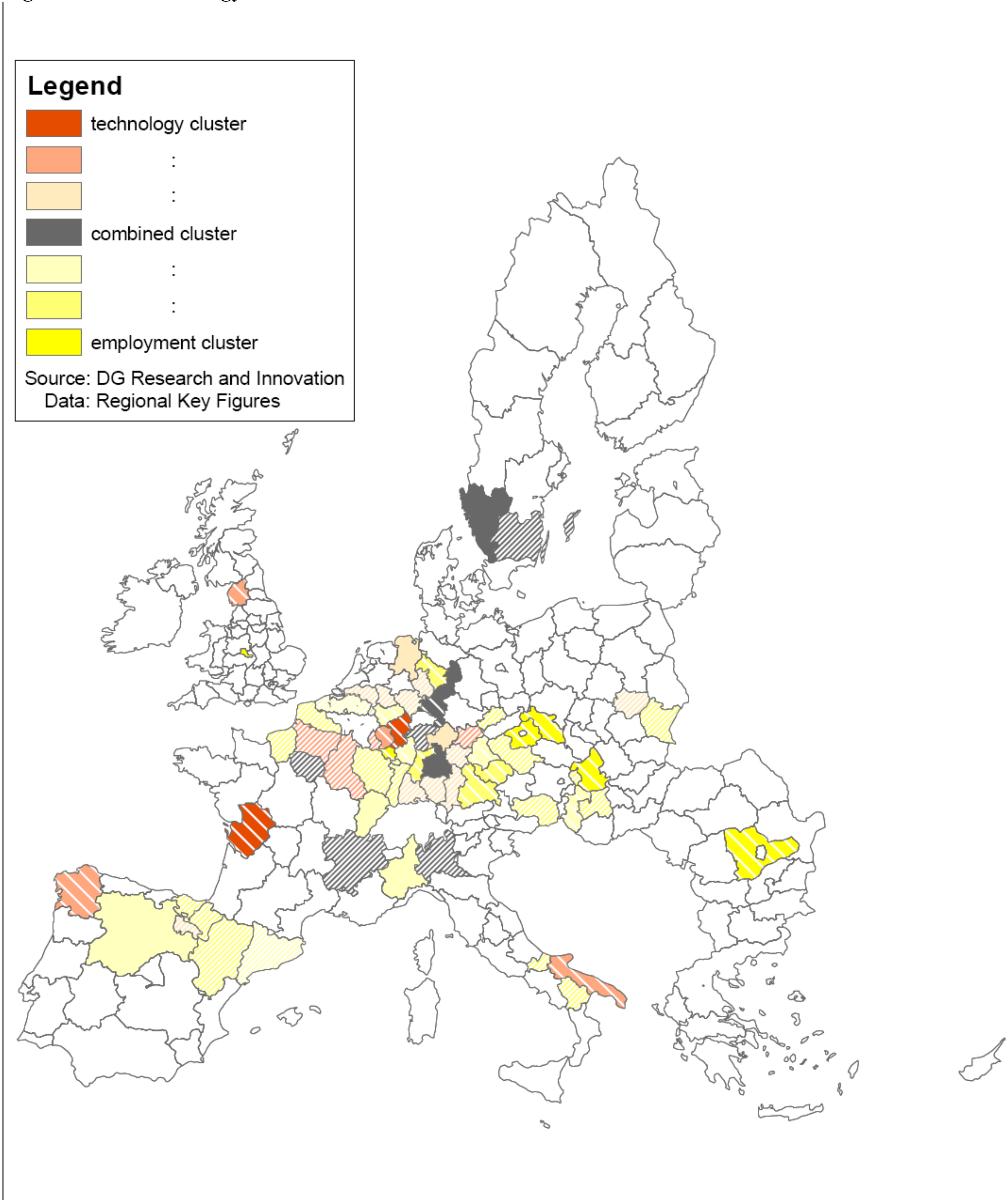
The automobile sector is important in the European economy. It is characterised by large manufacturing corporations, complemented in the value chain by a set of medium-sized companies acting as suppliers, and smaller firms usually with a high degree of specialisation. The 2010 EU R&D Investment Industrial Scoreboard (the top EU 1 000 R&D investors) identified 42 major companies active in this sector (Automobiles and Parts, according the ICB classification of sectors), with a total R&D investment of EUR 27.5 million, and a total employment of 2.1 million persons. 19 of these companies were located in Germany, 7 in France, 6 in Italy, 4 in the United Kingdom, 2 in Austria, besides companies in Sweden, Spain and the Netherlands.

The location of clusters based on employment data shows the presence of EU's largest car manufacturing firms, like Daimler, BMW and Volkswagen (Germany), Seat (Spain), Fiat (Italy), Renault (France) and Volvo (Sweden). A few clusters in other regions are also visible where suppliers are concentrated.[57]

It is interesting to compare the distribution of technology and employment cluster types in the automobile sector. A first finding is that overall clusters in the automotive industry are widely spread across the European Union, with the main sources of technology located in Western Europe and a dominance of employment clusters in the EU-12 Member States and in Spain. The comparison also highlights the fact that a country can have an employment cluster in the automotive sector without being located close to a corresponding technology cluster, as is the case for Poland and the North of Spain. In France, clusters of employment and clusters of patent application are both present but placed in different regions. However, compared to the IT and medical technology sectors, the automobile sector has a close proximity of clusters producing and using technologies (including more combined clusters).

[57] European Commission-financed project, Regional Key Figures Cluster booklet, August 2010.

Figure II.2.6. Technology clusters in the Automotive Field



Note: Based on Cluster Observatory Data; the majority of data points being from 2005; (figures may differ from claims of cluster management organisations); Categories calculated by the difference of the number of patent and the number of employment 'stars'; scaffolding indicates overall cluster strength with no scaffolding as the strongest category

Employment clusters in the field of medical technologies are mostly concentrated in Central Europe, while technology clusters are more distributed across Europe. SMEs play an important role.

Medical technology is a research-intensive sector. The United Kingdom, Germany, Italy, Ireland, France, Belgium, the Netherlands, Denmark and Sweden are the most important medical technology producers, with a special medical technology concentration for the regions of Wales, Freiburg, Upper Franconia or West Sweden. These regions display either a technology or an employment clustering effect. In France and Germany combined clusters are more frequent. This specialisation is also reflected in leadership in patents in the fields of medical technologies and related topics, in particular for Denmark, Sweden, the Netherlands and Germany.[58]

When compared with clusters in other sectors, in the case of the medical technologies the distribution is more spread out. It is also the case for the pharmaceutical companies, although they have a very marked presence in the United Kingdom, with 18 companies out of the 67 present in the 2010 R&D Industrial Scoreboard. Smaller countries, like Portugal, Luxembourg, Slovenia and Malta also account for at least one larger pharmaceutical firm in the Scoreboard. The Health Care Equipment sector (a services sector) shows a higher degree of concentration in Germany, Sweden and the United Kingdom, which constitute half of the companies present in the 2010 R&D Industrial Scoreboard.

It is worth mentioning the presence of combined clusters, technology and employment, around Switzerland, visible in the map below. Swiss Pharmaceutical and Health Care and equipment companies present in the 2010 R&D Industrial Scoreboard invested more than EUR 12 million in R&D in 2009 and employed more than 200 000 persons

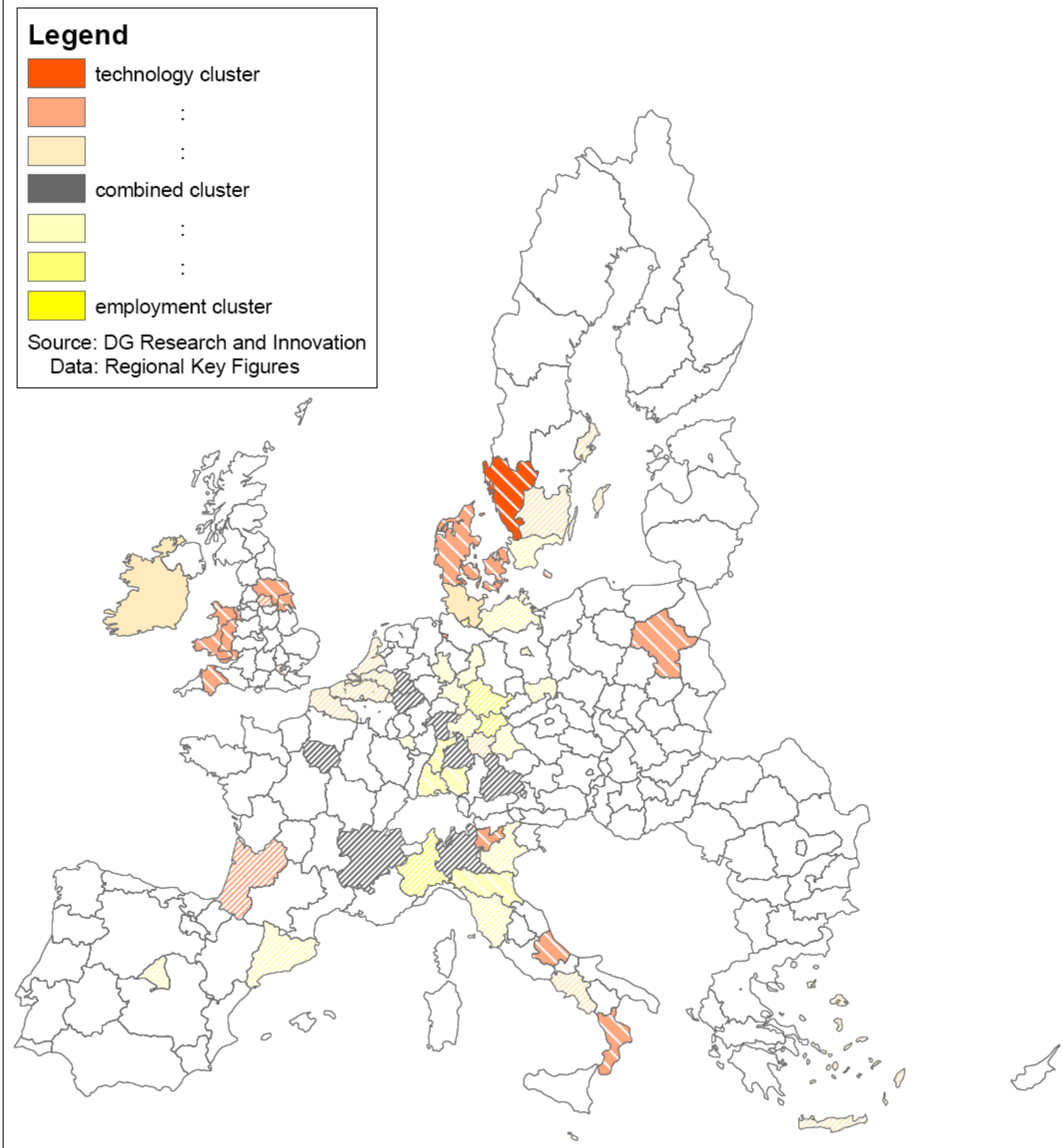
The use of medical technologies by firms is a key driver in the European market. For this aspect, it is mainly Germany and some Italian regions which show a concentration of employment clusters. The predominant firm structure in these regions is composed of SMEs, which are less R&D-intensive than larger companies, but which constitute an important source of employment. Technology clusters are more dispersed across Europe than employment clusters. In the heart of the EU the predominance is for mixed clusters.

A good example of a cluster in this field is Bioscience Wales, one of the United Kingdom's most successful bioscience clusters with a well-established reputation for scientific and academic excellence. It gathers 276 companies involved in the research, development and manufacture of medical, biotechnology and pharmaceutical products plus another 46 companies providing consultancy services to the sector. The sector registered a 19 % growth in the last three years and employs around 15 000 people.

In the last decade there has been a strong support from the Welsh Government to the sectors of bioscience, with specific programmes aimed at driving forward collaboration and research to improve the transfer of knowledge and expertise from the Welsh research base into the economy.

[58] For data on health technology patents, see also Part III, chapter 5.2 and for specialisation index in biotechnology see the section 'New Perspectives', chapter 2.4.

Figure II.2.7. Clusters in the Field of Medical Technologies



Note: based on Cluster Observatory Data; the majority of data points are from 2005; (figures may differ from claims of cluster management organisations); as well as on own calculations drawing on the EPO Worldwide Patent Statistical Database categories calculated by the difference of the number of patent and the number of employment 'stars'; scaffolding indicates overall cluster strength, with no scaffolding as the strongest category.