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Science, technology and innovation in Europe

2008 edition

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Democratic societies cannot function properly without a solid foundation of reliable and objective statistics. On the one hand, decision-makers at EU level, in Member States, in local governments and in businesses need statistics to refer to when making decisions and monitoring their impact. On the other, the public and mass media need statistics for drawing an accurate picture of contemporary society and evaluating the performance of politicians and others.
The statistics and indicators presented in this 2007 edition of “Science, Technology and Innovation in Europe” are fully in line with the strategic goals set by the European Council in Lisbon in 2000 – the “Lisbon strategy” – and Barcelona in 2002 aiming, respectively, to turn the European Union, by 2010, into the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion and, by the same date, to raise overall research investment in the EU from around 1.9% of GDP to approaching 3%, of which two thirds should be financed by the business sector.

The Lisbon and Barcelona European Councils both signalled the important role of R&D and innovation in the EU. Against this background, the 2005 initiative “Working together for growth and jobs” relaunched the Lisbon strategy. Knowledge and innovation for growth then became one of the three main areas for action in the new Lisbon partnership for growth and jobs, which put science, technology and innovation at the heart of EU policies. The concept of a European Research Area, introduced in 2000 as the contribution by research policy to the broader Lisbon strategy, has also been a highly successful tool for moving research higher up the political agenda.

In this context, relevant and meaningful indicators on science, technology and innovation are paramount for informing policy-makers about where Europe stands on the path towards more knowledge and growth. This information is also necessary to gain a better picture of how Europe is evolving, compared with the United States, Japan, China and other leading economies.

This publication demonstrates, with the aid of the relevant statistics, the progress made in recent years on research, development and innovation activities. Statistics on high-tech industries and knowledge-based services, patents and human resources in science and technology are also widely used to complete the picture.

Considering the continuously growing importance of innovation activities at the very top of the political agenda, this publication puts special emphasis on the results of the latest Community Innovation Survey (CIS) which focuses on product and process innovation, but also looks at the effects of innovation, the sources of information for innovation activities and expenditure on innovation and examines the factors hampering innovation and use of intellectual property rights.

“Science, Technology and Innovation in Europe” also gives a first insight into Eurostat’s current statistical activities in important emerging domains such as the career development of doctorate-holders or the development of new indicators in response to changing policy and user needs in the area of science, technology and innovation.

Michel GLAUDE
Director for Social Statistics and Information Society

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DISCLAIMER

The opinions expressed in this publication are those of the individual authors alone and do not necessarily reflect the position of the European Commission.

Data source

Eurostat is the data source for all tables and figures in this publication unless specified otherwise.

Maps

GISCO, Eurostat.

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Overview and executive summary

This publication presents an analysis of Science and Technology in Europe looking at the main statistical indicators in this field. It is intended for both generalists and specialists and is divided into three main parts:

- Part 1: Investing in R&D,
- Part 2: Monitoring the knowledge workers,
- Part 3: Productivity and competitiveness.

It also contains methodological notes and lists of abbreviations and symbols.

The statistics and indicators in this publication focus primarily on the 27 European Union Member States and, to a lesser extent, on the European Economic Area (EEA). This publication also looks at the EU candidate countries, whenever data are available. For the moment no data are available on the former Yugoslav Republic of Macedonia (FYROM). To allow high-level international comparison, data for China, Japan and the United States are in turn presented, where possible. There is also a regional analysis of the situation within the EU Member States. The data reflect the information available at Eurostat on 1 January 2007.

Given the numerous data sources involved, the coverage of the time series differs from one indicator to another. However, the first year taken into consideration for most indicators in this publication is 1995 (except for patents). As far as possible, this publication sets out to provide detailed and coherent time series.

Consistency with previous publications has also been maintained, adding further information in response to users' requirements. All the data presented in this Statistical book are available on Eurostat's NewCronos reference database.

1. Government Budget Appropriations or Outlays on R&D — GBAORD

Chapter 1 shows that in 2005 budget appropriations for R&D in the United States exceeded 90 billion 1995 constant PPS. In the European Union, the figure was almost 65 billion 1995 constant PPS, whereas in Japan it did not quite reach the 20 billion mark.

As a percentage of GDP, GBAORD in the EU-27, Japan and the United States stood at 0.74%, 0.71% and 1.06% respectively. Over the period 1995 to 1999, GBAORD in the United States and in the EU-15 declined in relative terms (as a percentage of GDP), compared with an increase over the same period in Japan. Between 1999 and 2005, the trends were distinctly different. GBAORD, expressed as a percentage of GDP, was stable in the EU-15, but increased slightly in Japan and even more in the United States.

Within the EU-27, in 2004 Finland had the highest government budget spending on R&D as a proportion of GDP (1.03%). At the other end of the scale, Greece, Cyprus, Slovakia, Luxembourg, Romania, Latvia and Malta showed GBAORD rates no higher than 0.3% of GDP.

Looking at the distribution of GBAORD by socio-economic objective, "Research financed from general university funds (GUF)" took the lion's share of the EU-27's GBAORD, with 31.4% of the total. In Japan too the main socio-economic objective was "Research financed from GUF", which took an even higher share (33.5%). However, in the United States over half of total GBAORD in 2005 was allocated to "Defence" (56.6%). Among the EU Member States, the distribution by socio-economic objective varies: in 2005 "Research financed from GUF" took the largest share of total GBAORD in 13 of the EU-27 Member States for which data are available. "Defence" was the leading socio-economic objective in only the United Kingdom (31.0%). "Non-oriented research" was the top objective for seven Member States: the Czech Republic (27.3%), Estonia (49.2%), Latvia (74.6%), Poland (65.1%), Romania (40.9%), Slovenia (59.7%) and Slovakia (35.9%).

At EU-27 level, budgets increased between 2000 and 2005 for every socio-economic objective except "Production and rational utilisation of energy" and "Exploration and exploitation of space". "Other civil research" and "Exploration and exploitation of the Earth" showed the highest increases.

2. R&D expenditure

Chapter 2 indicates the latest trends in R&D expenditure. In 2005 R&D expenditure as a share of GDP in the EU-27 remained stable at 1.84%. The gap with regard to R&D expenditure in Japan (3.33%) is widening, as R&D expenditure as a share of GDP is growing in Japan. However, the gap with the United States (2.62%) was narrower.

Looking at the estimates by sector, most R&D expenditure is financed by the business enterprise sector (BES). In 2003 the BES accounted for almost 64% of R&D expenditure in the EU-27, which is below the levels in the United States (69%) and Japan (76%).

In 2005 the leading EU-25 Member States in terms of R&D intensity were Sweden and Finland, with 3.86% and 3.48% of GDP going to R&D expenditure, respectively. Other EU-27 countries with R&D intensity above the EU average of

1.84% were Denmark (2.44%), Germany (2.51%), Austria (2.36%) and France (2.13%).

In 2005 the EU-27 spent EUR 201 billion on R&D, recording an annual average growth rate of 3.3% compared with 2000. Most R&D in the EU-27 is carried out in Germany (EUR 56.4 billion), France (EUR 36.4 billion) and the United Kingdom (EUR 30.0 billion). These three countries accounted for almost two thirds of total R&D expenditure in the EU-27. The highest annual average growth rates (AAGR) achieved from 2000 to 2005 were in new Member States (from the 2004 and 2007 enlargements): Malta (32.3%), Estonia (23.0%) and Cyprus (17.3%).

The top 15 regions in the EU-27 in terms of R&D expenditure as a percentage of GDP (R&D intensity) were mainly located in Germany (six regions out of the top 15). In 2003 the German region Braunschweig came first with 8.70%, which is more than four times the EU-27 average. Västsverige (SE) and Stuttgart (DE) followed with 6.03% and 4.66% respectively.

In terms of absolute R&D expenditure, the Île de France region was well ahead, with 7.7% of the total R&D expenditure in the EU-27, but as a ratio of GDP it was not in the top 15 regions (3.20%).

3. R&D personnel

As documented in Chapter 3, 1.44% of total employment in the EU-27 was in R&D in 2004, with a head count (HC) of 2.96 million. Measured in full-time equivalent (FTE), EU-27 R&D personnel totalled more than 2 million, an increase of 0.50% compared with the previous year.

At national level, Iceland led with 3.53% of total employment in R&D, ahead of Finland (3.24%), Sweden (2.51%), Denmark (2.41%) and Norway (2.27%).

In 2004, Germany and France employed two fifths of the R&D personnel in the EU-27, measured in full-time equivalent, with 473 000 and 352 000 respectively. Germany and France were ahead in every sector, often followed by Spain and Italy in third and fourth places.

In 2005, 1.28 million researchers, measured in FTE, were employed in the EU-27, an increase of 70 000 since 2003. In most of the EU-27 Member States the number of researchers increased between 2003 and 2005. Most European researchers work in Germany (271 000), France (200 000) and Spain (110 000).

Female researchers were under-represented in the EU-27 compared with males, especially in the business enterprise sector. In 2004 they made up 28.3% of all researchers and only 18.4% of researchers in the BES. The percentage of female researchers was generally higher in the new Member States (from the 2004 and 2007 enlargements) and candidate countries.

In 2004, 609 000 researchers, measured in FTE, were employed in the BES in the EU-27. The largest group of these business researchers were working in manufacturing (427 000). “Natural sciences” accounted for the highest proportion (28.5%) of researchers in higher education and the government sector.

With 6.5% of the EU-27 total, Île de France (FR) was the leading region in terms of R&D personnel (FTE). The leading region in terms of the proportion of R&D personnel in total employment in 2004 was Wien (AT) with 4.5%

4. Human resources in science and technology - HRST

Chapter 4 on human resources in science and technology shows that between 1999 and 2004 the total number of students taking tertiary education courses increased in Europe at an annual average rate of 4% for both female and male students. In 2004 more than 18 million people in the EU were following tertiary education courses, of whom more than 526 000 were PhD students. One student in four was following a course in either “science, mathematics and computing” or “engineering, manufacturing and construction” in 2004. Although in most countries more than half of all students were female, engineering and, to a lesser extent, science courses attracted fewer females. Some 54.8% of all tertiary education students in the EU were female, but only 24.0% on engineering courses and 37.5% on science courses.

Tertiary education institutions in the EU produced more than 3.5 million new graduates in 2004. Two Member States, namely the United Kingdom and France, turned out more than 30% of them. Comparing these new graduates with the young age group, for every thousand people aged between 20 and 29 years in the EU there were around 59 new graduates. There was a higher proportion of female graduates (compared with the female share of the student population). On average, 58.7% of all graduates in the EU were female in 2004. Five of the six EU countries with the highest shares of female tertiary graduates were new Member States.

The stock of human resources in S&T (HRST) is growing. Germany, the United Kingdom and France, with more than 10 million HRST each, had the largest HRST populations in 2006. These three countries combined accounted for nearly half of the EU’s 85 million HRST between 25 and 64 years old.

In terms of total employment in the same age group, employed HRST made up 36% of the total labour force in 2006. This was combined with strong growth of 3.2% over the period 2001-2006.

In 2006 the highest proportion of scientists and engineers (SE) could be found in Belgium, where 7.9% of the labour force declared that they were working in an occupation qualifying them as SE. In the majority of EU countries, scientists and engineers were predominantly male. In 2006, the gender ratio in Germany, Luxembourg and the United Kingdom was around four male scientists or engineers to one female.

Services have far more S&T workers than manufacturing. Close to half the people working in "knowledge-intensive services", which include "education", "health" and "social work", had completed tertiary S&T education in 2006.

In general, unemployment rates in 2006 were much lower for HRST than for non-HRST. The share of tertiary educated unemployed averaged a low 3% in the EU-27, while the unemployment rate for non-tertiary educated was as high as 8%.

In general, the highest regional concentrations of HRST as a share of the labour force are found in capital regions, in regions in central Europe and in the Nordic countries. At regional level, Inner London had the highest proportion of HRST in its labour force with 57.2% in 2006.

Looking at mobility of HRST, 25-34 year olds are more likely than older age groups to move from one job to another. In absolute terms, the United Kingdom and France recorded the highest job-to-job mobility amongst HRST aged 25-34, with a total of more than 830 000 people changing job during 2006. In relative terms, 7.5% of the HRST aged 25-34 changed jobs in 2006, compared with only 2.5% aged 45-64. At the level of international mobility of HRST, comparing the national with the non-national labour force, 58.7% of people that had moved to Slovakia to work were HRST, whereas only 29.8% of employed Slovakians were HRST. In Greece, the share of HRST among non-nationals was much smaller than among nationals, at only 13.7% compared with 30.3%.

5. Innovation

Chapter 5 presents the results of the Fourth Community Innovation Survey (CIS 4). Roughly following the structure of the CIS questionnaire, this chapter shows the main results at EU-27 and national levels.

In 2004 close to 40% of all EU-27 enterprises were "innovative", which means active in product and/or process innovation. The proportion of innovative enterprises increased with size. There is a strong correlation between innovation activity and the size of the enterprise.

The EU-27 average tells the European trends in innovation but in some cases the results at national level may be somewhat different. German enterprises were the most numerous in the European innovation landscape, whereas Bulgarian firms were the least represented.

Intramural expenditure on R&D is greater than extramural, but acquisition of machinery, equipment and software seems essential for many countries. Various reasons, such as the price of keeping innovations secret, may prompt enterprises to do more R&D in-house rather than to outsource.

Knowledge transfer is made up of a combination of information and cooperation. The results of use of sources of information and the types of partners may be different than expected. It emerges that the links between the business enterprise sector and both the government sector and higher education are rather weak.

Innovative enterprises give priority to improving the quality of goods and services. Innovation is driven primarily by commercial considerations. Other aspects, such as the environment, are seen as collateral.

Innovation seems to be hampered first and foremost by cost factors. Knowledge and market factors play almost a secondary role.

CIS 4 also provides information on use of intellectual property rights and on marketing and organisational innovations.

CIS 4 and the previous survey (CIS 3) are not entirely comparable, owing to changes in the questionnaire, but comparison of the two brings out some interesting points.

The 2006 European Innovation Scoreboard (EIS) is largely based on CIS data. The core part of the EIS is calculation of the Summary Innovation Index (SII), which makes it possible to divide the EU-27 Member States into four groups, based on their innovation performance.

These are:

- The i*nnovation leaders* – Sweden, Switzerland, Finland, Denmark, Japan and Germany.
- The *innovation followers* – the United States, the United Kingdom, Iceland, France, the Netherlands, Belgium, Austria and Ireland.
- The *catching-up countries* – Slovenia, the Czech Republic, Lithuania, Portugal, Poland, Latvia, Greece and Bulgaria.
- The *trailing countries* – Estonia, Spain, Italy, Malta, Hungary, Croatia and Slovakia.

Cyprus and Romania have relatively low SII results, but seem to be catching up rapidly.
The innovation performance and trends observed for Luxembourg, Norway and Turkey are very different, so they do not fit into any of these groups.

6. Patents

Patents statistics are widely used to generate indicators that help to measure a country's technological output. Chapter 6 looks at the data on triadic patent families, patent applications to the European Patent Office (EPO) and patents granted by the United States Patent and Trademark Office (USPTO).

The data for 2000 show that the triadic patent families were highly concentrated: 34% of them were American, 32% Japanese and 27% from the EU-27.

In 2003 a total of 62 250 patent applications to the EPO came from EU Member States, 48 768 from the United States and 27 987 from Japan. 77 585 patents granted by the USPTO came from inventors residing in the United States, 35 013 from Japanese residents and 23 723 from European residents. These figures show that there is a home country advantage. Data on patent families are generally less biased, as the "home advantage" disappears to a certain extent.

Germany was the best performing European country in terms of patent applications in 2003, not only in absolute EPO patent applications but also in proportion to GDP and per million inhabitants.

In 2003 EU-27 inventors applied to the EPO for 10 840 high-tech patents, whereas American inventors applied for 13 845 and Japanese for 6 834.

In terms of absolute EPO applications, Germany is again well ahead, but in relation to population size Finland, Israel and Sweden were the best performers in high-tech patenting.

Turning to ICT (information and communication technology) patent applications to the EPO, US inventors led in 2003 with 16 823 applications compared with 16 010 for the EU-27 and 10 507 for Japan.

For biotechnology the United States was also in the lead (3 331 patent applications), followed by the EU-27 (2 576) and Japan (1 035).

7. High-tech industries and knowledge-based services

Chapter 7 analyses Europe's performance in high-technology and knowledge-intensive services, looking at statistics on enterprises (value added, labour productivity, etc.), venture capital investments, high-tech trade, employment and R&D personnel and expenditure.

Enterprises in high-tech industries and knowledge-intensive services

In 2003 EU-27 enterprises in all high-tech sectors generated average production value of EUR 1.9 million. With EUR 7.9 million, high-tech enterprises in Ireland generated the highest production value, followed by Finland (EUR 4.5 million) and France (EUR 3.6 million).

Venture capital investment

In 2005 venture capital investment (VCI) was highest in Sweden, Denmark and in the United Kingdom, both at the earliest stage and at the expansion and replacement stages.

High-tech trade

Comparing the four leading economies in terms of high-tech trade — the EU-27, China, Japan and the United States — the EU-27 was the top importer and exporter of high-tech products. However, it also showed the largest high-tech trade deficit.

In the case of high-tech exports, EU-27 was closely followed by the United States. While exports from the US and Japan were on the decrease, the EU-27 remained quite stable between 1999 and 2005. On the other hand, China has been growing rapidly, catching up with Japan in 2003 and overtaking it in 2004 and 2005.

Employment in high-tech industries and knowledge-intensive services

In 2005 more than 140 million people were employed in services in the EU-27, but fewer than 40 million in manufacturing. Half of the 140 million jobs in services in the EU-27 were in knowledge-intensive services (KIS) and the other half in less knowledge-intensive services (LKIS).

Of the 39 million people employed in manufacturing, 11.9 million were working in medium-high-tech manufacturing and

2.3 million in high-tech manufacturing. Of the total manufacturing and services workforce of 180 million, almost 9 million people were employed in all high-tech sectors.

In the EU-27, 30.7% of all people employed in manufacturing were female. This ratio was often higher in the new Member States (from the 2004 and 2007 enlargements). The highest ratio of female employment was in high-tech manufacturing (34.1%). In the EU-27, 53.1% of people employed in all services were female. However, the proportion of female employees was lower in high-tech knowledge-intensive services (KIS) with 33.1%.

In 2005, regions specialising in high-tech and medium-high-tech manufacturing were highly concentrated in Germany. Capital regions were strong in knowledge-intensive services (KIS) and in high-tech KIS.

R&D in high technology

For the EU-27 Member States for which data are available, more than 90% of total business R&D expenditure was on high-tech and medium-high-tech manufacturing in Germany, Hungary and in the United Kingdom. This was also the case in Russia.

In general, the proportion of researchers among R&D personnel was higher in high-tech manufacturing than in total manufacturing. Hungary had the highest proportion with 84.3% of researchers in high-tech manufacturing.

8. The 2006 EU Industrial R&D Investment Scoreboard

Chapter 8 (produced by the European Commission's Directorate-General for Research) presents the main results of the 2006 EU Industrial R&D Investment *Scoreboard*. The *Scoreboard* compares the R&D investment performance of 1 000 EU companies with 1 000 non-EU companies in 2005.

At company level, the world top 50 R&D investors included 18 companies each from the EU and the United States, 10 from Japan (two fewer than in 2004) and two each from Switzerland and Korea.

R&D investment is concentrated in just a very few sectors and sub-sectors. The first three sub-sectors (or sectors) in the EU took 47% of the total R&D investment of the top 1 000 EU companies. They were automobiles and parts (sector), pharmaceuticals (sub-sector) and telecommunications equipment (sub-sector).

But R&D investment is also highly concentrated in the EU at country level. Three countries (Germany, France and UK) account for around three quarters of both total R&D investment and sales and about 60% of the total number of companies on the EU *Scoreboard*.

PART1

Chapter 1 - Government Budget Appropriations or Outlays on R&D — GBAORD

1

1.1 Introduction

Government budget appropriations or outlays on R&D — GBAORD — are one way of measuring how much governments spend on R&D, in other words, of ascertaining what priority governments give to the public funding of R&D. The advantage of the GBAORD data is their timeliness, but there are some drawbacks, such as data sources and harmonisation, that should be taken into account when using these data.

GBAORD includes all appropriations allocated to R&D in central government or federal budgets, and therefore refers to budget provisions, not to actual expenditure. Provincial or state government data should have been included when their input is significant. Unless otherwise stated, data include both current and capital expenditure. They cover not only government-financed R&D performed in government establishments, but also government-financed R&D in the business enterprise, private non-profit and higher education sectors, as well as abroad. Data on actual R&D expenditure, which are not available in their final form until some time after the end of the budget year concerned, may well differ from the original budget provisions. This and further methodological information can be found in the 'Proposed standard practice for surveys of research and experimental development' (Frascati Manual, OECD, 2002).

The data are compiled by national authorities using figures from public budgets. As data are not obtained through surveys, they are more difficult to compile because, in most countries, national budget data have their own terminology and methodology, and therefore often do not match fully the Eurostat/OECD methodology set out in the Frascati Manual.

Government R&D appropriations or outlays on R&D are broken down by socio-economic objective on the basis of NABS — Nomenclature for the analysis and comparison of scientific programmes and budgets, Eurostat 1994.

Eurostat collects aggregated data at the national level; these are checked, processed, and compared with other data sources, such as the Main Science and Technology Indicators (MSTI) published by the OECD.

The analysis of GBAORD data in the present publication covers the period 1995 to 2005 (which is provisional). The chapter is divided into two main parts:

- Total GBAORD,
- GBAORD by socio-economic objective.

Please note that the data presented in this publication reflect data availability in Eurostat's reference database as of June 2007.

For more details on the methodologies applied, please refer to the methodological notes.

1.2 Total GBAORD

The United States is the leading economy both in absolute and in relative terms as regards GBAORD

Of the three major economies, it was the United States between 1995 and 2005 that allocated most Government Budget Appropriations or Outlays to Research and Development (GBAORD), both in absolute and in relative terms.

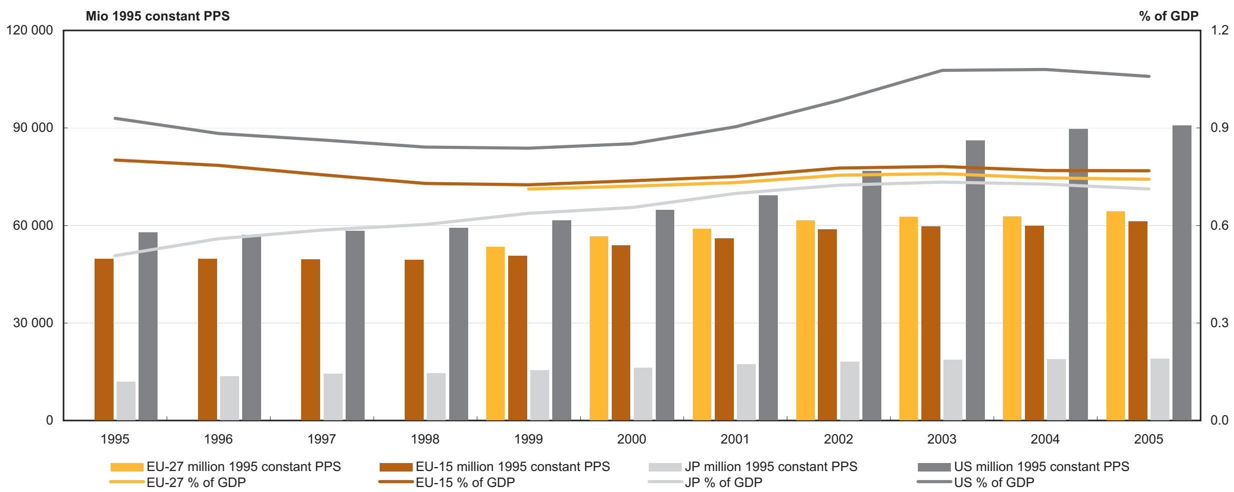
As Figure 1.1 shows, in 2005, total GBAORD from the United States amounted to some 90 billion in 1995 constant PPS. In the European Union, it exceeded 64 billion, whereas in Japan it did not quite reach the 20 billion mark.

In relative terms (as a percentage of GDP) the differences were less significant than in absolute terms, at least between Japan and other main economies. Indeed, GBAORD amounted to 0.71% of GDP in Japan, which was slightly lower than the EU-27 with 0.74%. The United States led with over 1% of GDP.

During the period 1995 to 1999, there was a decline in GBAORD in the United States and in the EU-15, expressed as a percentage of GDP, which followed similar trends. By contrast, in Japan, GBAORD increased during the same period.

Between 1999 and 2005, trends differed considerably. EU GBAORD as a percentage of GDP was relatively stable, whereas it increased slightly in Japan and more so in the United States.

Figure 1.1 **Total GBAORD in million of 1995 constant PPS and as a percentage of GDP, EU-15, EU-27, Japan and United States — 1995 to 2005**



Eurostat estimations: EU-27 and EU-15.
JP: Excluding R&D in the social sciences and humanities; 2005: provional data.
JP and US: Federal or central government only.
US: Excludes data for the R&D content of general payment to the Higher Education sector for combined education and research (public GUF) and excludes most or all capital expenditure.

1

Finland is the only Member State with GBAORD greater than 1% of GDP

Figure 1.2 shows GBAORD expressed as a percentage of GDP by country,. The main advantage of this indicator is that it does not take into account the weight of countries, thus making it easier to compare GBAORD across countries.

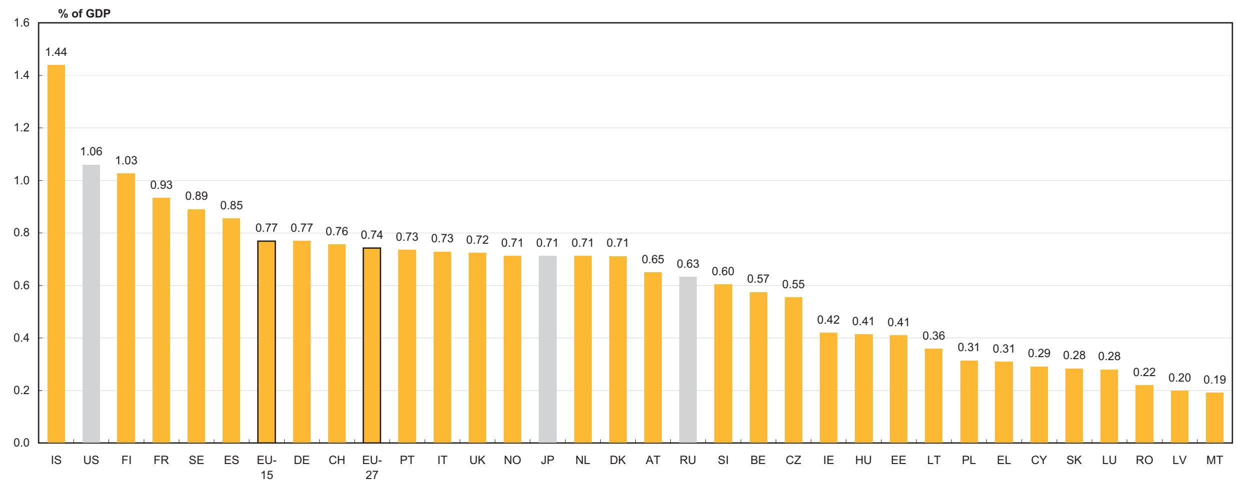
In 2005, EU-27 GBAORD was 0.74% of GDP. The EU-15 average was slightly higher at 0.77%.

However, the European averages mask large differences between countries. In fact, Iceland led in 2005, devoting 1.44% of GDP to GBAORD. In addition to Iceland and the United States, the only EU Member State with a GBAORD above 1% of GDP was Finland (1.03%). France ranked second among Member States with 0.93%, followed by Sweden (0.89%) and Spain (0.85%). Germany and Switzerland were also above the EU-27 average (0.74%), with all other countries ranking below it.

GBAORD of nine Member States was between the European average and 0.5% of GDP. This was also true of Norway, Japan and Russia.

Cyprus, Slovakia, Luxembourg, Romania, Latvia and Malta, where GBAORD did not reach 0.3% of GDP, came at the end of the scale.

Figure 1.2 **Total GBAORD as a percentage of GDP, EU-27 and selected countries — 2005**



Eurostat estimations: EU-15 and EU-27.
Provisional data: BE, CZ, IE, EL, ES, FR, HU, AT, IS and JP.
National estimations: EE and HU.
Federal or central government only: AT, JP and US.
Exceptions to the reference year: 2004: PL and CH.

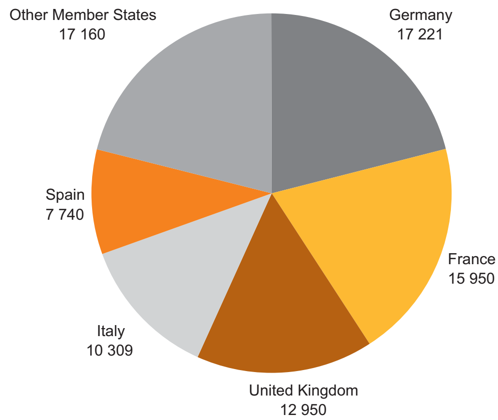
Five countries made up 80 % of total European GBAORD

Figure 1.3 shows the shares of the EU-27 total GBAORD from the five main budgeting countries. In 2005, EU-27 total GBAORD amounted to almost EUR 81 billion at current prices.

Germany allocated the highest budgets to GBAORD, with EUR 17.2 billion, followed closely by France with EUR 16 billion. The United Kingdom, Italy and Spain respectively allocated EUR 13.0, 10.3 and 7.7 billion. These five Member States made up approximately 80% of EU-27 total GBAORD.

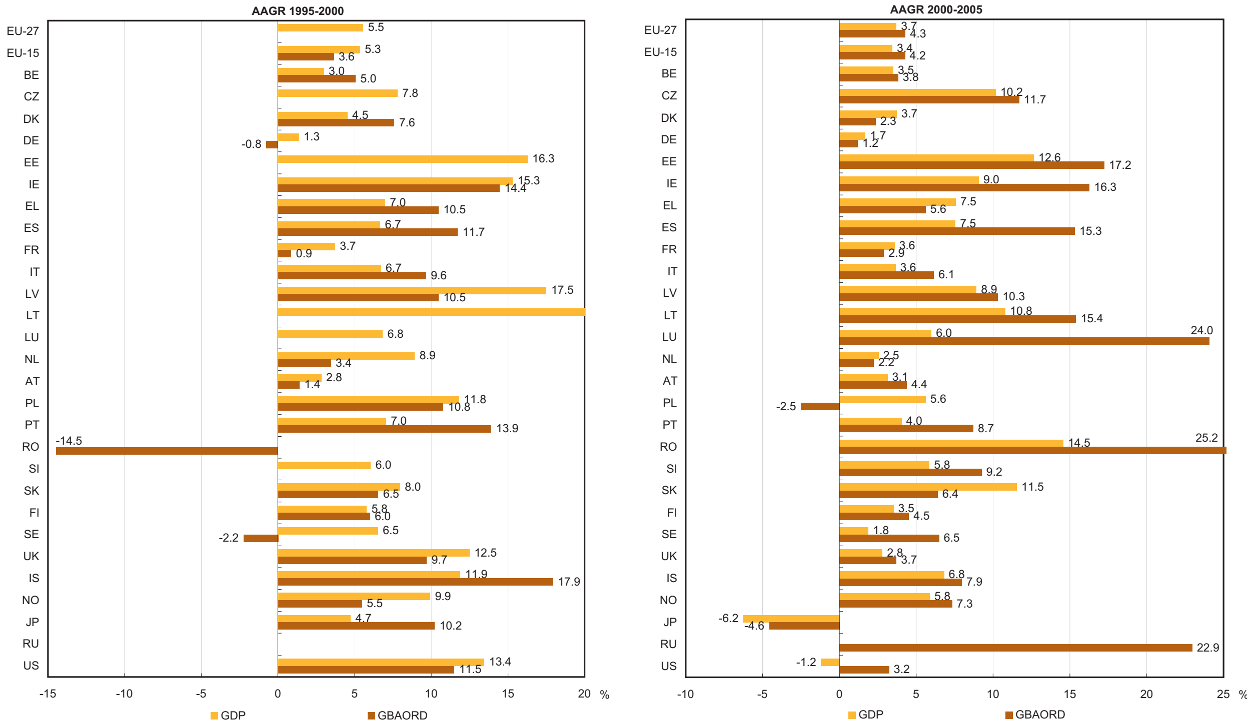
The remaining 22 Member States together granted EUR 17.2 billion. Of these, Belgium, Denmark, the Netherlands, Austria, Portugal, Finland and Sweden each allocated more than EUR 1 billion to GBAORD. This was also the case for Norway. At the other end of the scale, six Member States each allocated less than EUR 100 million to GBAORD. They were Estonia, Cyprus, Latvia, Lithuania Luxembourg and Malta (See also Table 1.5).

Figure 1.3 **Distribution of EU-27 total GBAORD, in EUR million — 2005**



Eurostat estimation: EU-27.
Provisional data: ES and FR.

Figure 1.4 **Annual average growth rate (AAGR) of GBAORD and of GDP ([1]), EU-27 and selected countries — 1995 to 2000 and 2000 to 2005**



([1]) AAGR is calculated in current EUR.
National estimations: SE (1995), EE (2000 and 2005), ES (2000).
Break in series: FI (1995) and US (2000).
Provisional data (2005): BE, CZ, IE, EL, ES, FR, HU, AT, IS and JP.
Exceptions to the reference period 2000-2005:
2002-2005: CZ;
2000-2004: PL and RU.
AT, JP and US: Federal or central government only.
US: Excludes data for the R&D content of general payment to the Higher Education sector for combined education and research (public GUF) and excludes most or all capital expenditure.
JP: Excluding R&D in the social sciences and humanities.

Figure 1.4 compares, by country, the annual average growth rates (AAGR) of total GBAORD (expressed in current prices) between 1995 and 2000 and between 2000 and 2005 with those of GDP.

In EU-15, GBAORD expressed in current terms increased at a rate of 3.6% between 1995 and 2000. However, over the same period, GDP - with a growth rate of 5.3% - rose faster than GBAORD.

In contrast, between 2000 and 2005, GBAORD in EU-15 grew at a rate of 4.2%, higher than the rate of growth in GDP (3.4%) over the same period.

The EU-27 annual average growth rates of GBAORD and GDP between 2000 and 2005 were similar to those of EU-15: at 4.3% and 3.7% respectively.

However, there were large differences across Member States. Between 1995 and 2000, three Member States saw their GBAORD decrease: Germany (-0.8%), Sweden (-2.2%) and Romania (-14.5%).

Only seven Member States, plus Iceland and Japan, saw their GBAORD grow faster than their GDP during this period. The AAGR even reached 17.9% and 14.4% in Iceland and Ireland respectively.

Between 2000 and 2005, trends differed quite markedly. In fact, GBAORD in the European Union grew faster than GDP. Moreover, GBAORD increased every country except Poland.

The countries where government support for R&D increased most noticeably between 2000 and 2005 were Romania, Luxembourg and Russia with rates of increase of 25.2%, 24.0% and 22.9% respectively.

Over the same period, GBAORD growth was lower than GDP growth only in Greece, the Netherlands, Poland and Slovakia.

The GBAORD growth rate was below the EU-27 average (3.7%) in some of the ‘older’ Member States: Belgium, Germany, France, Italy, the Netherlands, Austria, Sweden, Finland and United Kingdom.

1

1.3 GBAORD by socio-economic objectives

Almost one third of European GBAORD allocated to "Research financed from General University Funds"

Table 1.5 shows, by country, the total GBAORD in EUR million and its distribution by socio-economic objective of the NABS – Nomenclature for the analysis and comparison of scientific programmes and budgets – as a percentage of total.

As previously stated, the five main Member States in terms of GBAORD – Germany, France, the United Kingdom, Italy and Spain – accounted for approximately 80% of total EU-27 GBAORD.

"Research financed from General University Funds (GUF)" was not only the main socio-economic objective at EU-27 level; in 2005; it also accounted for the largest share of total GBAORD in the 13 Member States for which data by socio-economic objectives of the NABS are available. It was also the most important objective in Iceland, Norway, Switzerland and Japan. This socio-economic objective covers R&D related to various fields of science (FOS), such as natural sciences, engineering, medical sciences or social sciences.

"Non-oriented research" was the second most important socio-economic objective within EU-27 overall. It was also the main objective for seven Member States: Estonia (49.2%), Latvia (74.6%), Poland (65.1%), Slovenia (59.7%), Estonia (49.2%), Romania (40.9%), Slovakia (35.9%) and the Czech Republic (27.3%).

"Defence" – the third European socio-economic objective – was the leading objective only in the United Kingdom, with 31.0% of total GBAORD.

However, this objective also accounted for large shares in France, Sweden and Spain, with 22.3%, 17.4% and 16.1% respectively. Hence, the fact that "Defence" represented a substantial share of total European GBAORD (13.3%) is mainly due to the contribution made by these four countries.

Table 1.5 **Total GBAORD in EUR million and by socio-economic objectives as a % of total, EU-27 and selected countries — 2005**

	Exploration and exploitation of the earth	Infrastructure and general planning of land-use	Control and care of the environment	Protection and improvement of human health	Production, distribution and rational utilization of energy	Agricultural production and technology	Industrial production and technology	Social structures and relationships	Exploration and exploitation of space	Research financed from GUF	Non-oriented research	Other civil research	Defence	Total civil GBAORD	Total GBAORD in mio eur
EU-27	**1.7 s**	**1.7 s**	**2.7 s**	**7.4 s**	**2.7 s**	**3.5 s**	**11.0 s**	**3.1 s**	**4.9 s**	**31.4 s**	**15.1 s**	**1.6 s**	**13.3 s**	**84.6 s**	**81 328 s**
BE	0.6 p	0.7 p	2.5 p	1.7 p	2.0 p	1.3 p	30.9 p	4.1 p	8.8 p	18.5 p	25.2 p	3.2 p	0.4 p	99.6 p	1 714 p
BG	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
CZ	2.3	4.1	2.9	6.8	2.4	5.0 p	11.9 p	2.8 p	0.8 p	25.4 p	27.3 p	5.7 p	2.5 p	96.9 p	552 p
DK	0.6	0.9	1.7	7.2	1.7	5.6	6.3	6.3	2.0	45.3	20.6	1.2	0.7	99.3	1 482
DE	1.8 i	1.8 i	3.4 i	4.3 i	2.8 i	1.8 i	12.6 i	3.9 i	4.9 i	40.6 i	16.3 i	0.7 i	5.8 i	93.5 i	17 221
EE	0.3 e	8.1 e	5.4 e	4.3 e	2.2 e	13.5 e	5.8 e	6.4 e	0.0 e	0.0 e	49.2 e	4.0 e	1.0 e	94.6 e	45 e
IE	2.6 p	0.0 p	0.9 p	5.9 p	0.0 p	9.9 p	15.8 p	2.7 p	1.7 p	59.4 p	1.0 p	0.0 p	0.0 p	100	676 p
EL	3.6 p	2.9 p	4.0 p	6.9 p	2.1 p	5.5 p	9.2 p	5.7 p	2.1 p	47.6 p	9.2 p	0.7 p	0.5 p	99.5 p	558 p
ES	1.4 p	4.0 p	3.0 p	8.7 p	1.6 p	5.2 p	25.2 p	2.1 p	3.2 p	18.1 p	8.6 p	2.8 p	16.1 p	83.9 p	7 740 p
FR	0.9 p	0.6 p	2.7 p	6.1 p	4.5 p	2.3 p	6.2 p	0.4 p	9.0 p	24.8 p	17.8 p	2.3 p	22.3 p	77.7 p	15 950 p
IT	2.7	1.1	2.7	9.3	3.8	4.6	12.8	4.6	7.5	37.7	9.7	0.1	3.4	85.3	10 309
CY	1.6	1.6	0.8	10.0	0.0	20.5	0.0	8.2	0.0	31.8	25.4	0.0	0.0	100	40
LV	0.6	2.3	0.6	4.0	1.7	7.3	5.1	1.7	1.1	:	74.6	:	1.1	98.9	25
LT	2.6	1.8	6.8	12.4	3.4	17.5	6.0	20.1	:	:	:	29.3	0.2	99.8	74
LU	:	:	:	:	:	:	:	:	:	:	:	:	:	:	82
HU	2.3 p	2.0 p	10.3 p	14.6 p	11.5 p	15.0 p	21.5 p	8.9 p	2.3 p	6.4 p	4.8 p	0.3 p	0.1 p	99.9 p	367 p
MT	3.7	0.0	0.1	5.5	0.0	1.8	4.4	18.7	0.0	63.9	2.0	0.0	0.0	100	8.6
NL	0.7	4.0	1.6	3.8	3.8	5.9	9.6	2.2	3.2	48.2	10.7	4.7	1.4	98.6	3 598
AT	2.1 pi	2.2 pi	1.9 pi	4.4 pi	0.8 pi	2.5 pi	12.8 pi	3.4 pi	0.9 pi	55.0 pi	13.1 pi	0.9 pi	0.0 pi	100 pi	1 593 pi
PL	1.3	1.3	1.4	1.4	1.7	1.4	5.0	1.4	:	0.0	65.1	15.0	5.0	25.1	639
PT	1.6	4.5	3.5	7.6	0.9	9.9	15.1	3.4	0.2	38.8	10.4	3.4	0.6	99.4	1 082
RO	1.2	3.4	2.1	4.4	0.9	4.3	10.7	0.3	2.4	:	40.9	27.8	1.7	98.3	174
SI	0.4	0.8	3.1	2.0	0.5	3.2	22.6	2.7	0.0	0.0	59.7	0.2	4.9	95.1	167
SK	0.0	0.6	1.0	3.3	1.6	11.5	5.0	3.6	:	25.6	35.9 i	3.5	8.3 i	91.7	108
FI	1.0	2.0	1.8	5.9	4.8	5.9	26.1	6.1	1.8	26.1	15.2	:	3.3	96.7	1 614
SE	0.7	3.8	2.2	1.0	2.3 p	2.2 p	5.4 p	5.0 p	1.2	46.1	12.7	:	17.4	82.6	2 561
UK	2.3	1.1	1.8	14.7	0.4	3.3	1.7	3.5	2.0	21.7	16.0	0.5	31.0	69.0	12 950
IS	:	8.4 p	0.4 p	7.3 p	2.2 p	21.3 p	2.3 p	8.9 p	:	33.1 p	16.1 p	0.0	0.0	100 p	186 p
NO	1.9	2.0	2.1	7.7	3.0	8.6	8.3	6.4	2.2	38.5	12.9	:	6.5	93.0	1 694
CH	0.3 i	0.6 i	0.1 i	1.8 i	1.0 i	2.8 i	3.4 i	1.9 i	4.0 i	58.9	9.8 i	14.9 i	0.4 i	99.6	2 189
JP	1.8 i	4.2 i	0.9 i	3.9 i	17.1 i	3.3 i	7.1 i	0.7 i	6.7 i	33.5 i	15.6 i	:	5.1 i	94.9 i	26 840 i
RU	:	:	:	:	:	:	:	:	5.4	:	:	42.5	52.1	47.9	2 729
US	0.7 pi	1.5 pi	0.4 pi	22.8 pi	1.1 pi	1.9 pi	0.4 pi	1.1 pi	7.9 pi	:	5.6 pi	0.0	56.6 pi	43.4 pi	106 025 pi

Exceptions to the reference year: 2004: PL, CH and JP; 2003: RU.
Footnote 'i':
DE: Unrevised breakdown not adding to the revised total;
AT, CH, JP and US : Federal or central government only;
SK: Includes other classes;
JP: Defense is underestimated or based on underestimated data;
US: Total Excludes data for the R&D content of general payment to the Higher Education sector for combined education and research (public GUF).

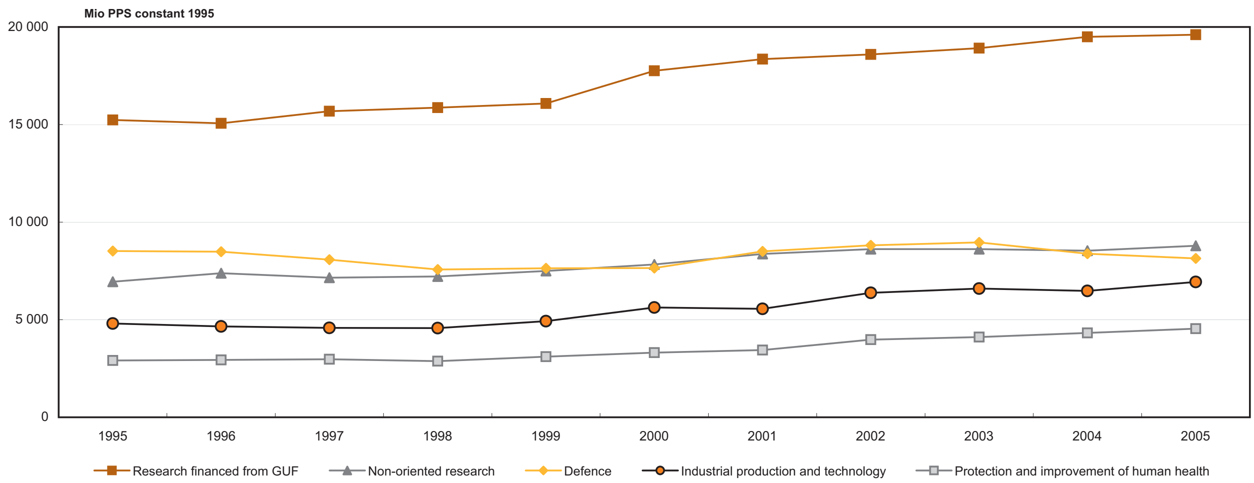
Compared to the EU-27 average (11.0%), some countries allocated the lion's share of their total government R&D budget to "Industrial production and technology". This was namely the case of Belgium (30.9%), Finland (26.1%), Spain (25.2%) and Hungary (21.5%).

More than 10% of total GBAORD went to "Agricultural production and technology" in Estonia, Cyprus, Lithuania, Hungary, Slovakia and also in Iceland. Iceland spent more than a fifth of its budget on this objective.

In Cyprus, Lithuania, Hungary and the United Kingdom, the Health R&D objective accounted for at least 10%.

The areas in which the EU-27 granted the smallest budgets in 2005 were "Other civil research", "Exploration and exploitation of the earth", "Infrastructure and general planning of land-use", "Control and care of the environment" and "Production and rational utilisation of energy".

Figure 1.6 **Main NABS socio-economic objectives in million 1995 constant PPS, EU-15 — 1995 to 2005**



Eurostat estimation: EU-15.

The importance of the "Defence" objective is being reduced in the EU

Figure 1.6 shows the trends in the five main European socio-economic objectives expressed in real terms (1995 constant PPS) between 1995 and 2005 for EU-15.

The same two sub-periods as those highlighted for the trends in total GBAORD (Figure 1.1) are also observed for the main socio-economic objectives. The first period was from 1995 to 1999, during which the main socio-economic objectives were stable or actually decreased. During the second period, from 1995 to 2005, all main socio-economic objectives – except for defence – showed an increase.

Research financed from GUF, which was the main European socio-economic objective, was also the item that witnessed the greatest increase in absolute terms. Indeed, it grew from 16 billion 1995 constant PPS in 1999 to 19 billion in 2005.

Except in 2000, the second main EU-15 socio-economic objective between 1995 and 2003 was "Defence"'. However, budgets allocated to this objective decreased after 2003, while those allocated to "non oriented research" continued to grow. In fact, non oriented research became the second European socio-economic objective in 2005.

At EU-15 level, as shown in table 1.7, budgets expressed in constant 1995 PPS increased between 2000 and 2005 for all socio-economic objectives except "Production and rational utilisation of energy" and "Exploration and exploitation of space". The latter two objectives declined, posting an AAGR of -1.2% and -0.1% respectively.

During the same period, "Other civil research" had the highest growth rate (11.3%), followed by "Exploration and exploitation of the earth" (7.8%) and "Protection and improvement of human health" (6.5%). However, these objectives were among the least important at European level (Table 1.5).

With the exception of Italy and Austria, "Research financed from GUF" - the first socio-economic objective in the European Union - grew in all countries between 2000 and 2005, even reaching an AAGR of 39.6% in Ireland.

"Defence", the third main objective at European level, showed considerable variations between among individual Member States, in terms of both trends and of volume. Indeed, it increased sharply in some countries, such as Italy, Latvia, Slovenia, Finland and Sweden, whereas it decreased in the Czech Republic, Germany, the Netherlands and Portugal. There was a similar pattern in Switzerland. At European level, this objective increased, although not by as much as total GBAORD. In other words, the relative importance of the "Defence" objective in European total GBAORD decreased between 2000 and 2005.

Government R&D budget trends for "Other civil research", which in the main increased at EU-15 level, also vary from country to country. While GBAORD allocations to this objective increased at an AAGR of approximately 90% in Spain and 70% in Austria, they decreased in Slovakia, recording a rate of -15.0% between 2000 and 2005.

Conversely, "Production and rational utilisation of energy", which decreased at EU-15 level (-1.2%), grew between 1999 and 2004 in twelve Member States, as well as in Norway, Switzerland, Japan and the United States. The highest growth rates were recorded in Lithuania and in the Czech Republic, with 45.4% and 18.4% respectively.

Table 1.7 **Annual average real growth rate (AAGR) of GBAORD by socio-economic objectives (1), EU-27 countries and selected countries — 2000 to 2005**

	Exploration and exploitation of the earth	Infrastructure and general planning of land-use	Control and care of the environment	Protection and improvement of human health	Production, distribution and rational utilization of energy	Agricultural production and technology	Industrial production and technology	Social structures and relationships	Exploration and exploitation of space	Research financed from GUF	Non-oriented research	Other civil research	Defence	Total civil GBAORD	Total GBAORD
EU-27	:	:	:	:	:	:	:	:	:	:	:	:	:	:	2.6 s
EU-15	7.8 s	5.8 s	2.6 s	6.5 s	-1.2 s	3.6 s	4.3 s	2.7 s	-0.1 s	2.0 s	2.3 s	11.3 s	1.3 s	2.8 s	2.6 s
BE	-6.3 p	-5.6 p	-3.7 p	3.3 p	-4.7 p	-13.3 p	8.1 p	0.4 p	-4.3 p	0.9 p	2.7 p	-4.5 p	4.4 p	1.8 p	1.8 p
BG	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
CZ	-1.1	11.2	-2.1	2.5	18.4	13.0 p	16.3 p	31.1 p	4.8 p	5.5 p	10.8 p	6.4 p	-0.2 p	8.6 p	8.5 p
DK	-13.2	-12.4	-8.2	1.5	-0.9	-13.0	-2.1	-9.3	-4.6	4.9	2.4	6.5	7.7	-0.1	0.0
DE	0.5 i	2.0 i	0.8 i	4.0 i	-3.5 i	-6.4 i	0.6 i	1.5 i	0.9 i	0.9 i	0.4 i	45.4 i	-5.8 i	0.4 i	0.1
EE	2.5 e	21.6 e	12.9 e	18.5 e	-7.4 e	15.9 e	2.7 e	69.6 e	-47.0 e	:	3.1 e	:	:	8.6 e	10.6 e
IE	64.0 p	-45.3 p	1.9 p	21.5 p	:	3.4 p	5.1 p	4.1 p	: p	39.6 p	-44.1 p	:	:	12.2	12.2 p
EL	2.0 p	-0.8 p	-1.8 p	-1.2 p	5.5 p	0.2 p	2.4 p	0.0 p	36.2 p	4.6 p	-1.7 p	2.0 p	6.9 p	2.5 p	2.5 p
ES	4.3 p	52.8 p	4.2 p	20.8 p	-3.5 p	15.7 p	15.9 p	23.2 p	0.7 p	4.4 p	34.2 p	91.2 p	0.5 p	13.6 p	10.7 p
FR	12.3 p	-1.8 p	10.5 p	3.8 p	-0.4 p	0.4 p	1.4 p	-15.6 p	-1.9 p	3.0 p	-2.8 p	4.5 p	1.7 p	0.7 p	0.9 p
IT	18.0	38.6	7.0	10.2	2.1	19.5	1.6	11.4	2.6	-1.6	2.5	:	38.5	0.1	3.2
CY	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
LV	-0.4	60.0	-17.9	-10.7	5.5	-2.7	-13.3	-14.3	7.4	:	41.9	:	17.5	9.7	9.8
LT	17.4	-4.7	21.4	30.2	45.4	28.7	-7.5	30.0	:	:	:	1.7	-4.7	12.3	12.2
LU	:	:	:	:	:	:	:	:	:	:	:	:	:	:	20.6
HU	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
MT	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
NL	2.7	-5.4	-15.5	9.4	0.8	9.2	-6.0	-8.1	0.5	1.2	-1.1	0.4	-5.2	-0.4	-0.5
AT	1.6 pi	11.4 pi	7.1 pi	13.5 pi	10.1 pi	0.2 pi	13.8 pi	13.6 pi	62.0 pi	-0.8 pi	2.3 pi	70.6 pi	2.5 pi	2.7 pi	2.7 pi
PL	:	:	:	:	:	:	:	:	:	:	:	:	:	:	-2.0
PT	5.4	-4.9	0.8	8.4	5.3	-0.1	8.4	5.2	-13.5	6.8	10.5	5.5	-6.9	5.5	5.4
RO	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
SI	-6.5	-5.6	23.9	13.5	-7.6	-1.5	12.0	12.5	:	:	5.0	:	126.2	5.7	6.8
SK	:	-14.6	-5.2	-7.8	0.6	-2.9	-15.2	-20.1	:	6.8	3.7 i	-15.0	:	:	-0.2
FI	-4.1	1.6	-0.8	0.4	1.1	5.4	1.6	5.8	-0.2	3.0	7.9	:	24.7	3.0	3.4
SE	-9.8	5.6	17.8	-0.1	-10.8 p	10.7 p	7.0 p	4.4 p	-12.5	4.6	10.4	:	28.0	4.5	7.0
UK	16.1	-4.3	-1.7	3.8	0.5	-0.5	3.4	0.2	1.5	5.7	9.5	10.0	0.2	5.0	3.4
IS	:	5.4 p	-2.7 p	5.2 p	-3.1 p	0.3 p	3.0 p	31.9 p	:	6.0 p	6.6 p	:	:	5.4 p	5.4 p
NO	0.1	0.7	-2.2	5.2	9.3	3.2	-3.3	1.8	2.3	3.2	12.4	:	9.1	3.3	3.7
CH	17.8 i	-1.0 i	-1.0 i	23.3 i	7.7 i	5.1 i	116.9 i	20.2 i	:	3.8	:	-12.8 i	-7.8 i	4.8	4.8
JP	6.0 i	6.9 i	5.9 i	3.7 i	2.4 i	2.5 i	4.9 i	-1.8 i	8.8 i	2.4 i	6.7 i	:	9.6 i	3.5 i	3.8 i
US	0.0 pi	0.2 pi	-1.1 pi	7.3 pi	4.6 pi	0.3 pi	-5.0 pi	12.5 pi	1.8 pi	:	3.3 pi	:	8.9 pi	4.7 pi	7.0 pi

(1) AAGR is calculated in 1995 constant PPS.
Exceptions to the reference period:
2002-2005: CZ and EE;
2000-2004: PL, CH and JP.

Footnote 'i':
DE: Unrevised breakdown not adding to the revised total;
AT, CH, JP and US : Federal or central government only;
SK: Includes other classes;
JP: Defense is underestimated or based on underestimated data;
US: Total Excludes data for the R&D content of general payment to the Higher Education sector for combined education and research (public GUF).

“Multiple Funding” — More than a Challenge for Austrian Universities

Graz University of Technology (TUG) will receive about €24 million over the next ten years from the MAGNA industrial group, to build up the 'Frank Stronach Institute (FSI).' This deal is definitely different from the usual ways of financing research in Austrian universities. Moreover, it can be labeled neither as typical contract research nor as a typical donation, therefore raising fundamental questions of science–industry cooperation in a given country. It is an altogether remarkable step on the long path to 'multiple funding', i.e., a broader finance base for the Austrian universities.

In a number of countries, including the United States and Canada, successful research universities boast a broad range of income sources, from public block funding and research grants to donations, royalties and tuition fees. In sharp contrast to this situation, the Austrian universities are nearly exclusively financed by public institutions. The major part comes from the federal government in the form of General University Funds (GUF). While overall public spending for R&D is about the OECD average (about 0.8 percent of GDP), our relative share of public university funding (more than 0.5 percent of GDP = the R&D share of GUF) is much higher than the OECD average (less than 0.4 percent). The share of private funding of university research is estimated at about only 3 percent of total university research funding and well below the OECD average. The private contributions generally do not come in the form of donations but as short and mid term contracts in which industry pays for specified and applied research work. Even in this category, Austrian universities attract less private money than average OECD counterparts. University reform in Austria as stipulated by the Universitätsgesetz (University Act) 2002 will slowly change this situation as it includes, inter alia, strong incentives for strategies, clearer research profiles, full costing and broadening of the financial base.

Source: Office of Science and Technology (Austria), 2007

Government Funding Mechanisms for Academic Research

Because U.S. universities generally do not maintain data on departmental research, U.S. totals are understated relative to the R&D effort reported for other countries. The national totals for Europe, Canada, and Japan include the research component of general university fund (GUF) block grants provided by all levels of government to the academic sector. These funds can support departmental R&D programs that are not separately budgeted. The U.S. federal government does not provide research support through a GUF equivalent, preferring instead to support specific, separately budgeted R&D projects. However, some state government funding probably does support departmental research at public universities in the United States.

Whereas GUF block grants are reported separately for Japan, Canada, and European countries, the United States does not have an equivalent GUF category. In the United States, funds to the university sector are distributed to address the objectives of the federal agencies that provide the R&D funds. Nor is GUF equivalent to basic research. The treatment of GUF is one of the major areas of difficulty in making international R&D comparisons. In many countries, governments support academic research primarily through large block grants that are used at the discretion of each individual higher education institution to cover administrative, teaching, and research costs. Only the R&D component of GUF is included in national R&D statistics, but problems arise in identifying the amount of the R&D component and the objective of the research. Government GUF support is in addition to support provided in the form of earmarked, directed, or project-specific grants and contracts (funds for which can be assigned to specific socioeconomic categories). In the United States, the federal government (although not necessarily state governments) is much more directly involved in choosing which academic research projects are supported than are national governments in Europe and elsewhere. In each of the European G-7 countries, GUF accounts for 50% or more of total government R&D to universities and for roughly 45% of the Canadian government academic R&D support. These data indicate not only relative international funding priorities but also funding mechanisms and philosophies regarding the best methods for financing academic research.

Source: National Science Board's Science and Engineering Indicators 2006, National Science Foundation

PART1

Chapter 2 - R&D expenditure

2.1 Introduction

R&D activities are often considered as being a main driver of economic development, innovation and growth. They comprise creative work undertaken systematically with a view to increasing the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications. The basic statistical variables are R&D expenditure (described in this chapter) and R&D personnel (see Chapter 3), which are measured at both national and regional levels.

The European goal in R&D, as set by the Lisbon and Barcelona European Councils, is the achievement by 2010 of an R&D intensity of at least 3% of GDP in the EU (taking into account the different starting points of Member States), with two thirds of R&D expenditure being financed by the business enterprise sector.

R&D expenditure means 'intramural' expenditure, i.e. all expenditure on R&D within a statistical unit or sector of the economy during a specific period, according to the sources of funds. Intramural R&D expenditure is broken down by institutional sector, i.e. by sector of performance.

Two manuals are used as methodological references for R&D surveys:

- Standard method for surveys on R&D and experimental development — *Frascati Manual,* OECD 2002;

- The regional dimension of R&D statistics and of innovation — *Regional Manual*, Eurostat, 1996.

This chapter presents the key indicators of R&D expenditure and it outlines the main trends over the past five years. It is divided into two sections:

- First, main trends are highlighted at national level by looking at the performance of the EU-27 Member States, Iceland, Norway and Candidate Countries. This part also considers the international level by looking at data for China, Japan and the United States.

- Second, R&D expenditure is analysed at the regional level, focusing on the regions of the EU-27 Member States, Iceland and Norway.

In this chapter, two main indicators are used to present R&D:

- R&D intensity (expressed as a percentage of GDP),
- R&D in volume (in euro).

Data on R&D expenditure are broken down into the following institutional sectors:

- the business enterprise sector (BES),
- the government sector (GOV),
- the higher education sector (HES),
- the private non-profit sector (PNP) and
- all sectors, which corresponds to the sum of the previous four sectors.

In addition to institutional sectors, other breakdowns are used to present R&D data, such as:

- the source of funds,
- the sector of activity,
- the size class,
- the field of science.

The regional analysis is carried out at NUTS 2 level. When other NUTS levels are used, this is indicated by a footnote. Readers should also note that, under the NUTS classification, the entire national territory of Denmark, Estonia, Cyprus, Latvia, Lithuania, Luxembourg, Malta, Slovenia and Iceland is considered as a NUTS 0, 1 or 2 region, which means that these countries as a whole may appear in rankings at NUTS 2 level.

The analysis covers the period 2000-2005. The same length of time series is not available for all countries. In general, when data for 2005 are not available for a particular country, the latest available year is presented.

The complete R&D expenditure time series are available in Eurostat's reference database NewCronos. Data for China, Japan and the United States are taken from OECD — *Main Science and Technology Indicators* (MSTI).

2.2 R&D at the national level

R&D intensity

Table 2.1 shows R&D expenditure expressed as a percentage of GDP — R&D intensity, by country and by sector of performance. The main advantage of this indicator's is that it neutralizes the economic importance of countries/regions, thus enabling comparison.

The EU-27's R&D intensity amounted to 1.84% in 2005. Up to almost two thirds of R&D (1.17% of GDP) was contributed by the business enterprise sector (BES). The higher education (HES) and government (GOV) sectors together accounted for almost all of the remaining third, i.e. 0.65% of GDP. The residual 0.02% of GDP was invested in the private non-profit sector (PNP).

Not only was EU-27 R&D intensity significantly lower than its main international competitors such as Japan (3.33%) and the United States (2.62%); it also fell short of the 3%-target to be achieved by 2010 as set by the Lisbon strategy.

R&D intensity in China reached 1.34% of GDP, which was notably lower than the EU-27 average. However, China's R&D intensity increased rapidly, whereas EU-27 R&D intensity decreased slightly during the same period.

Only two European Member States exceeded the 3% target: Sweden (3.86%) and Finland (3.48%). Four other Member States attained an R&D intensity of over 2%: Germany (2.51%), Denmark (2.44%), Austria (2.36%) and France (2.13%). This was also the case in Iceland (2.83% in 2004). All other Member States were below this threshold. Moreover, in twelve Member States R&D intensity accounted for less than 1% of GDP.

The BES accounted for the highest share of R&D intensity in a majority of Member States and in other countries. Exceptions were Bulgaria and Poland, where GOV was the main sector for R&D, and Greece, Cyprus, Lithuania and Portugal where HES took the largest share.

Table 2.1 **R&D expenditure as a percentage of GDP, by sector of performance, EU-27 and selected countries — 2003 to 2005**

	All sectors			Business enterprise sector			Government sector			Higher education sector		
	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005
EU-27	1.87 s	1.84 s	1.84 s	1.19 s	1.17 s	1.17 s	0.25 s	0.24 s	0.24 s	0.41 s	0.40 s	0.41 s
BE	1.89	1.85 p	1.82 p	1.31	1.28 p	1.24 p	0.13	0.13 p	0.14 p	0.42	0.41 p	0.41 p
BG	0.50	0.51	0.50	0.10	0.12	0.11	0.35	0.34	0.33	0.05	0.05	0.05
CZ	1.25	1.26	1.42	0.76	0.80	0.92	0.29	0.27	0.27	0.19	0.19	0.23
DK	2.56	2.48 p	2.44 p	1.77	1.69	1.67 p	0.18	0.17	0.18 p	0.59	0.61	0.58 p
DE	2.52	2.50	2.51 e	1.76	1.75	1.76 e	0.34 i	0.34 i	0.34 ei	0.43	0.41	0.42 e
EE	0.79	0.88	0.94 p	0.27	0.34	0.42 p	0.12	0.12	0.11	0.37	0.40	0.39
IE	1.16 e	1.21 p	1.25 p	0.77	0.78 p	0.82 p	0.09	0.09	0.08 p	0.29 e	0.33	0.35 p
EL	0.63	0.61 p	0.61 p	0.20	0.19 p	0.18 p	0.13	0.12 p	0.13 p	0.29	0.29 p	0.30 p
ES	1.05	1.06	1.12 p	0.57	0.58	0.61 p	0.16	0.17	0.19 p	0.32	0.31	0.32 p
FR	2.17	2.14	2.13 p	1.36	1.34	1.32 p	0.36	0.37	0.37 p	0.42	0.41	0.42 p
IT	1.11	1.10	:	0.52	0.53	0.55 p	0.19	0.20	0.17 p	0.37	0.36	:
CY	0.35	0.37	0.40 p	0.07	0.08	0.09 p	0.13	0.13	0.13 p	0.11	0.13	0.15 p
LV	0.38	0.42	0.57	0.13	0.19	0.23	0.09	0.08	0.11	0.16	0.15	0.23
LT	0.67	0.76	0.76	0.14	0.16	0.16	0.18	0.19	0.19	0.35	0.41	0.42
LU	1.66	1.66	1.56 p	1.48	1.46	1.34 p	0.18	0.18	0.19 p	0.01 e	0.02	0.02 p
HU	0.93 i	0.88 i	0.94 i	0.34	0.36	0.41	0.29 i	0.26 i	0.26 i	0.25	0.22	0.24
MT	0.26	0.63 b	0.61 p	0.08	0.45 b	0.42 p	0.02	0.01	0.02	0.16	0.17	0.17
NL	1.76	1.78 p	:	1.01	1.03	1.02 p	0.25 b	0.26	0.24 p	0.49	0.50 p	:
AT	2.21 e	2.23	2.36 p	:	1.51	1.60 p	:	0.11	0.12 p	:	0.59	0.63 p
PL	0.54	0.56	0.57	0.15	0.16	0.18	0.22	0.22	0.21	0.17	0.18	0.18
PT	0.74	0.77 p	0.81 p	0.25	0.27 p	0.29 p	0.13	0.12 p	0.11 p	0.28	0.30 p	0.32 p
RO	0.39	0.39	:	0.22	0.21	:	0.12	0.13	:	0.04	0.04	:
SI	1.32	1.45	1.22 i	0.84	0.97	0.87 p	0.29	0.29	0.23 i	0.18	0.19	0.12 i
SK	0.58	0.51	0.51	0.32	0.25	0.25	0.18 i	0.16 i	0.15	0.08	0.10	0.10
FI	3.43	3.46	3.48	2.42	2.42	2.46	0.33	0.33	0.33	0.66	0.68	0.66
SE	3.95 i	:	3.86	2.93 i	:	2.92	0.14 i	:	0.12	0.87	:	0.80
UK	1.79	1.73	:	1.14	1.09	:	0.18	0.18	:	0.40	0.40	:
IS	2.86	2.83	:	1.48	1.59	:	0.71	0.60	:	0.61	0.57	:
NO	1.73	1.62	1.51 p	0.99	0.89	0.82 p	0.26	0.25	0.24 p	0.48	0.48	0.45 p
CH	:	2.93	:	:	2.16	:	:	0.03 i	:	:	0.67	:
HR	1.11	1.22	:	0.44	0.51	:	0.24	0.25	:	0.43	0.45	:
CN	1.13	1.23	1.34	0.71	0.82	0.91	0.31	0.28	0.29	0.12	0.13	0.13
JP	3.20	3.17	3.33	2.40	2.38	2.54	0.30	0.30	0.28	0.44	0.43	0.45
RU	1.28	1.16	1.07	0.88	0.80	0.73	0.32	0.29	0.28	0.08	0.06	0.06
US	2.66 i	2.58 i	2.62 pi	1.84 i	1.79 i	1.82 pi	0.33 i	0.32 i	0.31 pi	0.37 i	0.37 i	0.37 pi

CN, JP, RU and US: source OECD-MSTI.
Footnote 'i':
DE: Includes other classes;
HU, SK: Defence excluded (all or mostly);
SI and SE: Underestimated or based on underestimated data;
SE, CH and US: Federal or central government only;
US: Excludes most or all capital expenditure.

One of Europe's key areas: the increase and improvement of investment in Research and Development

The European Commission has prepared a special webpage on growth and jobs. There, the actual problem of the lack of R&D investments is explained and solutions are put forward both at EU- and at Member State level. It also provides key messages (see below) and examples.

Key messages

- In order to compete internationally, the EU has to deliver high-quality innovative products and services. Research and development is needed to deliver them.
- Eco-innovation is an economic opportunity for the EU – with a real potential for higher growth. Europe is strong in this area and can use this to strengthen its global competitiveness. Therefore, the Commission will promote R&D in eco-innovation.
- Member States and the Commission need to work towards an increase in R&D spending of 3% of GDP. If Europe continues to invest less in R&D and to invest less efficiently, it cannot hope to attain its objective as the most dynamic and competitive world economy.
- Investment in R&D pays off in terms of economic and productivity growth.
- The new Framework Programme for Research and Development will be geared towards addressing the problems facing EU investment in research and development. It must be properly funded if it is to succeed in this ambition.

More information available on: http://ec.europa.eu/growthandjobs.

Source: European Commission, 2007

R&D intensity at international level

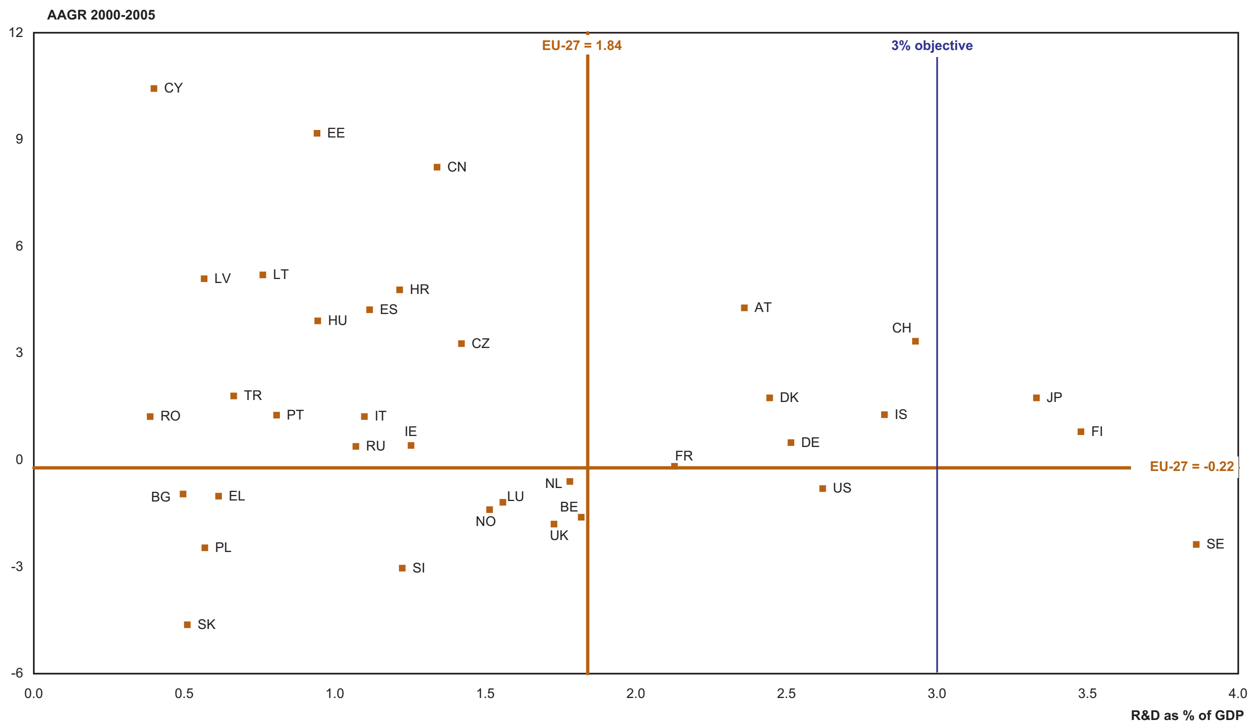
For many of the G-8 countries (i.e., the G-7 countries plus Russia), the latest R&D/GDP ratio is no higher now than it was at the start of the 1990s, which ushered in a period of slow growth or decline in their overall R&D efforts […]. The two exceptions, Japan and Canada, both exhibit substantial increases in this indicator between 1990 and 2002. In Japan this indicator declined in the early 1990s as a result of reduced or level R&D spending by industry and government, a pattern similar to that exhibited by the United States. Japan's R&D/GDP ratio subsequently rose to 3.1% in 2002, the result of a resurgence of industrial R&D in the mid-1990s coupled with anaemic economic conditions. In the 5 years between 1997 and 2002, real GDP in Japan grew by only 1.8%, so relatively small increases in R&D expenditures resulted in a rise in its R&D/GDP ratio. [In] contrast, over the same period real GDP grew by 21.8% in Canada; hence, the rise in its R&D/GDP ratio is more indicative of robust R&D growth.

Geopolitical events also affect R&D intensity indicators as evidenced by Germany and Russia. Germany's R&D/GDP ratio fell from 2.8% at the end of the 1980s, before reunification, to 2.2% in 1994. Its R&D/GDP has since risen to 2.5% in 2003. The end of the Cold War and collapse of the Soviet Union had a drastic effect on Russia's R&D intensity. R&D performance in Russia was estimated at 2.0% of GDP in 1990; that figure dropped to 1.4% in 1991 and then dropped further to 0.7% in 1992. The severity of this decline is compounded by the fact that Russian GDP contracted in each of these years. Both Russia's R&D and GDP exhibited strong growth after 1998. In the 5 years between 1998 and 2003, Russia's R&D doubled and its R&D/GDP ratio rose from 1.0% to 1.3%.

Overall, the United States ranked fifth among OECD countries in terms of reported R&D/GDP ratios. Israel (not an OECD member country), devoting 4.9% of its GDP to R&D, currently leads all countries, followed by Sweden (4.3%), Finland (3.5%), Japan (3.1%), and Iceland (3.1%). In general, nations in Southern and Eastern Europe tend to have R&D/GDP ratios of 1.5% or lower, whereas Nordic nations and those in Western Europe report R&D spending shares greater than 1.5%. This pattern broadly reflects the wealth and level of economic development in these regions.

Source: "Science and Engineering Indicators 2006", National Science Board, USA

Figure 2.2 **R&D as a percentage of GDP in 2005 and annual average growth rate (AAGR) 2000 - 2005(1), all sectors, EU-27 and selected countries**



(1) Calcultated on R&D expenditure expressed as a percentage of GDP.
MT does not appear because the 2002-2005 AAGR amounts to 32%. MT's R&D intensity amounted to 0.61% of GDP in 2005.
CN, JP, RU and US: source OECD-MSTI.

Exceptions to the reference year:
2004: IT, NL, RO, UK, IS, CH and HR;
2002: TR.

Exceptions to the reference period:
2000-2002: TR;
2000-2004: IT, NL, RO, UK, IS, CH and HR;
2001-2005: EL and SE.

Figure 2.2 shows R&D intensity, together with its annual average growth rate (AAGR).

In the EU-27, R&D intensity in 2005 was 1.84% of GDP, and between 2000 and 2005 the AAGR was - 0.22%.

Three main groups of countries can be distinguished in terms of their R&D intensity and of their AAGR: a group of leaders, a group of followers and a group of trailers.

In the group of leaders R&D intensity and its AAGR were above the EU-27 average. This group includes five Member States — Finland, Germany, Denmark, Austria and France — plus Japan, Switzerland and Iceland. These are countries that keep on increasing their lead.

Sweden may also be considered as belonging to the group of leaders, though its R&D AAGR was below the EU-27 average.

Among the leaders, Finland and Sweden were the only Member States to have already exceeded the 3%-objective set out by the Lisbon strategy. For the other countries in the leading group, reaching this target seems to be quite a realistic possibility, given the trends in their R&D expenditure patterns.

In the group of followers, R&D intensity was below the EU-27 average, but its AAGR was above it. This group includes twelve Member States, such as Spain, Italy, Cyprus and Romania. China, Russia and Turkey also belonged to this group.

Although these countries have been lagging, they are gradually closing the gap with the EU-27 average. Nevertheless, particular efforts seem to be needed in order to reach the 3%-target by 2010.

In the group of trailers, both R&D intensity and AAGR were below the EU-27 average. This group includes nine Member States – for example, the United Kingdom, Greece, Poland and Bulgaria. Norway also belonged to this group.

Not only are these Member States under the EU-27 average and a long way from the 3%-objective, but the existing gaps can be expected to increase. Moreover, if no major changes take place, these countries will not reach the 3%-target to be achieved by 2010.

2

R&D expenditure in volume

Table 2.3 shows that the EU-27 spent EUR 201 billion on R&D in 2005 as compared to EUR 251 billion spent by the United States and EUR 120 billion by Japan. As was stated above, most R&D expenditure was in the business enterprise sector (BES), but this phenomenon is more significant in Japan (75%) and in the United States (70%) than in the EU-27 (64%).

Between 2000 and 2005, EU-27 R&D expenditure increased at an AAGR of 3.3%. By comparison, Japan and the United States saw their R&D expenditure decrease during the same period. However, these decreases can be explained in part by changes in the exchange rate of their national currencies against the euro.

Within the EU-27, three Member States - Germany, France and the United Kingdom - accounted for almost two thirds of total EU-27 R&D expenditure. Germany alone, with EUR 56 billion, made up more than one quarter of EU-27 total. France and the United Kingdom followed with EUR 36 billion and EUR 30 billion respectively.

Three other Member States - Italy, Sweden and Spain - allocated more than EUR 10 billion to R&D. As mentioned earlier, Sweden was the leading Member State in terms of R&D intensity.

All the Member States registered growth in their R&D expenditure between 2000 and 2005. The highest growth was generally recorded in those Member States that joined the European Union recently (in 2004 and 2007) – such as Malta, Estonia and Romania.

The European leaders in R&D expenditure in absolute terms — Germany, France and the United Kingdom — experienced only slight growth or remained at the same level over the period.

Both total R&D expenditure and business R&D expenditure increased in all the Member States. Slovenia was the only Member State to record a decrease in R&D spending in its higher education sector, whereas R&D expenditure in the government sector declined in Denmark, Malta, Portugal, Slovenia and the United Kingdom.

Table 2.3 R&D expenditure in EUR million and annual average growth rate (AAGR), by sector of performance, EU-27 and selected countries — 2000-2005

	All sectors			Business enterprise sector			Government sector			Higher education sector		
	2000	2005	AAGR 2000-2005	2000	2005	AAGR 2000-2005	2000	2005	AAGR 2000-2005	2000	2005	AAGR 2000-2005
EU-27	170 632 s	201 020 s	3.33	110 472 s	128 091 s	3.00	23 519 s	26 447 s	2.37	35 285 s	44 357 s	4.68
BE	4 964	5 428 p	1.80	3 589	3 705 p	0.64	312	416 p	5.90	1 005	1 237 p	4.24
BG	71	106	8.33	15	23	8.49	49	71	7.75	7	11	9.69
CZ	744	1 417	13.75	446	914	15.41	188	265	7.05	106	232	17.01
DK	3 892	5 097 p	5.54	2 596	3 481 p	6.04	492	367 p	-5.67	770	1 215 p	9.56
DE	50 619	56 356 e	2.17	35 600	39 406 e	2.05	6 873	7 650 e	2.17	8 146	9 300 e	2.68
EE	37	104 p	22.96	8	47 p	41.32	9	12	6.51	19	43	17.30
IE	1 284 e	2 020 p	9.48	900	1 320 p	7.96	104	135 p	5.37	280 e	565 p	15.05
EL	852	1 112 p	6.90	278	326 p	4.04	188	228 p	4.98	383	548 p	9.41
ES	5 719	10 100 p	12.05	3 069	5 491 p	12.34	905	1 707 p	13.53	1 694	2 888 p	11.26
FR	30 954 b	36 396 p	3.29	19 348	22 543 p	3.10	5 361 b	6 305 p	3.30	5 804 b	7 100 p	4.11
IT	12 460	15 253	5.19	6 239	7 293	3.98	2 356	2 722	3.67	3 865	5 005	6.67
CY	25	54 p	17.30	5	12 p	18.68	11	18 p	9.15	6	20 p	27.46
LV	38	73	14.13	15	30	14.40	8	14	10.37	14	29	15.86
LT	73	157	16.53	16	32	15.30	31	39	5.06	27	86	26.29
LU	364	458 p	4.71	337	395 p	3.23	26	56 p	16.59	1	7 p	50.72
HU	405 i	838 i	15.63	180	362	15.02	106 i	235 i	17.27	97	211	16.69
MT	12	27 p	32.30	3	19 p	85.86	2	1	-26.37	7	8	4.01
NL	7 626	8 723 p	3.42	4 458	5 039	3.11	974 b	1 252	6.48	2 120 b	2 430 p	3.47
AT	4 029 e	5 784 p	7.50	2 638	3 919 p	8.23	242	297 p	4.21	1 135	1 544 p	6.36
PL	1 197	1 386	2.98	432	440	0.38	386	504	5.48	377	438	3.01
PT	927 e	1 189 p	5.11	258 e	430 p	10.82	222 e	162 p	-6.08	348 e	465 p	6.01
RO	149	235	12.15	103	130	5.96	28	80	30.17	17	24	7.95
SI	297	338 i	2.62	167	241 p	7.56	77	64 i	-3.53	49	32 i	-8.30
SK	143	194	6.35	94	97	0.61	35	58	10.33	14	40	23.90
FI	4 423	5 474	4.36	3 136	3 877	4.33	468	523	2.25	789	1 042	5.71
SE	10 511 i	11 109	1.39	8 118 i	8 410	0.89	297 i	343	3.63	2 085	2 314	2.64
UK	29 070	29 956	0.75	18 884	18 883	0.00	3 672	3 078	-4.32	5 985	7 012	4.04
IS	251 e	297	4.23	142 e	167	4.26	64 e	63	-0.66	41 e	60	10.01
NO	3 037	3 599 p	4.33	1 814	1 944 p	1.75	444	577 p	6.79	780	1 078 p	8.43
CH	6 852	8 486	5.49	5 065	6 257	5.43	90 bi	91 i	0.23	1 566	1 943	5.54
HR	271	345	12.90	115	144	11.54	60	72	9.52	95	129	16.60
CN	1 389	:	:	465	:	:	86	:	:	839	:	:
JP	153 860	119 748	-8.02	109 181	89 783	-6.31	15 217	11 149	-9.85	22 354	16 358	-9.89
RU	2 948	5 473	16.73	2 087	3 780	16.02	721	1 383	17.71	134	299	22.16
US	289 917 i	251 254 pi	-3.51	216 552 i	176 241 pi	-5.02	29 926 i	30 652 pi	0.60	33 221 i	34 111 pi	0.66

Footnote 'i':
- DE: Includes other classes;
- HU, SK: Defence excluded (all or mostly);
- SI and SE: Underestimated or based on underestimated data;
- SE, CH and US: Federal or central government only;
- US: Excludes most or all capital expenditure.

Exceptions to the reference year 2000:
- 2001: EL, SE and NO;
- 2002: MT and HR.

Exceptions to the reference year 2005:
- 2004: IT, NL, RO, UK, IS, CH, HR, RU, US;
- 2003: JP.

Exceptions to the reference period 2000-2005:
- 2000-2003: JP;
- 2000-2004: IT, NL, RO, UK, IS, CH, RU, US;
- 2001-2005: EL, SE and NO;
- 2002-2004: HR;
- 2002-2005: MT.

Figure 2.4 (all sectors) indicates that business enterprises are the principal source of financing for R&D expenditure in the EU-27 as a whole (55%). This also applies in the majority of individual Member States and other countries observed. The Lisbon strategy, however, aims to reach two-thirds financing by the BES in Europe.

The BES already finances two-thirds or more of R&D in Germany (67%), Luxembourg (80%) and Finland (69%). The same is true of Switzerland and Japan. Denmark and Sweden posted shares of over 60%.

The sources of finance are more balanced in the Member States that recently joined the EU (2004 and 2007 enlargements), the Candidate Countries and Russia. With the exception of the Czech Republic, Latvia and Slovenia, the government sector's share is far greater than that of the business sector in these countries. This may be explained by the fact that the government sector was traditionally very strong in these countries and that the business sector still requires time to develop further, in order to be able to invest more funds in R&D.

The remaining sources - 'abroad' and 'other national sources' - are of minor importance in the majority of countries, except in Estonia, Greece, Latvia, Malta, Austria and the United Kingdom, where more than 15% of R&D expenditure is financed from 'abroad'.

The breakdown by sources of funds shows that the BES has one principal source, whereas total R&D expenditure in all sectors has at least two main sources. On average for the EU-27, 82% of business R&D expenditure was self-financed and, moreover, business enterprises were the main source of funds in all Member States.

The lowest shares were found in Austria (67%), Romania (67%) and the United Kingdom (66%). In Austria and in the United Kingdom, this is explained by the fact that business R&D was to a large extent financed from abroad, while in Romania the government sector contributed more to BES R&D.

Figure 2.4 **Total and business enterprise R&D expenditure by source of funds as a percentage of total, EU-27 and selected countries — 2004**

Eurostat estimation: EU-27.
IE and US: Provisional data.
HU (all sectors): Defence excluded.
US: Excludes most or all capital expenditure.

Exceptions to the reference year:
2003: BE, DK, EL, LU, NL, PT, SE, IS, NO, JP and US;
2002: MT and TR.

2

Table 2.5 presents an overview of the breakdown of business R&D expenditure by sector of activity based on NACE Rev 1.1 (see methodological notes). 'Manufacturing' is by far the most important sector of activity in the EU-27, accounting for 82% of the total, followed by 'services', with approximately 16%. The other sectors add up to a mere 2%.

With an R&D expenditure of EUR 35.2 billion, Germany was the leader in 'manufacturing' in absolute terms, while the United Kingdom ranked second (EUR 15.2 billion). The United Kingdom ranked first in 'services' with R&D expenditure of EUR 4.2 billion.

Not only leading in absolute terms, Germany also ranked first in relative terms with more than 90% of business R&D expenditure in 'manufacturing'. Five other Member States, which included France and the United Kingdom, achieved shares over 80%.

However, the distribution varied across Member States. Specifically, the services sector accounted for more business R&D expenditure than did the manufacturing sector in seven Member States as well as in Iceland, Norway, Croatia and Russia.

In Romania and to a lesser extent in Poland, other sectors of activity, mainly agriculture, accounted for an appreciable share of business R&D expenditure.

Table 2.5 **Business enterprise R&D expenditure in EUR million, by sector of activity (NACE Rev 1.1), EU-27 and selected countries — 2004**

	Total	Agriculture, hunting, forestry and fishing	Mining and quarrying	Manufacturing	Electricity, gas and water supply	Construction	Services
EU-27	123 582 s	837 s	478 s	101 132 s	797 s	416 s	19 922 s
BE	3 714 p	50 e	7 e	2 937 e	26 e	59 e	668 e
BG	24	:	:	11	0	0	13
CZ	701	3	1	429	0	9	259
DK	3 332	:	:	:	:	:	:
DE	38 611	76	24	35 176	83	30	3 222
EE	32	0	:	13	0	:	18
IE	1 150 p	5 p	0 p	700 p	0 p	0 p	445 p
EL	313	2	4	200	0	1	107
ES	4 865	55	7	2 748	33	70	1 952
FR	21 646	311	152	18 463	393	86	2 025
IT	7 057	0	52	5 195	28	12	1 769
CY	10	0	0	3	0	0	6
LV	21	0	:	9	0	0	11
LT	29	:	1	23	0	:	6
LU	379	:	:	179	0	:	200
HU	297	4	0	239	2	1	52
MT	3	:	0	2	0	0	1
NL	4 804	68	95	3 750	24	29	839
AT	3 556	3	3	2 550	8	17	975
PL	327	15	8	207	4	11	81
PT	338	1	1	151	3	4	179
RO	130	16	10	81	6	4	13
SI	254	0	4	205	0	0	45
SK	86	2	0	32	:	:	51
FI	3 683	1	6	2 937	6	27	707
SE	7 886 i	23	7	6 336	54	:	1 466
UK	18 319	174	81	15 224	99	44	4 156
IS	142	3	0	40	1	1	96
NO	1 821	27	98	799	6	24	867
CH	6 257	:	:	5 033	:	:	1 224
HR	114	4	:	10	0	3	97
TR	367	3	1	318	3	0	43
RU	3 353	38 i	50 i	687 i	11 i	9 i	2 398 i

EU-27: Distribution by sector of activity is estimated on the basis of available Member States.
Exceptions to the reference year:
2003: EL, FR, LU, NL, PT, SE, UK, IS, HR and RU;
2002: MT and TR.

Footnote 'i':
SE: Underestimated or based on underestimated data;
US: Excludes most or all capital expenditure.

With the exception of enterprises employing 250 to 499 persons, one of the main results of Table 2.6, which looks at R&D expenditure by size-class of enterprises, is that business R&D expenditure increases with the size of enterprises in the EU-27 as a whole and in most of its Member States.

In Germany (87%), Sweden (82%) and the United Kingdom (76%), the highest share of business R&D expenditure was in those enterprises employing more than 500 persons.

However, this rule cannot be applied strictly to small countries, probably owing to the fact that they have fewer large and very large enterprises compared to the bigger economies.

It also seems that, in many countries, enterprises belonging to the 50-to-249 persons employed size class invest more than those in the 250-to-499 persons employed size class.

The distribution of business R&D expenditure by size class was quite different in Russia. Enterprises employing 250 to 499 persons ranked first, followed by enterprises with 10 to 49 persons employed. Larger enterprises (more than 500 persons employed) received the smallest share of R&D spending.

Table 2.6 Business enterprise R&D expenditure in EUR million, by size class, EU-27 and selected countries — 2004

	Total	0 person employed	1 to 9 persons employed	10 to 49 persons employed	50 to 249 persons employed	250 to 499 persons employed	500 and more persons employed
EU-27	123 582 s	34 s	1 374 s	5 872 s	14 257 s	8 700 s	93 345 s
BE	3 608	9	128	441	794	380	1 857
BG	24	0	1	2	3	9	7
CZ	701	4	12	62	176	81	365
DK	3 355	:	148	357	518	413	1 919
DE	38 029	:	70	668	2 448	1 705	33 139
EE	32	:	4	7	7	3	12
IE	1 150 p	0 p	36 p	219 p	294 p	174 p	428 p
EL	313	:	4	56	105	24	125
ES	4 865	:	115	806	1 257	662	2 025
FR	22 210	:	:	:	:	:	:
IT	7 293	:	:	:	:	:	:
CY	10	0	2	1	2	0	5
LV	21	:	2	5	6	1	6
LT	29	:	2	3	11	4	9
LU	393	:	:	:	:	:	:
HU	297	:	10 i	20	23	23	220
MT	3	:	:	1	1	0	0
NL	4 804	:	:	388	898	:	:
AT	3 556	:	90 i	251	622	372	2 222
PL	327	1	2	18	106	73	126
PT	338	:	14	52	69	69	134
RO	130	1	35	9	30	15	39
SI	254	1	8	11	52	16	166
SK	86	2	2	5	33	19	26
FI	3 683	:	80 i	268	403	338	2 595
SE	7 886 i	:	:	:	964	455	6 466
UK	18 319	9	314	826	2 729	1 933	13 967
IS	:	:	:	:	:	:	:
NO	1 960	:	:	459	645	140	715
CH	6 257	:	77	426	777	709	4 269
RU	3 176	298	207	783	509	1 229	150

EU-27:Distribution by size class is estimated on the basis of available Member States.
Exceptions to the reference year:
2003: BE, DK, DE, EI, NL, PT, SE, UK and NO;
2002: MT and RU.

Footnote 'i':
HU, AT and FI: Includes other classes;
SE: Underestimated or based on underestimated data.

Table 2.7 gives an insight into the breakdown of R&D expenditure in government and higher education sectors by fields of science (see methodological notes).

In 2004, 'natural sciences' received the largest share of R&D expenditure in the EU-27 as a whole and in 16 of its Member States. This was also the main field of scientific research in Norway. The United Kingdom gave absolute priority to 'natural sciences', with 96% (government sector only).

'Engineering and technology' was the top scientific field in Belgium, Spain, Luxembourg, Romania, Finland and Iceland, while 'Medical sciences' led in Austria and Sweden.

'Social sciences' was the main field only in Malta and Croatia. However, 'social sciences' accounted for a substantial share of R&D expenditure in Luxembourg, Portugal and Norway.

None of the countries allocated the largest part of their GOV and HES R&D expenditure to 'agriculture' or the 'humanities'. However, 'agriculture' accounted for more than 20% of R&D expenditure in Bulgaria (26.1%), Cyprus (22.3%) and Iceland (22.8%).

Hungary (14.8%) and Estonia (14.0%) devoted the highest shares of their R&D expenditure to the 'humanities'.

Table 2.7 **R&D expenditure in EUR million and by field of science as a percentage, government and higher education sectors, EU-27 and selected countries — 2004**

	Total	Agriculture	Engineering and technology	Medical sciences	Natural sciences	Social sciences	Humanities
EU-27	**68 366 s**	**6.0 s**	**20.6 s**	**18.7 s**	**34.9 s**	**11.0 s**	**8.8 s**
BE	1 504	12.4	27.1	19.5	19.2	14.2	7.6
BG	76	26.1	19.2	4.2	38.3	3.8	8.2
CZ	395	9.9	23.8	10.2	42.4	6.5	7.3
DK	1 467	10.5	12.7	24.6	26.1	12.5	13.4
DE	16 604	4.6	23.9	16.7	37.4	7.1	10.2
EE	49	12.9	21.4	11.0	30.7	10.1	14.0
IE	630	12.7	14.4	14.5	36.6	15.8	6.1
EL	695 p	:	:	:	:	:	:
ES	4 069	9.7	22.6	22.0	18.2	15.9	11.6
FR	12 866	:	:	:	:	:	:
IT	7 727	6.6	14.6	18.1	44.4	14.5	1.8
CY	33	22.3	4.7	1.3	40.3	19.2	12.2
LV	26	9.6	22.8	4.7	47.8	9.9	5.2
LT	108	6.6	24.5	14.4	26.4	16.6	11.5
LU	46 e	2.2 p	44.2 p	12.9 p	14.7 p	21.6 p	1.5 p
HU	390 i	14.1 i	18.1 i	12.0 i	28.2 i	12.7 i	14.8 i
MT	8	2.4	13.4	18.4	14.3	36.7	13.6
NL	3 418	:	:	:	:	:	:
AT	1 671	5.5	12.5	28.6	28.5	13.1	11.9
PL	750	10.6	31.4	13.5	32.6	11.3	0.7
PT	564	13.3	20.7	9.6	29.4	19.7	7.4
RO	104	5.6	35.7	21.4	26.7	5.4	5.2
SI	124	9.7	19.8	7.8	50.0	8.5	4.3
SK	88 i	10.2 i	19.7 i	12.1 i	41.7 i	13.1	3.2
FI	1 537	7.7	26.9	21.2	22.1	17.9	6.2
SE	2 715 i	4.7	26.1	29.3	19.5	13.2	6.4
UK	9 429 b	:	:	:	96.0	4.0	:
IS	126	22.8	25.9	12.5	18.5	12.3	7.8
NO	1 451	11.3	13.4	21.8	22.7	22.3	8.4
HR	201	9.5	21.7	10.9	20.9	23.4	13.7
TR	913	8.3	10.0	57.9	3.9	12.7	7.1
RU	1 682	4.5	45.1	6.2	37.1	4.2	2.8

EU-27:Distribution by field of science is estimated on the basis of available Member States.

Exceptions to the reference year:
2003: BE, DK, LU, PL, PT, SE, IS and NO;
2002: NI and TR;
2001: UK.

Distribution by field of science:
Government sector only: IT and UK;
Higher education sector only: SE and TR.

Footnote 'i':
HU and SK: Defence excluded (all or mostly);
SE: Federal or central government only.

2.3 R&D at the regional level

Figure 2.8 R&D expenditure in the top 10 EU regions, as a percentage of EU-27, all sectors — 2003

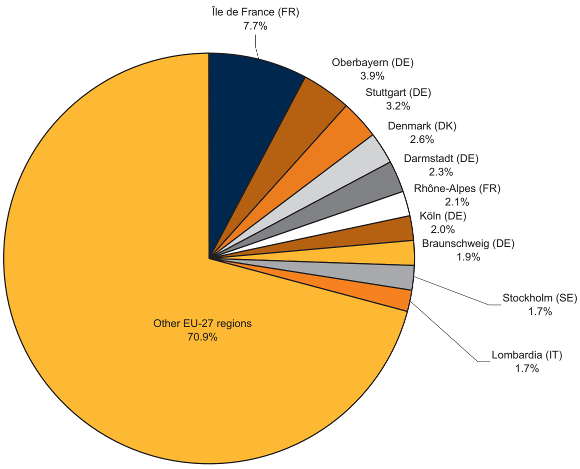


Figure 2.8 shows the shares of the leading regions in EU-27 total R&D expenditure (calculated in EUR), while Table 2.9 displays the leading regions in terms of their R&D expenditure with respect to GDP (R&D intensity).

In 2003, almost 30% of R&D expenditure in the EU-27 was concentrated in ten regions. Five of these regions were in Germany and two were in France. Denmark (the entire country is classified at NUTS 2 level) was the fourth leading region in absolute terms. The two remaining regions in the top 10 were Stockholm (SE) and Lombardia (IT)

Île de France (FR) was in the lead with R&D expenditure accounting for 7.7% of the EU-27 total, followed by Oberbayern (DE) and Stuttgart (DE).

The regions with the highest R&D intensity were nearly the same as those with the highest concentration of R&D activity in terms of volume. To be exact, Stockholm (SE) and three of the German regions that were in the absolute top 10 — Braunschweig, Stuttgart and Oberbayern — also belonged to the leading regions in relative terms (Table 2.9). Moreover, the three German regions are among the four leading European regions in terms of R&D intensity.

With R&D intensity amounting to 8.7% of GDP, Braunschweig (DE) clearly came first. It was followed by Västsverige (SE), with approximately 6%. All other European regions had R&D intensities below 5%. However, all 15 leading regions were above the 3% target set in the Lisbon strategy. As can also be seen in Map 2.10, this was true for about twenty European regions, of which nine were German, four Swedish, three Finnish, two Austrian and two French. East of England (UK), which is classified at NUTS 1 level, was also one of the regions with an R&D intensity of above 3%.

Braunschweig

Braunschweig unites tradition and high technology, outstanding infrastructure and an excellent location at the heart of northern Europe. Its spectrum ranges from biotechnology via financing all the way to transportation technology. The Technical University as well as the numerous internationally renowned research establishments are the reason for Braunschweig having a very high proportion of business set ups in high-tech sectors.

The Braunschweig Region of Science links the various high-tech core areas of competence in an effective way. Scientific organisations and research establishments as well as companies all work together closely.

Source: http://www.braunschweig.de

Table 2.9 Top 15 EU regions in terms of R&D expenditure, as a percentage of GDP, all sectors — 2003

Regions	% of GDP	EUR million	% of EU-27
EU-27	1.87 s	187 708 s	100 s
Braunschweig (DE)	8.70	3 595	1.9
Västsverige (SE)	6.03	3 135	1.7
Stuttgart (DE)	4.66	5 996	3.2
Oberbayern (DE)	4.60	7 352	3.9
Pohjois-Suomi (FI)	4.60	726	0.4
Stockholm (SE)	4.31	3 276	1.7
Östra Mellansverige (SE)	4.25	1 632	0.9
Sydsverige (SE)	4.13	1 490	0.8
Berlin (DE)	3.94	3 096	1.6
Tübingen (DE)	3.89	1 908	1.0
East Of England (UK)	3.85	4 595	2.4
Karlsruhe (DE)	3.83	3 166	1.7
Midi-Pyrénées (FR)	3.72	2 283	1.2
Etelä-Suomi (FI)	3.55	2 933	1.6
Länsi-Suomi (FI)	3.49	1 139	0.6

UK: NUTS level 1.
Exception to the reference year: East Of England (UK): 1999.

Four of the top 15 regions in terms of R&D intensity were quite small in terms of volume (making up less than 1% of EU-27 total): Pohjois-Suomi (FI) ranked fifth, Östra Mellansverige (SE) seventh, Sydsverige (SE) eighth and Länsi-Suomi (FI) 15th.

As shown in Map 2.10, only a few countries had at least one region with an R&D intensity of above 2% of GDP. In addition to Germany, France, Sweden and the United Kingdom mentioned earlier, these also included Austria, the Netherlands and the Czech Republic. Denmark and Iceland (the entire countries are classified at NUTS 2 level) also displayed shares in excess of 2%.

Regional differences in R&D expenditure
Implications for regional governance

Introduction

Increasing overall EU expenditure in R&D is one of the core elements of the Lisbon Strategy, embodied in the so-called Barcelona target (3% of GDP should be spent on R&D, of which 2%-points should be private). Within the system of Integrated Guidelines and open co-ordination, this EU-wide target serves as a reference value at the national and regional level.

Current regional differences in R&D expenditure (as a share of regional income) are vast. Most regions show R&D expenditure well below the 3% level; only 21 out of 254 regions reach the 3% target (2002 figures). These regions can be found in Germany (11), Finland (3), France, Austria and the UK (2 each), the Netherlands, Sweden and the Czech Republic (1 each). Braunschweig (DE) leads (7.1%) followed by Pohjois-Suomi (FI, 4.2%), East of England (UK, 3.9%) and Středni Ĉechy (CZ, 3.5%), Vienna (AT, 3.4%) and Île de France (FR, 3.4%). We find very low income proportions spent on R&D in southern and eastern regions. Regional disparities are considerable both within the EU as a whole as within Member States.

The main question the presentation deals with is **whether it is sensible to reproduce the Barcelona target on a regional scale**. Does it make sense to expect each and every one of 254 (NUTS-2) regions in the European Union to spend 3% of their regional income on R&D? The answer is no. Subsequently, the presentation discusses **an alternative approach to policies to enhance regional competitiveness, based on local-global interfaces**.

Implications for regional governance within the Lisbon Strategy

In short, the Barcelona target is too simple and out of touch with the more complex economic reality. Our considerable knowledge of that reality is insufficiently incorporated into the Lisbon policies. What does this imply for regional governance?

The Lisbon strategy uses the open method of coordination and rests heavily on benchmarking. Although the open method of coordination was introduced to cater for diversity, its application has increasingly led to the set-up of regional policies with similar objectives, similar instruments and similar policy concepts. In Europe, too many policymakers try to simply copy the success of well-known best practices and aim for regional competitiveness by creating favorable conditions for the formation of high-tech clusters in the field of information technology, biotechnology and nanotechnology. This disregards that only a limited number of regions can be expected to succeed as high-tech regions. Most regions in Europe are either traditional industrial regions or peripheral agricultural regions. Traditional industrial regions face the legacy of an economic mono-structure and have problems in socio-economic conversion. Peripheral agricultural regions have depended on agriculture for centuries and face specific problems such as the outward emigration of young people.

Rather than jumping on the bandwagon of investing in high-tech clusters, low-tech regions should invest in policies that face these specific problems and make the best possible use of their own competitive advantages.

However, traditional regional policies dealing with the restructuring of “old economies” have not always been successful, for a number of reasons:

- they often involve a mixture of possibly conflicting goals (restructuring, employment, environment, regional prestige);
- they often do not cure the underlying problems, especially due to “subsidy addiction” which maintains inertia and does not constitute an incentive for real reorientation.

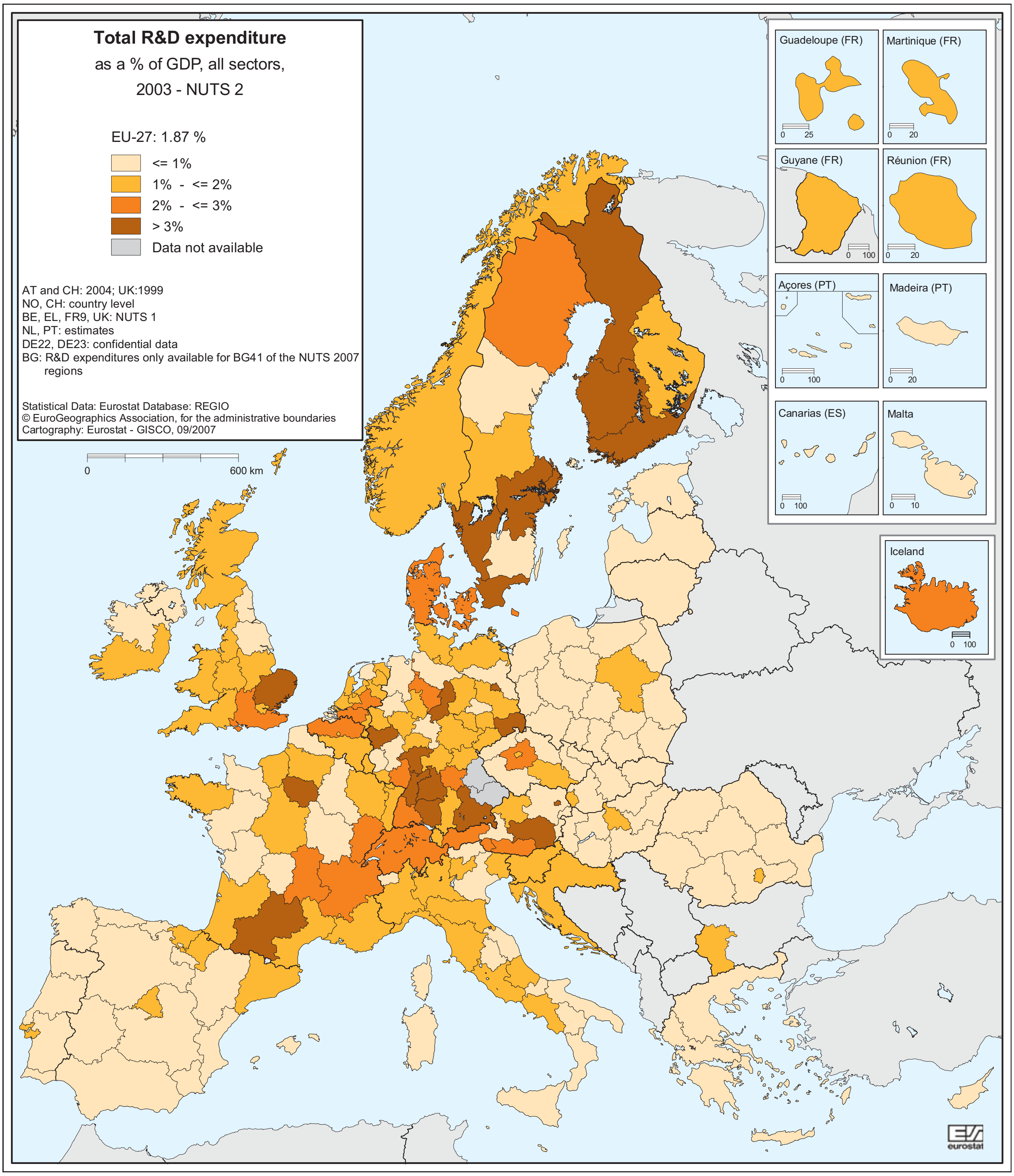
How can we avoid these pitfalls? In current research on regional policy, attention is increasingly drawn to so-called creative global-local interfaces through which local traditions are brought in line with global trends. An example of such an interface is the Danish region of Jutland, which has successfully combined its local tradition in furniture-making with the global trends of lifestyle and product quality, resulting in Danish design furniture. Another example is the French region North Pas-de-Calais which has combined its traditional local clothing sector with the global trend of convenience shopping by setting-up mail order services. Yet another example is the Polish region around Krakow where traditional building and painting know-how is combined with global sustainability trends, resulting in flourishing restoration services.

Interestingly enough, the new combinations mentioned above were effected from the bottom-up, involving local and regional stakeholders (local firms, residents, universities, business associations and governments) rather than by a subsidy-based top-down policy. Moreover, such combinations do not require cutting-edge technologies; they make an intelligent use of existing opportunities. Rather than focusing on high-tech R&D most European regions should focus on how to organise processes by which old crafts are combined with new tricks.

More information available on:
http://ec.europa.eu/regional_policy/conferences/od2006/doc/presentations/b/groenendijk_10b02.doc.

Source: Nico Groenendijk, Jean Monnet Chair of European Economic Governance,
Centre for European Studies, University of Twente, 2006

Map 2.10 Total R&D expenditure as a percentage of GDP, all sectors, NUTS 2 — 2003



PART2

Chapter 3 - R&D personnel

3.1 Introduction

As seen in Chapter 2, Research and Development (R&D) activities are often regarded as a catalyst for economic growth, as they comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

The quantity of R&D personnel is one of the two basic R&D input indicators, the other being R&D expenditure.

As it is a key element of knowledge, S&T dissemination and development, the R&D personnel indicator has become increasingly appreciate by policymakers. R&D personnel data measure the human resources going directly into R&D activities. R&D personnel includes all persons employed directly in R&D, as well as those providing direct services, such as R&D managers, administrators and clerical staff.

Two manuals are used as methodological references for R&D surveys:

- Proposed Standard Practice for Surveys on Research and Experimental Development — *Frascati Manual*, OECD, 2002.
- The Regional Dimension of R&D and Innovation Statistics — *Regional Manual*, Eurostat, 1996.

This chapter presents the key R&D personnel indicators as well as the main trends during the period 2000-2005. It is divided into two sections:

- First, the main trends are highlighted at national level, by examining the performance of the EU-27 Member States, Iceland, Norway and the candidate countries. This part also looks at the global level by making comparisons with China, Japan and Russia.
- Second, R&D personnel is analysed at regional level, by focusing on the regions of the EU-27 Member States, Iceland and Norway.

Two populations are measured in every section of this chapter:

- Total R&D personnel and its sub-population
- Researchers.

'Researchers', as defined as professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, and in the management of the projects concerned, Frascati Manual (paragraph 301), are possibly the most important population in terms of R&D activities.

As recommended by the Frascati Manual, R&D personnel data are expressed in two units: full-time equivalent (FTE) and head count (HC).

- The FTE unit corresponds to one year's work by one person.
- The HC unit corresponds to the number of individuals who are employed mainly or partly on R&D.

For the purposes of comparison between different regions and periods, the derived unit based on HC 'as a percentage of total employment' is frequently used in this chapter.

Data concerning R&D personnel are broken down by the following institutional sectors:

- the business enterprise sector (BES),
- the government sector (GOV),
- the higher education sector (HES),
- the private non-profit sector (PNP), and
- all sectors, which is equivalent to the sum of the four sectors.

In addition to sectors of performance, other breakdowns can be used, such as:

- sector of economic activity,
- field of science.

The regional analysis is carried out at the NUTS 2 level. Other levels of NUTS are used in certain instances for particular countries, and this is specified in each case by means of a footnote. Readers should also note that, according to the NUTS classification, the entire national territory of Denmark, Estonia, Cyprus, Latvia, Lithuania, Luxembourg, Malta, Slovenia and Iceland is considered as a NUTS 0, 1 or 2 region, which means that those countries as a whole may appear in rankings at the NUTS 2 level.

The analysis refers to the period 2000-2005 (or 2004). The same length of time series does not cover all countries. In general, therefore, when data for the reference year are not available for a particular country, the latest year available is presented.

The complete R&D personnel time series are available on Eurostat's reference database NewCronos. Data for China and Japan are taken from OECD — *Main Science and Technology Indicators* (MSTI).

Head count (HC) vs full time equivalent (FTE)

Headcount (HC) data are the most appropriate measure for collecting additional information about R&D personnel.

However, R&D may be the primary function of some persons or it may be a secondary function. It may also be a significant part-time activity. To count only persons whose primary function is R&D would result in an underestimate of the effort devoted to R&D; to carry out a headcount of everyone spending some

time on R&D would lead to an overestimate. The number of persons engaged in R&D must, therefore, also be expressed in full-time equivalents (FTE) on R&D activities.

More information on: http://www.uis.unesco.org/TEMPLATE/pdf/S&T/Workshops/CAsia/Almaty_7.pdf

Source: UNESCO Institute for Statistics (UIS), 2006

3.2 R&D personnel at the national level

R&D personnel as a percentage of total employment

As with R&D intensity (chapter 2.2), R&D personnel expressed as a percentage of total employment — R&D personnel intensity — also enables comparisons between countries and regions (Figure 3.1).

In 2004, 1.44% of total EU-27 employment was connected to R&D activities, of which 0.63% of a percentage point was in the business enterprises sector.

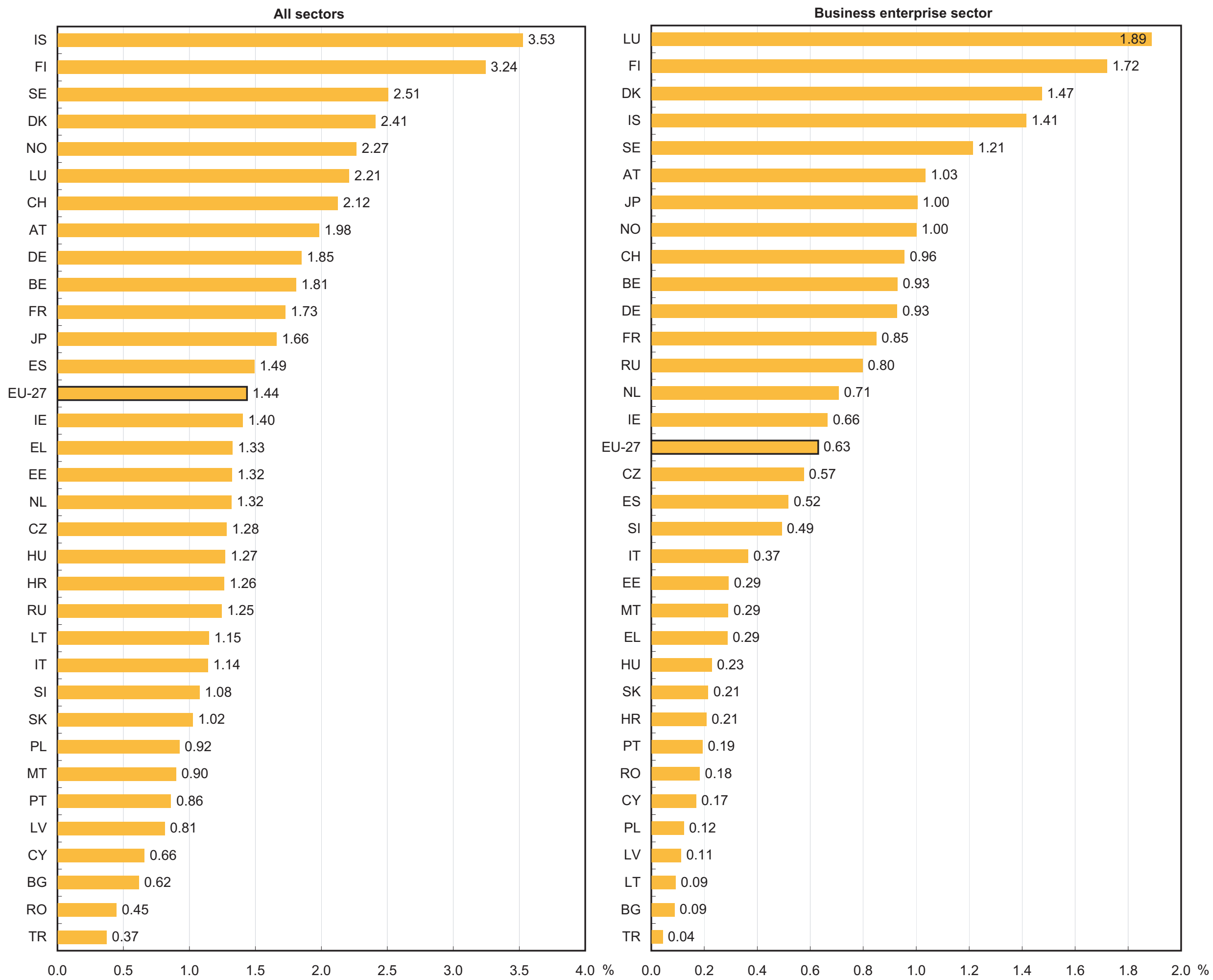
However, R&D personnel intensity varied significantly across countries. At 3.53%, Iceland displayed by far the highest share of persons employed in R&D. It was followed by Finland, the only EU Member State having a share above 3%. R&D personnel made up more than 2% of total employment in three other Member States: Sweden (2.51%), Denmark (2.41%) and Luxembourg (2.21%). This was also the case for Norway (2.27%) and Switzerland (2.12%).

An analysis of the contribution of the business enterprise sector (BES) to R&D personnel intensity reveals that this sector was relatively most important in Luxembourg, with 1.89 percentage points, and in countries from Northern Europe, such as Finland, Denmark and Iceland where this sector represented 1.72, 1.47 and 1.41 percentage points respectively.

The relatively low contribution from BES in the new Member States (2004 and 2007 enlargements) may be explained by the fact that the government sector has traditionally been more important in terms of R&D in those countries and that the business sector still needs time to develop, as was corroborated by R&D intensity data (Chapter 2).

3

Figure 3.1 R&D personnel (HC), in all sectors and the business enterprise sector, as a percentage of total employment, EU-27 and selected countries — 2004



EU-27: Eurostat estimation.
IE: Provisional data.
MT: Break in series.
NL (all sectors): National estimation.

Exceptions to the reference year:
2003: BE, DE, EL, LU, NL, PT, SE, IS, NO and JP;
2002: TR.

As can be seen in Table 3.2, the BES - with 0.63% of total employment, or 44% of all personnel employed in R&D - was the single most important sector for total R&D personnel intensity in the EU-27. However, the contribution from this sector did not exceed 20% in Bulgaria, Latvia, Lithuania and Poland. The same was also true of Croatia and Turkey.

The higher education sector (HES) came just behind the BES, as the second most important sector in terms of R&D personnel. R&D personnel In the EU-27 accounted for 0.61% of total employment in this sector. In other words, approximately 42% of all persons employed in R&D were active in this sector. In nine Member States - which included Estonia, Spain and Poland, for example - more than half of total R&D personnel worked in the higher education sector.

The government sector (GOV) made up only 13% of total R&D personnel in the EU-27 (0.18% of total employment). However, in Bulgaria, the Czech Republic, Cyprus, Lithuania and Romania, more than one in five persons engaged in work related to research were employed in the government sector.

As a general rule, with the exceptions of Luxembourg and Russia, HES always employed a significant share of R&D personnel, although there was much greater variation in the distribution in BES and GOV across countries

Table 3.2 **R&D personnel (HC) by sector of performance, as a percentage of total employment, EU-27 and selected countries — 2002 to 2004**

	All sectors			Business enterprise sector			Government sector			Higher education sector		
	2002	2003	2004	2002	2003	2004	2002	2003	2004	2002	2003	2004
EU-27	1.44 s	1.44 s	1.44 s	0.62 s	0.62 s	0.63 s	0.19 s	0.19 s	0.18 s	0.61 s	0.62 s	0.61 s
BE	1.80	1.81	:	0.92	0.93	0.92 p	0.09	0.10	:	0.77	0.77	:
BG	0.61	0.61	0.62	0.07	0.08	0.09	0.40	0.39	0.38	0.14	0.14	0.15
CZ	1.13	1.18	1.28	0.47	0.51	0.57	0.29	0.28	0.28	0.37	0.38	0.42
DK	2.27	2.24	2.41	1.39	1.32	1.47	0.17 b	0.19	0.18	0.70 b	0.72	0.74
DE	:	1.85	:	:	0.93	:	:	0.24	0.24	:	0.69	0.68
EE	1.18	1.28	1.32	0.20	0.26	0.29	0.17	0.19	0.18	0.80	0.81	0.82
IE	1.38	1.39	1.40 p	0.67	0.66	0.66 p	0.09	0.09	0.09	0.61	0.64	0.65
EL	:	1.33	:	0.32	0.29		:	0.21	:	:	0.82	:
ES	1.40	1.45	1.49	0.44 b	0.48	0.52	0.19	0.20	0.22	0.76	0.76	0.75
FR	1.72 i	1.71 i	1.73 i	0.84	0.84	0.85	0.23 i	0.21 i	0.21 i	0.62	0.63	0.64
IT	1.16	1.13	1.14	0.39	0.37	0.37	0.18	0.19	0.20	0.56	0.55	0.55
CY	0.61	0.64	0.66	0.16	0.17	0.17	0.24	0.22	0.21	0.16	0.18	0.22
LV	0.93	0.79	0.81	0.24	0.12	0.11	0.16	0.15	0.14	0.53	0.53	0.56
LT	0.97	1.01	1.15	0.04	0.05	0.09	0.25	0.23	0.23	0.68	0.73	0.82
LU	:	2.21	:	:	1.89	:	0.25	0.29	:	:	0.03 e	:
HU	1.26 i	1.24 i	1.27 i	0.24	0.24	0.23	0.30 i	0.29 i	0.29 i	0.71	0.71	0.75
MT	0.76	0.66	0.90 b	0.05	0.07	0.29 b	0.17	0.03	0.04	0.54	0.57	0.57
NL	1.34 e	1.32 e	:	0.75	0.71	0.84	0.17	0.20 b	0.19 b	0.40 e	0.41 e	:
AT	1.77	:	1.98	0.92	:	1.03	0.16	:	0.15	0.68	:	0.78
PL	0.89	0.93	0.92	0.08	0.11	0.12	0.21	0.19	0.17	0.60	0.63	0.63
PT	0.81 e	0.86	:	0.16 e	0.19	:	0.15 e	0.14	:	0.40 e	0.42	:
RO	0.40	0.44	0.45	0.20	0.19	0.18	0.10	0.11	0.11	0.11	0.14	0.15
SI	1.36	1.06	1.08	0.59	0.48	0.49	0.31	0.21	0.21	0.44	0.36	0.37
SK	0.99	0.97	1.02	0.26	0.21	0.21	0.21 i	0.21 i	0.19 i	0.53	0.55	0.62
FI	3.08	3.16	3.24	1.65	1.70	1.72	0.42	0.42	0.42	0.97	1.02	1.07
SE	:	2.51	:	:	1.21	:	:	0.13	:	:	1.16	:
UK	:	:	:	:	:	:	0.08	0.08	0.08	:	:	:
IS	:	3.53	:		1.41	:	:	1.12	:	:	0.85	:
NO	2.25	2.27	:	0.99	1.00	1.05	0.29	0.29	:	0.97	0.97	:
CH	:	:	2.12	:	:	0.96	0.04	:	0.04	1.06	:	1.13
HR	1.08	1.12	1.26	0.17	0.15	0.21	0.32	0.36	0.41	0.60	0.62	0.65
TR	0.37	:	:	0.04	:	:	0.04	:	:	0.29	:	:
JP	1.58	1.66	:	0.93	1.00	:	0.11	0.11	:	0.51	0.52	:
RU	1.32	1.30	1.25	0.86	0.85	0.80	0.39	0.39	0.38	0.07	0.07	0.06

Footnote 'i':
FR, HU and SK: Defence excluded (all or mostly);
CH: Federal or central government only.

R&D personnel in the EU-27 expressed as a percentage of total employment increased between 2000 and 2004, at an annual average growth rate (AAGR) of 1.20% — Figure 3.3.

In comparison, EU-27 R&D intensity — i.e. R&D expenditure as a percentage of GDP — decreased between 2000 and 2005 (Chapter 2).

However, six Member States — Sweden, Greece, the Netherlands, Slovakia, Latvia and Slovenia — also witnessed a relative decline in R&D personnel compared to total employment. This was also the case in Switzerland and Russia.

Belgium and Bulgaria recorded a positive annual average growth rate of 0.59% and 0.56% respectively, which was below the EU-27 average.

Among the countries with an annual average growth rate below that of the EU-27, only Belgium, Switzerland and Sweden had a R&D personnel intensity higher than the EU-27 average (1.44%).

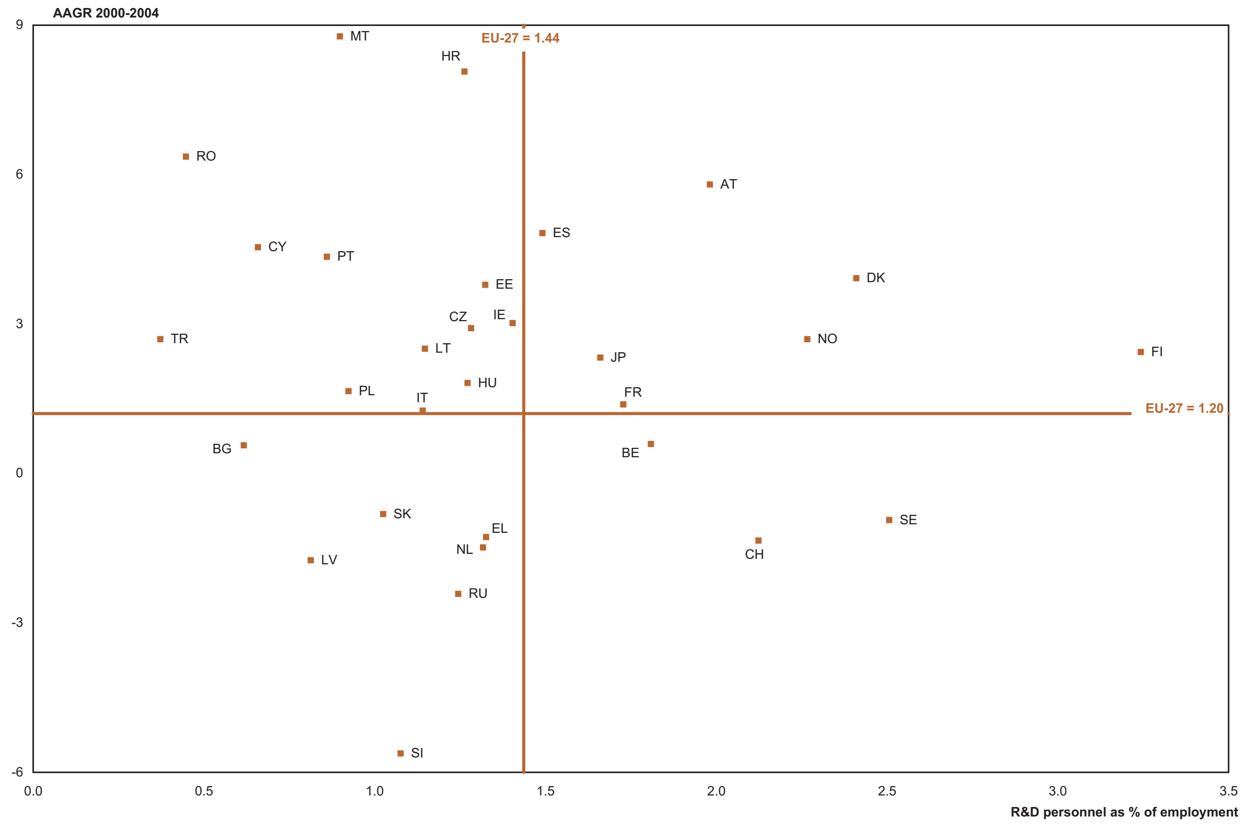
All other Member States saw their shares of R&D personnel in total employment grow faster than the EU-27 average.

Moreover, some of those Member States, such as Finland, Denmark and France, also had relatively more personnel employed in R&D than the EU-27 average. This means that those countries were not only among the leaders in terms of R&D personnel intensity, but also enhanced their leadership during the period shown. This was also the case for Norway and Japan.

Finally, eleven EU Member States and two candidate countries were below the European average in terms of R&D personnel intensity, but, as their AAGR was higher than the EU-27 average, these countries were catching up.

Malta (8.8%), Croatia (8.1%) and Romania (6.4%) witnessed the highest growth rates not only among the above eleven countries, but also compared to the rest.

Figure 3.3 **R&D personnel (HC) as a percentage of total employment in 2004 and annual average growth rate (AAGR) of this share 2000-2004, EU-27 and selected countries**



AAGR is calcultated on R&D personnel expressed as a percentage of total employment.

Exceptions to the reference year:
2003: BE, EL, PT, SE, NO and JP;
2002: TR.
EU-27: Eurostat estimation.
MT: break in series.
IE: provisional data.
NL: national estimation.
FR: Defence excluded (all or mostly).

Exceptions to the reference period:
2000-2002: TR;
2000-2003: PT;
2001-2003: EL, SE, NO, JP;
2001-2004: ES;
2002-2003: BE and NL;
2002-2004: MT, AT and HR.

R&D personnel in full time equivalent

Counted as full time equivalent (FTE), more than 2 million persons in the EU were employed in R&D activities in 2004. More than half of these (1.1 million FTE) were employed in the business enterprise sector (BES). Whereas the higher education sector (HES) counted 642 000 FTE and the government sector (GOV) 312 000 FTE employed in R&D, The remainder, 21 000 FTE, were employed in the private non profit sector.

Germany alone, with 473 000 FTE, made up 23% of total EU-27 R&D personnel counted as FTE. German dominance was even more noticeable in the business enterprise sector, with 27% of EU-27's total FTE in R&D.

Whichever the sector, Germany led in absolute terms, followed by France. Generally, Spain and Italy ranked third or fourth.

On average, only 30.6% of the FTE employed in R&D in the EU in 2004 were female. Nevertheless, in three Member States - Bulgaria, Latvia and Lithuania - women counted as FTE were in the majority.

With the exception of Sweden, the share of female R&D personnel in FTE was even lower in the BES than it was in all sectors.

The overall trend of EU-27 R&D personnel expressed in FTE reveals growth between 2000 and 2004 both for all sectors and for the BES at an annual rate of 1.5%. R&D personnel in the HES also increased, but more rapidly (2.6%); however, it declined in the GOV (-0.7%).

Table 3.4 **R&D personnel in FTE and percentage of women in 2004 and annual average growth rate (AAGR) 2000-2004, by sector of performance, EU-27 and selected countries**

	All sectors			Business enterprise sector			Government sector			Higher education sector		
	R&D PSL in FTE	% of women	AAGR 2000-2004	R&D PSL in FTE	% of women	AAGR 2000-2004	R&D PSL in FTE	% of women	AAGR 2000-2004	R&D PSL in FTE	% of women	AAGR 2000-2004
EU-27	2 089 675 s	30.6 s	1.5 s	1 114 016 s	21.4 s	1.5 s	312 422 s	41.0 s	-0.7 s	642 266 s	41.0 s	2.6 s
BE	52 256	30.3	-1.8	31 375	22.4	-4.0	3 757	32.7	1.2	16 532	43.8	1.7
BG	15 647	52.7	0.6	2 158	47.9	0.2	10 384	57.6	-0.7	3 036	39.6	5.9
CZ	28 765	30.6	4.4	15 064	21.4	6.9	7 422	43.0	0.9	6 104	38.0	3.4
DK	41 607	36.8	3.2	27 230	32.9	4.3	3 439	43.0	-13.2	10 697	44.1	8.8
DE	472 533	27.2	-0.7	298 072	18.5	-1.1	73 867	37.0	1.8	100 594	45.7	-1.2
EE	4 735	47.5	6.3	1 083	29.3	26.9	810	63.8	-3.9	2 752	49.1	4.5
IE	15 713	29.5	5.3	9 650	22.6	2.6	1 222	38.5	-4.0	4 841	40.9	16.8
EL	31 849	34.8	2.6	11 608	19.2	1.9	5 101	41.9	4.0	14 947	44.2	2.4
ES	161 933	37.4	7.6	71 123	28.4	10.9	27 166	48.6	4.9	63 331	42.5	6.4
FR	352 485	:	1.9	197 223	:	2.6	51 931 i	:	-0.7	97 036	:	1.9
IT	164 026	33.7	2.2	67 519	18.5	1.3	32 401	43.0	0.9	60 694	44.5	2.6
CY	1 017	39.0	10.6	224	33.5	11.7	352	44.1	0.3	368	34.8	28.0
LV	5 103	56.5	-1.6	881	52.4	-10.4	1 013	62.4	-4.0	3 208	55.7	2.6
LT	10 557	52.4	-2.7	981	43.5	14.6	3 041	53.3	-11.6	6 535	53.2	1.1
LU	4 318	:	4.2	3 655	:	2.3	512	:	14.0	151	:	60.0
HU	22 826	:	-0.8	6 704	:	0.9	7 595	:	-1.9	8 527	:	-1.0
MT	717 b	26.5 b	22.8	383 b	17.8 b	126.0	45	59.6	-42.1	288	32.8	4.3
NL	91 594 p	:	1.0	49 915	:	1.2	13 579	:	1.8	28 100 p	:	1.2
AT	42 891	23.6	5.0	29 143	15.7	4.4	2 035	40.9	-0.6	11 502	39.9	7.9
PL	78 362	28.9	-0.2	12 978	13.7	-8.6	19 685	25.3	1.1	45 572	34.9	2.4
PT	25 529	45.5	4.0	6 124	29.1	14.7	4 917	58.3	-6.5	11 147	49.0	4.4
RO	33 361	46.7	-0.4	16 368	43.7	-7.7	9 853	52.3	6.8	6 917	45.4	16.3
SI	7 132	36.4	-4.5	3 855	32.4	-1.6	1 750	44.3	-9.1	1 482	38.1	-4.0
SK	14 329	44.8	-1.5	3 473	36.8	-9.5	3 493 i	52.5 i	-4.4	7 285	45.2	5.6
FI	58 281	:	2.6	32 612	:	2.6	7 337	:	0.1	17 822	:	3.6
SE	72 978	18.1	0.1	48 113	25.1	-1.6	3 000	33.7	2.8	21 495	:	3.4
UK	:	:	:	151 908	:	1.1	20 796	37.3	-8.5	:	:	:
IS	2 940	38.9	3.6	1 352	34.1	5.6	775	38.2	4.1	728	46.0	0.2
NO	29 748	:	3.2	16 263	:	3.1	4 985	:	1.5	8 500	:	4.3
CH	52 250	:	0.0	33 085	:	-2.2	810 i	:	-2.5	18 355 e	:	4.8
HR	11 162	49.6	-7.2	2 831	46.6	6.7	3 634	51.3	9.5	4 697	50.1	-20.6
TR	28 964	31.5	3.6	5 918	22.8	-0.9	5 502	23.1	16.3	17 544	37.1	
JP	882 414	:	-0.5	580 628	:	-0.1	61 893	:	1.5	224 049	:	-0.6
RU	951 569	:	-1.4	568 173	:	-2.5	282 422	:	0.5	99 402	:	0.0

AAGR is calcultated on R&D personnel expressed in FTE.

Exceptions to the reference year:
2003: BE, DK, DE, PT, SE, IS and JP;
2002: TR.

Footnote 'i':
FR and SK: Defence excluded (all or mostly);
CH: Federal or central government only.

Exceptions to the reference period:
2000-2002: TR;
2000-2003: IS and JP;
2001-2004: BE, SE and NO;
2002-2004: MT, AT and HR.

R&D personnel in head count

In terms of head count (HC), EU-27 R&D personnel reached almost 3 million persons, remaining fairly stable between 2002 and 2004.

The leading countries in terms of R&D personnel expressed in HC were the same as for R&D personnel expressed in FTE: namely Germany, followed by France, Italy and Spain.

With a headcount of 1.3 million, the business enterprise sector (BES) again accounted for the largest share of R&D personnel in the EU-27, but the higher education sector (HES) followed more closely behind than when R&D personnel is expressed in full time equivalent (Table 3.4). This indicates that a larger share of R&D personnel is employed part-time in the HES than in the BES.

The higher education sector made up more than half of total R&D personnel in Estonia, Greece, Spain, Latvia, Lithuania, Hungary, Malta, Poland and Slovakia.

With 378 000 persons employed (HC) in R&D activities, the government sector clearly lagged behind the BES and the HES at EU-27 level.

Table 3.5 R&D personnel in head count (HC), by sector of performance, EU-27 and selected countries — 2002 to 2004

	All sectors			Business enterprise sector			Government sector			Higher education sector		
	2002	2003	2004	2002	2003	2004	2002	2003	2004	2002	2003	2004
EU-27	2 929 502 s	2 949 477 s	2 964 172 s	1 269 744 s	1 269 009 s	1 299 993 s	383 358 s	385 011 s	378 094 s	1 243 543 s	1 262 242 s	1 256 645 s
BE	73 187	73 629	:	37 534	37 812	38 112 p	3 846	3 916	:	31 205	31 284	:
BG	16 847	17 400	18 025	1 866	2 398	2 544	11 039	10 977	11 053	3 913	3 920	4 338
CZ	53 695	55 699	60 148	22 361	24 122	26 967	13 508	13 357	13 220	17 577	17 877	19 725
DK	61 915	60 525	65 994	37 837	35 726	40 346	4 759 b	5 010	4 882	18 929 b	19 406	20 348
DE	:	664 731	:	:	333 285	:	:	84 695	87 586	:	246 751	242 128
EE	6 921	7 600	7 882	1 164	1 529	1 735	980	1 145	1 099	4 694	4 813	4 894
IE	24 486	25 194	26 584	11 960	12 037	12 800	1 609	1 657	1 609	10 917	11 500	12 175
EL	:	56 708	:	13 218	12 259	:	:	9 148	:	:	35 088	:
ES	232 019	249 969	267 943	73 461 b	82 327	92 888	31 536	35 306	39 499	126 275	131 725	135 027
FR	412 938 b	415 061	421 312	200 961	203 264	206 955	54 358 bi	50 690 i	51 284 i	148 830 b	153 131	155 347
IT	253 084	249 889	255 535	85 687	81 189	81 822	39 343	42 610	44 061	122 358	120 736	123 266
CY	1 937	2 102	2 235	511	567	571	750	724	705	494	601	757
LV	9 153	8 002	8 273	2 346	1 228	1 135	1 580	1 472	1 443	5 220	5 302	5 694
LT	13 540	14 534	16 436	553	781	1 309	3 504	3 301	3 330	9 483	10 452	11 797
LU	:	4 135	:	:	3 533	:	478	548	:	:	54 e	:
HU	48 727 i	48 681 i	49 615	9 428	9 438	8 870	11 767 i	11 474 i	11 483	27 532	27 769	29 262
MT	1 121	975	1 329 b	75	97	428 b	251	37	52	795	841	849
NL	109 224 e	106 980 e	:	61 514	57 442	68 286	13 924	15 957 b	15 137	32 793 e	33 581 e	:
AT	65 725	:	74 191	34 020	:	38 737	6 010	:	5 531	25 072	:	29 358
PL	122 987	126 241	127 356	11 312	15 035	16 846	28 543	25 390	23 578	83 011	85 745	86 823
PT	41 601 e	44 036	:	8 352 e	9 882	:	7 876 e	7 273	:	20 300 e	21 488	:
RO	38 433	39 985	40 725	19 088	17 232	16 601	9 111	9 641	10 162	10 234	12 859	13 739
SI	12 379	9 506	10 155	5 330	4 278	4 638	2 826	1 926	2 022	4 013	3 265	3 450
SK	21 025	20 928	22 217	5 425	4 545	4 642	4 402 i	4 458 i	4 046 i	11 192	11 917	13 442
FI	73 121	74 773	76 687	39 239	40 089	40 674	10 064	9 903	9 943	23 126	24 049	25 298
SE	:	108 146	:	:	52 346	:	:	5 521	:	:	49 909	:
UK	:	:	:	:	:	:	23 400	22 761	22 579	:	:	:
IS	4 970	5 466	:	1 810	2 193	:	1 299	1 740	:	1 468	1 323	:
NO	51 086	51 175	:	22 436	22 572	23 865	6 650	6 642	:	22 000	21 961	:
CH	:	:	84 090	:	:	37 820	1 635 i	:	1 595 i	41 955 e	:	44 675 e
HR	16 515	17 216	19 739	2 524	2 237	3 233	4 858	5 487	6 398	9 133	9 492	10 108
TR	79 958	:	:	9 107	:	:	8 644	:	:	62 207	:	:
JP	1 032 826	1 081 099	:	609 694	653 380	:	70 342	72 367	:	331 499	335 983	:
RU	870 878 i	858 470 i	839 338 i	568 628 i	558 668 i	537 473 i	257 462 i	256 098 i	258 078 i	44 135 i	43 120 i	43 414 i

Footnote'i':
FR, HU and SK: Defence excluded (all or mostly);
CH: Federal or central government only;
RU: Underestimated or based on underestimated data.

Researchers in full time equivalent — FTE

Among all the persons employed (FTE) in R&D activities in the EU-27 (Table 3.4), more than 60% were classified as researchers (Table 3.6). They accounted for 1.28 million FTE in 2005.

In a global comparison, the number of researchers in Russia in the same year was 465 000 FTE and in China and Japan in 2003 it amounted to 862 and 675 000 respectively.

Among the EU Member States, Germany (with 271 000) ranked first in terms of researchers followed by France (200 000 in 2004).

More than half of the EU researchers (627 000 thousand FTE) were in 2005 employed in the business enterprise sector. The second largest employer of researchers was the higher education sector (460 000 FTE). At the same time, the government sector employed only 176 000 researchers.

Table 3.6 — Researchers in FTE, by sector of performance, EU-27 and selected countries — 2003 to 2005

	All sectors			Business enterprise sector			Government sector			Higher education sector		
	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005
EU-27	1 206 766 s	1 248 608 s	1 277 090 s	585 487 s	609 407 s	627 473 s	169 813 s	172 102 s	176 250 s	437 025 s	453 796 s	459 661 s
BE	30 917	31 465 p	31 953 p	16 242	16 322 p	16 266 p	2 026	2 124 p	2 238 p	12 389	12 742 p	13 168 p
BG	9 589	9 827	10 053	1 225	1 239	1 157	6 113	6 168	6 076	2 193	2 362	2 607
CZ	15 809	16 300	24 169 b	6 558	7 297	10 353 b	4 833	4 661	6 113 b	4 318	4 274	7 575 b
DK	24 882	26 167	28 187 p	14 734	15 877	17 664 p	2 337	2 287	2 029 p	7 669	7 846	8 287 p
DE	268 942	270 649	271 119 e	161 980	162 239	165 019 e	38 719	42 646	40 100 e	68 243	65 764	66 000 e
EE	3 017	3 369	3 331	505	661	883	478	486	474	1 974	2 162	1 905
IE	10 039	11 010	11 487 p	6 012	6 300	6 768	553	559	419	3 474	4 151	4 300 p
EL	15 631	:	17 024 p	4 295	:	4 328 p	2 136	:	2 307 p	9 072	:	10 251 p
ES	92 523	100 994	109 753 p	27 581	32 054	35 521 p	15 489	17 151	20 240 p	49 196	51 616	53 779 p
FR	192 790	200 064	:	100 646	106 439	:	24 541 i	24 779 i	:	64 403	65 498	:
IT	70 332	72 012	:	26 866	27 594	28 297 p	13 976	14 237	14 428 p	27 774	28 226	:
CY	490	583	644 p	103	108	130 p	109	104	107 p	256	349	375 p
LV	3 203	3 324	3 282	464	448	468	517	490	589	2 222	2 385	2 224
LT	6 606	7 356	7 637	442	484	716	1 686	1 676	1 805	4 478	5 196	5 116
LU	1 949	2 031	2 091 p	1 594	1 546	1 532 p	325	342	383 p	30 e	143	176 p
HU	15 180 i	14 904	15 878	4 482	4 309	5 008	4 741 i	4 693	4 959	5 957	5 902	5 911
MT	276	436 b	442 p	51 p	199 b	189 p	9	19	28	216	218	225
NL	37 282	:	:	19 399	23 158	22 666 p	7 672 b	7 752	7 034	10 211	:	:
AT	:	25 955	28 207 e	:	16 508	17 940 e	:	1 030	1 119 e	:	8 281	8 999 e
PL	58 595	60 944	62 162	6 829	8 334	9 412	13 233	12 804	12 175	38 455	39 716	40 449
PT	20 242	20 623 p	21 003 p	3 794	3 954 p	4 114 p	3 440	3 194 p	2 948 p	10 062	10 600 p	11 138 p
RO	20 965	21 257	22 958	9 920	9 092	10 319	6 043	6 326	7 082	4 941	5 654	5 386
SI	3 775	4 030	3 834	1 516	1 657	1 901	1 044	1 124	1 160	1 178	1 204	742
SK	9 627	10 718	10 921	1 914	1 815	1 947	2 436 i	2 345 i	2 503 i	5 273	6 509	6 458
FI	:	41 004	39 582	:	23 397	21 967	:	4 200	4 374	:	13 037	12 879
SE	48 186	48 784	54 175 b	28 403 i	28 295 i	36 697 bi	2 287 i	2 345 i	3 018 bi	17 146	17 794	14 210 b
UK	:	:	:	99 352	96 747	95 052	9 445	9 205	:	:	:	:
IS	1 917	:	2 155	836	:	1 012	467		501	562	:	585
NO	20 989	21 163	21 653	11 480 i	11 063 i	10 692 i	3 258 i	3 300 i	3 449 i	6 251	6 800	7 512
CH	:	25 400	:	:	12 640	:	:	425 i	:	:	12 335 e	:
HR	5 861	7 140	:	913	1 015	:	2 158	2 420	:	2 790	3 705	:
TR	:	:	:	:	:	:	:	:	:	:	:	:
CN	862 108	:	:	484 164	:	:	191 957	:	:	185 987	:	:
JP	675 330	:	:	458 845	:	:	33 711	:	:	172 396	:	:
RU	487 477	477 647	464 577	267 850	257 621	237 959	146 370	147 896	154 827	71 174	70 844	70 494

Footnote 'i':
FR, HU and SK: Defence excluded (all or mostly);
SE, NO and TR: University graduates instead of reseachers;
CH: Federal or central government only.

Importance and rationale of the 'People' programme in the Seventh research Framework Programme (FP7)

'Abundant and highly trained qualified researchers are a necessary condition to advance science and to underpin innovation, but also an important factor to attract and sustain investments in research by public and private entities. Against the background of growing competition at world level, the development of an open European labour market for researchers free from all forms of discrimination and the diversification of skills and career paths of researchers are crucial to support a beneficial circulation of researchers and their knowledge, both within Europe and in a global setting. Special measures to encourage young researchers and support early stages of scientific career, as well as measures to reduce the 'brain drain', such as reintegration grants, will be introduced.'

More information available on: http://cordis.europa.eu/fp7/people/home_en.html

Source:CORDIS, 2007

As can be seen from Table 3.6, the number of researchers counted as FTE in the EU-27 increased in every sector between 2000 and 2005. The annual average growth rates for all sectors and the BES reached 2.9% and 3.8% respectively (Figure 3.7).

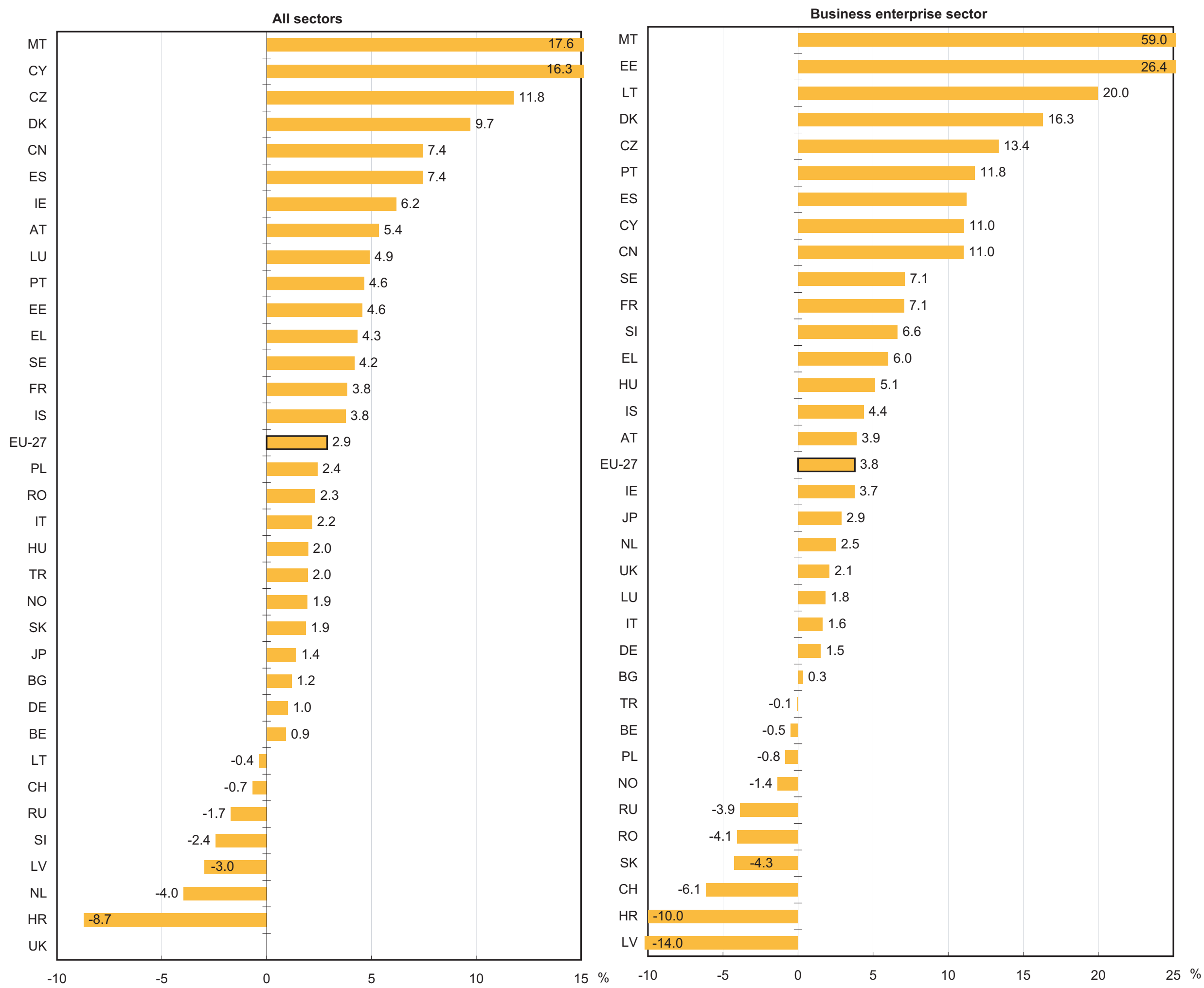
In an international comparison, Japan and China also displayed positive rates of growth in their numbers of researchers. The share of researchers even increased more rapidly in China (7.4%) than in the EU-27 (2.9%). Growth in Japan (1.4%), was weaker. Similar trends can be found for the BES.

Looking at the national level for all sectors, the highest growth rates were recorded in Malta (17.6%), Cyprus (16.3%), the Czech Republic (11.8%) and Denmark (9.7%). Also Spain had a relatively high growth rate of 7.4%, which was the same as for China.

In the BES, the highest growth rates were found in the smaller Member States such as Malta (59.0%), Estonia (26.4%) and Lithuania (20.0%).

In four of the countries shown, the number of researchers declined both in all sectors and in the BES. The greatest decline for all sectors was recorded by Croatia with an AAGR of -8.7% and, for the BES, in Latvia with -14.0 %.

Figure 3.7 **Annual average growth rate (AAGR) of researchers in FTE, all sectors and business enterprise sector, EU-27 and selected countries — 2000-2005**



EU-27: Eurostat estimation.
CZ and SE: Break in series.
DE and AT: National estimations.
BE, DK, IE, EL, CY, LU, MT and PT: Provisional data.
FI: AAGR was not calculated because data is available only for 2004-2005.

Exceptions to the reference period:
2000-2002: TR;
2000-2003: NL (all sectors), CN and JP;
2000-2004: FR, IT (all sectors) and CH;
2001-2005: DK, EL (all sectors), SE, IS and NO;
2001-2004: ES;
2002-2004: HR;
2002-2005: MT and AT.

Researchers by gender

Figure 3.8 shows the share of female researchers measured as head count (HC), both for all sectors and for the business enterprise sector (BES).

With 28.3% and 18.4% of all sectors and the BES respectively, women still are underrepresented among the EU-27's researchers

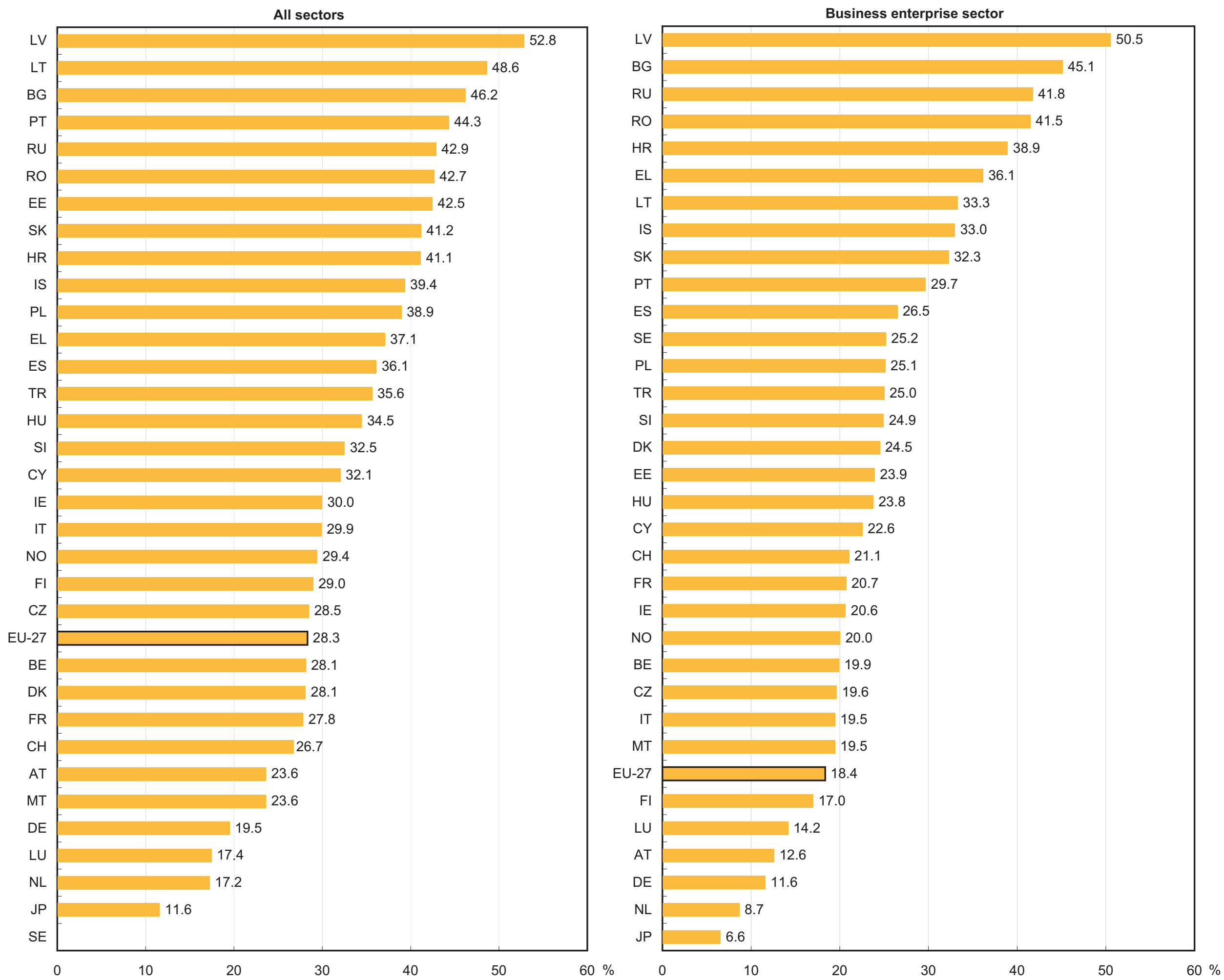
Latvia was the only country in which female researchers, with a 52.8 % share in all sectors, were more common than male. Six other Member States — Lithuania, Bulgaria, Portugal, Portugal, Romania and Estonia — recorded a share of female researchers of over 40%. Apart from Portugal, these were all new Member States (2004 and 2007 enlargements). The share of female researchers also exceeded 40% in Croatia and in Russia.

At the other end of the scale are the Netherlands, Luxembourg and Germany, where females account for less than 20% of all researchers. This share was even lower in Japan (11.5%).

The business enterprise sector displayed a similar pattern. However, shares of female researchers were always lower in this sector by comparison with all sectors. This was true both for the EU-27 and for all individual countries for which data are shown.

For some countries, the share of female researchers was markedly lower in the BES compared to all sectors. This was notably the case of Estonia, Lithuania, Portugal and Poland.

Figure 3.8 **Percentage of female researchers (in HC), all sectors and business enterprise sector, EU-27 and selected countries — 2004**



EU-27: Eurostat estimation.
BE (BES): Provisional data.
LU and NL (all sectors): National estimations.
MT: Break in series.
SE (BES) and NO: University graduates instead of researchers.
RU: Underestimated or based on underestimated data.

Exceptions to the reference year:
2003: BE (all sectors), DK, DE, EL, LU, NL, PT, SE, IS, NO (all sectors) and JP;
2002: TR.

Women in science: Under-represented and under-measured

Women account for a minority of the world's researchers. This is particularly the case in higher-income countries. The higher percentage of industrial research in these countries provides only a partial explanation of the low degree of women's participation in research. A more gender-balanced workforce is found in Eastern Europe and the CIS, Latin America and the Caribbean, as well as some South East Asian countries.

Overall, the under-representation of women in research activities can be traced back to education systems, particularly at the higher levels. Although female participation in higher education has increased globally over the last decade, it remains weak in the most advanced degree programmes.

It is therefore of foremost importance to further analyse other aspects hindering women's access to, continuity and advancement in research positions. This involves issues related to stereotyping, working conditions (the "work/life" balance), labour market conditions, governance and the role of researchers in society.

More information available on: http://www.uis.unesco.org/template/pdf/s&t/BulletinNo3_v12EN.pdf

Source: UNESCO Institute for Statistics (UIS), 2006

Women at the heart of the European research agenda

Gender equality means putting men and women on an equal footing. In an ideal world, this would mean no specific allowances for women would need to be made in research agendas. However, given the substantial gender imbalance in the sciences – women make up half the student population, but hold only 15% of senior academic positions – clear allowances need to be made to promote a healthier gender equilibrium.

The current disequilibrium jeopardises Europe's bid, in the context of its landmark Lisbon Strategy, to forge the world's leading knowledge-based economy. The EU is moving ahead to boost investment in R&D to 3% of its collective gross domestic product (GDP). This is likely to involve the creation of some 700 000 new research-related jobs by 2010 – which Europe will have trouble filling as long as half of its population remain sidelined in the S&T field.

Traditionally, research agendas have not taken the specific needs of women into account. However, if society is to develop a better understanding and acceptance of the developments in science and technology, specific measures must be taken to address both the under-representation of women in science, and the lack of attention paid to gender differences within research.

More information available on: http://ec.europa.eu/research/science-society/index.cfm?fuseaction=public.topic&id=27

Source: European Commission, 2007

Researchers by economic activity

Table 3.9 provides an overview of the breakdown of business enterprise researchers in full time equivalents (FTE) classified by sector of economic activity (NACE). In terms of number of researchers, manufacturing was by far the most important sector of economic activity in 2004 in the EU-27. It made up 70.0% of the entire BES, followed by 'Services' with approximately 27.5%. All the other sectors together made up 2.4%.

With almost 143 000 researchers, Germany led in 'Manufacturing', while the United Kingdom ranked first in 'Services' with 28 000 researchers.

Not only leading in absolute terms of the countries shown, Germany also ranked first in relative terms ,with 88% of business enterprise researchers in 'Manufacturing'. Only France also had a share of over 80% of BES researchers in this sector of economic activity.

However, the distribution varied across Member States. In nine of the Member States, Norway and Croatia, the services sector employed more researchers than did the manufacturing sector.

In Romania, other sectors of activity, mainly 'Agriculture' and, to a lesser extent, 'Mining', accounted for a significant share of business researchers.

Table 3.9 Business enterprise researchers in FTE, by economic activity (NACE Rev 1.1), EU-27 and selected countries — 2004

	Total	Agriculture, hunting, forestry and fishing	Mining and quarrying	Manufacturing	Electricity, gas and water supply	Construction	Services
EU-27	609 407	5 398	2 117	426 748	4 021	3 388	167 735 s
BE	16 322 p	186 i	33 i	10 699 i	116 i	368 i	5 211 i
BG	1 239	:	:	462	0	0	773
CZ	7 297	28	1	3 654	3	53	3 558
DK	15 877	78	:	9 414	:	62	6 287
DE	161 980	215	54	142 537	421	215	18 540
EE	661	0	:	314	17	:	327
IE	6 300	8	2	3 290	0	0	3 000
GR	4 295	10	13	1 960	2	19	2 290
ES	32 054	233	45	15 366	185	701	15 524
FR	106 439	1 145	436	85 245	1 725	408	17 479
IT	27 594	:	94	17 071	88	39	10 302
CY	108	2	0	47	3	1	56
LV	448	:	:	176	:	11	261
LT	484	:	6	364	2	:	112
LU	1 546	:	:	:	:	:	:
HU	4 309	95	3	2 859	69	13	1 270
MT	47	:	0	30	1	0	16
NL	23 158	211	336	14 044	152	746	7 669
AT	16 508	13	10	11 458	42	81	4 904
PL	8 334	0	2	3 872	14	0	4 447
PT	3 794	24	2	1 414	14	56	2 283
RO	9 092	1 305	718	5 644	501	68	856
SI	1 657	0	25	1 272	0	0	360
SK	1 815	48	0	464	:	:	1 297
FI	23 397	3	22	18 516	27	109	4 720
SE	28 403 i	98	42 i	21 567 i	121 i	:	6 575 i
UK	96 747	1 000	:	:	:	:	28 000
NO	11 063 i	76	433	4 570	35	119	5 830
CH	12 640	:	:	9 365	:	:	3 275
HR	1 015	21	0	222	:	23	749
TR	3 697	61	45	2 715	20	4	852

EU-27: Distribution by sector of activity is estimated on the basis of available Member States.
Exceptions to the reference year:
2003: DE, EL, PT and SE;
2002: TR.
Footnote 'i':
BE: Unrevised breakdown not adding to the revised total;
SE and NO: University graduates instead of researchers.

Researchers by field of science

Table 3.10 provides an insight into the breakdown of researchers in the government (GOV) and higher education (HES) sectors by fields of science (FOS).

In 2004, 'Natural sciences' (28.5%) accounted for the largest share of researchers from the two sectors in EU-27. This was also true for each individual country for which data are available, with the exceptions of Denmark, Spain, Malta Romania and Norway. Cyprus (44.4%) and Italy (41.4%) had the highest proportion of researchers devoted to this FOS.

With an EU average of 20.9%, 'Engineering and technology' was second most important FOS in the two sectors, in terms of employment,. In Romania this field was the leading FOS with a share of 31.9%.

Two other FOS each employed more than 15% of the EU's GOV and HES researchers. These fields were 'Medical sciences' (15.8%) and 'Social sciences' (15.6%). In Malta, Denmark and Spain, by far the majority of researchers in these sectors were engaged in 'Medical sciences', with 31.7%, 23.6% and 22.7% respectively. In Hungary and Lithuania, noticeable shares - of around 20 % - of the GOV and HES researchers were active in Humanities.

At EU-27 level, only 6.5% of GOV and HES researchers were active in the field of 'Agriculture'. However, this share was over 10% in Belgium, Bulgaria, Denmark, Portugal and Slovenia.

Table 3.10 Researchers by field of science as a percentage, government and higher education sectors, EU-27 and selected countries — 2004

	Total	Agriculture	Engineering and technology	Medical sciences	Natural sciences	Social sciences	Humanities
EU-27	625 898 s	6.5 s	20.9 s	15.8 s	28.5 s	15.6 s	12.7 s
BE	14 416	10.7	20.7	18.1	22.1	17.7	10.6
BG	8 530	12.2	25.0	7.9	33.8	10.3	10.7
CZ	8 935	8.2	24.1	9.3	36.1	11.7	10.5
DK	10 133	10.5	13.8	23.6	23.1	13.5	15.4
DE	108 410	4.5	23.5	11.4	37.0	10.0	13.6
EE	2 648	5.7	19.5	6.8	35.7	15.8	16.5
IE	4 710	7.2	16.3	15.1	34.3	17.6	9.5
EL	:	:	:	:	:	:	:
ES	68 767	7.5	19.2	22.7	18.5	18.3	13.8
FR	90 276 i	:	:	:	:	:	:
IT	42 463	6.8	16.1	20.3	41.4	13.2	2.2
CY	452	6.1	6.6	1.6	44.4	27.0	14.3
LV	2 875	6.5	17.2	5.7	36.8	19.8	14.1
LT	6 872	4.9	18.4	11.8	26.6	18.9	19.4
LU	485	:	:	:	:	:	:
HU	10 595	9.7	12.1	12.8	28.2	16.0	21.2
MT	237	2.0	11.7	31.7	10.0	30.1	13.5
NL	17 883	:	:	:	:	:	:
AT	9 311	4.0	15.3	20.3	31.3	16.4	12.7
PL	52 520	8.6	21.6	15.9	24.3	18.8	10.8
PT	13 502	10.8	19.6	9.8	31.0	20.4	8.4
RO	11 980	3.7	31.9	20.4	25.5	11.4	7.1
SI	2 328	12.3	20.0	11.5	39.3	10.3	6.7
SK	8 854 i	6.4 i	21.4 i	15.8 i	32.9 i	17.5	6.0
FI	17 237	:	:	:	:	:	:
SE	20 139 i	:	:	:	:	:	:
UK	:	:	:	:	:	:	:
NO	9 509 i	8.6	11.8	20.5	22.2	26.3	10.5

EU-27: Distribution by field of science is estimated on the basis of available Member States.
Distribution by field of science:
Government sector only: IT.
Exceptions to the reference year:
2003: BE, NL, PT and NO.
Footnote 'i':
FR and SK: Defence excluded (all or mostly);
SE and NO: University graduates instead of researchers.

3.3. R&D personnel at the regional level

Île de France (FR) - with more than 135 000 persons employed in R&D - was the leading region in terms of R&D personnel in FTE (Figure 3.11). This region on its own accounted for 6.5% of total R&D personnel in EU-27.

Germany, with six regions, was the most represented country among the top leading regions in absolute terms. Oberbayern (DE) and Stuttgart (DE) ranked second and third, with 59 000 and 47 000FTE respectively.

Denmark, which is classified as a region at NUTS level 2, was ranked fourth in absolute terms. Spain and Italy were represented twice in the top 15, while Belgium and Finland both had one region in the rankings.

Comparing the two rankings, it appears that the top 15 regions in terms of the absolute number of R&D personnel do not automatically have the highest shares.

The leading region as regards the share of R&D personnel in total employment was Wien (AT), with 4.52%. This represented approximately 17 000 FTE, which was almost eight times lower than Île de France FR). Conversely, Île de France (FR) — the leading region in absolute terms — was ranked only in twelfth place as a share of total employment (3.52%).

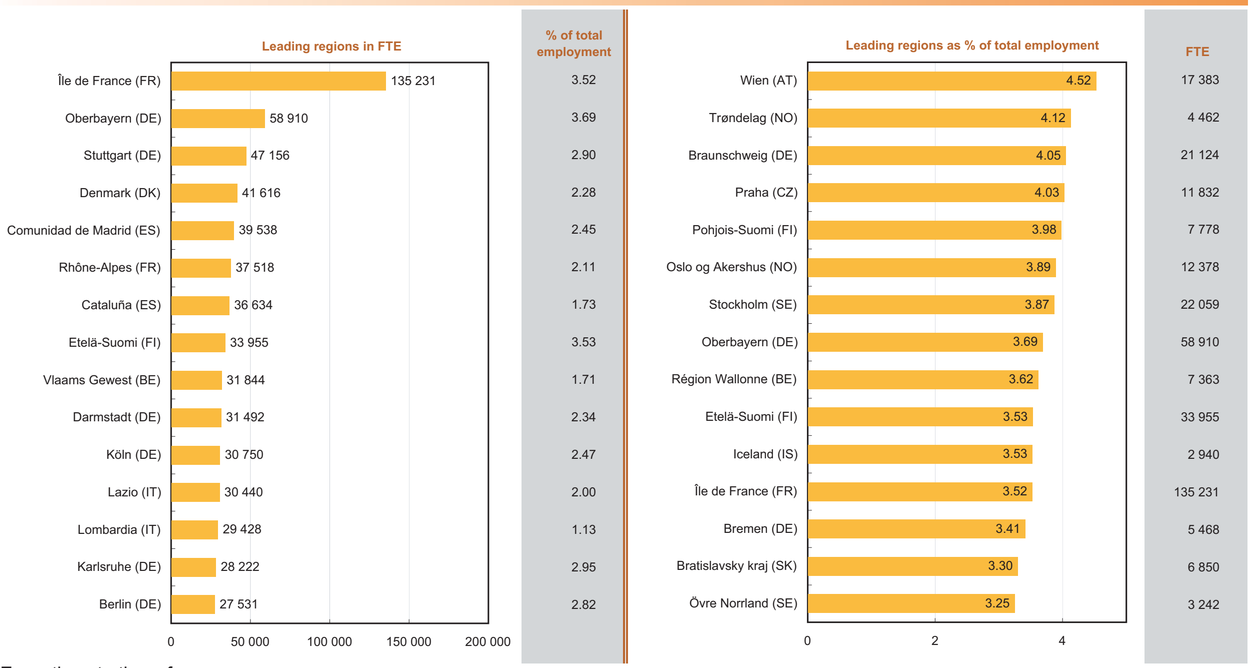
The regions of Trøndelag (NO) and Braunschweig (DE) are ranked second and third with 4.12% and 4.05% respectively. Iceland, which is also classified as a region at NUTS level 2, is ranked eleventh as a share of total employment.

One of the salient features of the top 15 leading regions in relative terms is that seven of them are in fact capital regions.

Map 3.12 provides an overview of the percentage of researchers as a share of total employment. Only nine European regions had more than a 2% share in 2003. Among them, Trøndelag (NO) led with a share of 2.95%. Iceland, two German regions — Oberbayern and Bremen (DE) — and five capital regions — Wien (AT), Oslo og Akershus (NO), Bratislavsky kraj (SK), Région de Bruxelles-Capitale (BE) and Praha (CZ) — also had a share of researchers exceeding 2% of total employment.

All other European regions were below this threshold of 2%. Moreover, only six other European regions recorded a percentage higher than 1.5%: Île de France (FR) and five German regions.

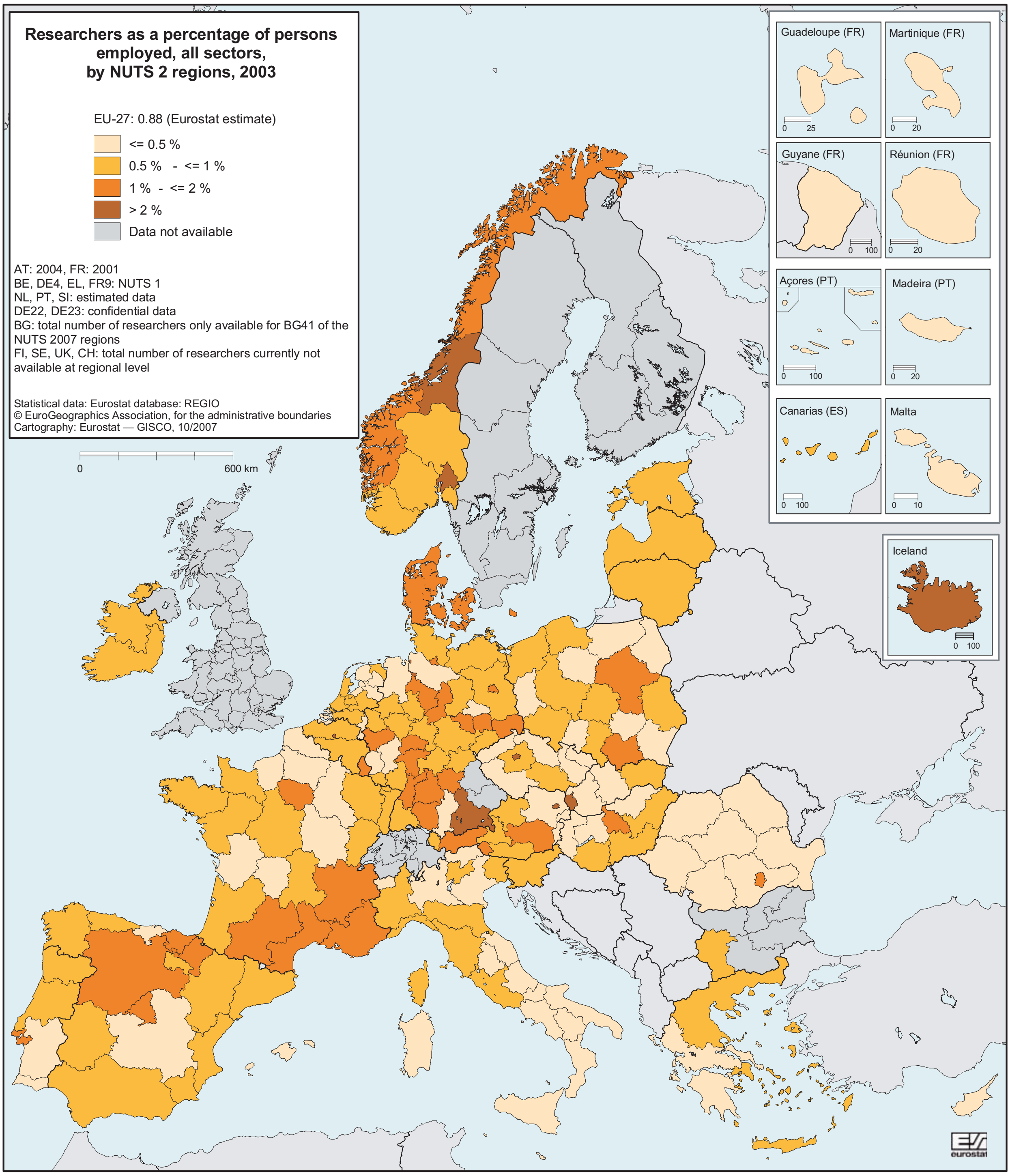
Figure 3.11 **Top 15 regions in terms of R&D personnel in FTE and as a percentage of total employment (HC), all sectors — 2003**



Exceptions to the reference year:
- 2004: CZ, ES, AT, FI;
- 2002: FR;
- 1999: SE.

NUTS 1: BE.

Map 3.12 **Researchers as a percentage of persons employed, all sectors by NUTS 2 regions — 2003**



PART2

Chapter 4 - Human Ressources in Science and Technology

4.1 Introduction

The European Union (EU) places strong emphasis on the need to invest more in research and development and human capital through better education and skills. This is considered to be a key determinant of economic growth in a knowledge-based economy.

In 2005, new EU policy lines were set up through the Relaunch of the Lisbon Strategy to focus priorities on economic growth and employment. A strong partnership for jobs and growth would have to be developed based on the "knowledge for growth" concept, between the EU, Member States and all stakeholders.

Statistics on Human Resources in Science and Technology (HRST) contribute significantly to measuring this new economy and its dynamism. They review the supply of, and demand for, highly qualified people in science and technology. The aim of this chapter is to examine three aspects in detail: education inflows, stocks of HRST and HRST mobility.

To support the analysis of Human Resources in Science and Technology, a number of sub-categories, described in Figure 4.1, were defined in line with the recommendations laid down in the Manual on the Measurement of Human Resources devoted to Science and Technology (S&T) — the Canberra Manual (1) — on the basis of the following internationally harmonised standards:

- The International Standard Classification of Education (ISCED), giving the level of formal education achievement;
- The International Standard Classification of Occupations (ISCO), detailing the type of occupation.

Human Resources in Science and Technology — HRST — are defined as persons fulfilling at least one of the following conditions:

- Human resources in terms of education — HRSTE: individuals having successfully completed tertiary level education in an S&T field of study — ISCED 97 version levels 5a, 5b or 6,

and/or

- Human resources in terms of occupation — HRSTO: individuals working in an S&T occupation as professionals and technicians — ISCO-88 COM codes 2 or 3.

To define the S&T field of study more precisely, according to the Canberra Manual (§ 71), seven broad S&T fields of study are used: Natural Sciences, Engineering and Technology, Medical Sciences, Agricultural Sciences, Social Sciences, Humanities, and Other Fields.

Furthermore, even though the official definition of HRST as set out in the Canberra Manual contains the terms "S&T" (Science and Technology), the definition is not restricted by these terms: HRSTE covers all fields of study, while HRSTO refers to two specific major ISCO classes:

ISCO 2 'Professionals' and ISCO 3 'Technicians and associate professionals' — see methodological notes.

An HRST sub-population of particular interest is 'Scientists and Engineers' (SE). Those more likely to be involved in leading-edge technology professions are 'Physical, mathematical and engineering' occupations (ISCO-88 COM code 21), and 'Life science and health' occupations (ISCO-88 COM code 22) (2).

Data are calculated from two main sources:

- The inflows, which use data from Eurostat's education database, collected via the joint Unesco/OECD/Eurostat — UOE — questionnaire on education statistics;
- The European Union Labour Force Survey — EU LFS — which is used for elaborating data on stocks and mobility for HRST.

The education inflows detailed in Chapter 4.2 are a useful measure of the current and future supply of Human Resources in S&T, because by completing tertiary level education the individual will move into the stock of HRST. Inflows can be sub-divided into various groups, each providing a different focus. Measurements are divided into participation in tertiary education (used to estimate potential future inflow rates into the labour market) and graduation from tertiary education (actual inflows).

Information on participation in tertiary education also includes data on foreign students. These data give an idea of the proportion of internationally mobile students in Europe. Lastly, doctoral students, entering the most highly educated section of the work force, are analysed more closely.

Data on stocks of Human Resources in S&T in Chapter 4.3, meanwhile, provide an indication of the number of HRST at a particular point in time. These can then be broken down to provide information on socio-economic categories of interest, such as the gender ratio, age distribution, type of occupation or the sector of economic activity in which people are working.

Finally, HRST mobility results show two different aspects: the job-to-job mobility of employed HRST in Chapter 4.4 and the international mobility of HRST in and outside the EU in Chapter 4.5. Job-to-job mobility illustrates the ability of HRST to move between different jobs and is based on the length of stay with the same employer. The indicator is built up by considering the number of HRST employed in years t and t-1 who have changed jobs during the past 12-month period. A high intensity of HRST job-to-job mobility is considered as a good stimulus for the economy of a country.

The international mobility of HRST is based on the person's citizenship. It is defined as the particular legal bond between an individual and their state acquired by birth or naturalisation.

(1) Manual on the Measurement of Human Resources devoted to S&T, Canberra Manual, OECD, Paris, 1994.

(2) Scientists and engineers differ, however, from the Frascati Manual definition of researchers, which includes persons in ISCO-88 Major Group 2 Professional Occupations, Research and Development Department Managers ISCO-88 1237 and members of the armed forces with similar skills who perform R&D; Standard method for surveys on R&D and experimental development, Frascati Manual, OECD 2002, paragraph 302.

Figure 4.1 Definitions of Human Resources in Science and Technology (HRST) categories

			HRSTE – **HRST in terms of Education** –			
			Tertiary education			*Lower than tertiary education*
			ISCED 6	*ISCED 5a*	*ISCED 5b*	*ISCED < 5*
HRSTO – **HRST in terms of Occupation** –	*ISCO 2*	Professionals	HRST Core – **HRSTC**			HRST without tertiary education
	ISCO 3	Technicians				
	ISCO 1	Managers	HRST non-core			Non-HRST employed
	ISCO 0, 4-9	All other occupations				
		Unemployed	HRST unemployed – HRSTU			Non-HRST unemployed – NHRSTU
		Inactive	HRST inactive			Non-HRST inactive

Lisbon strategy for growth and jobs

The meeting of the European Council in Lisbon in March 2000 launched the Lisbon Strategy aimed at making the European Union "the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion" and achieving full employment by 2010. This strategy, developed at subsequent meetings of the European Council, rests on three pillars: an economic pillar preparing the ground for the transition to a competitive, dynamic, knowledge-based economy; a social pillar designed to modernise the European social model by investing in human resources and combating social exclusion; and an environmental pillar drawing attention to the fact that economic growth must be decoupled from the use of natural resources. Recognising the limited progress achieved so far towards these targets, the European Council decided in 2005 to **relaunch the Lisbon Strategy** to focus priorities on economic growth and employment. This revised strategy, no longer based on all the targets set in 2000, retained only the figure of 3% of GDP for research as an objective.

As part of this process, a new set of employment guidelines for the period 2005 to 2008 was adopted by the Council in July 2005 to reflect the renewed focus on jobs, and they form part of the Integrated Guidelines. The employment guidelines continue to reflect the EU's overall goal of achieving full employment, quality and productivity at work, and social and territorial cohesion, and advocate a lifecycle approach to work that tackles the problems faced by all age groups. The **employment guidelines** fall under three broad areas for action, namely to:

- Attract and retain more people in employment and modernise social protection systems;
- Improve adaptability of workers and enterprises and the flexibility of labour markets;
- Increase investment in human capital through better education and skills.

The follow-up of the Lisbon strategy for growth and jobs will be an important theme for 2007. The consensus on innovation reached at the European Council in Lahti will put the spotlight on measures at both European, national and local level to stimulate innovation in all sectors of the economy. In addition, it will be useful to assess progress made and discuss future approaches regarding one of the core elements of the Lisbon strategy for growth and jobs – the European Research Area (ERA). Some progress has been made since the concept was endorsed at the Lisbon European Council in 2000. The ERA concept combines: a European "internal market" for research, where researchers, technology and knowledge freely circulate; effective European-level coordination of national and regional research activities, programmes and policies; and initiatives implemented and funded at European level.

Sources: Integrated guidelines for growth and jobs (2005-2008), Brussels, 12.4.2005, COM (2005) 141 final 2005/0057 (CNS); Employment in Europe, 2006, European Commission, DG for Employment, Social Affairs and Equal Opportunities, Unit D1, October 2006; The European Research Area: New Perspectives, European Commission, Brussels, 4.4.2007, COM(2007) 161 final

4.2 Education inflows

Participation in tertiary education

In 2004, close to one seventh of the total EU student population were following a tertiary education, which represented more than 18 million students. Comparing these students to the total population aged 20-29 (as the majority of tertiary students are in this interval) then one out of four in this age group in Europe was in tertiary education. But national disparities are clearly apparent. In absolute numbers, 70% of the students participating in tertiary education are found in 6 EU countries, mainly owing to the size of the countries and the large university network. Compared to the population aged 20-29, Finland had the highest proportion in the EU.

Looking at the specific fields of education of "Science, mathematics and computing" and "Engineering, manufacturing and construction", it appears that one student in four was studying one of these subjects at EU-27 level in 2004. These students taking a science or engineering course accounted for nearly 7% compared to the population aged 20-29.

Nevertheless, engineering courses were more popular than science. Close to 4% was studying engineering compared to the population aged 20-29, while less than 3% were on science courses. This was reflected in most EU countries, the exceptions being Ireland, Greece, Cyprus, the UK, Iceland and Norway. Finland, where there is close cooperation between the Finnish educational institutions and industry, had the highest proportion of students compared to the population aged 20-29 (12.4%) studying engineering. Conversely, Greece had the highest proportion studying science (6.7%). In Bulgaria and Romania, the share of students in engineering compared to the population 20-29 years was more than four times the share of students following a course in science.

Table 4.2 Students participating in tertiary education, total and in selected fields of study, proportion of the population aged 20-29 and proportion of female students, EU-27 and selected countries — 2004

	Students participating in tertiary education, 2004								
	In any field			In science, mathematics and computing			In engineering, manufacturing and construction		
	Total	% of population aged 20-29	% female	Total	% of population aged 20-29	% female	Total	% of population aged 20-29	% female
EU-27	18 234 656 s	27.6 s	54.8 s	1 711 631 s	2.8 s	37.5 s	2 367 365 s	3.8 s	24.0 s
EU-25	17 320 470 s	28.2 s	54.8 s	1 665 958 s	2.9 s	37.0 s	2 171 796 s	3.8 s	23.4 s
BE	386 110	29.8	53.8	35 722	2.8	28.5	44 270	3.4	22.8
BG	228 468	22.6	52.5	11 496	1.1	49.6	50 463	5.0	32.2
CZ	318 858	19.8	51.2	30 028	1.9	35.4	65 655	4.1	20.3
DK	217 130	34.3	57.9	19 761	3.1	31.8	22 501	3.6	33.6
DE	2 330 457	25.8	49.4	347 397	3.8	33.8	360 034	4.0	18.9
EE	65 659	34.5	61.8	6 580	3.5	39.9	7 859	4.1	26.9
IE	188 315	28.2	55.2	23 094	3.5	41.2	20 790	3.1	16.7
EL	597 007	40.3	51.7	99 359	6.7	37.9	90 404	6.1	28.1
ES	1 839 903	27.7	53.8	241 763	3.6	35.9	324 936	4.9	27.7
FR	2 160 300	27.1	55.0	:	:	:	:	:	:
IT	1 986 497	27.7	56.2	153 683	2.1	48.7	319 739	4.5	27.1
CY	20 849	21.7	47.9	2 623	2.7	33.2	843	0.9	10.1
LV	127 656	38.8	62.3	8 833	2.7	33.5	12 280	3.7	20.9
LT	182 656	39.0	60.0	11 280	2.4	36.0	35 578	7.6	27.8
LU	2 717	39.0	60.0	152	2.4	36.0	267	7.6	27.8
HU	422 177	27.8	57.3	24 174	1.6	33.7	54 406	3.6	18.6
MT	7 867	14.4	55.9	468	0.9	33.1	698	1.3	26.9
NL	543 396	27.6	50.9	41 224	2.1	19.6	44 576	2.3	13.5
AT	238 521	24.3	53.3	28 528	2.9	34.6	30 004	3.1	20.6
PL	2 044 298	33.9	57.6	138 839	2.3	40.3	272 641	4.5	22.5
PT	395 063	24.9	56.1	30 968	2.0	49.2	85 414	5.4	26.7
RO	685 718	20.1	54.8	34 177	1.0	57.5	145 106	4.3	30.2
SI	104 396	35.1	56.9	5 358	1.8	30.3	17 508	5.9	23.7
SK	164 667	18.0	54.1	14 903	1.6	34.4	28 621	3.1	28.7
FI	299 888	46.4	53.4	34 816	5.4	41.3	80 167	12.4	18.5
SE	428 642	40.0	59.5	41 379	3.9	41.9	71 949	6.7	28.2
UK	2 247 441	31.9	57.0	325 026	4.6	36.1	180 656	2.6	18.9
IS	14 710	37.6	64.5	1 351	3.5	35.2	980	2.5	31.1
NO	213 845	38.1	59.6	22 184	4.0	32.7	13 874	2.5	23.8
EEA30	18 463 211 s	27.7	54.8 s	1 735 166 s	:	37.5 s	2 382 219 s	:	24.0 s
CH	195 947	21.8	44.9	22 656	2.5	26.4	26 622	3.0	13.9
HR	:	:	:	:	:	:	:	:	:
TR	1 972 662	:	41.4	144 889	:	40.3	281 986	:	18.9

Eurostat estimations for selected fields of study without FR: EU-27, EU-25 and EEA-30.
Exception to the reference year: LU 1999.
Students of all ages participating in tertiary education are divided by the population aged 20-29 years.

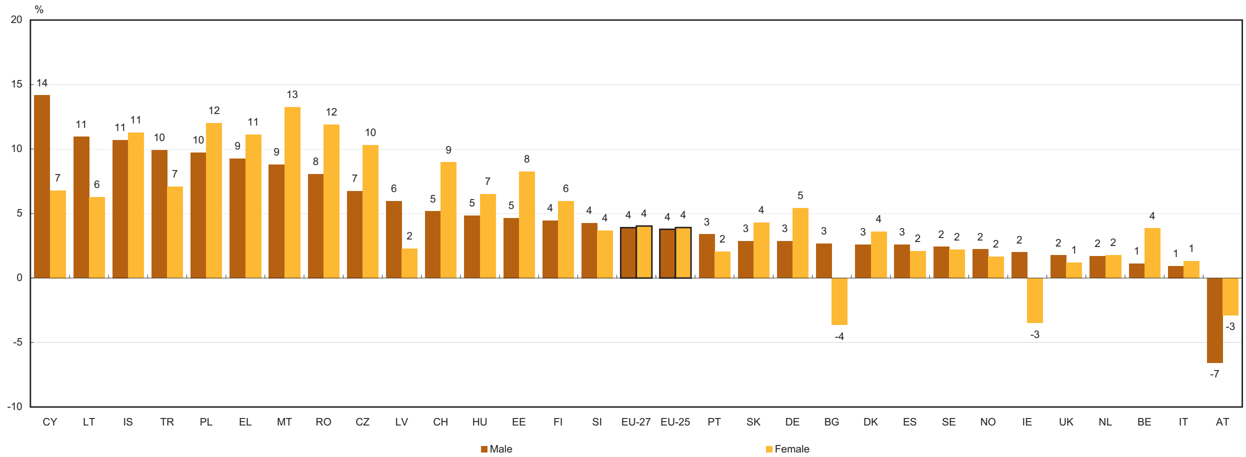
Regarding the gender distribution, although females accounted for more than half of all students in all countries — with the exception of Turkey, Switzerland, Cyprus and Germany — this was not the case when it came to analysing the specific fields of study of science and engineering in Table 4.2. Parity in science fields in the EU was only achieved in Romania (57.5%) and almost reached in Bulgaria and Portugal (49.6% and 49.2% respectively), countries where student participation in science was well below the EU average. At EU level, nearly four out of ten students in science in 2004 were female, while the corresponding proportion in the Netherlands was as low as one in five.

“Engineering, manufacturing and construction” courses have even more problems attracting female students. Denmark and Bulgaria, with 33.6% and 32.2%, had the highest ratios of female engineering students in the EU. At the other end of the scale, Cyprus scored the lowest percentage of female students in engineering, with a rate of only 10.1%.

As shown in Figure 4.3, the overall number of tertiary students in science and engineering is growing in both genders. Between 1999 and 2004, the number of students in tertiary education in EU-27 increased at an annual average rate of 4% both for female and male students.

Over this period, the highest growth for scientist and engineer male students in the EU is found in Cyprus (14%). This large increase still falls below the growth of male tertiary students in all fields (close to 18% in the same period). Malta scored the highest EU growth for female students in science and engineering, with 13%. At the bottom of the scale, Austria saw a decrease in its number of both male and female students following science and engineering courses (-7% for male students and -3% for female students). Meanwhile, most of the new Member States displayed growth rates for male and female students in these specific fields higher than or equal to the EU-27 annual growth rate, especially among female students.

Figure 4.3 **Annual average growth rates of the number of students participating in tertiary education in Science and Engineering, by gender, EU-27 and selected countries — 1999 to 2004**



Exceptions to the reference period: EU-27, EU-25, BE and TR 2000/2004; PT 2001/2004; EL and CH 2002/2004.
Eurostat estimations: EU-27 and EU-25.

Erasmus Mundus

The Erasmus Mundus programme is a cooperation and mobility programme in the field of higher education which promotes the European Union as a centre of excellence in learning around the world. It supports European top-quality Masters courses and enhances the visibility and attractiveness of European higher education in third countries. It also provides EU-funded scholarships for third country nationals participating in these Masters courses, as well as scholarships for EU nationals studying at partner universities throughout the world.

Erasmus Mundus was first introduced in July 2001. Subsequently, the Commission adopted a programme proposal, Erasmus World (renamed Erasmus Mundus), in July 2002. On 5 December 2003, the Erasmus Mundus programme decision was adopted and entered into force on 20 January 2004. The Erasmus Mundus programme has earned political support from governments, policy makers and higher education institutions all over Europe. It is seen as a useful means to face the need to stimulate the process of the convergence of degree structures and to enhance the attractiveness of European higher education world-wide. These are themes central to the Bologna process and to national reform of higher education in Member States. Furthermore, Erasmus Mundus coincides with the European Union’s Lisbon Strategy, a commitment to making Europe the most competitive and knowledge-based economy in the world and a reference for high quality and excellence in education.

Source: http://ec.europa.eu/education/programmes/mundus/index_en.html

Student mobility

The previously described national figures for overall participation in tertiary education include also foreign students. A foreign student is defined according to the citizenship of the individual. Overestimation of foreign students may exist in some countries. In some cases, for example, permanently resident second-generation immigrants with foreign nationalities can constitute an important group of students. Despite these limitations, foreign students can otherwise be interpreted as internationally mobile students.

Foreign students participating in tertiary education and those choosing to study subjects related to Science and Engineering (S&E) in 2004 are shown in Figure 4.4. Large disparities from one EU country to another exist between the proportion of foreign students and the total respective student population. Cyprus, with a 32% share, was the leading EU country with the highest proportion of foreign students, followed by the United Kingdom with a share of 16.2%.

This proportion fell to as low as 0.4% in Poland and Lithuania.

In Finland and Germany, respectively 40.8% and 34.0% of all internationally mobile students followed science and engineering related disciplines. These proportions exceeded the popularity of S&E programmes for the total tertiary student population at national level found in Table 4.2 (38.3% and 30.3% respectively).

Looking at the S&E fields in the United Kingdom and Cyprus, nearly 20% of all students studying S&E in 2004 were foreign (19.9% and 18.4% respectively). Furthermore, Cyprus also featured one of the highest annual growth rates between 1999 and 2004, with an annual increase of 24% in the number of foreign S&E students. The highest annual growth rate among the EU countries was shown by the Czech Republic with 34%. Despite a general trend towards growth, a few EU countries registered a loss of foreign students, such as Latvia (-23%), Romania (-4%) and Austria (-2%).

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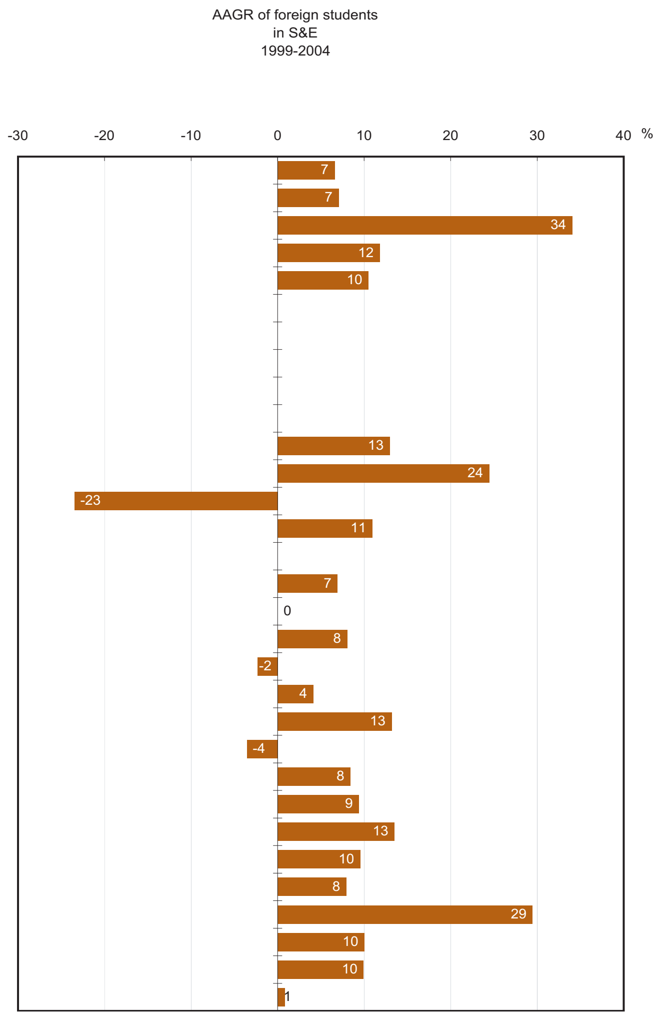
Figure 4.4 **Foreign students participating in tertiary education, total and in proportion of S&E students, EU-27 and selected countries — 2004**

	Foreign students			
	In any field		In S&E	
	Total	As % of the respective student population	Total	As % of the respective student population
BE	37 091	9.6	6 889	8.6
BG	8 286	3.6	1 602	2.6
CZ	14 923	4.7	3 808	4.0
DK	17 162	7.9	5 123	12.1
DE	260 314	11.2	88 541	12.5
EE	1 090	1.7	:	:
IE	10 201	5.6	:	:
EL	14 361	2.4	:	:
ES	41 734	2.3	5 703	1.0
FR	237 587	11.0	:	:
IT	40 641	2.0	8 388	1.8
CY	6 679	32.0	638	18.4
LV	2 390	2.0	131	0.7
LT	738	0.4	163	0.3
LU	:	:	:	:
HU	12 913	3.1	2 582	3.3
MT	442	5.6	29	2.5
NL	21 259	3.9	4 175	4.9
AT	33 707	14.1	8 079	13.8
PL	8 118	0.4	730	0.2
PT	16 155	4.1	4 735	4.1
RO	9 730	1.5	923	0.5
SI	1 108	1.1	271	1.2
SK	1 640	1.0	328	0.8
FI	7 915	2.6	3 227	2.8
SE	36 458	8.5	11 879	10.5
UK	364 271	16.2	100 612	19.9
IS	489	3.3	80	3.4
NO	12 392	5.8	2 910	8.1
CH	35 705	18.2	10 644	21.6
TR	15 298	0.8	3 619	0.8



Exceptions to the reference year: EE, IE, LV and RO 2003.
Exceptions to the reference period: PT, SK and TR 2000/2004; BE and CY 2001/2004; CH 2002/2004; LV and RO 1999/2003.

Doctoral students

Doctoral students are defined as students following the second stage of tertiary education programmes (ISCED level 6). These programmes are devoted to advanced study and original research. They are not based on course-work only, and lead to the award of an advanced research degree, e.g. a doctorate in economics, in sociology or in physics ([1]). Therefore, indicators of the number of doctoral students as shown in Table 4.5 provide an idea of the extent to which countries will have researchers at the highest level of education. In 2004, even when excluding Germany, Luxembourg and Slovenia — for which no data were available — approximately 526 000 doctoral students were counted in the EU. In other words, 2.9% of the total student tertiary population (excluding the three missing countries) in 2004 were following a doctoral programme. Almost one third of these doctoral students was found in France and in the UK, mainly owing to the wide diversity of doctoral programmes and qualifications proposed. In addition, parity was almost reached as European female doctoral students accounted for almost half of all doctoral students (46.9%). Looking at the doctoral student participation in specific fields of education, "Science, mathematics and computing" are more popular than "Engineering, manufacturing and construction", which is the opposite of the picture for the total tertiary student participation shown in Table 4.2. In the EU, Greece and Cyprus had the highest proportion of their doctoral students taking science courses. Conversely, engineering attracted more doctoral students than science in many of the new Member States and Scandinavian countries. Up to one in three of all doctoral students in the Czech Republic followed engineering courses in 2004. In addition, female doctoral student preferences largely went to "Science, mathematics and computing" rather than "Engineering, manufacturing and construction". While parity was almost achieved in science in the EU in 2004, almost 70% of the doctoral students in engineering were males.

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Table 4.5 **Doctoral students (ISCED level 6), total and in selected fields of study, proportion of the population aged 20-29 and proportion of female doctoral students, EU-27 and selected countries — 2004**

	Doctoral students (ISCED level 6), 2004								
	In any field			In science, mathematics and computing			In engineering, manufacturing and construction		
	Total	Per 1 000 population aged 20-29	% female	Total	Per 1 000 population aged 20-29	% female	Total	Per 1 000 population aged 20-29	% female
EU-27	525 574 s	8.0	46.9 s	88 112 s	:	42.5 s	69 760 s	:	27.7 s
EU-25	502 695 s	8.2	46.7 s	85 547 s	:	42.3 s	65 737 s	:	26.5 s
BE	7 014	5.4	38.9	2 143	1.7	37.9	946	0.7	20.3
BG	4 834	4.8	51.0	766	0.8	47.9	1 107	1.1	36.6
CZ	23 282	14.4	36.4	5 005	3.1	38.9	6 856	4.2	19.6
DK	5 093	8.0	43.2	926	1.5	34.1	1 018	1.6	24.9
DE	:	:	:	:	:	:	:	:	:
EE	1 653	8.7	53.5	469	2.5	44.6	219	1.2	35.2
IE	4 339	6.5	45.7	1 613	2.4	45.2	705	1.1	24.5
EL	18 907	12.8	41.9	8 346	5.6	35.3	2 277	1.5	31.1
ES	76 895	11.6	50.7	11 486	1.7	47.1	7 782	1.2	29.1
FR	101 309	12.7	47.1	:	:	:	:	:	:
IT	37 608	5.2	51.0	9 486	1.3	51.4	7 305	1.0	34.2
CY	202	2.1	49.5	85	0.9	45.9	5	0.1	20.0
LV	1 425	4.3	58.2	225	0.7	46.7	209	0.6	33.5
LT	2 623	5.6	55.7	488	1.0	53.7	577	1.2	33.4
LU	:	:	:	:	:	:	:	:	:
HU	7 835	5.2	42.3	1 813	1.2	33.6	840	0.6	25.7
MT	17	0.3	23.5	:	:	:	:	:	:
NL	7 054	3.6	41.1	:	:	:	:	:	:
AT	15 524	15.8	45.5	2 558	2.6	35.5	2 037	2.1	21.9
PL	32 054	5.3	47.6	4 892	0.8	51.7	6 544	1.1	28.0
PT	17 445	11.0	54.0	3 080	1.9	54.8	2 813	1.8	33.7
RO	18 045	5.3	51.4	1 799	0.5	53.5	2 916	0.9	50.8
SI	:	:	:	:	:	:	:	:	:
SK	9 371	10.2	40.6	1 402	1.5	41.9	2 255	2.5	26.3
FI	21 207	32.8	50.5	3 060	4.7	45.8	5 481	8.5	26.5
SE	22 460	21.0	47.1	4 492	4.2	39.1	4 994	4.7	28.7
UK	89 378	12.7	43.9	23 978	3.4	37.6	12 874	1.8	21.2
IS	51	1.3	52.9	7	0.2	28.6	5	0.1	60.0
NO	4 356	7.8	42.6	1 207	2.1	34.6	645	1.1	18.8
EEA30	529 981 s	7.9	46.9 s	89 326 s	:	42.4 s	70 410 s	:	27.6 s
CH	15 850	17.6	38.8	4 525	5.0	33.1	1 686	1.9	19.8
HR	:	:	:	:	:	:	:	:	:
TR	24 891	:	38.8	3 608	:	41.4	4 682	:	31.5

Eurostat estimations without DE, LU, SI: EU-27, EU-25 and EEA-30 and for selected fields of study also without FR, MT, NL.
Doctoral students of all ages are divided by the population aged 20-29 years.

([1]) International Standard Classification of Education, ISCED 1997, UNESCO, 1997.

Graduation from tertiary education

Though student participation rates are a useful proxy for future expectations of the national stocks of HRST, they should be complemented by data on the actual number of people becoming HRST. Data on tertiary graduates measure this.

In 2004, there were more than 3.5 million new tertiary graduates in the European Union — see Table 4.6. Two EU Member States, the United Kingdom and France, accounted for more than 30% of these tertiary graduates. Poland, which had reformed and modernised its tertiary education system, came next with a share of 13.6% of all EU graduated tertiary students in 2004.

Balancing these new graduates against the young population, for every thousand persons aged 20-29 in the EU there were close to 59 new graduates. However, this proportion varies from more than 80 new graduates per thousand 20-29 year olds in the United Kingdom, Ireland, Lithuania and Poland, to just over 30 new graduates in Austria. As previously seen in Table 4.2, this country also had a participation in tertiary education below the EU average.

The majority of these tertiary graduates in the EU in 2004 were female (58.7%). This proportion of all female graduates was higher than the proportion they achieved in terms of participation (54.7%). In addition, five of the six EU countries with the highest shares of female tertiary graduates were new Member states. In Estonia, more than 70% of tertiary graduates were female.

Table 4.6 Graduates from tertiary education, total and in selected fields of study, proportion of the population aged 20-29 and proportion of female graduates, EU-27 and selected countries — 2004

	Graduates from tertiary education, 2004								
	In any field			In science, mathematics and computing			In engineering, manufacturing and construction		
	Total	Per 1 000 population aged 20-29	% female	Total	Per 1 000 population aged 20-29	% female	Total	Per 1 000 population aged 20-29	% female
EU-27	**3 569 884 s**	**58.7 s**	**58.7 s**	**354 611 s**	**5.7 s**	**40.3 s**	**464 687 s**	**7.5 s**	**24.3 s**
EU-25	**3 376 515 s**	**57.2 s**	**58.7 s**	**344 543 s**	**6.0 s**	**39.8 s**	**431 254 s**	**7.5 s**	**23.6 s**
BE	76 996	59.4	57.1	6 945	5.4	30.3	7 630	5.9	20.8
BG	45 957	45.4	58.3	2 235	2.2	56.4	7 418	7.3	37.2
CZ	54 341	33.7	58.0	4 120	2.6	39.5	8 018	5.0	24.2
DK	46 726	73.8	58.8	4 374	6.9	33.5	4 695	7.4	31.1
DE	319 791	35.4	52.7	32 178	3.6	34.9	53 725	5.9	17.1
EE	10 235	53.8	71.6	879	4.6	47.9	854	4.5	33.1
IE	55 852	83.6	57.0	8 290	12.4	43.0	7 061	10.6	17.5
EL	48 135	32.5	60.9	8 292	5.6	41.9	4 864	3.3	38.0
ES	298 448	44.9	57.7	32 816	4.9	37.2	50 368	7.6	25.8
FR	584 849	79.1	56.6	75 894	10.3	41.0	95 481	12.9	21.7
IT	324 505	45.2	58.1	23 871	3.3	53.7	49 744	6.9	28.7
CY	3 547	36.9	59.7	347	3.6	42.9	119	1.2	20.2
LV	23 852	72.5	69.2	1 264	3.8	39.3	1 845	5.6	28.2
LT	38 095	81.3	66.5	1 841	3.9	43.9	6 489	13.9	33.3
LU	:	:	:	:	:	:	:	:	:
HU	68 070	44.9	63.5	2 668	1.8	37.6	5 301	3.5	23.7
MT	2 145	37.3	57.3	100	1.7	30.0	112	1.9	31.3
NL	96 890	49.3	56.1	6 909	3.5	24.1	8 693	4.4	15.9
AT	30 664	31.3	50.6	2 584	2.6	35.7	6 281	6.4	17.2
PL	486 313	80.6	65.5	24 969	4.1	41.1	34 144	5.7	27.6
PT	68 668	43.3	65.9	7 363	4.6	50.8	10 008	6.3	33.9
RO	147 412	43.3	57.3	7 833	2.3	58.8	26 015	7.6	32.4
SI	14 888	50.1	60.4	558	1.9	40.0	2 219	7.5	21.2
SK	35 371	38.6	56.7	3 310	3.6	41.1	5 220	5.7	31.6
FI	38 645	60.3	62.0	3 083	4.8	48.8	8 154	12.7	21.8
SE	53 848	50.3	61.0	5 156	4.8	45.9	11 945	11.2	28.6
UK	595 641	84.6	57.7	86 732	12.3	37.4	48 284	6.9	20.1
IS	2 838	72.6	66.6	314	8.0	42.0	145	3.7	29.7
NO	32 043	57.1	60.3	2 554	4.5	26.2	2 559	4.6	22.7
EEA30	**3 605 136 s**	**54.0**	**58.7 s**	**357 503 s**	**:**	**40.2 s**	**467 445 s**	**:**	**24.3 s**
CH	60 342	67.1	44.1	5 968	6.6	21.8	7 214	8.0	11.4
HR	:	:	:	:	:	:	:	:	:
TR	258 858	:	44.0	24 573	:	45.1	49 910	:	23.2

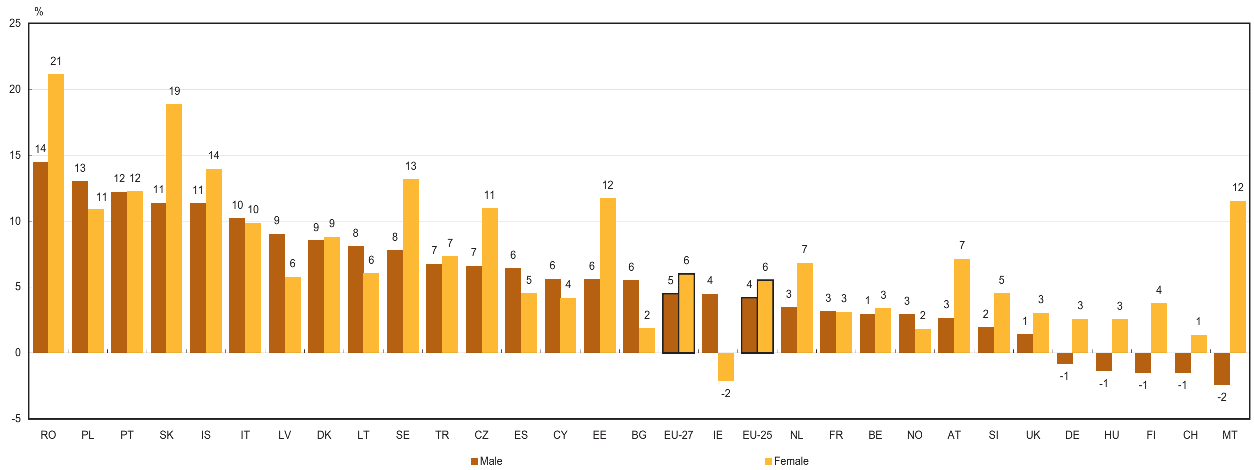
Eurostat estimations: EU-27, EU-25 and EEA-30.
Exceptions to the reference year: FR, MT and FI 2003; LU 1998.
Graduates of all ages from tertiary education are divided by the population aged 20-29 years.

Looking at the graduate distribution by specific fields of study, close to one out of four EU graduates received their diploma in science or engineering related disciplines. As previously seen in Table 4.2, the engineering fields of study were the most popular in most EU countries. But national specificities exist. For example, Lithuania had almost 14 new tertiary graduates in engineering for every thousand persons aged 20-29 and 3.5 times less in science. Conversely, the United Kingdom, with one of the highest shares of tertiary graduates in science compared to the population aged 20-29 (12.3‰), reached only a proportion of 7 tertiary graduates in engineering for every thousand persons aged 20-29.

Whilst the female proportion was close to parity in the science fields of study, accounting for 40.3% of science graduates in the European Union, the corresponding percentage for females in engineering was much lower, with a share of only 24.3%.

In science, five EU countries had a share of female graduates in tertiary education above 50%, of which Bulgaria and Romania, the two new Member States, were in top position. In engineering, females were much under-represented. The highest share of female tertiary graduates in this field is scored by Greece with only 38%.

Figure 4.7 **Annual average growth rates of graduates from tertiary education in Science and Engineering, by gender, EU-27 and selected countries — 1999 to 2004**



Exceptions to the reference period: FR, MT and FI 2003/1999; CH 2002/2004; BE 2000/2004.
Eurostat estimations: EU-27 and EU-25.

The annual average growth rates of graduates from tertiary education in Science and Engineering (SE) by gender for each EU country and other selected countries are illustrated in Figure 4.7. In most of the countries, the number of new SE graduates in tertiary education is increasing mainly because students have become more aware of the economic and social benefits of tertiary education.

In the EU, Romania had the highest growth rates for both genders between 1999 and 2004, with 14% for male and 21% for female graduates. This is the main result of the major reform initiated by the Romanian higher education institutions themselves since 1990. New curricula as well as efficient new universities have been set up under the reform programme and the number of students enrolled in various study programmes available in Romania has been steadily rising.

The EU average increase ranges from 5% for male graduates to 6% for female graduates. Looking at the new Member States, seven out of twelve had annual average growth rates above the EU average for both genders.

Europe is progressing towards a knowledge economy with regard to human resources as most of the EU countries recorded an increase in the number of SE graduates in tertiary education. Five countries are nevertheless exceptions to this trend with a decline for male graduates between 1999 and 2004. Ireland was the only country scoring a negative annual growth rate for female graduates with -2%.

Doctoral Graduates

Of the 3.5 million new EU tertiary graduates in 2004, more than 93 thousand graduated with a doctorate — Table 4.8. This is two times more than the United States and six times more than Japan. In Europe, Germany was the leading EU country in terms of the absolute number of doctoral graduates — as around one in four doctoral graduates in Europe graduated in Germany — followed by the United Kingdom (with a total of 15 257 doctoral graduates in 2004). Compared to the total population aged 20-29, Sweden had the highest share of new doctorates with 3.6‰. Germany was next, followed by Austria and Portugal. In these countries, compared to 1 000 persons aged 20-29 years, 2.5 persons obtained a doctorate in 2006.

Again, Sweden is the EU country scoring the highest proportion of doctorates compared to the population aged 20-29 in science and engineering. Close to one in a thousand persons aged 20-29 achieved a doctoral diploma in these fields of study. Overall, science, mathematics and computing were more popular doctoral fields of study than engineering, manufacturing and construction.

In 2004, 43.4% of the EU doctorates graduated in 2004 were female. Proportions of over 60% were registered in Estonia and Cyprus.

Disparities exist between the specific fields of study of science and engineering. In science, there were seven EU countries with more female doctoral graduates than male. For engineering, the proportion of female doctoral graduates in all EU countries is way below 50%. The closest to parity was in Bulgaria, where 39.2% of all doctoral graduates in engineering were females. But this fell to as low as 18.6% in Austria or 11.8% in Germany.

Table 4.8 Doctoral graduates (ISCED level 6), total and in selected fields of study, proportion of the population aged 20-29 and proportion of female doctorate graduates, EU-27 and selected countries — 2004

	Doctoral graduates (ISCED 6 level), 2004								
	In any field			In science, mathematics and computing			In engineering, manufacturing and construction		
	Total	Per 1 000 population aged 20-29	% female	Total	Per 1 000 population aged 20-29	% female	Total	Per 1 000 population aged 20-29	% female
EU-27	93 235 s	1.5 s	43.4 s	26 117 s	0.4 s	39.1 s	13 000 s	0.2 s	23.6 s
EU-25	90 163 s	1.6 s	43.2 s	25 889 s	0.4 s	39.0 s	12 236 s	0.2 s	23.2 s
BE	1 479	1.1	33.9	658	0.5	28.9	89	0.1	20.2
BG	392	0.4	50.8	77	0.1	55.8	74	0.1	39.2
CZ	1 732	1.1	35.6	410	0.3	34.9	468	0.3	21.2
DK	788	1.2	35.9	100	0.2	26.0	376	0.6	27.9
DE	23 138	2.6	39.0	6 025	0.7	29.5	2 107	0.2	11.8
EE	209	1.1	62.2	50	0.3	44.0	16	0.1	37.5
IE	683	1.0	45.7	265	0.4	45.3	108	0.2	28.7
EL	1 295	0.9	38.1	711	0.5	32.3	119	0.1	21.0
ES	8 168	1.2	47.5	2 249	0.3	48.9	603	0.1	27.9
FR	8 420	1.1	41.7	4 042	0.5	38.4	779	0.1	25.9
IT	6 351	0.9	50.9	1 931	0.3	54.0	1 177	0.2	31.2
CY	13	0.1	61.5	6	0.1	83.3	:	:	:
LV	84	0.3	58.3	15	0.0	53.3	13	0.0	38.5
LT	301	0.6	57.5	70	0.1	61.4	62	0.1	33.9
LU	:	:	:	:	:	:	:	:	:
HU	893	0.6	42.9	171	0.1	32.7	36	0.0	33.3
MT	5	0.1	20.0	:	:	:	:	:	:
NL	2 679	1.4	39.4	499	0.3	37.7	483	0.2	23.4
AT	2 443	2.5	40.5	444	0.5	35.1	397	0.4	18.6
PL	5 460	0.9	46.9	867	0.1	52.9	908	0.2	24.1
PT	3 963	2.5	54.7	1 013	0.6	51.5	579	0.4	35.6
RO	2 680	0.8	49.3	151	0.0	45.7	690	0.2	28.7
SI	355	1.2	40.6	93	0.3	40.9	86	0.3	25.6
SK	854	0.9	45.0	177	0.2	46.3	155	0.2	29.7
FI	1 759	0.3	48.7	306	0.5	43.1	361	0.6	25.5
SE	3 834	3.6	42.6	944	0.9	39.1	1 096	1.0	25.9
UK	15 257	2.2	43.1	4 843	0.7	37.9	2 218	0.3	21.2
IS	10	0.3	50.0	4	0.1	50.0	:	:	:
NO	756	1.3	39.8	:	:	:	6	:	50.0
EEA30	94 001 s	:	43.4 s	26 121 s	:	39.1 s	13 006 s	:	23.6 s
CH	2 952	3.3	36.9	791	0.9	32.7	319	0.4	20.4
HR	:	:	:	:	:	:	:	:	:
TR	2 680	:	38.0	368	:	37.8	418	:	34.9

Eurostat estimations: EU-27, EU-25 and EEA-30.
Exception to the reference year: FR, MT and FI 2003.
Doctoral graduates of all ages are divided with the population aged 20-29 years.

Statistics on the Careers of Doctorate Holders (CDH statistics)

It has been increasingly perceived over the years that the provision of sufficient and well-trained human resources in R&D and beyond, will be a challenge for EU countries. The Lisbon and the Barcelona European Council Conclusions as well as the EU strategy for growth and employment, emphasized the needs for boosting the overall R&D and innovation efforts in the EU. These strategies require the mobilization of a very high qualified workforce of doctorate holders working in research or in other areas of the economy. Indeed, doctoral graduates are at the same time the most qualified people in terms of educational attainment and those who are trained and most predisposed for research careers. They are expected to contribute to the advancement and diffusion of knowledge and technologies.

In the recent years, the user needs for measuring the career development and mobility of the highest skilled part of the labour force were discussed and identified. The "Availability and Characteristics of Surveys on the Destination of Doctorate Recipients in OECD Countries" inventory in 2003 showed that many national surveys existed and provided valuable information for the understanding of career patterns and mobility of the target population. However, such surveys had been developed to serve national statistical needs and were not harmonised internationally.

For this reason, the OECD launched in 2004 a collaborative project to improve countries' capability to survey recipients of highly advanced degrees. The objective was to develop an internationally comparable production system of indicators on their careers and mobility. The UNESCO's Institute for Statistics (UIS) and Eurostat, joined rapidly this project on "Statistics on the Careers of Doctorate Holders" (CDH). These efforts also led to the creation of an international Expert Group bringing together more than 40 countries from a wide variety of regions world-wide. The CDH project measure personnel characteristics, the career development, mobility or other characteristics linked to the highest skilled workforce. The overall objective is to develop international statistics of high quality on mobility and career paths of the highest educated part of the work force. The project focuses on doctorate holders as this small group is considered most likely to contribute to the advancement and diffusion of knowledge and technologies.

Based on the work of the Expert Group, a set of project components were elaborated to be used for the compilation and production of harmonised and high quality CDH statistics, including:

- Output tabulation program: This template used by countries when delivering the requested data to the international organisations, currently consists of around 30 tables, dealing with different aspects of the doctorate holders and their career paths.
- Definitions of variables used in tabulations
- Methodological guidelines: These guidelines are building on best practices and aiming at further strengthening the quality of the output. The guidelines also define and structure the target population and the sources to be used are also described and some aspects of data collection, data processing and estimation of results are taken up.
- Core model questionnaire: all questions helping to complete the output tabulation.
- A structure for national data compilation methodologies to be delivered together with the output tables.

Three sub groups worked in parallel on the project components: developing a set of tables for data compilation led by the OECD, harmonization of methodology led by Eurostat and developing a model questionnaire led by UIS.

The implementation of this package of project components started at European level in 2007 and an updated methodology template was made available to countries together with a technically improved template of the CDH statistics questionnaire in the autumn of 2007.

A majority of EU countries engaged efforts in the building up of the necessary national infrastructure for CDH statistics and for the implementation of the national CDH statistics surveys. The CDH statistics should be compiled at national level every two years. Countries will compile the CDH statistics at national level in 2007, based on the reference year 2006. Eurostat will start the data treatment when the first data is incoming (most probably during the spring 2008).

A broad evaluation of the CDH statistics 2006 is due to take place in 2008. . The detailed assessment reports on tables, indicators and methodology used, provided by countries early 2008, will be used to assess the 2006 data and metadata submissions, in order to establish an improved version of the CDH package in view of the next data collection exercises.

Sources: Workshop on Statistics on the Careers Development of Doctorate Holders (CDH statistics), Luxembourg, 26-27 April 2007; Working Group Meeting on Statistics on science, Technology and Innovation, Luxembourg, 05/06 November 2007; Mapping careers and mobility of doctorate holders: draft guidelines, model questionnaire and indicators, the OECD/Eurostat/ UNESCO careers of doctorate holders (CDH) project

4.3 Stocks of human resources in science and technology

The global dimension to the demand for Human Resources in Science and Technology (HRST) and access to international sources of S&T personnel is becoming more and more important. After having analysed the supply of human resources in science and technology through the inflow provided by tertiary education, this section looks at the demand side of HRST by analysing the labour markets in the EU Member States. In general, the HRST supply increased as inflows of graduates from tertiary education also increased.

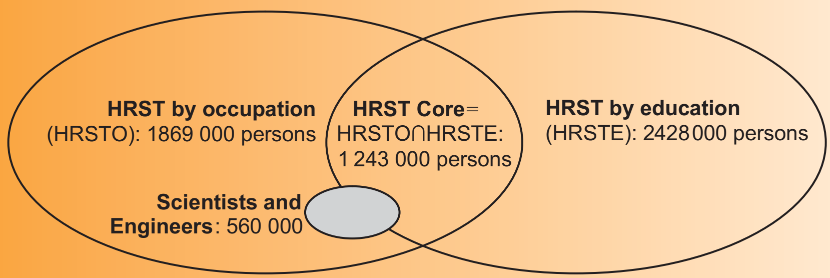
The measurement of stocks of HRST and of its various sub-categories — named "HRST in terms of occupation" (HRSTO), "HRST in terms of education" (HRSTE), "HRST core" (HRSTC) and "Scientists and Engineers" (SE) — provides broad indicators on the state of the labour markets for knowledge workers in European countries.

HRST stocks at national level

Table 4.9 shows the stocks of human resources in science and technology (HRST) in 2006 and the growth in the number of persons employed in S&T over time. Germany, the United Kingdom and France, with more than 10 million HRST in each country, had the largest HRST populations in 2006. In other words, nearly half of the EU's 85 million total HRST were found in these three countries.

Even if national disparities exist in terms of gender distribution, the EU-27 average in 2006 reached parity, with 50.1% female HRST. Proportions of over 50% were registered in 16 out of the 27 EU countries. In Latvia, the proportion of female HRST was the highest within the EU, at 64.5%. Two other countries, Estonia and Lithuania, followed closely with proportions over 60%. Conversely, this figure was only 42.2% in Malta.

Human resources in science and technology in Australia



The number of Australians with an advanced diploma, bachelor degree or higher degree (HRSTE) and/or employed as specialist managers or professionals (HRSTO) was more than 3 million in August 2001. This represented 21% of the population aged 15 years and over. The HRSTE increased from 11% in 1991 to 16% in 2001, while the share of HRSTO increased from 10% in 1991 to 13% in 2001. Australia's stock of scientists and engineers increased by 17.6% over the five-year period. Of the HRST in 2001, 34% were aged 15-34 years, 49% were aged 35-54 years and 17% were aged 55 years and over. Females accounted for 51% of the persons who were HRST in 2001.

Of the persons with selected qualifications and/or employed in selected occupations (HRST) in 2001, 11% were persons born overseas who had not taken out Australian citizenship, with the main countries of origin being the United Kingdom (64 000), New Zealand (42 000) and India (19 000). By state and territory, HRST ranged from 16% to 22% of the population in 2001, with the exception of the Australian Capital Territory where the percentage was 36%.

Australian HRST as a percentage of total Australian population ranked fifth in comparison with ten European countries for which similar data are available. Australia was ranked below Finland, Belgium, Denmark and the Netherlands but above Ireland, Germany, France, Spain, Italy and Portugal.

Source: Human Resources by selected qualifications and occupations, in Australia, 2001, Australian Bureau of Statistics, May 2003

Focusing on the sub-groups of HRST, 40% of HRST were tertiary educated and employed in S&T (HRSTC). In addition, in all EU countries the number of HRSTC increased between 2001 and 2006, even though male HRSTC decreased marginally in Bulgaria and Finland. Slovenia had the highest growth rate in the number of tertiary educated males working in S&T occupations as well as the second highest for females (12.3% and 10.8% respectively). Looking at the growth rates of tertiary educated females employed in S&T, the annual average growth rate of Luxembourg was above that of Slovenia, at 15.0%.

In addition, growth in the number of HRSTC was higher for females than for males in most of the EU countries (21 countries out of 27). The EU-27 average showed a growth of 4.7% for females against 2.9% for males. This is mainly due to the efforts made by many EU countries to institute positive actions and measures to support women in science and engineering fields and promote gender equality.

Table 4.9 Human resources in Science and Technology (S&T) stocks, 25-64 years old, by HRST category and proportion of females and annual average growth rate of HRSTC, 2001 to 2006, EU-27 and selected countries — 2006

	HRST Human resources in S&T		HRSTC Human resources in S&T core		HRSTE Human resources in S&T in terms of education excluding HRSTC		HRSTO Human resources in S&T in terms of occupation excluding HRSTC		Annual average growth rate of HRSTC 2001-2006	
	1 000s	% female	1 000s	% female	1 000s	% female	1 000s	% female	% male	% female
EU-27	**84 674 s**	**50.1 s**	**34 036 s**	**51.3 s**	**26 316 s**	**48.4 s**	**24 322 s**	**50.0 s**	**2.9 s**	**4.7 s**
EU-25	**81 511 s**	**49.8 s**	**32 592 s**	**51.1 s**	**25 463 s**	**48.4 s**	**23 457 s**	**49.7 s**	**2.9 s**	**4.7 s**
BE	2 137	49.6	907	52.5	849	49.8	381	42.3	2.0	3.3
BG	1 055	59.4	491	68.0	422	54.7	141	43.3	-0.1	2.6
CZ	1 740	51.9	536	45.9	266	45.1	938	57.2	3.7	5.4
DK	1 328	51.4	673	56.6	358	45.0	297	47.5	2.7	3.8
DE	16 737	47.1	6 337	42.9	4 503	39.2	5 897	57.6	1.4	2.9
EE	276	61.6	104	71.2	127	50.4	45	71.1	3.7	3.6
IE	772	52.7	324	54.0	353	53.3	95	45.3	6.1	8.9
EL	1 484	48.5	747	49.5	520	47.7	217	46.5	4.7	6.7
ES	8 081	48.6	3 383	50.5	3 719	49.8	979	37.2	5.2	7.3
FR	10 744	50.3	4 365	52.0	3 685	55.5	2 694	40.4	1.1	2.5
IT	8 373	49.1	2 636	51.5	1 513	55.9	4 224	45.1	3.0	6.9
CY	141	47.5	64	48.4	57	50.9	20	30.0	4.0	6.2
LV	363	64.5	138	71.7	123	60.2	102	58.8	4.0	4.9
LT	591	61.3	242	72.3	245	45.7	104	73.1	0.6	3.3
LU	90	46.7	48	43.8	19	47.4	23	52.2	9.2	15.0
HU	1 409	58.3	571	57.4	419	52.5	420	65.2	4.7	6.2
MT	45	42.2	17	47.1	9	55.6	18	33.3	0.0	9.9
NL	3 781	48.0	1 657	47.6	1 028	43.9	1 096	52.6	3.8	6.5
AT	1 426	44.5	446	46.4	356	36.8	623	47.4	5.7	4.5
PL	5 005	58.5	2 180	59.6	1 454	52.9	1 371	62.5	9.4	7.9
PT	1 101	53.2	523	61.4	257	54.1	321	39.3	6.6	6.2
RO	2 108	53.7	953	52.5	431	40.1	724	63.4	4.3	6.1
SI	375	54.1	166	60.2	80	46.3	130	50.8	12.3	10.8
SK	791	55.8	270	49.6	163	44.8	359	65.2	9.1	5.0
FI	1 234	54.5	550	58.9	445	54.6	239	44.4	-0.2	2.4
SE	2 092	51.6	1 004	59.4	455	51.6	633	39.2	3.0	4.0
UK	11 395	47.9	4 704	51.8	4 460	46.9	2 231	42.0	2.0	3.9
IS	62	54.8	31	54.8	13	53.8	18	55.6	8.8	9.1
NO	1 059	50.9	545	55.0	268	51.5	245	41.6	0.0	2.4
EEA30	**85 795 s**	**50.1 s**	**34 612 s**	**51.4 s**	**26 597 s**	**48.4 s**	**24 585 s**	**50.0 s**	**2.9 s**	**4.7 s**
CH	1 817	42.0	733	35.2	464	34.7	620	55.8	1.9	7.2
HR	:	:	:	:	:	:	:	:	:	:
TR	:	:	:	:	:	:	:	:	:	:

Eurostat estimations: EU-27, EU-25 and EEA-30.
Exceptions to the reference year: LU, IS and CH 2005.
Exceptions to the reference period: LU, IS and CH 2001/2005.

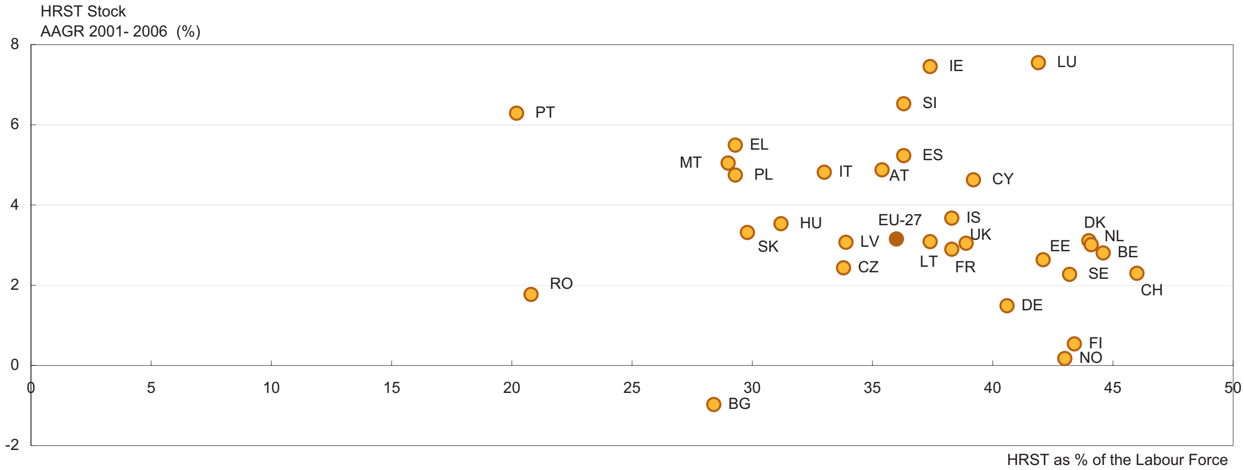
Employment of Human Resources in S&T – some features

The evolution of the HRST stock between 2001 and 2006 as well as its share in the total labour force are illustrated in Figure 4.10. In the EU average, the HRST stock accounted for 36% of the total labour force in 2006. This proportion is combined with positive growth of 3.2% over the period 2001-2006. Nevertheless, large differences between the countries are apparent.

Luxembourg and Ireland had the largest average growth in HRST, with around 7.5%. These two countries combine large growth with a relatively high share of HRST among the labour force (41.9% and 37.4% respectively). By comparison, Portugal, which had a 2001 to 2006 average HRST growth of 6.3%, accounted for the smallest share of HRST among the labour force in the EU, with 20.2%.

At the other end of the scale, Bulgaria registered a decrease in its number of HRST during the same period with an annual average reduction close to -1%. Looking at HRST as a proportion of the total labour force, Romania and Portugal (as mentioned before) featured low percentages (around 20%), while Belgium, Denmark, Estonia, the Netherlands, Finland, Sweden, Norway and Switzerland reached proportions close to 45%. Nevertheless, the growth of HRST stock was nearly nil in Norway and Finland whereas for the rest of these countries, it reached a growth of over 2%. One explanation of these proportions could be the cross-border movement of highly skilled workers resulting from the promotion of intra-EU mobility.

Figure 4.10 **Annual average growth rates of HRST, 2001 to 2006, and their proportion of the labour force, EU-27 and selected countries — 2006**



Exceptions to the reference period: LU, IS and CH 2001/2005.

Highly qualified persons employed in S&T by occupation

To enrich the information given in Figure 4.10, Figure 4.11 details the type of occupation of tertiary educated persons employed in science and engineering (HRSTE) in the EU and other countries and relates it to the labour force.

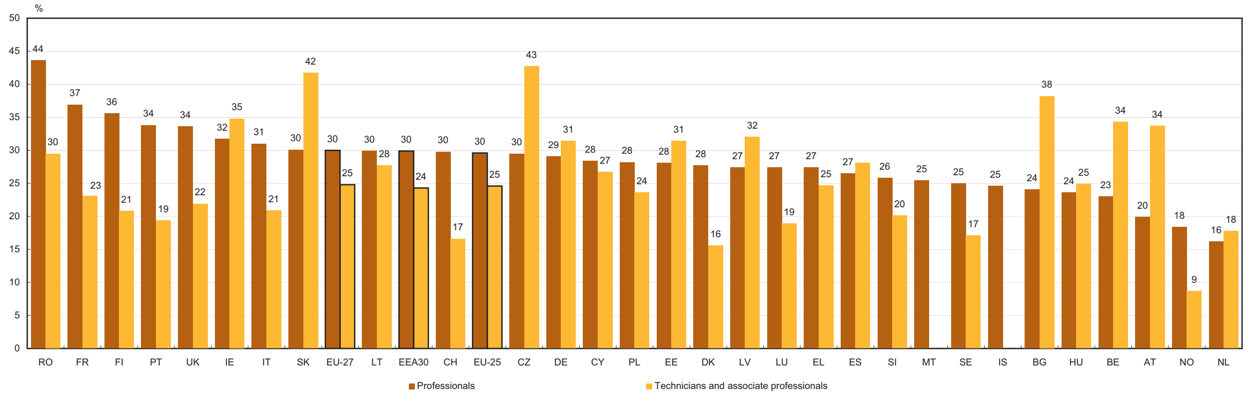
In most of the countries, HRSTE were more likely to work as professionals than as technicians. Professionals conduct research, improve or develop concepts, theories and operational methods, or apply knowledge relating to different areas of science. Technicians and associate professionals perform mostly technical and related tasks connected with research and the application of scientific and artistic concepts and operational methods, and government or business regulations, and teach at certain educational levels.

The EU average of employed HRSTE as a percentage of the labour force in 2006 was 25% in technician occupations and up to 30% in professional occupations. Romania had the highest share of HRSTE occupied as professionals among the labour force (44%), followed by France and Finland (37% and 36% respectively).

Moreover, Denmark is the EU country having the lowest share of HRSTE working as technicians in terms of labour force, with 16%.

Notable exceptions to this trend are Austria, Bulgaria, the Czech Republic, Slovakia and Belgium, where the share of HRSTE occupied as technicians was much higher than that of professionals. In the Czech Republic and Slovakia more than two out of five employed technicians were HRSTE.

Figure 4.11 **Employed HRST with tertiary education in Science and Engineering (HRSTE), by selected field of occupation, as a percentage of labour force, EU-27 and selected countries — 2005**



Eurostat estimations: EU-27, EU-25 and EEA-30.
Exceptions to the reference year: ES 2004; CZ 2003.
Unreliable data: LT, SI and IS for Technicians; EE and MT for Professionals and Technicians.

Scientists and engineers

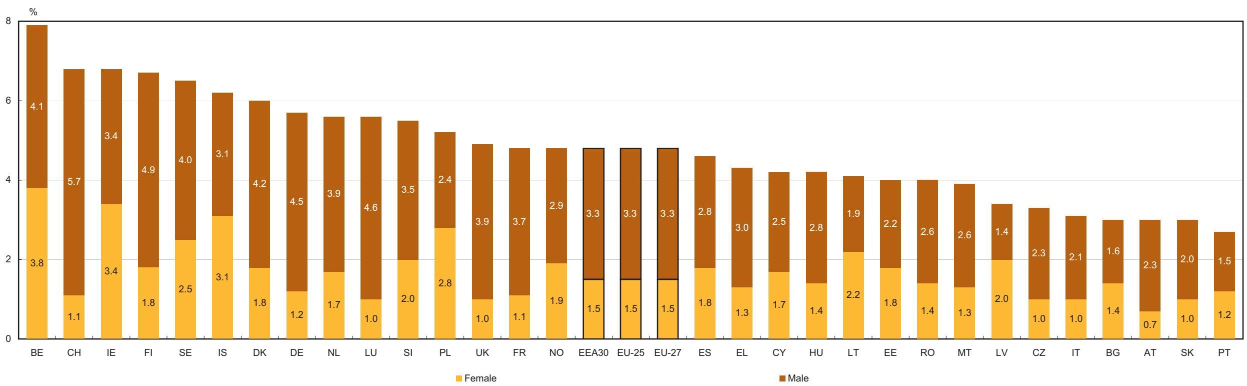
Scientists and Engineers — SE — are an HRST subset of particular interest. By definition, it encompasses all people working in specific occupations listed in 'Physical, mathematical and engineering' occupations (ISCO-88 COM code 21) as mathematicians or civil engineers and in 'Life science and health' occupations (ISCO-88 COM code 22) as biologists or medical doctors (see more in methodological notes).

Figure 4.12 illustrates the gender distribution of Scientists and Engineers as a percentage of the total labour force in 2006. Clearly, scientists and engineers were more likely to be male than female in 2006, and this in most of the countries. The male proportion was especially high in Switzerland. Notable exceptions were Latvia, Poland and Lithuania, where scientists and engineers were more likely to be female.

In 2006, the gender ratio in Germany, Luxembourg and the United Kingdom was around four male scientists or engineers to one female. Ireland was the only EU country which achieved gender parity in the distribution of male and female SE in 2006, and this with a high proportion of scientists and engineers among the labour force (6.8%).

The highest proportion of scientists and engineers in 2006 was found in Belgium, where almost 8% of the labour force declared that they had an occupation qualifying them as scientists or engineers. At the other end of the scale is Portugal, where the proportion of scientists and engineers fell to under 3% of the total labour force.

Figure 4.12 **Breakdown of Scientists and Engineers (SE), 25-64 years old, by gender, as a percentage of the total labour force, EU-27 and selected countries — 2006**



Exceptions to the reference year: LU, IS and CH 2005.
Eurostat estimations: EU-27, EU-25 and EEA-30.
Unreliable data: EE for Female and Male; MT for Female and LT for Male.

HRST intensity by sector of economic activity

Table 4.13 **HRST intensity of employed people with S&T education (HRSTE), as a percentage of total employment, 25-64 years old, in selected sectors of economic activities, EU-27 and selected countries — 2006**

	HRST intensity — share of employed 25-64 years old HRSTE of total employment — in sectors of economic activity					
	Agriculture, hunting, forestry, fishing, mining and quarrying	Utilities and construction	Manufacturing		Services	
			High and Medium high-tech	Medium low and Low-tech	Knowledge-intensive services (KIS)	Less knowledge-intensive services (LKIS)
EU-27	**7.3**	**14.1**	**25.9**	**13.8**	**46.0**	**19.9**
EU-25	**8.7**	**14.2**	**26.5**	**14.4**	**45.9**	**19.8**
BE	14.9	17.2	33.2	21.0	60.7	25.5
BG	4.8	11.4	18.2	10.4	59.5	25.3
CZ	6.8	9.6	12.1	6.4	33.0	11.3
DK	14.0	15.9	36.2	21.2	52.8	28.3
DE	18.6	23.2	29.4	16.4	40.6	20.4
EE	: u	25.8 u	: u	22.8	58.0	34.0
IE	11.5	15.2	40.9	19.9	57.3	23.8
EL	2.4	6.6	25.6	11.8	60.4	19.1
ES	11.0	17.3	41.9	23.0	60.5	25.2
FR	11.7	11.6	30.7	16.8	45.4	20.8
IT	3.0	3.4	9.9	5.2	35.3	8.8
CY	: u	14.6	31.9 u	13.3	62.6	27.6
LV	9.2	11.6	: u	12.9	47.3	24.6
LT	6.9 u	18.7 u	24.7 u	20.5	56.2	34.0
LU	: u	4.6 u	25.8 u	17.2	47.6	22.6
HU	8.7	9.3	13.2	8.5	44.7	16.7
MT	: u	: u	: u	: u	38.5	9.8
NL	12.1	13.7	32.5	18.3	48.1	23.5
AT	10.8	14.4	20.8	16.2	34.5	12.4
PL	3.5	12.7	21.4	10.8	49.7	22.1
PT	2.1	4.4	12.8	4.2	41.8	9.5
RO	2.4	12.9	13.0	7.5	41.2	19.4
SI	5.9 u	12.7 u	20.6	9.8	48.7	23.8
SK	6.8	9.1	10.8	7.3	38.4	13.6
FI	18.4	21.8	43.5	25.4	51.6	33.9
SE	13.9	10.1	22.7	11.6	46.2	24.8
UK	24.2	17.6	33.3	20.6	47.3	23.1
IS	: u	12.9	: u	13.5	48.7	22.3
NO	19.0	12.1	24.9	19.3	51.8	25.2
EEA30	**7.4**	**14.0**	**25.9**	**13.9**	**46.0**	**19.9**
CH	17.1	19.7	36.9	19.5	42.0	24.6
HR	:	:	:	:	:	:
TR	:	:	:	:	:	:

Exceptions to the reference year: LU, IS and CH 2005.
Eurostat estimations without LU and IS: EU-27, EU-25 and EEA-30.

HRST intensity in a specific sector of economic activity can be defined as the share of employed people in that sector that have successfully completed tertiary education in S&T — employed HRSTE. In turn, this can be used as a proxy for knowledge intensity in each sector of economic activity.

Table 4.13 shows the HRST intensity in specific sectors of economic activity classified according to NACE Rev.1.1.

Knowledge-Intensive Services (KIS) — which cover activities related for example to post and telecommunications, computer and related activities as well as research and development (see methodological notes) — was the most knowledge-intensive sector in the EU in 2006, as almost half of all persons employed in this sector had tertiary S&T education. Cyprus posted the highest EU rate at 62.6%, followed by Belgium (60.7%), Spain (60.5%) and Greece (60.4%). In contrast the corresponding proportion in the Czech Republic amounted to only 33%.

As expected, 'High and Medium high-tech manufacturing' was the second sector in terms of high HRST intensity, with an average EU rate close to 26%. In Finland, 43.5% of the persons employed in this sector were tertiary educated. Ireland and Spain followed with somewhat lower proportions (40.9% and 41.9% respectively). In contrast, Italy scored the lowest HRST intensity in 'High and Medium high-tech manufacturing', with only 9.9%. In addition, this country had the lowest proportion in all sectors. This is mainly to be linked with the comparatively low level of tertiary level education in this country.

Unemployment

This section provides results on the unemployment rates for human resources in S&T with tertiary education (HRSTU) and human resources without tertiary education (NHRSTU).

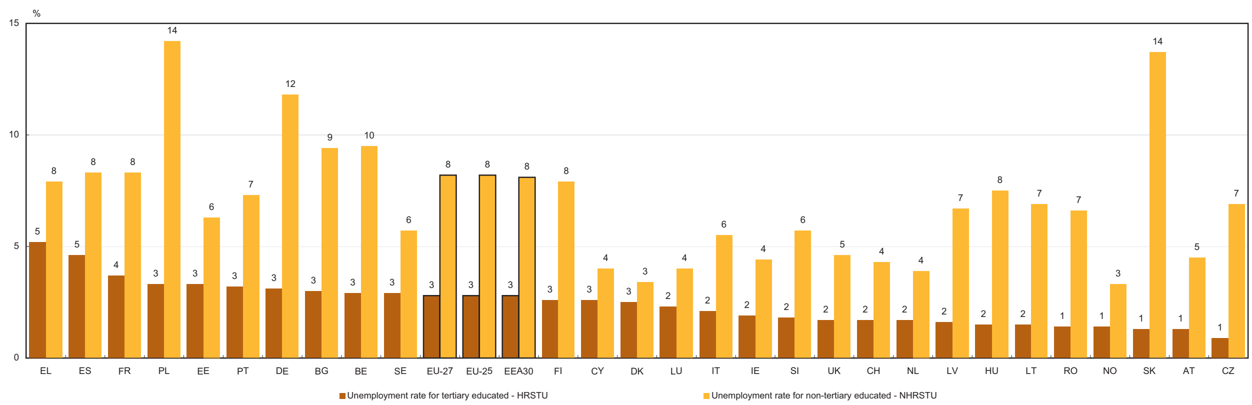
Unemployment rates in 2006 for those with tertiary level education were much lower than the unemployment rates for those without tertiary education in all countries shown (Figure 4.14). The share of tertiary educated unemployed reached a low 3% on average in the EU-27, while the unemployment rate for non-tertiary educated amounted to 8%.

For the tertiary educated population, individual Member States show smaller deviations from the EU average. The highest unemployment rate was found in Greece, with 5%, while the lowest rate was recorded in the Czech Republic (1%). The Czech Republic introduced many reforms to develop the market economy and a high education level was encouraged. Workers with greater levels of education and training are thought to be more adaptable to the changes in jobs that occur with economic transformation.

However, finding and keeping a job when you do not possess tertiary level education is more difficult. The EU average unemployment rate in 2004 was 8%, but as high as 14% in Poland and Slovakia. The lowest unemployment rate for non tertiary educated persons was found in Denmark and in Norway (3%).

When examining whether countries with high growth rates of HRST, such as Ireland, Luxembourg, Slovenia and Portugal (see Table 4.10), have low unemployment rates, it can be seen that this is not the case.

Figure 4.14 **Unemployment rates for tertiary and non-tertiary educated population, 25-64 years old, EU-27 and selected countries — 2006**



Exceptions to the reference year: LU, IS and CH 2005.
Eurostat estimations without LU and IS: EU-27, EU-25 and EEA-30.

HRST stocks at regional level

This section describes the stocks of human resources in S&T (HRST) at regional level. Regional dynamism varies considerably in Europe.

Particular attention needs to be paid to the quality of regional results. The size of the samples, which are intended to provide a representative estimate of the population of the region, can become too small and be prone to sampling errors. This is especially true when data are disaggregated by sector of economic activity, the main reason why data by sector of economic activity are presented at the NUTS 1 regional level only in Table 4.16.

In any case, the guidelines provided by the ***European Union Labour Force Survey*** with regard to the minimum levels at which data can be considered reliable were strictly applied. In most cases, data were well above the minimum sample size guidelines set for using the ***European Union Labour Force Survey***. Data are flagged as unreliable when this was not the case.

Regional picture of HRST among the labour force in the European Union

Map 4.15 illustrates the regional distribution of human resources in S&T (HRST), as a percentage of the total labour force, at the NUTS 2 level in 2006. European regions are not equally endowed with stocks of human resources in S&T.

Differences between the regions can be seen and pools of concentration can be quoted. The highest concentrations of HRST as a share of the labour force are found in capital regions, in regions in central Europe and in the Nordic countries. The English region Inner London had the highest proportion of HRST among the labour force. The proportion was 57.2% in 2006. In contrast, in the same country, the regions of East Riding and North Lincolnshire and Lincolnshire had the lowest proportion of employed HRST in terms of the labour force with a share below 30%.

Three Belgian regions concentrated in 2006 more than 50% of the total employed persons in HRST. These regions were Région de Bruxelles-Capitale (52.9%), Province Vlaams-Brabant (55.3%) and Province Brabant Wallon (56.3%).

In the Netherlands all regions had a proportion of HRST above 30% in 2006. In contrast, Greece had regional proportions of HRST in terms of labour force below 30% in the majority of its regions, except for the capital region, Attiki, where this proportion amounted to only 36.8% in 2006.

European regional policy

European regional policy is designed to bring about concrete results, furthering economic and social cohesion to reduce the gap between the development levels of the various regions. The idea is to create potential so that the regions can fully contribute to achieving greater growth and competitiveness and, at the same time, to exchange ideas and best practices. This is the main purpose of the new initiative Regions for economic change. The whole regional policy is in line with the priorities set by the EU for growth and jobs defined by the Lisbon Strategy.

The European Fund for Regional Development (EFRD), the European Social Fund (ESF) and the Cohesion Fund contribute to three objectives:

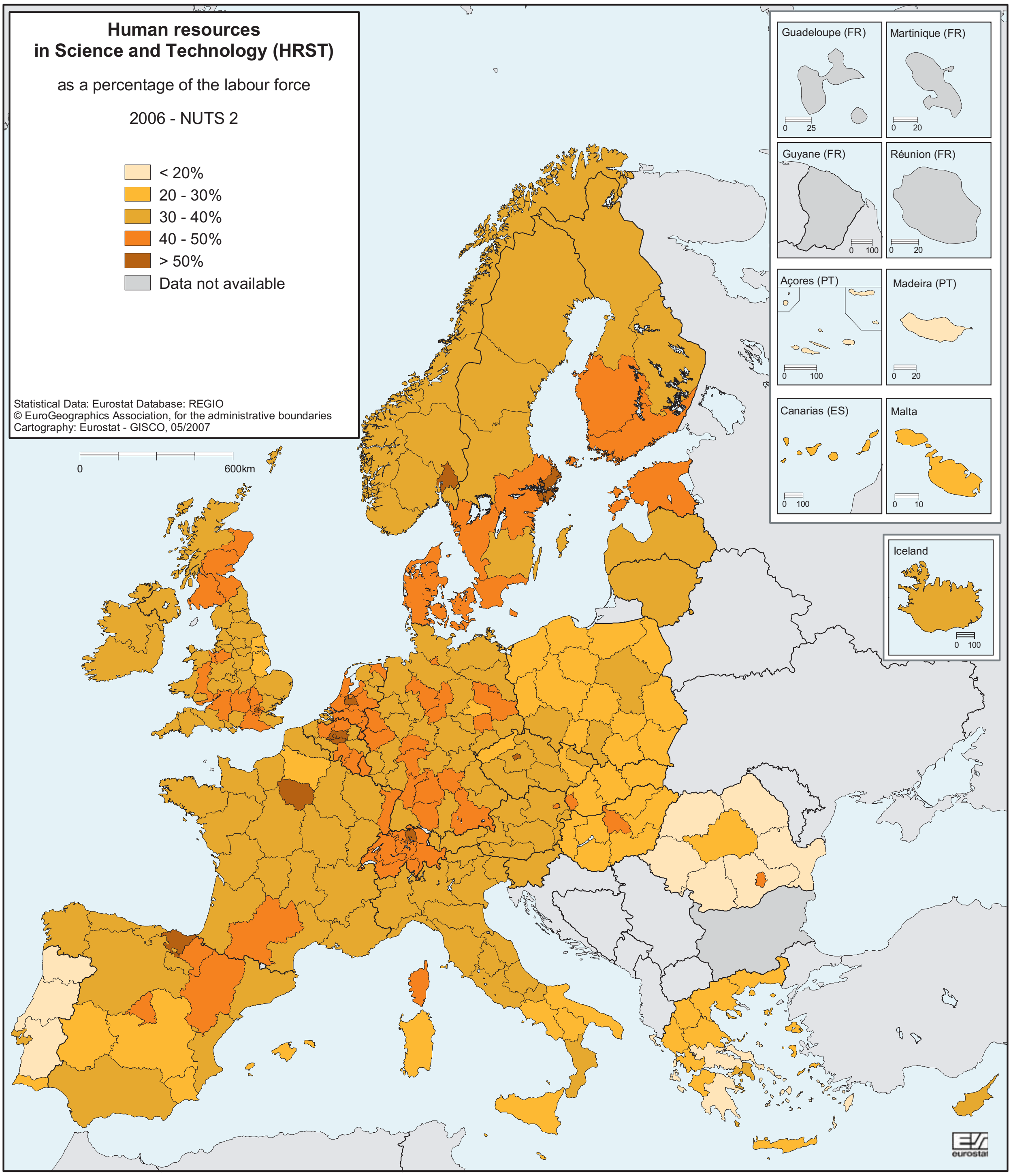
The Convergence objective is to promote growth-enhancing conditions and factors leading to real convergence for the least-developed Member States and regions.

The Regional Competitiveness and Employment objective aims to strengthen competitiveness and attractiveness, as well as employment, through a two-fold approach. First, development programmes will help regions to anticipate and promote economic change through innovation and the promotion of the knowledge society, entrepreneurship, the protection of the environment, and the improvement of their accessibility. Second, more and better jobs will be supported by adapting the workforce and by investing in human resources.

The European Territorial Cooperation objective will strengthen cross-border cooperation through joint local and regional initiatives, transnational cooperation aimed at integrated territorial development, and interregional cooperation and exchange of experience.

Source: Internet website on Regional Policy – Inforegio, European Commission, http://ec.europa.eu/regional_policy/index_en.htm

Map 4.15 Human Resources in Science and Technology (HRST) as a percentage of the labour force — 2006



Regional differences by sector of economic activities

Table 4.16 shows the first 30 regions in Europe in terms of their proportion of employed HRST having tertiary education (HRSTE). Results for total manufacturing and total services are detailed at the NUTS 1 regional level in 2006.

Generally, the share of HRSTE working in the services sector is higher than in manufacturing. The EU average of HRSTE among total employment in the services sector was 31.0%; the figure for manufacturing 17.1%.

London (UK) had the highest proportion of employed HRSTE in the manufacturing industry as a whole (44.9%). In parallel, in total services, this region took third place in terms of the share of HRSTE among total employment (45.7%). Five of the top 10 regions having the highest proportion of HRSTE in the total employed population working in manufacturing can also be found in the top 10 classification for services: London (UK), Île de France (FR), Bruxelles-Capitale (BE), Noreste (ES), Comunidad de Madrid (ES).

In contrast, Hamburg (DE), which ranked fifth in total manufacturing, showed a specialisation of the HRSTE in this sector. This region does not appear in the top 30 regions in services. The same remark is also true for Lietuva (Latvia), ranked fourth, and Kypros/Kibris, ranked tenth in services, which do not appear in the top 30 regions in manufacturing. For these two countries and also Eesti (Estonia), the fact is noteworthy as they are countries compared to leading regions.

Table 4.16 The top 30 EU-27 regions ranked according to the proportion of employed human resources in terms of education (HRSTE), in total manufacturing and in total services, in thousands and as a percentage of total employment — 2006

Country (Ranking)		Region — NUTS 1	Total manufacturing	
			1 000s	As % of total employment in manufacturing
		EU-27	6 709 s	17.1 s
1	UK	London	103	44.9
2	FR	Île de France	208	41.5
3	BE	Bruxelles-Capitale	10	39.2
4	ES	Noreste	170	37.0
5	DE	Hamburg	36	34.1
6	ES	Comunidad de Madrid	103	32.2
7	UK	South East	148	30.4
8	DE	Berlin	44	29.5
9	FI	Manner-Suomi	129	29.1
10	ES	Noroeste	86	28.6
11	DE	Sachsen	104	28.3
12	FR	Méditerranée	65	28.0
13	IE	Ireland	74	27.8
14	UK	Scotland	68	26.3
15	UK	North West	118	26.2
16	ES	Este	316	25.6
17	UK	East of England	87	25.1
18	UK	South-West	76	25.0
19	FR	Sud-Ouest	103	24.9
20	DE	Mecklenburg-Vorpommern	23	24.5
21	BE	Vlaams Gewest	123	24.2
22	DK	Danmark	102	24.2
23	EE	Eesti	33	23.7
24	DE	Baden-Württemberg	378	23.6
25	BE	Région Wallonne	43	23.3
26	NL	Zuid-Nederland	73	23.2
27	UK	Wales	42	23.2
28	DE	Brandenburg	38	23.0
29	FR	Centre-Est	138	22.8
30	DE	Hessen	126	22.7

Country (Ranking)		Region — NUTS 1	Total services	
			1 000s	As % of total employment in services
		EU-27	43 798 s	31.0 s
1	BE	Bruxelles-Capitale	167	52.6
2	ES	Noreste	606	48.7
3	UK	London	1 372	45.7
4	LT	Lietuva	371	43.2
5	FR	Île de France	1 646	42.9
6	BE	Vlaams Gewest	770	42.4
7	EE	Eesti	168	42.2
8	ES	Comunidad de Madrid	952	42.2
9	BE	Région Wallonne	391	41.6
10	CY	Kypros/Kibris	105	40.6
11	ES	Noroeste	453	40.2
12	FI	Manner-Suomi	675	39.8
13	DE	Berlin	481	39.7
14	IE	Ireland	534	39.6
15	PL	Centralny	720	39.3
16	DE	Sachsen	480	39.1
17	UK	Scotland	704	38.8
18	DK	Danmark	775	37.7
19	ES	Centro	500	37.7
20	NL	West-Nederland	1 096	36.5
21	ES	Este	1 394	36.2
22	DE	Brandenburg	294	35.8
23	EL	Voreia Ellada	296	35.8
24	HU	Kozep-Magyarorszag	332	35.7
25	EL	Attiki	452	35.4
26	SE	Sverige	1 181	35.3
27	PL	Wschodni	419	34.9
28	UK	South East	1 121	34.9
29	ES	Sur	845	34.5
30	LU	Luxembourg	54	34.4

Eurostat estimation without LU: EU-27.

4.4 Mobility

This section analyses the mobility of highly qualified individuals. Data on job-to-job mobility can be defined as the movement of employed HRST from one job to another, within a one-year period. These criteria do not include inflows into the labour market from unemployment or inactivity.

Employed HRST are those who have:

- successfully completed tertiary level education in an S&T field of study and are employed in any type of occupation

or

- are not formally qualified as stated above but are employed in an S&T occupation.

Table 4.17 shows the number of employed HRST aged 25-64 years that have changed jobs during 2005, broken down by age groups and gender in absolute numbers and as a percentage of total HRST population.

Table 4.17 **Job-to-job mobility of employed HRST, broken down by age group and by gender, in thousands and as a percentage of employed HRST population, EU-27 and selected countries — 2005**

	Job mobile HRST									
	25 to 34 years old		35 to 44 years old		45 to 64 years old		Female		Male	
	1000s	As % of HRST total	1000s	As % of HRST total	1000s	As % of HRST total	1000s	As % of HRST total	1000s	As % of HRST total
EU-27	**:**	**7.5**	**:**	**4.2**	**:**	**2.5**	**:**	**4.4**	**:**	**4.6**
BE	63	10.6	28	4.6	14	2.1	49	5.5	56	5.8
BG	: u	: u	: u	: u	: u	: u	: u	: u	: u	: u
CZ	24	5.2	19	4.1	17	2.5	27	3.4	32	4.1
DK	45	14.4	43	11.9	28	6.0	56	9.7	61	10.7
DE	331	10.3	271	5.2	160	2.5	344	5.1	417	5.2
EE	5 u	9.6 u	5 u	8.9 u	9 u	9.3 u	11	8.1	9 u	11.1 u
IE	: u	: u	: u	: u	: u	: u	: u	: u	: u	: u
EL	22	5.6	16	3.7	4	1.1	20	3.7	21	3.3
ES	293	11.9	112	5.8	42	2.6	230	8.5	217	6.6
FR	413	14.2	166	6.7	96	3.3	309	7.9	366	8.2
IT	196	10.0	108	4.4	52	2.0	171	5.2	184	5.0
CY	5	11.6	2	4.6	1	3.6	4	7.1	4	6.6
LV	7 u	7.8 u	: u	: u	7 u	5.5 u	9	4.7	9	7.2
LT	17 u	9.2 u	9 u	5.9 u	: u	: u	15 u	4.7 u	17 u	7.7 u
LU	2	7.0	1	4.9	: u	: u	2	4.8	2	4.3
HU	25	6.6	8	2.7	11	2.2	23	3.4	21	4.1
MT	: u	: u	: u	: u	: u	: u	: u	: u	2	6.5
NL	: u	: u	: u	: u	: u	: u	: u	: u	: u	: u
AT	46 u	11.7 u	31 u	6.4 u	14 u	3.1 u	42 u	7.3 u	49 u	6.6 u
PL	124	8.0	33	2.9	37	2.5	95	4.1	99	5.5
PT	36	9.5	8	3.0	: u	: u	25	5.2	23	5.0
RO	40	6.3	19	3.8	27	4.0	42	4.3	44	5.2
SI	15	14.1	6	6.2	4	3.0	12	6.9	12	8.4
SK	15	7.1	8	3.8	8	2.9	16	4.4	14	4.6
FI	41	15.0	28	8.6	23	4.9	48	8.6	43	8.7
SE	23 u	4.9 u	17 u	3.4 u	10 u	1.2 u	23 u	2.5 u	27 u	3.0 u
UK	421	14.3	269	8.8	248	6.4	444	9.6	495	9.4
IS	3	15.4	2	11.9	1	5.7	3	10.7	3	9.9
NO	35	13.3	22	7.5	14	3.4	33	6.9	38	7.7
CH	63	14.1	43	7.8	27	3.8	54	7.7	79	7.8
HR	:	:	:	:	:	:	:	:	:	:
TR	:	:	:	:	:	:	:	:	:	:

Exceptions to the reference year: ES, AT and SE 2004; EE 2003; FR 2002.
Owing to too many missing or unreliable data, the EU aggregate in thousands has not been calculated.
The EU aggregate as % of HRST total has been calculated by only using the available countries.

The 25-34 year olds were most likely to move from one job to another in 2006. In absolute numbers, the United Kingdom and France had the highest number of mobile HRST with more than 830 000 persons in total. In relative terms, 45% of the HRST that changed jobs in 2006 were aged 25-34, whereas only 26% were found in the 45-64 age group.

Looking at the proportion of mobile HRST among the total HRST population in the EU, Finland and Denmark had the most mobile HRST population aged 25-34, with a share of 15% and 14.4% respectively. The HRST aged 45-64 in Denmark were also relatively mobile compared to the other countries (6%) but the highest share of mobile HRST for this age group was found in Estonia (9.3%).

Looking now at the gender distribution, there is not much difference between male and female job-to-job mobility. Even when looking at the EU average, female HRST were slightly less mobile than their male counterparts (4.4% against 4.6%). However, in the Baltic countries male HRST seem to be somewhat more mobile than female HRST.

Overall it can be seen that HRST in Denmark, Estonia, Finland, the UK and Iceland are most mobile. However, National Labour Market conditions and policies applied in each EU country play a major role in the job-to-job mobility results. The flexicurity concept (loose legislation for employment protection plus a generous social safety net for the unemployed plus high spending on labour market policies) implemented in Denmark is one example that encourages mobility.

Europeans and Mobility

What do Europeans think about mobility?

Europeans have rather positive views on the benefits of long-distance mobility and think that it is a good thing for individuals (46% are in favour, against 11% who think it is a bad thing), as well as for the labour market (49% are in favour and 19% against) and for European integration (57% are for and 10% against). They are more doubtful about the impact of long-distance mobility on family life, where 32% think the impact might be positive, but a similar share (27%) thinks it would be negative.

What are the views of EU citizens that have already moved long distances?

For the large majority of long-distance movers, the experience was positive. Almost half of them (46%) declare that no aspect of their life deteriorated after the move, and a fair percentage of them have seen their job (25%) and money (22%) situation improve together with their housing conditions (37%).

Recent data from the European Labour Force Survey illustrates that, for people already in employment, moving to another region or country seems to increase the risk of becoming unemployed or inactive. This is partly because when a couple moves, it is often difficult for both partners to find a job at the same time. Even so, as mentioned above, 25% of long-distance movers have seen their job situation or working conditions improve, while very few have seen it deteriorate (less than 5%). In fact, moving to another country (or to another region) appears to improve the chances of finding a job for unemployed and the inactive. 59% of those who were unemployed in another EU country the previous year had found a job in the current year. This was in contrast to 35% that stayed in the same country (see Table A). Europeans seem to be well aware of the opportunity of mobility as a solution to unemployment or the difficulty in finding a job. Two thirds of those asked would be prepared to leave their region in search of new work. This percentage remains high in all countries, but varies from almost 50% in Hungary, Ireland and Malta to more than 70% in France, the Netherlands, Poland and Sweden. More strikingly, between 25% (Austria, Ireland, Hungary) and 50% (Poland, Luxembourg) would be prepared to move to another EU country to find a job.

Table A: Links between cross-country mobility and year-to-year job mobility in Europe

EU-15		Current work status			
Country of residence year before	**Work Status year before**	**Employed**	**Unemployed**	**Inactive**	
Same Country	**Employed**	94%	3%	3%	100%
	Unemployed	**35%**	43%	22%	100%
	Inactive	**5%**	2%	93%	100%
Other EU-15 Country	**Employed**	74%	13%	12%	100%
	Unemployed	**59%**	25%	16%	100%
	Inactive	**26%**	10%	64%	100%

Source: Europeans and mobility: First results of an EU-wide survey, Eurobarometer survey on geographic and labour market mobility, EC, 2006

4.5 Nationality

The international mobility of human resources in science and technology (HRST) is illustrated in Table 4.18. It compares the national labour force with the non-national labour force, where the latter is persons having different nationality than of the country of residence (see methodological notes).

Of the persons that have moved to Slovakia to work, 58.7% were HRST when only 29.8% of employed Slovakians were HRST. In Greece the share of HRST among non-nationals was much smaller than among nationals, at only 13.7%.

In Luxembourg, the large majority of the non-national HRST were citizens from other EU countries (93.2%). This is partly explained by the combination of being a small country, its geographical location and the presence of some major EU institutions requiring EU qualified human resources. Conversely, in Greece and Poland, seven out of ten non-national HRST were citizens of countries outside the EU.

Table 4.18 Human Resources in Science and Technology (HRST), 15-74 years old, by nationality, in thousands and as a percentage of respective labour force and distribution of non-nationals, EU-27 and selected countries — 2006

	Nationals		Non-nationals		% of non-nationals	
	1000s	As % of respective labour force	1000s	As % of respective labour force	Having EU-27 citizenship	Having citizenship outside EU-27
BE	2 227	45.3	174	37.3	75.9	24.1
BG	1 209	28.4	: u	: u	: u	: u
CZ	1 896	33.7	20	37.0	45.0	55.0
DK	1 398	43.7	58	52.3	41.4	58.6
DE	18 147	42.1	1 207	26.0	46.4	53.6
EE	283	44.6	52	31.2	: u	: u
IE	: u	: u	: u	: u	: u	: u
EL	1 590	30.3	54	13.7	29.6	70.4
ES	8 303	38.1	778	23.4	44.3	55.7
FR	11 843	39.0	484	25.1	42.8	57.2
IT	:	:	:	:	:	:
CY	141	40.3	22	32.0	59.1	40.9
LV	437	33.9	: u	: u	: u	: u
LT	669	37.4	: u	: u	: u	: u
LU	55	42.7	44	40.9	93.2	6.8
HU	1 561	31.1	14	36.2	71.4	28.6
MT	53	29.1	2 u	27.7 u	: u	: u
NL	4 175	44.4	135	37.3	60.7	39.3
AT	1 484	36.5	139	26.6	61.2	38.8
PL	5 637	29.3	17 u	37.8 u	29.4 u	70.6 u
PT	1 186	20.3	38	17.8	31.6	68.4
RO	2 301	20.7	8 u	37.7 u	: u	: u
SI	416	36.4	1 u	15.9 u	: u	: u
SK	875	29.8	3 u	58.7 u	: u	: u
FI	1 348	43.5	19	37.7	52.6	47.4
SE	2 236	43.2	117	42.7	52.1	47.9
UK	11 713	38.8	879	41.1	35.7	64.3
IS	66	38.3	2	39.7	:	:
NO	1 125	43.0	50	43.8	64.0	36.0
CH	1 698	48.7	373	36.4	69.2	30.8
HR	552	25.8	2	32.8	:	:
TR	:	:	:	:	:	:

Exceptions to the reference year: ES, AT and SE 2004; EE 2003; FR 2002.
Owing to many missing or unreliable data, the EU aggregates were not calculated.

PART3

Chapter 5 - Innovation

5.1 Introduction

Innovation is a continuous process; measuring such a dynamic process is no straightforward operation. The Community Innovation Survey (CIS) was created to add more details to the traditional innovation indicators, such as R&D expenditure and patent statistics. The general aim of the CIS is to collect innovation data in order to provide a better understanding of innovation and how it relates to economic growth.

European studies on innovation apply a series of instruments to obtain data on innovation and to assess national innovation performance. The two main instruments are the CIS and the European Innovation Scoreboard (EIS). The two are interlinked; the EIS uses – inter alia – data collected by Eurostat within the framework of the CIS.

This chapter starts with an introduction to the Community Innovation Survey (methodology, history and other innovation surveys).

It then presents in detail the results of the latest survey, CIS 4. The results are shown first at European and then at national level.

Another part of this chapter briefly compares CIS 4 with CIS 3.

The final part of the chapter focuses on the European Innovation Scoreboard.

5.2 Community Innovation Survey

CIS 4

The Community Innovation Survey (CIS) is a survey conducted every four years by EU Member States to monitor Europe's progress on innovation. The innovation policies of the Member States and the European Union depend on the existence of a sound statistical basis.

The CIS provides this basis. It creates a better understanding of the innovation process and analyses the effects of innovation on the economy (on competitiveness, employment, economic growth, trade patterns, etc.). Data gathering and analysis have been supported under the various Community RTD Framework Programmes. Since 2000 the CIS has become a major source of data for the "European Innovation Scoreboard". To keep the Scoreboard up to date, the Commission has asked Member States to carry out the CIS more frequently.

CIS 4 was launched in 2005 in nearly every country concerned (the EU Member States and candidate countries, plus Norway and Iceland) using a harmonised questionnaire and survey method which define the structure of the questions to be asked and the statistical methods to be used by the countries participating.

The CIS 4 survey is based on Commission Regulation No 1450/2004, which establishes the legal basis for innovation statistics and makes it compulsory to deliver data on a number of basic variables. The methodological basis of the CIS is provided by the Oslo Manual, a joint publication by Eurostat and the OECD. CIS 4 goes beyond the 1997 Oslo Manual (2nd edition) to include innovative activities such as organisational innovations that are included in the 2005 revision. Generally, however, it is still based on the 2nd edition of the Oslo Manual.

The survey seeks information about both product and process innovation and organisational and marketing innovation. CIS 4 collects information on a number of dimensions of innovation, including the number of enterprises that innovate by introducing new or improved products or new or improved processes within the company, and the number of enterprises that introduce at least one innovation. The CIS draws a distinction between innovations that are new to the enterprise and those which are new to the market.

Expenditure on innovation includes R&D, capital investment, training and marketing costs. Data are also collected on protecting innovations by different kinds of intellectual property rights, such as patents and copyrights. Most of the questions cover new or significantly improved goods or services or the introduction of new or significantly improved processes, logistics or distribution methods. Organisational and marketing innovation is covered by one specific question.

The CIS 4 questionnaire not only focuses on product and process innovation, but also looks at the effects of innovation and the sources of information about innovation activities such as cooperation and examines the factors hampering innovation. It is shorter than the CIS 3 questionnaire and is perceived as less difficult by the countries participating.

The period covered by the survey is 2002-2004, i.e. the three years from the beginning of 2002 to the end of 2004. The reference year for CIS 4 is 2004.

Data are collected by the statistical offices or competent research institutes in the Member States. The results of the surveys are processed at national level using a common methodology and then further processed by Eurostat to increase cross-country comparability. To keep enterprise-level information strictly secret, the micro-level database remains confidential and is accessible to Eurostat staff only. The Oslo Manual is currently being revised to adapt it to new directions of European innovation policy. Among other things, the next CIS should contribute to a better understanding of the "non-technical" aspects of innovation, such as management techniques, organisational change, design and marketing issues.

The next round of the Community Innovation Survey – CIS 2006 – has already been launched or soon will be. It covers data for 2004 to 2006.

CIS 2008 is also being prepared and will be launched in 2008/2009 to gather data for the reference years 2006 to 2008.

CIS – History

Countries have conducted four rounds of the Community Innovation Surveys. All four are based on the appropriate version of the Oslo Manual. With each round, the scope of the surveys has expanded and the number of countries participating increased.

The first round – CIS 1, conducted in 1993 – covered innovative activities from 1990 to the end of 1992. CIS 1 was limited to the manufacturing sector.

The second round – CIS 2, conducted in 1997 – covered activities from 1994 to the end of 1996. CIS 2 was based on the 1997 revision of the Oslo Manual (OECD, 1997) and was expanded to include selected services. Different surveys were used for manufacturing industry and services. The CIS 2 data show wide variations in the proportion of innovative firms across EU countries, industries and sectors. Just over half of the manufacturing enterprises in the EU innovated between 1994 and 1996 (51%), compared with 40% of the services enterprises. The proportion of innovators ranged from 26% (Portugal) to 73% (Ireland) in manufacturing and from 13% (Belgium) to 58% (Ireland) in services.

The third round – CIS 3, conducted in 2001 – covered activities from 1998 to the end of 2000. CIS 3 was expanded to include not only manufacturing but also the entire services sector.

CIS 2 and CIS 3 differed substantially in a number of ways. Because countries were not required to implement CIS 3, there is no single questionnaire or collection methodology. The conceptual and methodological differences make it hard to compare results between countries within CIS 3 or within any individual country between CIS 3 and CIS 1 or CIS 2.

The CIS 3 statistics for the EU alone show that 44% of enterprises had innovative activities between 1998 and 2000. More businesses innovated in manufacturing ("industry") than in services (47% v. 40%).

Roughly 40% of enterprises in 16 countries had innovating activities, ranging from a low of 28% in Greece to a high of 51% in Germany. As with CIS 2, countries display wide heterogeneity in all CIS measures of innovation. Strategic and organisational changes, measured for the first time in CIS 3, are more frequent in businesses with innovative activities than in businesses without.

Definitional and methodological issues may contribute to the wide variations in the reported numbers of innovative firms, over and above actual differences in innovative behaviour. Widespread non-technological innovations, such as organisational change, are probably linked to technological innovation, particularly in services, but were not measured in CIS 2. The definition of "technological" itself appeared to pose problems. The word may have different meanings in different languages, and countries did not always use the word in their questionnaires. Response rates for CIS 3 ranged from 20% to 30% (in Belgium, Denmark and Germany) to more than 80% (in France and Norway). Part of the difference in response rates may be due to differences in collection methods. For example, CIS 3 was mandatory in five countries (Norway, Spain, France, Italy and Sweden), including the two with the highest response rates (France and Norway), but voluntary elsewhere. Non-response analysis for CIS 3 reveals differences between respondents and non-respondents for some countries, but no bias in the aggregate data.

In order to obtain more recent data for the main indicators on innovation in 2003, a condensed version of the CIS, called "CIS light", has been launched in several countries.

Innovation surveys in other countries

Australia

Australia conducted four innovation surveys between 1993 and 2005. The 2003 survey covered more industries, excluded businesses with fewer than five employees and was mailed to a stratified random sample of businesses. The 2003 survey was based on the 1997 Oslo Manual, making it comparable with the CIS surveys. Australia expanded its 2003 survey by adding questions on non-technological innovation.

Australia decided not to conduct further separate innovation surveys. Instead, it plans to introduce an Integrated Business Characteristics Strategy (IBCS), which will collect information on innovation and information technology use in conjunction with its Business Characteristics Survey (BCS). This strategy will reduce the total number of businesses surveyed because information on basic characteristics, innovation and information technology will be requested from the same sample. Core questions on innovation and information technology will be asked each year. In alternate years, detailed questions will be asked on innovation or information technology. Because the revised strategy directly collects data on innovation and technology and also on the basic business characteristics for the same businesses, researchers will have business-level micro data making it possible to model complex relationships among these variables and productivity and economic growth. In time, longitudinal analyses will become possible as the IBCS contributes data to the longitudinal business database which Australia is developing.

Source: ABS ITU Bulletin 14, August 2006

Brazil

The Brazilian Institute of Geography and Statistics (IBGE) published the results of the Pintec survey on technological innovation in enterprises conducted every two years. What conclusions can be drawn from the 2005 round? In general, the proportion of innovative enterprises did not change significantly between 2003 and 2005 with 33.3% and 33.4% respectively.

The decrease from 31.1% to 28.9% in the innovation rate observed for the smallest enterprises (with fewer than 50 employees) was counterbalanced by a big increase in the rate for enterprises with more than 50 employees, from 44% to 50.4%. Another interesting figure, the percentage of enterprises that introduced a product innovation to the national market, rose from 2.7% to 3.2% but is still very low. R&D expenditure has also increased to average from 2.5% to 2.8% of net turnover.

In 2005 numerous measures were taken in favour of innovation (for example, the Property Law and the Innovation Law). We will have to wait for the results of Pintec 2007 to know the first effects of these moves

Translated from: http://www.bulletins-electroniques.com/actualites/50792.htm

Canada

Canada has conducted a series of surveys of innovation and technologies since the early 1990s. The most recent Surveys of Innovation were carried out in 2003 and 2005.

The 2003 Survey of Innovation covered information and communication technology industries, selected professional, scientific and technical services, selected natural resource support services and selected transport industries.

The 2005 Survey of Innovation surveyed manufacturing and logging industries for the reference period 2002-2004.

The surveys were based on the relevant version of the Oslo Manual. It is mandatory for Canadian businesses to respond to the surveys. The response rate for the 2005 survey was 72%.

Source: Canada Statistics

China

There is no recent innovation survey of China but a full picture of the state of the art in innovation in China is given in the OECD Review of China's National Innovation System.

http://www.oecd.org/dataoecd/54/20/39177453.pdf

New Zealand

In 2005, 52% of New Zealand businesses reported innovation activity. The rate includes businesses which implemented innovations (47%) and businesses with ongoing innovations or which abandoned innovations (5%).

The innovation rate increases with the size of business: 68% of businesses with 100 or more employees, compared with 46% of businesses with six to nine staff.

The industries with the highest innovation rates are finance and insurance (68%) and manufacturing (65%).

A small number of other countries have conducted innovation surveys based on the definition in the Oslo Manual (2005). Only high-level comparisons can be made between countries, because of differences between survey design and methodology, population and reference periods. The innovation rate in New Zealand is higher than in France (46%) and Norway (40%).

Source: Statistics New Zealand,
Innovation in New Zealand 2005

South Africa

The Centre for Science, Technology and Innovation Indicators (CeSTII) conducted the first official South African Innovation Survey.
The broad objectives of the 2005 South African Innovation Survey were to:

- produce a set of internationally comparable data and indicators providing insights into the patterns of innovation in the mining, manufacturing and services sectors in South Africa;
- collect information on the sources and resources for innovation in enterprises;
- provide an indication of the extent of public funding for innovation activities that is taken up by enterprises;
- draw national and international comparisons of innovation intensity; and
- obtain an understanding of the importance of R&D and non-R&D based innovation in different sectors.

The current survey is closely based on the fourth round of the European Community Innovation Survey (CIS 4) and CeSTII worked closely with the OECD and Eurostat on this point.

Nearly 52% of South African enterprises had technological innovation activities, comprising both product (goods and services) and process innovations. A further 11% reported only marketing or organisational innovations. South African levels of innovation compare favourably with other countries such as Sweden, the United Kingdom and Portugal. In a previous Innovation Survey in South Africa (University of Pretoria/Eindhoven University, 2003) 44% of the enterprises were recorded as innovative over the survey period 1998-2000, which compared well with EU countries at the time.

Source: Centre for Science, Technology and Innovation Indicators (CeSTII), The South African Innovation Survey 2005

5.3 EU-27 aggregates

There is a strong correlation between innovation activity and size of enterprise

Figure 5.1 shows that the proportion of innovative enterprises increases significantly with the size of enterprise.

In the EU-27, 71% of the large enterprises, 53% of the medium-sized and 35% of the small enterprises are innovative. Although the percentages for small enterprises are much lower than for large firms, nevertheless more than one in three is actively innovating.

It should be borne in mind that in the Community Innovation Survey (CIS) small enterprises have at least 10 employees. Self-employed entrepreneurs and very small enterprises are not covered by the CIS. This does not mean that these enterprises are not actively innovating, but they may not innovate in the same way and for this reason are not comparable with larger enterprises.

Research and development (R&D) are essential for innovation in new goods and services. A certain size is necessary if an enterprise is to be continuously active in R&D. Many small and medium-sized enterprises cannot pay one or more employees to work full time on R&D. The problem with an R&D employee is that he or she does not necessarily produce something that can be sold in the short run. Many technical products need long years of research.

5

Figure 5.1 EU-27 innovative and non-innovative enterprises by size class, as a percentage of all enterprises — 2004

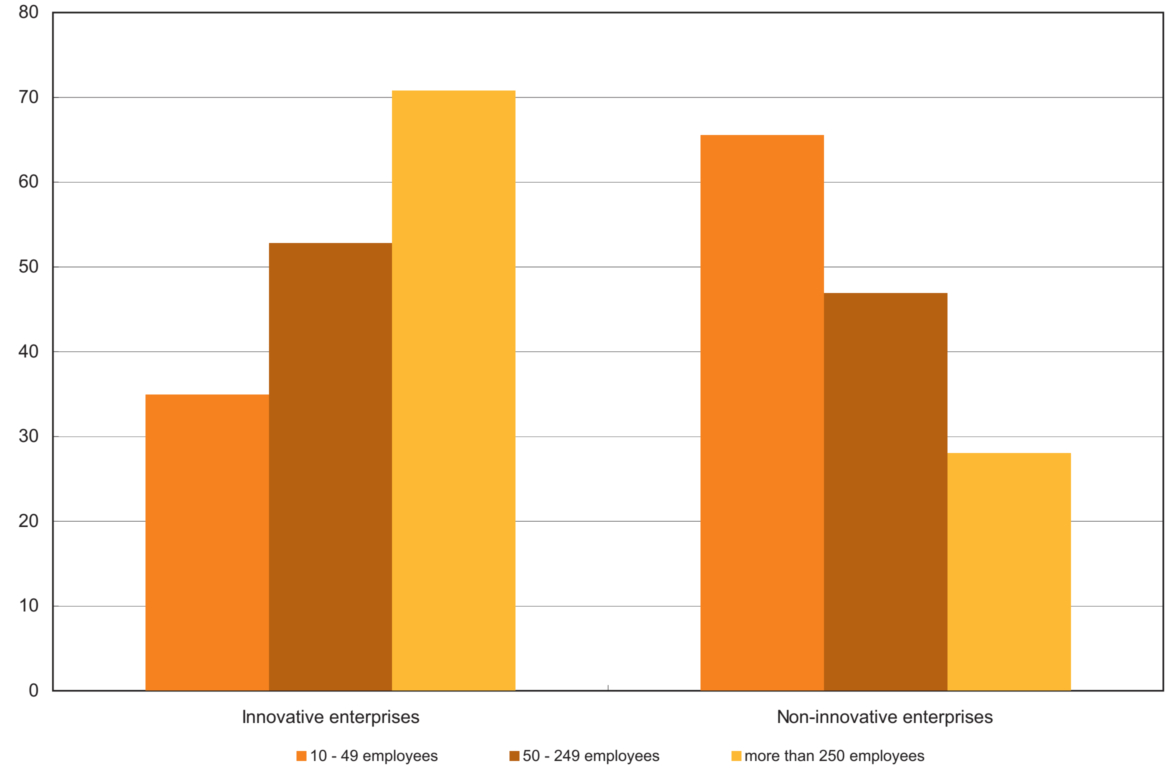
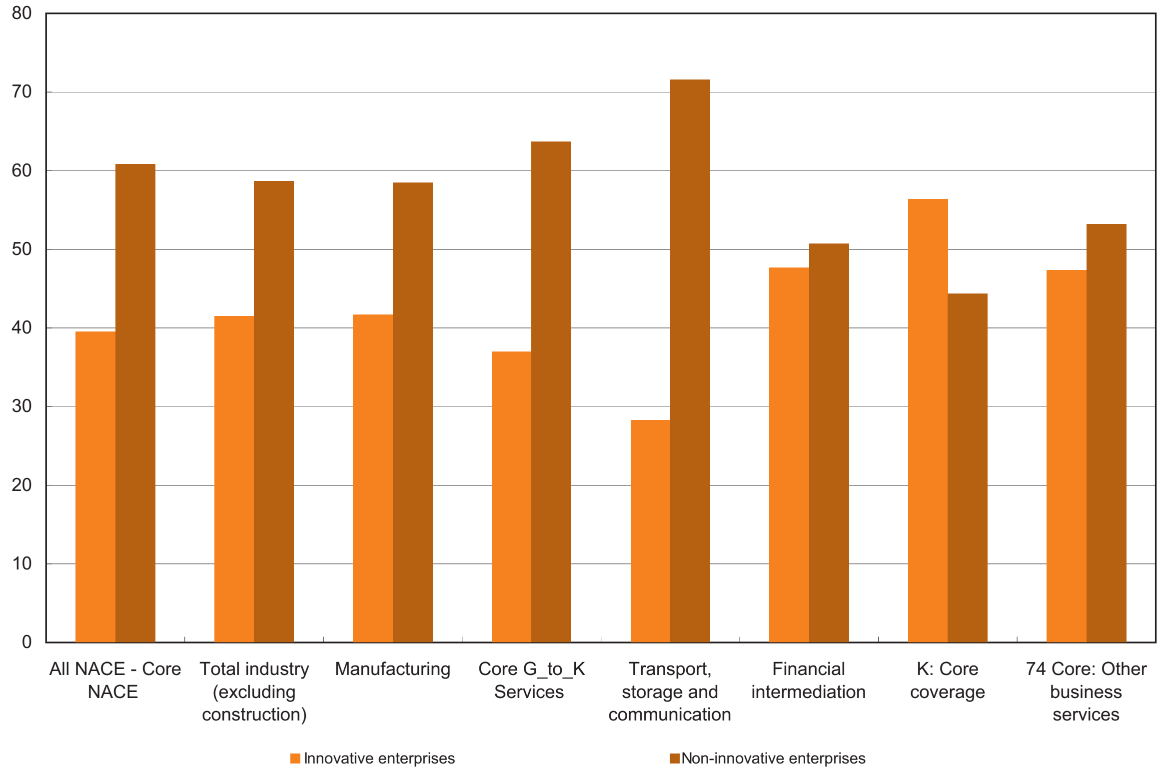


Figure 5.2 EU-27 innovative and non-innovative enterprises by selected NACE, as a percentage of all enterprises — 2004



Close to 40% of all EU enterprises are innovative. This figure varies, depending on the economic activity of the enterprises. The rate for transport, storage and communication is noticeably lower than the average for the entire NACE, but the score for financial intermediation and for economic activities classified in NACE section K (core coverage) is much higher.

The K core coverage includes computer and related activities (NACE 72), architectural and engineering activities (NACE 74.2) and technical testing and analysis (NACE 74.3). The proportion of innovative enterprises active in other business services which are part of section K (47%) is higher than the overall average for all economic activities. Comparing the whole of NACE section K with other business services reveals that 53% of the enterprises in the K core coverage are innovative. Unsurprisingly, the highest shares of innovative enterprises can be found among computer and related activities.

The Community Innovation Survey not only differentiates between innovative and non-innovative enterprises but also provides a further breakdown of the enterprises with innovation activities. Enterprises with only organisational and/or marketing innovations are not considered innovative (see flowchart below).

The percentages shown in Figure 5.3 do not add up to 100% because data are missing for some countries. Nevertheless, the figure gives several pieces of information. Novel innovators make up by far the largest group of innovative enterprises. Only 3% of the innovative enterprises are established innovators with only ongoing and/or abandoned innovation activities. Product and process innovation are often linked. Some 16% of the novel innovators are active in both types of innovation. The percentage of enterprises with new or significantly new products is higher than those introducing innovative processes.

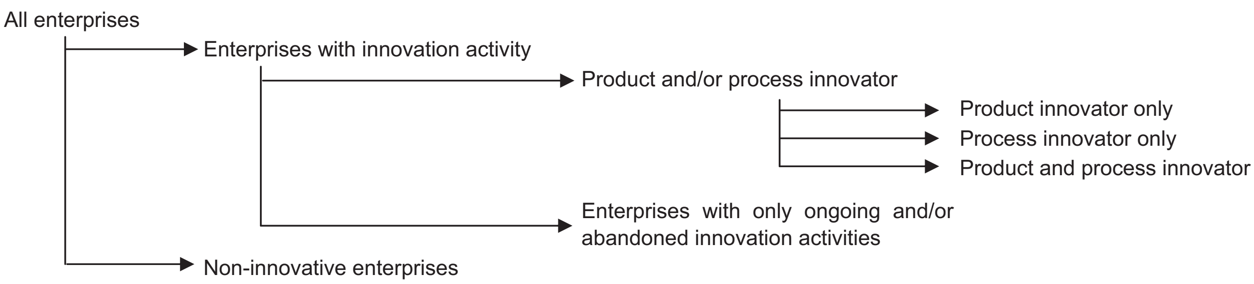
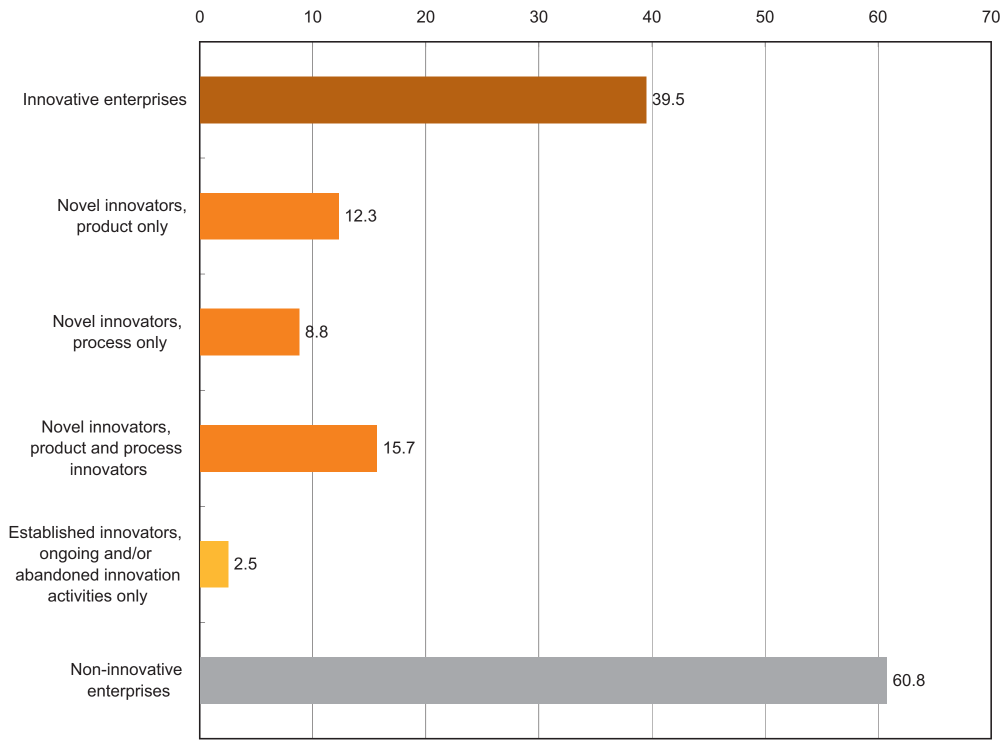
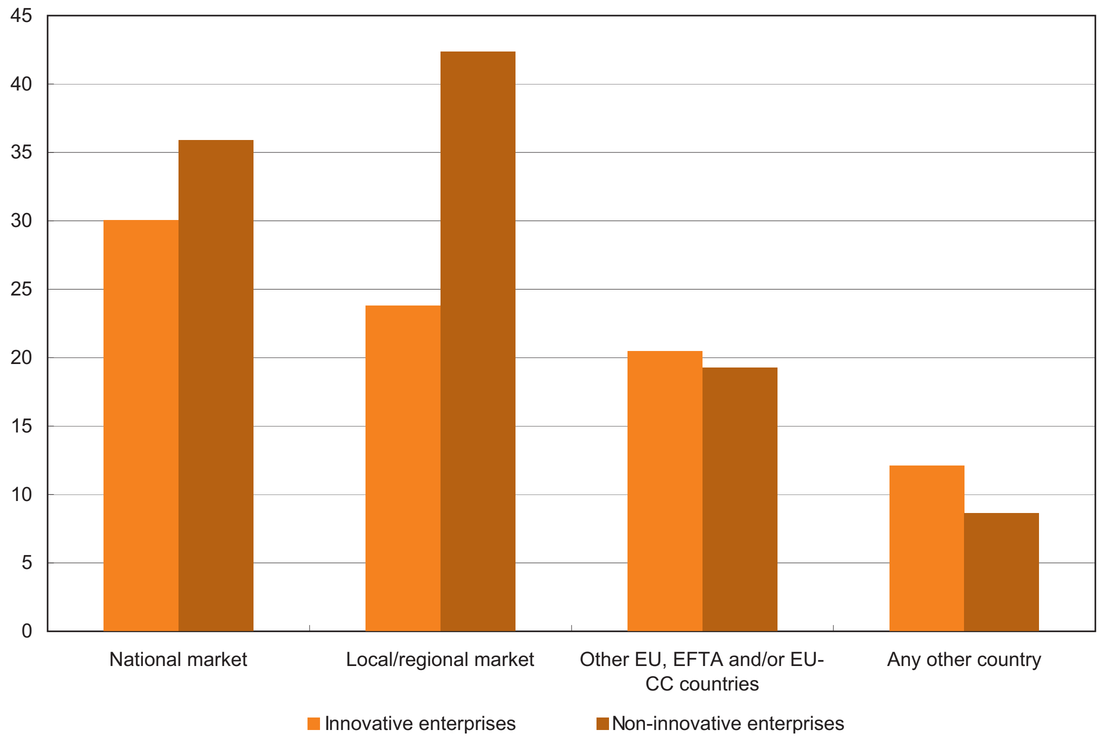


Figure 5.3 **EU-27 enterprises by type of innovator, as a percentage of all enterprises — 2004**



Data missing on non-innovative enterprises for LV and UK; on types of innovator also for SI.

Figure 5.4 EU-27 innovative and non-innovative enterprises by markets, as a percentage of all enterprises — 2004



Data missing for AT, FI, IE, LV, PL, SI and UK; on local/regional market also for BE and LT.

The enterprises surveyed were asked about the geographical markets on which they sell their goods or services. Although the data for the EU-27 in Figure 5.4 do not cover all the Member States, the results reveal some differences between the geographical markets of innovative and non-innovative enterprises.

First of all, the ranking of the markets is not the same for both groups. For innovative enterprises the national market is the most important, followed by the local/regional market. The European market ranks third and the "any other country" market fourth.

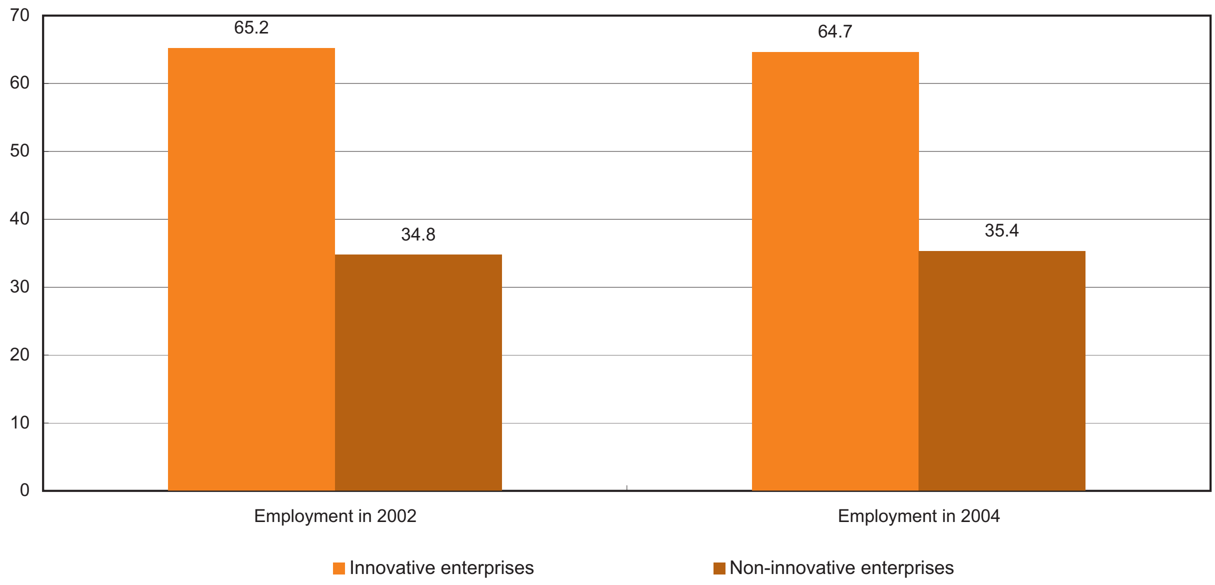
For the non-innovative enterprises the local/regional market is the most important and the national market comes second, followed by the European market. As for innovative enterprises, the "any other country" market ranked last.

Not only the rankings of the markets differ, but also the shares of each subgroup. Whereas the non-innovative enterprises recorded higher percentages on their local/regional and national markets than the innovative enterprises, the opposite was the case for the European and non-European markets.

The analysis of the markets should take that into account because of transport costs. Indeed, in many cases markets geographically closer to the enterprise have a cost advantage.

For countries outside Europe not only the cost of transport but also taxes, legal and administrative barriers may act as a hindrance, further explaining the lower shares of these markets.

Figure 5.5 EU-27 innovative enterprises and non-innovative enterprises by number of employees, as a percentage of employment of all enterprises, in 2002 and 2004



Data missing for AT, LV, SI and UK; for 2002 also for FI and IE; on non-innovative enterprises also for IE.

Figure 5.5 compares employment in innovative and non-innovative enterprises in 2002 and in 2004.

Although data are missing for several countries and this reduces the likelihood of forming a very precise picture of the situation in the EU-27, it can be said that, as mentioned earlier, innovative enterprises made up about 40% of all enterprises in 2004. Taking only large enterprises into account, this percentage rose to more than 70%. Combining these two pieces of information, it is not very surprising that close to two thirds of the jobs are provided by innovative enterprises.

Comparison of the 2002 and 2004 data reveals only very small differences. The share of employment in non-innovative enterprises increased very slightly to the detriment of innovative enterprises.

Figure 5.5 shows only percentages, but in absolute figures employment in the EU-27 increased by an annual average growth rate of 1% between 2002 and 2004 (taking into account only the data from the countries for which figures are available).

The growth rates for individual countries may be quite different. They are shown in Table 5.23 in the section presenting the national data.

Figure 5.6 EU-27 innovative enterprises, turnover of new or significantly improved products only new to the firm and turnover of new or significantly improved products new to the market by size class, as a percentage of total turnover — 2004

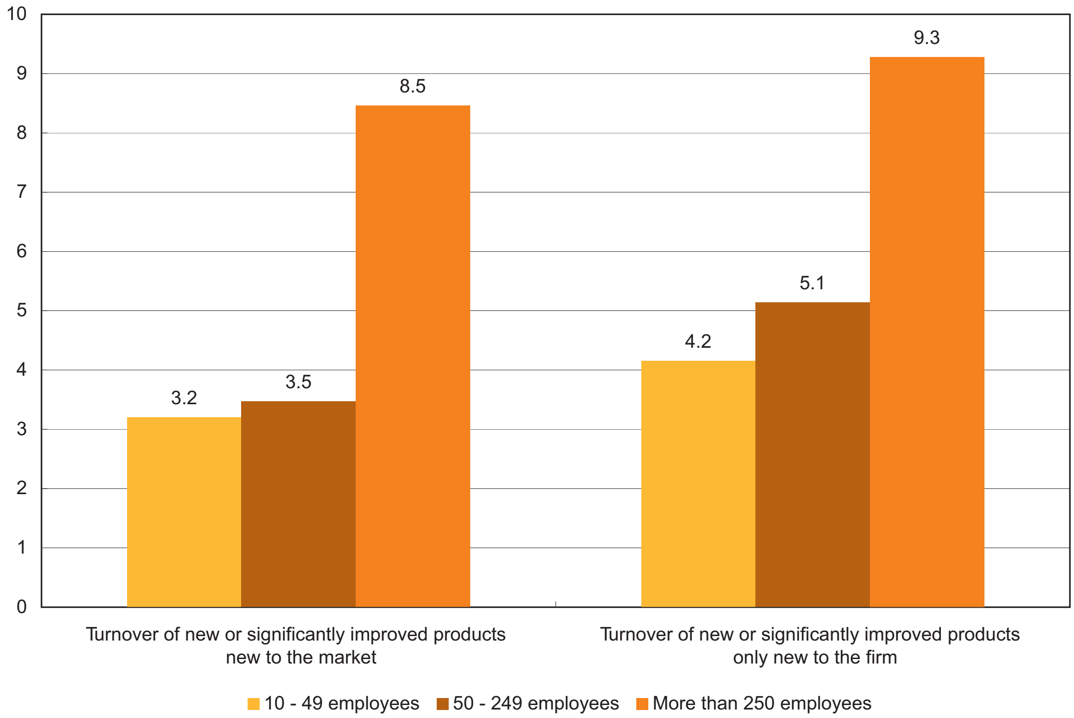


Figure 5.6 shows the EU-27 turnover from new or significantly improved products which are new to the market and from new or significantly improved products only new to the firm, as a percentage of total turnover.

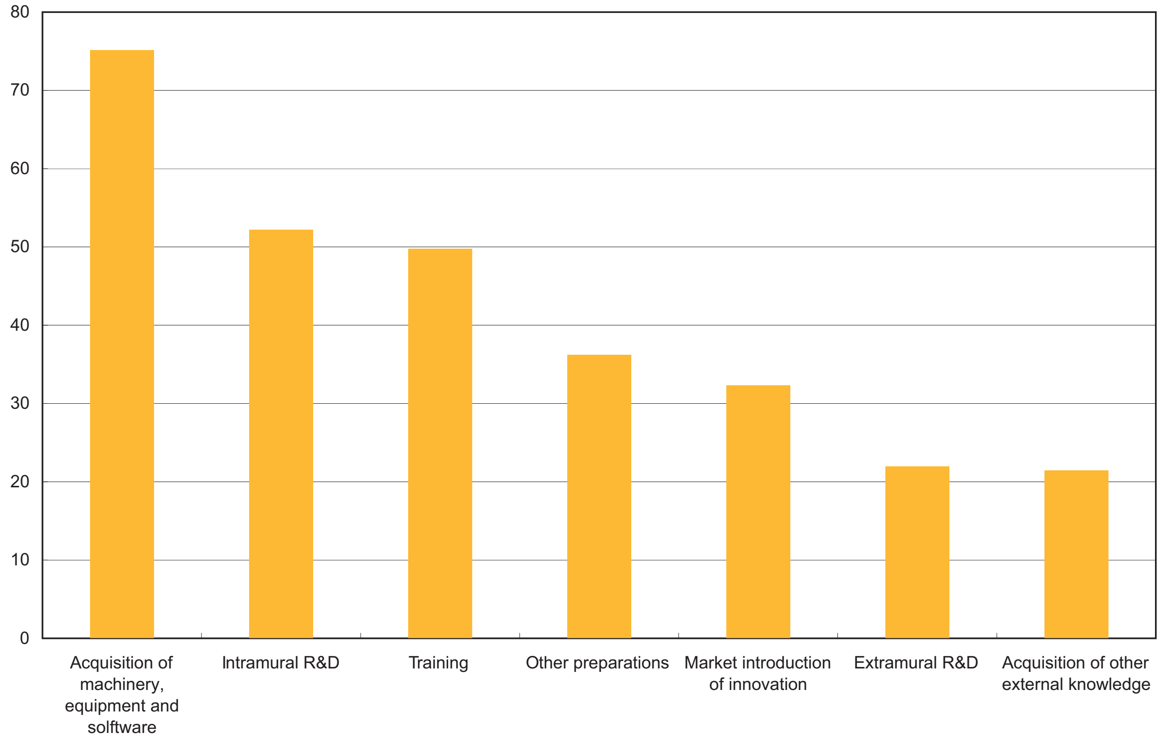
The indicator on the left is defined as turnover in products that are also new to the market and may also include world firsts. One drawback of this indicator is that enterprises may not know if their innovative products are really new to the national or global market or only new to their own market. The term "market" can be defined very strictly or more broadly.

As the products covered by the indicator on the right are not new to the market but only to the enterprise, the sales of these products can be used as a proxy for use of products (or technologies) already introduced elsewhere. This indicator measures the degree of technology dissemination.

Both indicators are broken down by the size class of innovative enterprises. For both indicators the largest enterprises have by far the highest turnover. The percentages of turnover from new or significantly improved products which are new to the market are slightly lower than the figures for turnover from new or significantly improved products that are new to the firm.

The difference in the shares of small and medium-sized enterprises is quite low for turnover from products new to the market but more marked for turnover from products new to the firm.

Figure 5.7 **EU-27 innovative enterprises engaged in intramural R&D, extramural R&D, acquisition of machinery, equipment and software, acquisition of other external knowledge, training, market introduction of innovation and other preparations, as a percentage of innovative enterprises — 2004**



Missing Data missing for AT, FI, LV, SI and UK; on training, other preparations and market introduction of innovation also for IE.

The involvement of innovative enterprises in R&D can take very different forms. About two thirds of all innovative enterprises in the EU-27 are engaged in acquisition of machinery, equipment and software. But for this indicator, not all acquisitions of machinery, equipment and software are taken into account. The definition of the indicator includes only acquisition of advanced machinery, equipment and computer hardware or software to produce new or significantly improved products and processes.

More than half of the innovative enterprises are active in intramural R&D. Intramural R&D, also called in-house R&D, consists of creative work undertaken within the enterprise to increase its stock of knowledge and use thereof to devise new and improved products and processes (including software development).

In nearly one out of every two innovative enterprises, employees are involved in training activities. The training can be provided for personnel internally or externally but should be aimed specifically at developing and/or introducing new or significantly improved products and processes.

More than one third of the innovative enterprises in the EU-27 are engaged in other preparations. This term covers procedures and technical preparations to introduce new or significantly improved products and processes that are not covered elsewhere.

Introduction of new or significantly improved goods and services onto the market — in other words innovation — , including market research and launch advertising, concerns almost one out of every three innovative enterprises in the EU-27.

Outsourcing and buying R&D or other knowledge from other companies (including other enterprises in the same group) or from public or private research organisations are the options chosen least frequently.

Only slightly over 20% of the innovative enterprises declared that they were engaged in extramural R&D or in acquisition of other external knowledge.

Acquisition of other external knowledge includes purchasing or licensing patents and non-patented inventions, know-how and other types of knowledge from other enterprises or organisations.

Commission welcomes Member States' agreement on the European Institute of Technology

The Competitiveness Council today agreed on a general approach for the European Institute of Technology (EIT), proposed by the European Commission in October 2006. By combining the worlds of academia, research and business, the EIT will be a flagship for excellence in innovation, research and higher education. Subject to the European Parliament's agreement later this year, the EIT should be able to begin operations in 2008. It will be organised on the basis of "Knowledge and Innovation Communities" (partnerships of universities, research organisations, companies and other stakeholders in the innovation process) and coordinated by a small governing structure.

Welcoming the Council's agreement, European Commission President José Manuel Barroso said: *"This is a very important step forward, bringing the EIT closer to lift-off. By strengthening Europe's capacity to bridge the innovation gap with its major competitors, the EIT will help drive a Europe of results. It will help us boost jobs and growth in a lasting and environmentally sustainable way. The Commission is grateful for the German Presidency's strong support for the EIT proposal and looks forward to working with the future Portuguese Presidency and with the European Parliament to reach a final agreement and to get the EIT operational as soon as possible."*

The EIT aims to integrate and boost innovation, research and higher education by pooling the best resources available at European level and beyond.

For the first time, Europe will promote the development of "Knowledge and Innovation Communities" (KICs), partnerships of universities, research organisations, companies and other stakeholders. These will perform innovation activities, cutting-edge and innovation-driven research, and postgraduate education and training activities. Each KIC will develop activities in an area of key interest for businesses and citizens. For the selection of initial KICs, priority EU policies, such as renewable energy and climate change, will be taken into account.

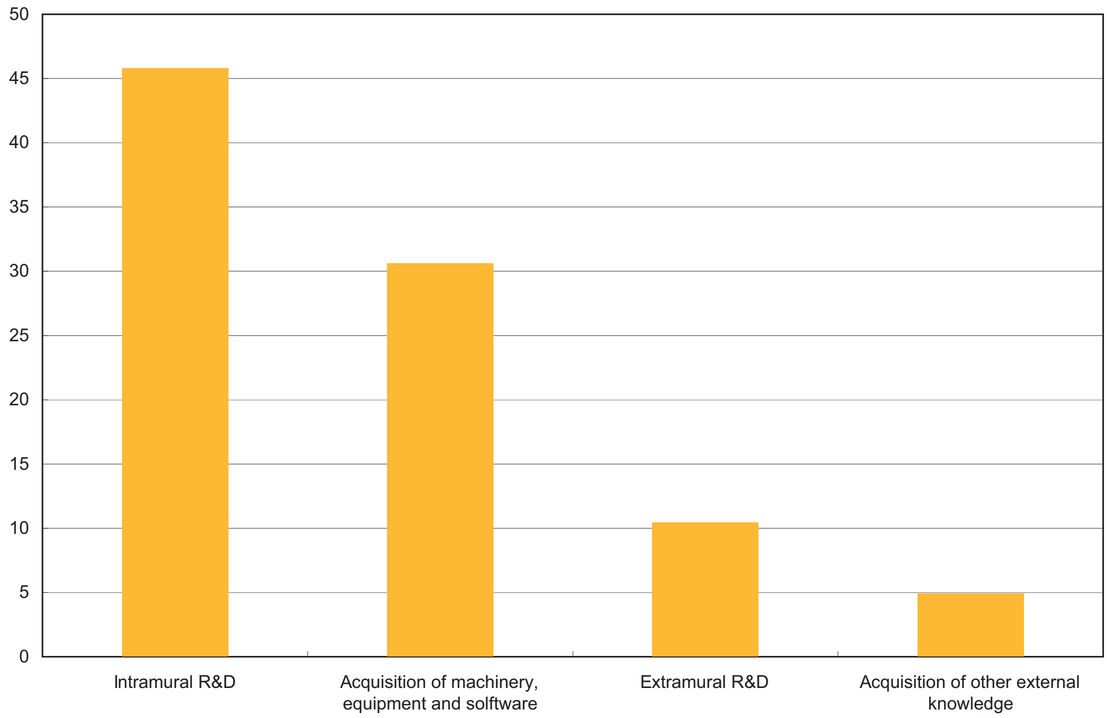
The involvement of business at all levels, both strategic and operational, will be a cornerstone of the project. Business will be strongly represented on the Governing Board of the EIT.

The funding of the EIT will come from a variety of sources; including a contribution directly from the Community budget – an amount of €308.7 million. This will cover the costs of the EIT's governing structure and the European dimension of the project, notably the costs of coordination and mobility that are necessary to sustain the KICs.

Once the European Parliament and the Council of Ministers reach a final agreement and adopt the Regulation, the EIT Governing Board will be appointed and the EIT structure and secretariat established. The selection of the first KICs will take place no later than two years after the appointment of the Governing Board.

For more information please see: http://ec.europa.eu/education/policies/educ/eit/index_en.html

Figure 5.8 **EU-27 expenditure by innovative enterprises on intramural R&D, extramural R&D, acquisition of machinery, equipment and software, acquisition of other external knowledge, as a percentage of total innovation expenditure — 2004**



Data missing for AT, FI, LV, SI and UK; on extramural R&D also for SE.

The innovative enterprises were also asked to estimate their expenditure on four types of innovation activity. Figure 5.8 shows the estimated percentages of total innovation expenditure for the EU-27.

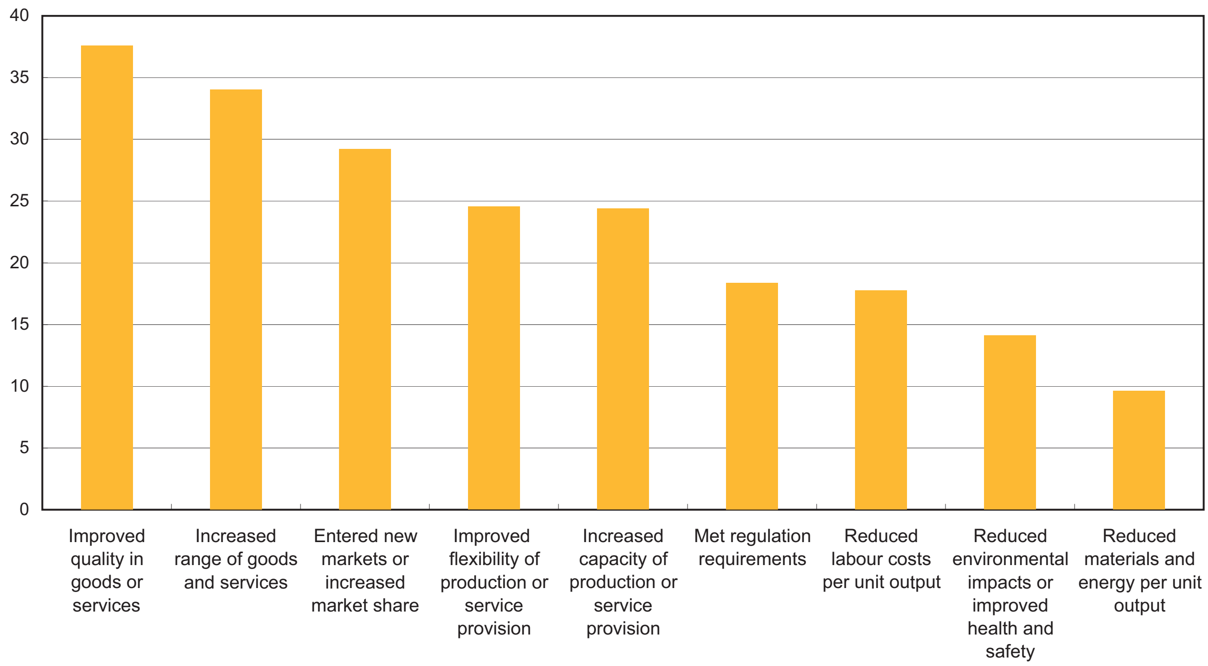
On average, innovative enterprises spent more than 45% of their total innovation expenditure on intramural R&D in 2004. This is the highest share for any individual innovation activity, because in-house R&D covers not only the salaries and related costs for the research personnel but also capital expenditure on buildings and equipment specifically for R&D.

Around 30% of the innovation expenditure of the innovative enterprises went on acquisition of machinery, equipment and software.

Extramural R&D made up 10% of the innovation expenditure. This is a much lower amount than for in-house R&D. Strategically, it may be better for an enterprise to keep most of its R&D in-house.

The lowest share (5%) of innovation expenditure by innovative enterprises was used for purchasing other external knowledge.

Figure 5.9 **EU-27 innovative enterprises, highly important effects of innovation, as a percentage of innovative enterprises — 2004**



Missing Data missing on “Reduced labour costs per unit output” and “Met regulation requirements” for UK.

The highly important effects of innovation shown in Figure 5.9 reflect the reasons why enterprises in the EU-27 innovate.

The three effects considered highly important by most innovative enterprises are typical sales targets: better quality, more choice and higher turnover.

38% of the innovative enterprises considered “improved quality in goods and services” a highly important effect. “Increased range of goods and services” and ‘“entered new markets or increase market share” scored 34% and 29% respectively.

Close to 25% of the innovative enterprises classified as highly important one or both effects that, more or less, concern the internal organisation of the enterprise. “Improved flexibility of production/service provision” may also lead to better and/or higher production but primarily develops the performance of the enterprise. The same applies to “increased capacity of production/service provision”. If more is produced, more can be sold. This aim may be achieved by replacing old by new and highly productive machinery.

The four remaining effects were chosen as highly important by under 20% of the innovative enterprises. For the last effect the figure even fell below 10%.

Regulations generally come from outside the enterprise. National or European authorities force the business sector to meet regulatory requirements. If enterprises innovate to meet regulatory requirements, they do so less by choice but more because they are under an obligation to do so.

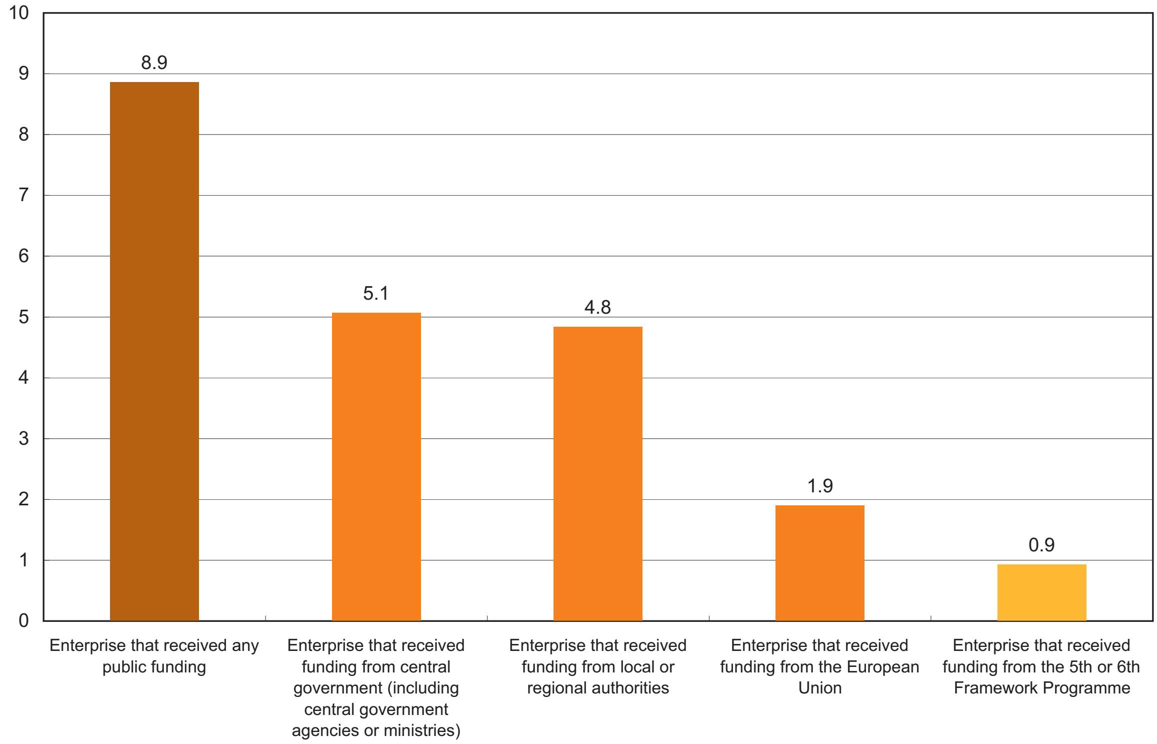
The last three effects do not seem to be the main aims of the innovative enterprises, but they are considered more or less positive collateral effects of innovation.

Reducing environmental impact or improving health and safety does not concern the innovating enterprise alone but has a positive effect on society as a whole. The enterprise may use this effect as a sales argument.

Reducing material and energy consumption and reducing labour costs both have a positive impact on production costs. Lower costs open up the possibility to cut prices and sell more. Another choice may be to leave prices the same and make bigger profits which can then be invested, for example in innovative activities.

But in most cases the idea of innovation is associated with new products or services rather than with improving those that already exist.

Figure 5.10 **EU-27 innovative enterprises, public funding broken down by sources, as a percentage of all enterprises — 2004**



Data missing on enterprises that received any public funding for IE, LV, SE, SI and UK; on breakdown also for PL and on Framework Programmes also for MT.

Close to 9% of the innovative enterprises (expressed as a percentage of all enterprises in the EU-27 countries for which data are available) received public funding during the reference period. This percentage is an average and may vary substantially across countries.

Figure 5.10 also shows the breakdown by sources. On average, central government was the source of funding for 5% of the innovative enterprises.

Nearly the same percentage of innovative enterprises received funding from a local or regional administration.

Conversely, under 2% of the innovative enterprises received funding from a European authority. Nearly half of the innovative enterprises that received funds from a European source were in fact financed by the 5th or 6th Framework Programme.

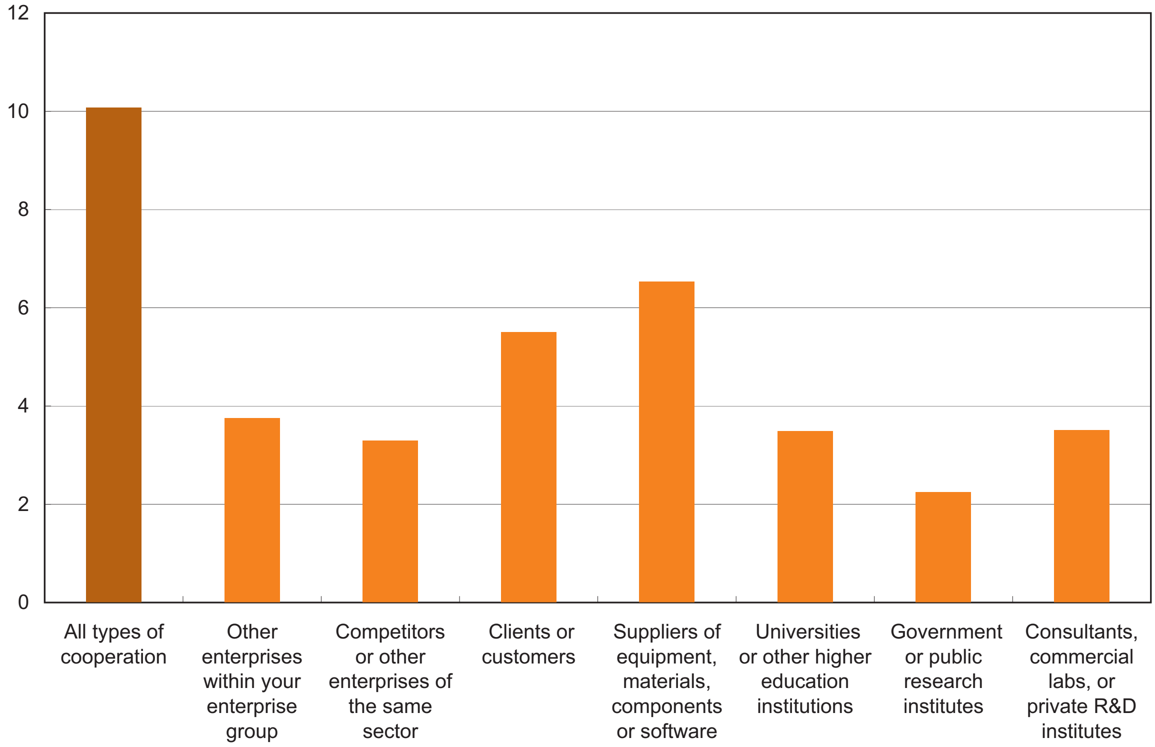
Framework Programmes (FPs) have been the main channels through which the European Union provides financial support for research and development activities covering almost every field of science. FPs are proposed by the European Commission and adopted by the Council and the European Parliament following the co-decision procedure.

FPs have been implemented since 1984 and cover a period of five years, with the last year of one FP overlapping with the first year of the next. As the reference period for CIS 4 was 2002 to 2004, two different programmes were concerned:

- the Fifth Framework Programme of the European Community for research, technological development and demonstration activities (1998–2002);
- and the Sixth Framework Programme for Research and Technological Development (FP6) (2002–2006).

The current FP – FP7 – has been in operation since 1 January 2007 and will expire in 2013. It is the first to cover a period of seven years. It is designed to build on the achievements of its predecessor towards creating the European Research Area and to go further towards developing a knowledge-based economy and society in Europe.

Figure 5.11 EU-27 innovative enterprises by type of cooperation, as a percentage of all enterprises — 2004



At EU-27 level, about 10% of innovative enterprises cooperated with other enterprises and universities, public research institutes and the like. The data shown draw no distinction between enterprises cooperating with one or more partners.

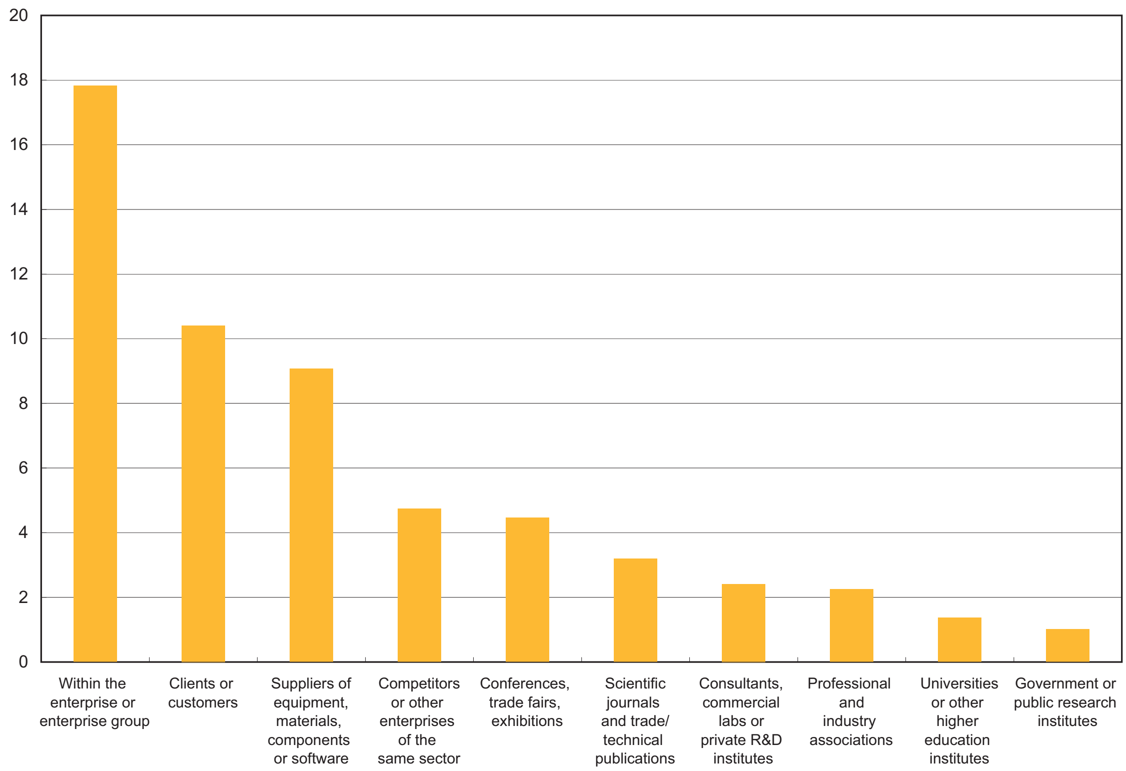
As public funding programmes aim mostly at strengthening cooperation between the business enterprise sector and the other two sectors (government and higher education), the results are very interesting.

Who are the cooperation partners of innovative enterprises? The most important appear to be suppliers of equipment, materials, components or software, followed by clients or customers. These forms of cooperation are facilitated by commercial links already existing between the partners involved. The same also applies to the type of partner which ranked third ("other enterprises within your enterprise group") with close to 4%.

The other four types of partners scored between 2% and 3% of the innovative enterprises at EU level.

Public-sector institutions are among the least frequently used cooperation partners. The links between the business enterprise sector and both the government and the higher education sectors seem quite weak.

Figure 5.12 **EU-27 innovative enterprises by source of information, as a percentage of all enterprises — 2004**



Data missing for AT, LV, SE, SI and UK; on “Consultants, commercial labs or private R&D institutes” and “Professional and industry associations” also for PL.

Not only cooperation but also information plays a key role in knowledge transfer and innovation.

The enterprises surveyed were offered a choice between ten different sources of information.

Figure 5.12 shows the results for the innovative enterprises.

The enterprise itself or its own group clearly led the ranking of sources of information, with close to 18% of the innovative enterprises. This result may be a bit surprising at first glance, but a short analysis shows that it is perfectly in line with the other results of CIS 4. Innovative enterprises are often large and many of them are also part of a group. They frequently conduct intramural R&D but do not cooperate so much. However, as mentioned earlier, information is vital for innovation so the enterprise itself or its own group is the most obvious choice as a source of information.

Clients and customers ranked second with 10% and suppliers of equipment, materials, components or software third with 9%. This can be explained by the fact that these two sources of information are also among the most important cooperation partners.

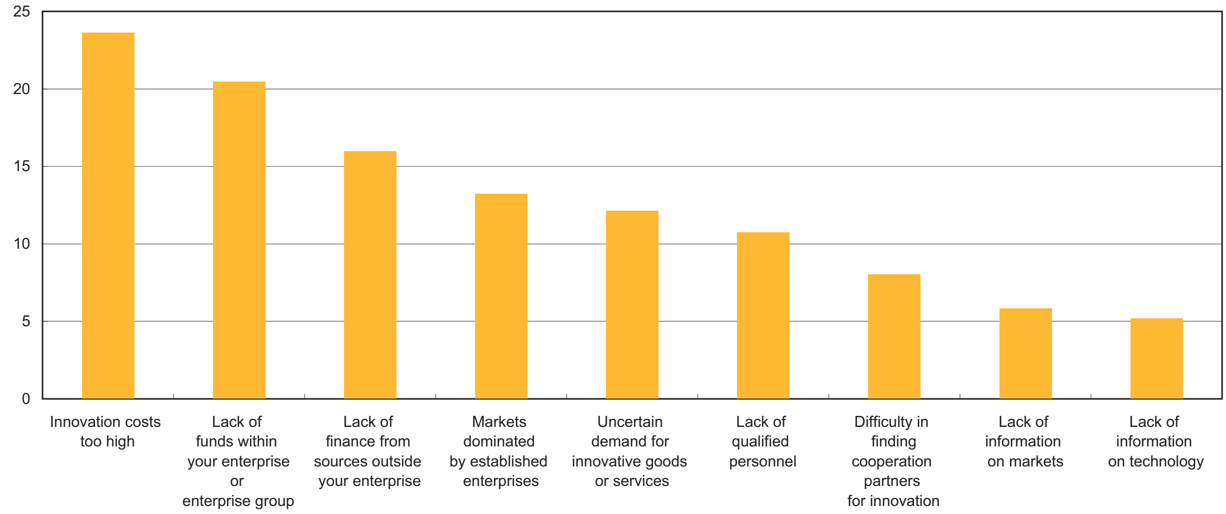
All other sources of information fell short of the 5% mark.

The proportion of innovative enterprises that used private sources of information, such as conferences, consultants or professional associations, was higher than in the public sector.

At the other end of the scale, the least used sources of information are the higher education and government sectors. It would be interesting to investigate further why these sources are the least used. There might be barriers to using these sources of information. Moreover, the EU average may mask national differences.

Basically, these results are another sign of the weak link between the public and private sectors.

Figure 5.13 **EU-27 innovative enterprises by highly important hampering factor, as a percentage of innovative enterprises — 2004**



Data missing on "lack of finance from sources outside your enterprise" and "lack of funds within your enterprise or enterprise group" for UK; on "difficulty in finding cooperation partners for innovation" for UK and PL; and on "markets dominated by established enterprises" for PL.

Numerous factors hamper enterprises from carrying out innovation activities.

The innovative enterprises were asked to rank nine different factors hampering innovation.

Figure 5.13 ranks the results by the proportions of innovative enterprises that considered the factors concerned a significant hindrance.

The first three factors are financial: costs are too high and financing too low. The fact that innovation is mostly very expensive cannot be denied. Enterprises that are doing in-house R&D have to invest in technical equipment and pay salaries for highly skilled personnel. These costs are high and very often the outcome is not immediate and does not emerge until in the long run. Once an invention is made, it may also be important to protect it. Protection methods such as patent applications in turn require funds.

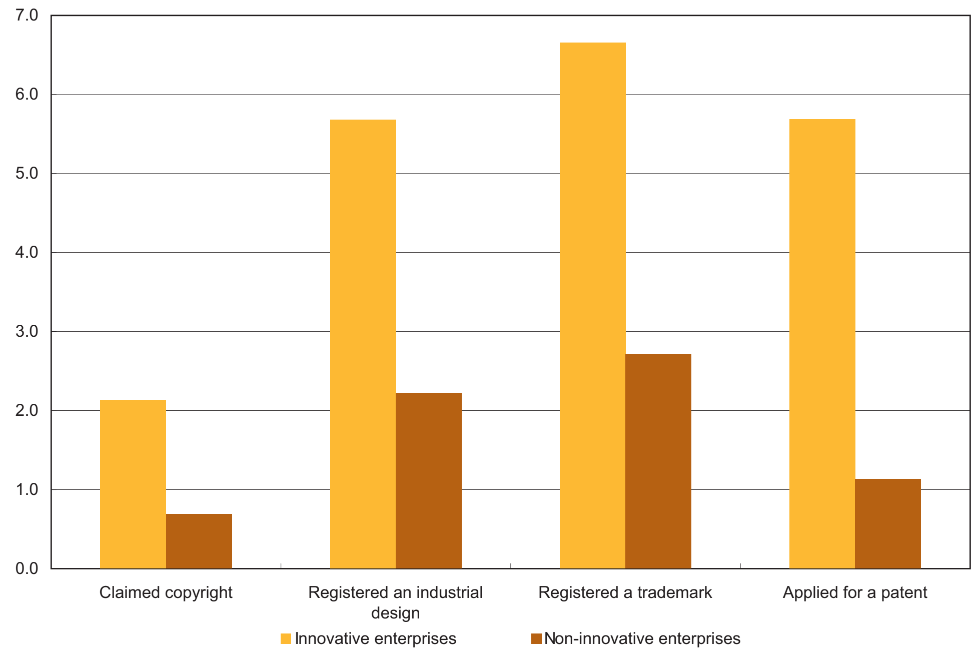
The next three factors concern the market situation: domination by established enterprises, uncertain demand and unsuitable job market. On many markets competition is very tough and product cycles are becoming shorter. Some markets are saturated and it is not easy continuously to come up with ideas for new products and services.

At the end of the scale, there are two factors that have already been analysed in response to other questions: cooperation and information.

The last three factors mentioned did not reach the 10% mark as highly significant hindrances. This result is somewhat surprising. On the one hand, Figures 5.11 and 5.12 show that innovative enterprises are not very active on cooperation and do not seem to use the sources of information as intensively as they might. But on the other Figure 5.13 leaves the impression that innovative enterprises do not really consider information and cooperation as key elements of innovation.

This analysis of hampering factors must take into account that the EU-27 values only indicate trends. The situation may be somewhat different at national level. Moreover, even at national level, the barriers to innovation may not be equally distributed between enterprises. Instead, there are typical sets of barriers to innovation, depending on the age, size, industry and innovativeness of the firm. For this reason, global solutions may not be efficient and the current trend is to identify clusters and find solutions adapted to their needs.

Figure 5.14 **EU-27 innovative and non-innovative enterprises by protection method, as a percentage of all enterprises — 2004**



Data missing for AT, LV, SE, SI and UK; on non-innovative enterprises which claimed copyright or registered a trademark also for MT.

In most cases, innovation implies intensive use of human and financial resources. For this reason, the outcome of innovative processes, such as inventions, needs to be protected.

There are different methods, depending on what has to be protected. A patent application is used for a technical invention, whereas a trademark protects a specific name.

Further details on intellectual property rights are given in Section 5.4, which presents the national data. CIS 4 focuses on four methods of protection:

- claimed copyrights;
- registered an industrial designs;
- registered a trademarks
- applied for a patent.

Figure 5.14 compares the protection methods used at EU-27 level by innovative and non-innovative enterprises. Unsurprisingly, the scores for non-innovative enterprises are much lower for all four methods than those recorded by innovative enterprises.

Innovative enterprises mostly have recourse to trademarks. Industrial design and patents are used in equal proportions. Copyrights are used less because they mainly cover non-technical works.

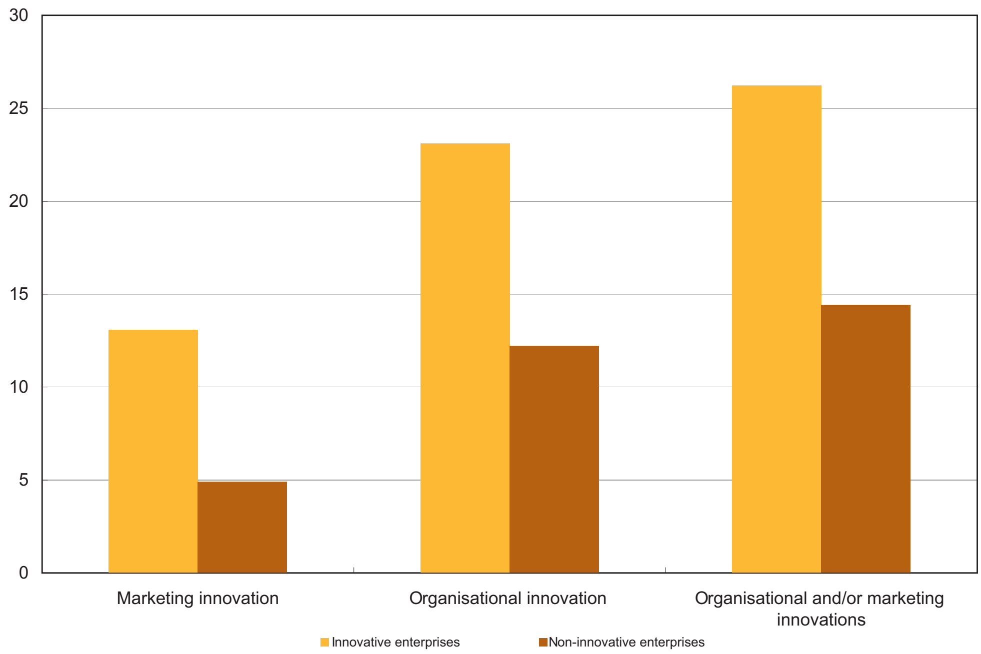
At a much lower level, non-innovative enterprises make broadly similar use of protection methods. They use trademarks most frequently, followed by registering industrial designs. By contrast, non-innovative enterprises rarely apply for patents and claim copyrights even less.

“Non-innovative” just means that the enterprise has not developed any new product or introduced any process innovation. However, as revealed in Figure 5.15, non-innovative enterprises can be active in organisational and/or marketing innovations, but are less active in these two areas than innovative enterprises. For both groups the proportion of enterprises active in organisational innovations is higher than the proportion carrying out marketing innovations.

As in the case of product and process innovators, marketing and organisational innovation are related. The proportion of enterprises introducing organisational and/or marketing innovations is lower than the sum of the enterprises active in one or the other type of innovation because some of them are engaged in both.

As the data in Figure 5.15 are shown as percentages of all enterprises, they can be added up. This shows that 18% of all enterprises introduced marketing innovation, 35% organisational innovation and 41% organisational and/or marketing innovations.

Figure 5.15 EU-27 innovative and non-innovative enterprises that introduced organisational and/or marketing innovations, organisational innovation and marketing innovation, as a percentage of all enterprises — 2004



Data missing for FI, LV, SE, SI and UK.

The enterprises surveyed were asked to assess four effects of organisational innovation. Figure 5.16 once again compares innovative and non-innovative enterprises. The figures for non-innovative enterprises are lower because they introduced fewer organisational innovations.

As with product and process innovation, commercial aspects are also considered the most important effects. Improved quality scored highest, followed by the reduction in the time to respond to customer or supplier needs. Cost reduction and positive impacts on employees ranked third and last respectively for both groups.

Readers should note that in Figure 5.16 data for eight countries are missing and that, due to this, the EU-27 values are only indicative.

Table 5.16 EU-27 innovative and non-innovative enterprises by highly important effect of organisational innovation, as a percentage of all enterprises — 2004

Highly important effects	Innovative enterprises	Non-innovative enterprises
Improved employee satisfaction and/or reduced rates of employee turnover	4.1	2.0
Reduced costs per unit output	4.7	2.2
Improved quality of goods or services	10.2	4.0
Reduced time to respond to customer or supplier needs	9.1	3.8

Data missing for AT, FI, IE, LV, PL, SE, SI and UK.

5.4 Innovation data at the national level

German enterprises were the most numerous in the European innovation landscape

This presentation of the CIS 4 results by country closely follows the structure of the underlying questionnaire.

Close to two thirds of all German enterprises (65 896) are active in innovation, which means that they introduced at least one production innovation (goods or services) and/or process innovation during the reference period from 2002 to 2004.

Innovation activities include acquisition of machinery, equipment, software and licences, engineering and development work, training, marketing and R&D when they are specially undertaken to develop and/or implement a product or process innovation.

Germany is followed by seven other countries in which at least half of all enterprises are innovative: Austria, Luxembourg, Ireland, Iceland, Denmark, Belgium and Sweden.

At the other end of the scale, Romania, Latvia and Bulgaria reported percentages below 20%.

Looking at the absolute figures, the ranking is quite different, due essentially to the different sizes of the national economies. Germany is still in the lead, but is followed by Italy, the United Kingdom, France, Spain and Poland.

General information about the enterprises

Figure 5.17 **Innovative enterprises, total number and as a percentage of all enterprises, by country, EU-27 and selected countries — 2004**

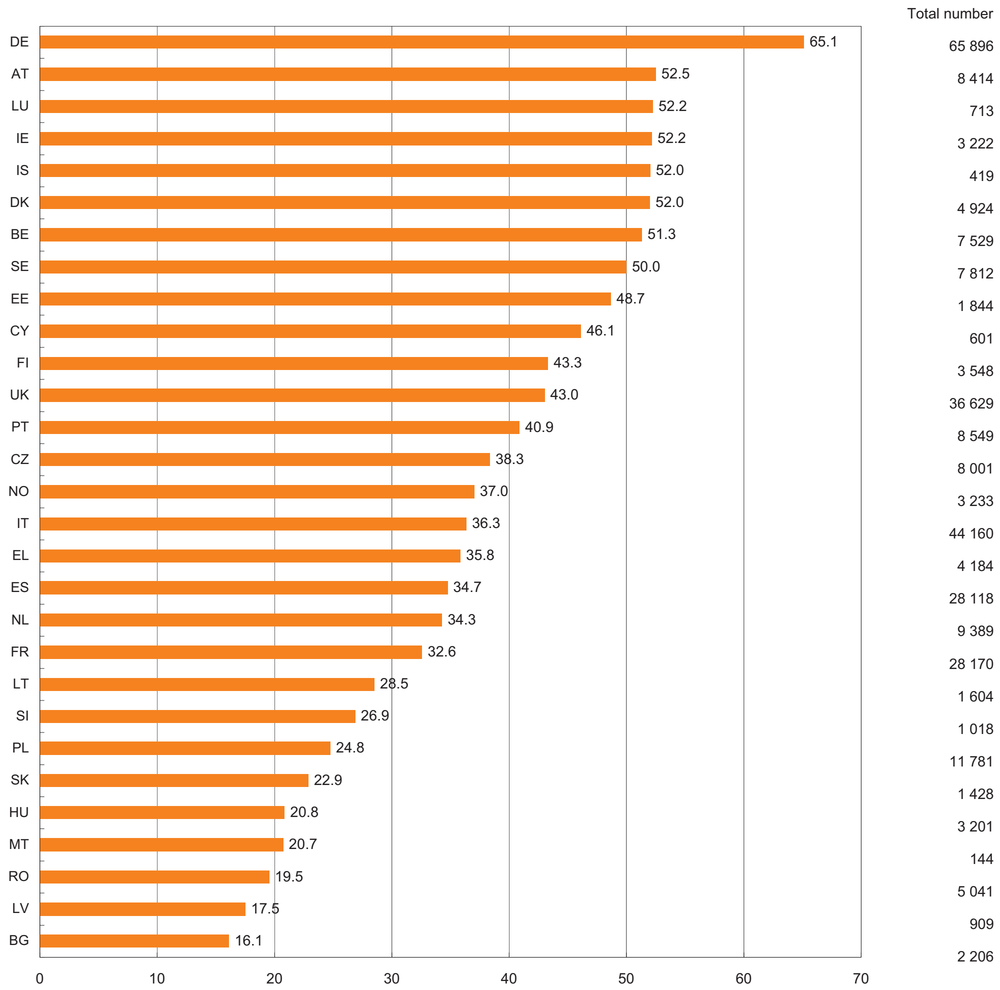
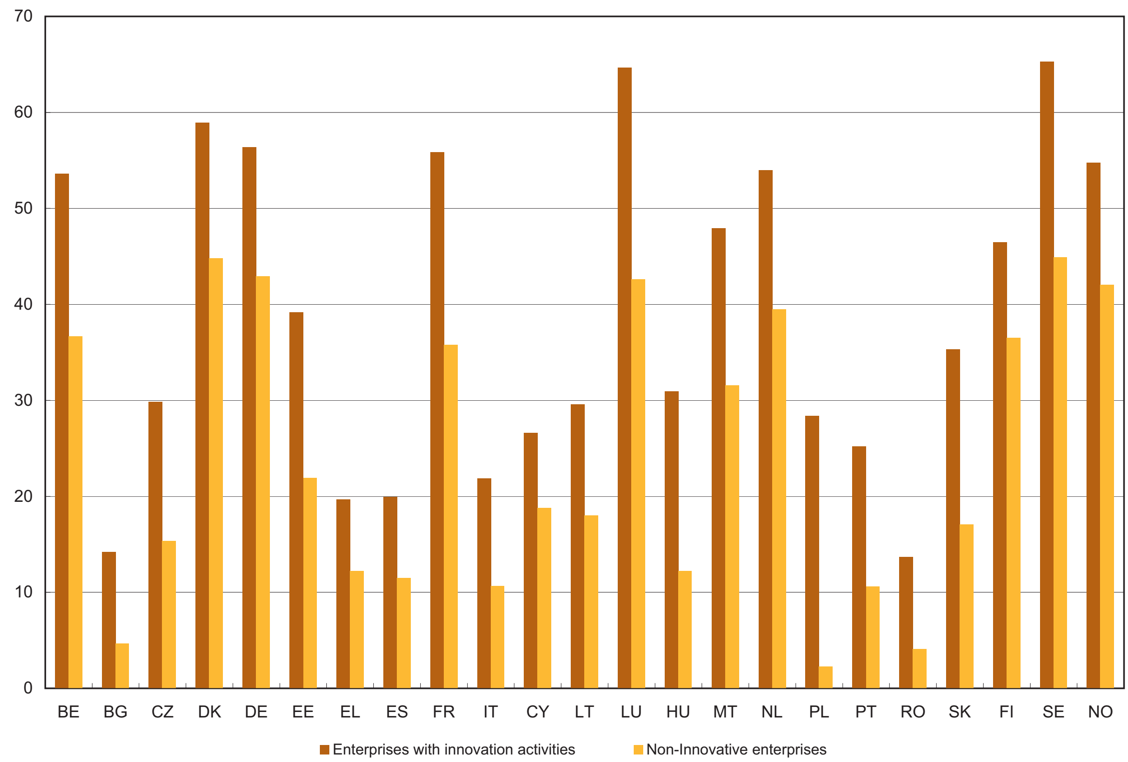


Figure 5.18 Innovative and non-innovative enterprises which are part of a group, as a percentage of innovative and non-innovative enterprises, by country, EU-27 and Norway — 2004



MData missing/confidential for IE, LV, AT, SI, and UK.

To form a better picture of the structure of enterprises in the countries concerned, the CIS 4 questionnaire asked the enterprises to indicate if they were part of a group and which country the head office is located in. The second part of this question asked the enterprises about their geographical markets.

A group consists of two or more legally defined enterprises under common ownership. Each enterprise in the group may serve different markets, as with national or regional subsidiaries, or serve different product markets. The head office is also part of the group.

Figure 5.18 compares the proportion of innovative enterprises which are part of a group with the proportion of non-innovative enterprises.

The percentages of innovative enterprises which are part of a group vary between 65% in Sweden and 14% in Bulgaria. For non-innovative enterprises the percentages range from 45% in Sweden to 2% in Poland.

Comparison of the results for the individual countries shows higher percentages of enterprise groups among the innovative enterprises in every country. Whereas the difference between the two groups is 7% in Greece it rises to 26% in Poland. There seems to be a correlation: being part of a group seems to have a positive influence on innovation activities. A group can invest more easily in R&D activities which may lead to innovation.

Figure 5.18 provides additional information. Enterprise structures vary across EU Member States: in countries such as Sweden and Luxembourg far more enterprises are part of groups than in other countries, especially the most recent EU Member States, i.e. Bulgaria and Romania.

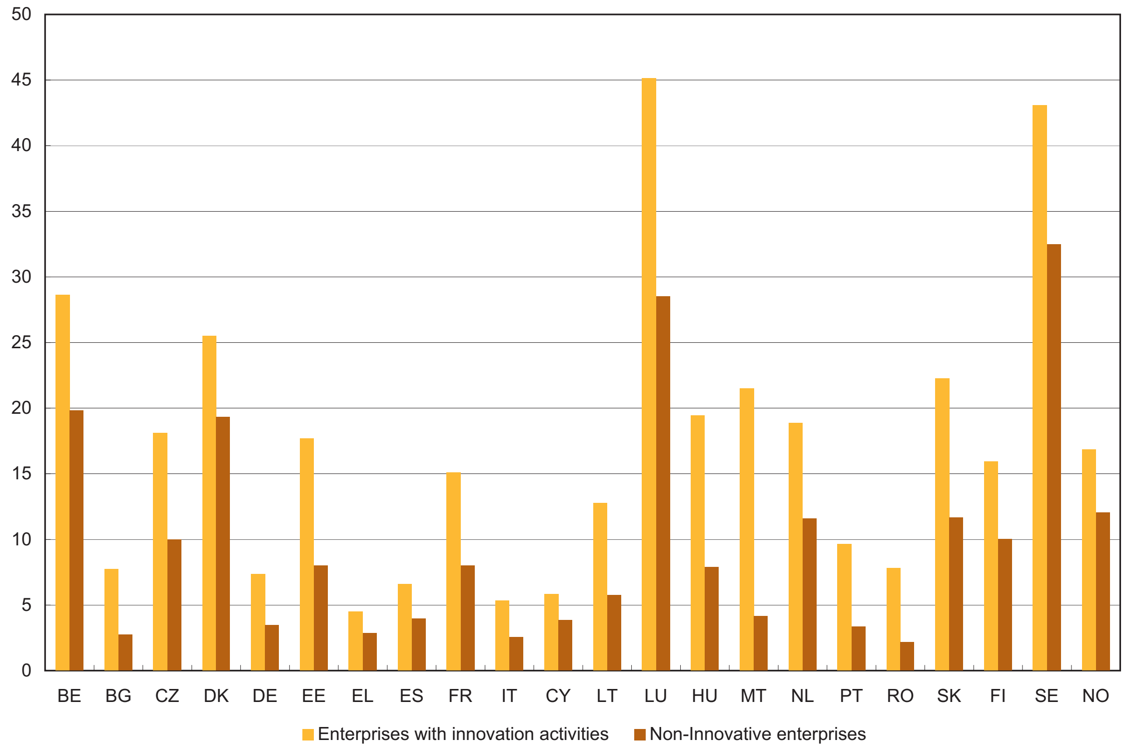
Figure 5.19 concentrates on one subgroup of the enterprises shown in Figure 5.18. It takes a closer look at groups with a head office in another country.

The proportion of innovative enterprises is still higher than that of non-innovative enterprises. This means that not only being part of a group but also having a head office in another country seems to encourage innovation.

Comparison of the two figures points to a further finding. Luxembourg, Sweden and, to a lesser extent, Belgium and Denmark have the highest proportions of groups with a head office in another country out of all EU Member States for both innovative and non-innovative enterprises.

Large economies, such as Germany and France, have rather high proportions of groups but low percentages of groups with a head office in another country.

Figure 5.19 **Innovative and non-innovative enterprises which are part of a group and have a head office in another country, as a percentage of innovative and non-innovative enterprises, by country, EU-27 and Norway — 2004**



Data missing/confidential for IE, LV, AT, PL, SI and UK; data unreliable for: FR.

Table 5.20 Innovative and non-innovative enterprises which sold goods or services during the three years 2002 to 2004, as a percentage of innovative and non-innovative enterprises, by geographic market and by country, EU-27 and Norway — 2004

	Innovative enterprises				Non-innovative enterprises			
	Local/regional market	National market	Other EU, EFTA and/or EU-CC countries	Any other country	Local/regional market	National market	Other EU, EFTA and/or EU-CC countries	Any other country
BE	:	92.9	77.2	34.5	86.0	:	56.8	18.3
BG	59.9	75.6	32.5	23.4	44.9	70.3	17.0	8.6
CZ	13.3	40.9	37.2	8.6	43.4	25.4	28.6	2.6
DK	99.9	89.4	67.5	47.5	80.1	96.6	44.5	22.4
DE	41.2	69.4	45.5	28.1	52.2	59.6	28.1	11.7
EE	63.7	79.2	70.4	31.4	62.5	61.3	59.6	26.1
IE	:	:	:	:	:	:	:	:
EL	95.9	87.3	48.7	34.6	82.1	92.8	40.4	18.2
ES	95.8	80.7	46.5	26.0	66.0	94.1	29.4	14.0
FR	74.9	83.8	56.5	41.3	56.6	84.5	28.8	16.3
IT	48.3	72.0	51.2	31.2	57.2	55.6	32.2	17.5
CY	96.2	78.4	28.1	23.0	78.8	92.7	19.2	16.1
LV	:	:	:	:	:	:	:	:
LT	:	93.6	55.5	35.4	89.1	:	38.2	18.0
LU	60.4	83.3	67.5	41.1	81.9	58.7	58.3	22.9
HU	74.3	90.6	59.2	30.7	80.5	65.6	37.3	13.6
MT	-	72.2	19.4	8.3	88.0	-	9.4	2.5
NL	62.5	87.3	65.2	33.5	71.7	64.1	46.5	18.5
AT					:	:	:	:
PL	:	:	:	:	:	:	:	:
PT	85.5	88.2	58.1	34.7	76.8	85.8	40.8	18.9
RO	29.0	62.5	36.3	9.0	44.3	46.9	22.9	2.8
SI	: c	: c	: c	: c	: c	: c	: c	: c
SK	89.0	61.8	62.3	20.3	39.8	90.3	43.9	7.5
FI	:	:	:	:	:	:	:	:
SE	75.8	64.8	60.9	33.3	36.4	88.1	33.1	13.7
UK	:	:	:	:	:	:	:	:
NO	25.2	73.7	43.5	30.5	54.2	43.9	20.0	12.5

For MT and CZ only one answer chosen is taken into account.

Table 5.20 compares the geographical markets of innovative and non-innovative enterprises. It draws a distinction between four markets:

- local/regional market within the country
- national market
- other EU, EFTA and or EU candidate countries
- any other country

The enterprises surveyed were not restricted to a single answer but were allowed to choose up to four replies.

In general, all the percentages are higher for innovative than for non-innovative enterprises. Their geographical markets seem to be larger and more diversified than those of non-innovative enterprises. Innovation seems to stimulate sales of goods and/or services.

Every country displays higher percentages for innovative enterprises selling goods and/or services on international markets. For regional/local and national markets there is no general rule. The results vary across countries. In several countries, such as the Czech Republic, Germany, Italy, Luxembourg, Hungary, the Netherlands, Romania and Norway, non-innovative enterprises are more heavily represented on regional/local markets than innovative enterprises. In some other countries this is the case for the national market, namely in Denmark, Greece, Spain, France, Cyprus, Slovakia and Sweden.

In every country the percentages for the “other EU, EFTA and/or candidate countries” and “any other country” markets were always higher for innovative than for non-innovative enterprises.

In general, intra-European trade is more important for all enterprises than trade with non-EU countries. This may be explained by the fact that the geographical distances to other EU countries are often shorter than to other countries. Customs and tax issues also play an important role.

Table 5.21 Innovative enterprises as a percentage of all enterprises, by size-class and by country, EU-27 and selected countries — 2004

	Total	Between 10 and 49 employees	Between 50 and 249 employees	250 employees or more
BE	51.3	46.6	66.0	83.0
BG	16.1	13.5	22.8	33.3
CZ	38.3	32.3	50.2	69.8
DK	52.0	48.6	58.7	77.8
DE	65.1	59.7	74.4	88.6
EE	48.7	45.3	57.9	79.8
IE	52.2	47.2	65.4	75.1
EL	35.8	33.9	43.1	66.6
ES	34.7	32.3	43.8	66.0
FR	32.6	26.8	51.3	72.6
IT	36.3	33.3	52.7	68.9
CY	46.1	42.7	60.9	81.5
LV	17.5	14.1	27.2	53.5
LT	28.5	22.4	42.0	64.3
LU	52.2	46.9	62.6	79.2
HU	20.8	16.9	30.5	52.4
MT	20.7	16.9	28.9	66.7
NL	34.3	29.5	48.4	71.4
AT	52.5	48.3	63.8	81.9
PL	24.8	18.4	39.4	64.4
PT	40.9	35.9	60.4	72.0
RO	19.5	15.7	24.3	41.8
SI	26.9	19.1	40.9	69.9
SK	22.9	16.0	34.3	57.8
FI	43.3	36.9	60.1	76.0
SE	50.0	45.1	66.5	77.8
UK	43.0	39.9	52.7	62.5
IS	52.0	49.5	59.5	63.3
NO	37.0	32.4	53.5	63.4

As shown in Table 5.21, there is a strong correlation between innovation activities and enterprise size. The percentage of innovative enterprises is higher amongst large and medium-sized enterprises than amongst small businesses.

Similarly to the analysis of whether or not the enterprise was part of a group, innovation seems to be facilitated by certain infrastructure. Enterprises need to be a certain size before they can have their own R&D department. One problem with small enterprises is that they indeed innovate but do not have sufficient resources (financial, human, etc.) to make profits from their innovations.

The lowest figures in Table 5.21 are always for Bulgaria and the highest for Germany. The reason is that the figures are expressed as percentages of all enterprises. Taking only the innovative ones into account produces the same ranking as shown in Figure 5.17.

The percentages of innovative enterprises vary from 14% to 60% for small businesses, from 23% to 74% for medium-sized enterprises and from 33% to 89% for large enterprises.

5

Table 5.22 Innovative enterprises, as a percentage of all enterprises, by NACE and by country, EU-27 and selected countries — 2004

	All NACE - Core NACE	Total industry (excluding construction)	Manufacturing	Core G_to_K Services	Transport, storage and communication	Financial intermediation	K: Core coverage	74 Core: Other business services
BE	51.3	58.1	58.2	45.3	33.0	47.8	63.5	56.6
BG	16.1	18.0	18.2	12.7	7.2	29.5	38.3	25.7
CZ	38.3	41.1	41.7	33.9	22.5	56.6	44.8	32.7
DK	52.0	57.7	57.8	46.0	47.7	43.5	56.8	42.8
DE	65.1	72.8	74.0	57.5	46.0	80.5	78.6	68.5
EE	48.7	46.9	48.2	50.7	32.6	74.7	53.5	41.8
IE	52.2	60.9	61.4	43.8	40.9	:	73.0	:
EL	35.8	35.1	34.9	36.8	37.8	50.2	79.5	57.6
ES	34.7	36.5	36.9	32.1	24.2	49.7	55.1	47.0
FR	32.6	36.1	36.4	29.0	18.5	38.0	46.8	32.6
IT	36.3	37.5	37.6	33.5	23.1	40.4	41.8	38.6
CY	46.1	53.2	53.2	37.9	26.0	77.1	40.4	28.2
LV	17.5	17.4	17.4	17.6	12.0	42.3	24.8	12.6
LT	28.5	31.2	31.2	25.7	16.4	52.7	45.5	32.3
LU	52.2	48.9	49.3	53.2	35.7	66.8	64.0	64.1
HU	20.8	21.1	21.2	20.4	13.9	47.2	35.1	24.3
MT	20.7	26.3	27.0	16.1	8.8	31.7	42.9	: c
NL	34.3	41.6	41.5	29.2	17.6	29.6	47.8	42.9
AT	52.5	57.5	57.5	47.9	32.7	61.0	66.7	54.0
PL	24.8	26.6	26.2	22.0	15.5	42.6	26.8	20.8
PT	40.9	39.1	38.8	44.3	44.7	53.9	60.6	52.2
RO	19.5	21.6	21.8	16.1	16.8	23.8	24.4	15.2
SI	26.9	34.3	35.0	16.0	14.3	21.1	27.2	28.8
SK	22.9	26.9	27.3	17.0	17.7	44.1	32.5	15.9
FI	43.3	49.3	50.5	36.8	26.8	42.5	49.7	33.7
SE	50.0	54.3	54.9	45.9	23.0	46.3	63.3	57.8
UK	43.0	44.4	44.6	41.8	28.4	40.9	59.3	49.6
IS	52.0	52.6	52.0	51.4	45.9	53.9	61.5	26.2
NO	37.0	43.4	44.0	31.6	18.2	25.5	55.5	45.7

The analysis based on the NACE (Statistical Classification of Economic Activities in the European Community) makes it possible to identify the sectors of the economy in which innovative enterprises are best represented.

Sector K (Core coverage) includes K 72 "Computer and related activities", K 74.2 "Architectural and engineering activities and related technical consultancy" and K 74.3 "Technical testing and analysis". In 16 of the 29 countries shown in Table 5.22 the highest shares of innovative enterprises are in this sector. Unsurprisingly, all sectors linked to computer activities are highly significant for innovation.

More surprising, perhaps, are the results for the financial intermediation sector. It covers J 65 "Financial intermediation, except insurance and pension funding", J 66 "Insurance and pension funding, except compulsory social security" and J 67 "Activities auxiliary to financial intermediation." Ten of the 29 countries recorded their highest percentages in the financial intermediation sector.

Denmark, Slovenia and Finland are the exceptions. These three countries reported their highest shares of innovative enterprises in manufacturing (NACE section D).

A cross-country comparison does not make much sense for this table, because the results are biased by the overall ratio of innovative to non-innovative enterprises in each country. Germany, which has the highest percentage for every NACE section, also has the highest percentages for most of the sub-sections. The only exceptions are "transport, storage and communication" where the percentage of innovative enterprises is slightly higher in Denmark and sector K (Core coverage), where Greece scores higher than Germany.

Table 5.23 Innovative enterprises, by number of employees in 2002 and 2004 and AAGR of employees and turnover, by country, EU-27 and selected countries — 2004

	Total number of employees in 2002	Total number of employees in 2004	AAGR - Number of employees	AAGR - Turnover
BE	945 087	941 368	-0.2	10.7
BG	266 446	273 738	1.4	21.6
CZ	1 095 717	1 090 574	-0.2	3.7
DK	531 614 u	519 797	-1.1	3.5
DE	9 034 437	8 931 721	-0.6	1.6
EE	117 873	127 841	4.1	14.4
IE	:	282 268	:	:
EL	326 813	309 496	-2.7	5.7
ES	2 090 921 u	2 339 477	5.8	8.9
FR	4 096 989	4 250 893	1.9	7.3
IT	3 243 156	3 294 942	0.8	3.0
CY	39 626	40 971	1.7	-4.1
LV	:	:	:	:
LT	201 854	206 810	1.2	7.5
LU	70 481	69 350	-0.8	1.4
HU	554 438	548 481	-0.5	8.9
MT	21 501	21 559	0.1	-1.4
NL	1 310 122	1 254 252	-2.2	4.7
AT	: c	: c	:	6.9
PL	1 996 553	2 112 436	2.9	4.8
PT	596 712	588 223	-0.7	4.9
RO	1 244 836	978 997	-11.3	11.0
SI	: c	: c	:	:
SK	365 609	347 039	-2.6	13.4
FI	:	577 548	:	:
SE	820 731	817 004	-0.2	8.0
UK	:	:	:	:
IS	:	:	:	:
NO	225 597	265 952	8.6	19.9

Table 5.23 shows the trend in the number of employees and turnover between 2002 and 2004 for innovative enterprises.

There is no general trend for all EU Member States. Eleven countries recorded a negative annual average growth rate (AAGR) of between 11% (Romania) and less than 1% (Belgium, the Czech Republic, Germany, Luxembourg, Hungary, Portugal and Sweden) in the number of employees in enterprises with innovative activities.

The highly negative growth rate for innovative enterprises in Romania is surprising because Romania has a fast growing economy and a declining unemployment rate. The trend may be explained by migration of highly educated people to countries where wages and salaries are higher and living conditions better.

Ten other countries recorded a positive AAGR for the number of employees in innovative enterprises. They vary between 6% in Spain and less than 1% in Italy and Malta.

The overall trend in the turnover of innovative enterprises is positive in nearly every country. The only exceptions are Cyprus (-4%) and Malta (-1%).

The positive AAGRs range from 22% (Bulgaria) to 1% (Luxembourg). The four best-performing countries are Bulgaria (22%), Estonia (14%), Slovakia (13%) and Romania (11%), all of which joined the EU recently and have fast-growing economies. Belgium, one of the “old” Member States, ranks fifth with 11% and is the last country in the ranking exceeding 10%.

Product (goods or services) and process innovation

Before starting to analyse the results on product and process innovation, it is necessary to explain what is meant by these terms and what is excluded and to give some examples.

Product innovations cover goods and services with characteristics or intended uses that differ significantly from previous products produced by an enterprise. This includes significant changes in technical specifications, components and materials, incorporated software, user-friendliness or other functional characteristics. Unlike process innovations, they are sold directly to customers.

The innovation (new feature or improvement) must be new to the enterprise, but does not have to be new to the sector or to the market.

Product innovations do not include:

- minor changes or improvements;
- routine upgrades;
- seasonal changes (such as for clothing lines);
- customisation for a single client that does not include significantly different attributes to products made for other clients;
- design changes that do not alter the function or technical characteristics of the goods or services;
- the simple resale of new goods and services purchased from other enterprises, but do include goods and services developed and produced by foreign affiliates for the enterprise in question.

Innovative goods

- Introducing entirely new products;
- Replacing inputs with materials with enhanced characteristics (breathable textiles, light but strong composites, environment-friendly plastics, etc.);
- Introducing new or improved components in existing product lines (global positioning systems (GPS) in vehicles, cameras in mobile telephones, fasteners in clothing, etc.);
- Household appliances that incorporate software that improves user-friendliness or convenience, such as toasters that automatically shut off when the bread is toasted.

Innovative services

- Improving customer access, such as home pick-up and drop-off services for rental cars;
- DVD subscription services, where for a monthly fee customers can order a predefined number of DVDs via the Internet with mail delivery to their home and return via a pre-addressed envelope;
- Internet services, such as banking, bill-payment systems, electronic purchase and issuing of travel and theatre tickets;
- New forms of warranty, such as an extended warranty on new or used goods, or bundling warranties with other services, such as with credit cards, bank accounts or customer loyalty cards;
- Installing gas heaters in outdoor restaurants and bar terraces.

Process innovations occur in both services and manufacturing and include new or improved production methods or delivery and distribution systems. They include significant changes in specific techniques, equipment and/or software intended to improve the quality, efficiency or flexibility of production or supply or to reduce environmental and safety hazards.

The innovation (new feature or improvement) must be new to the enterprise, but does not have to be new to the sector or to the market.

Process innovations do not include:

- minor changes or improvements;
- increases in production or service capacity by adding manufacturing or logistics systems that are very similar to those already in use;
- innovations that have a significant client interface, such as pick-up services (these are product innovations).

Improved methods of manufacturing or producing goods or services

- Installation of new or improved manufacturing technology, such as automation equipment or real-time sensors that can adjust processes;
- New equipment required for new or improved products;
- Computer-assisted product development;
- Digitisation of printing processes.

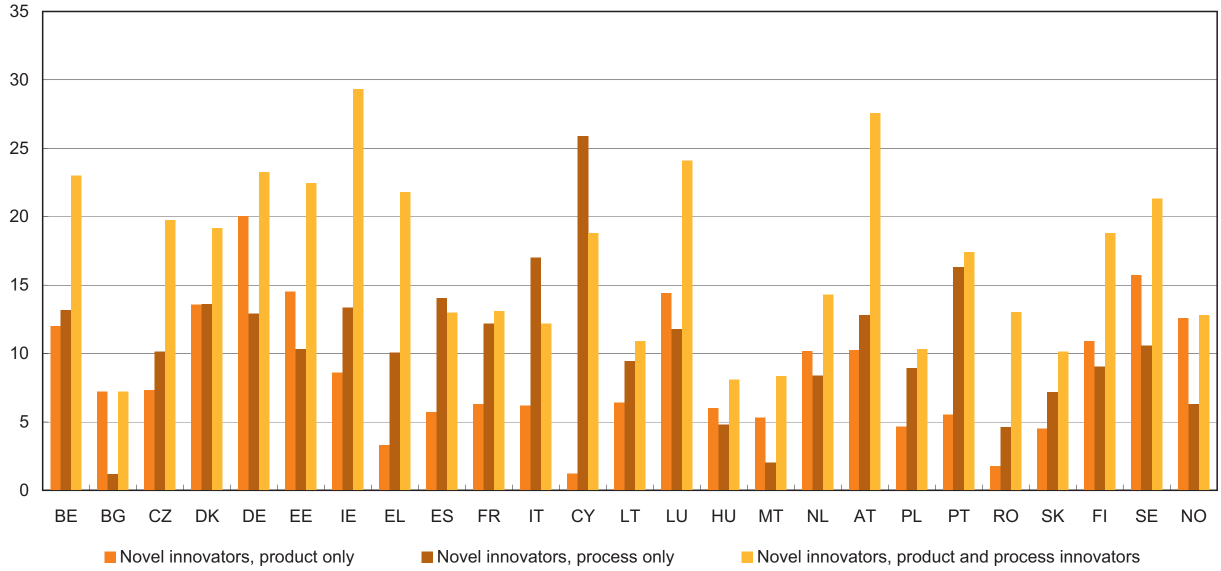
Improved distribution and operations

- Introduction of bar-coding or passive radio frequency identification (RFID) chips to track materials through the supply chain;
- GPS tracking systems for transport equipment;
- Automated feed-back to suppliers using electronic data exchange;

Improved ancillary operations

- Introduction of software to identify optimum delivery routes;
- New or improved software or routines for purchasing, accounting or maintenance systems.

Figure 5.24 **Breakdown of innovative enterprises, by type of innovator, as a percentage of all enterprises, by country, EU-27 and Norway — 2004**



Data missing/confidential for LV, SI and UK.

Figure 5.24 splits innovative enterprises into three types of innovators:

- product innovators,
- process innovators,
- product and process innovators.

As explained earlier, "products" can be either goods or services. The questionnaire drew a distinction between three types of process innovations: improved methods of manufacturing or producing goods or services, improved distribution and operation and improved ancillary operations (see previous page for definitions and examples.)

A first glance at Figure 5.24 gives the impression that there is no common pattern for innovative attitudes across countries, but this may be misleading.

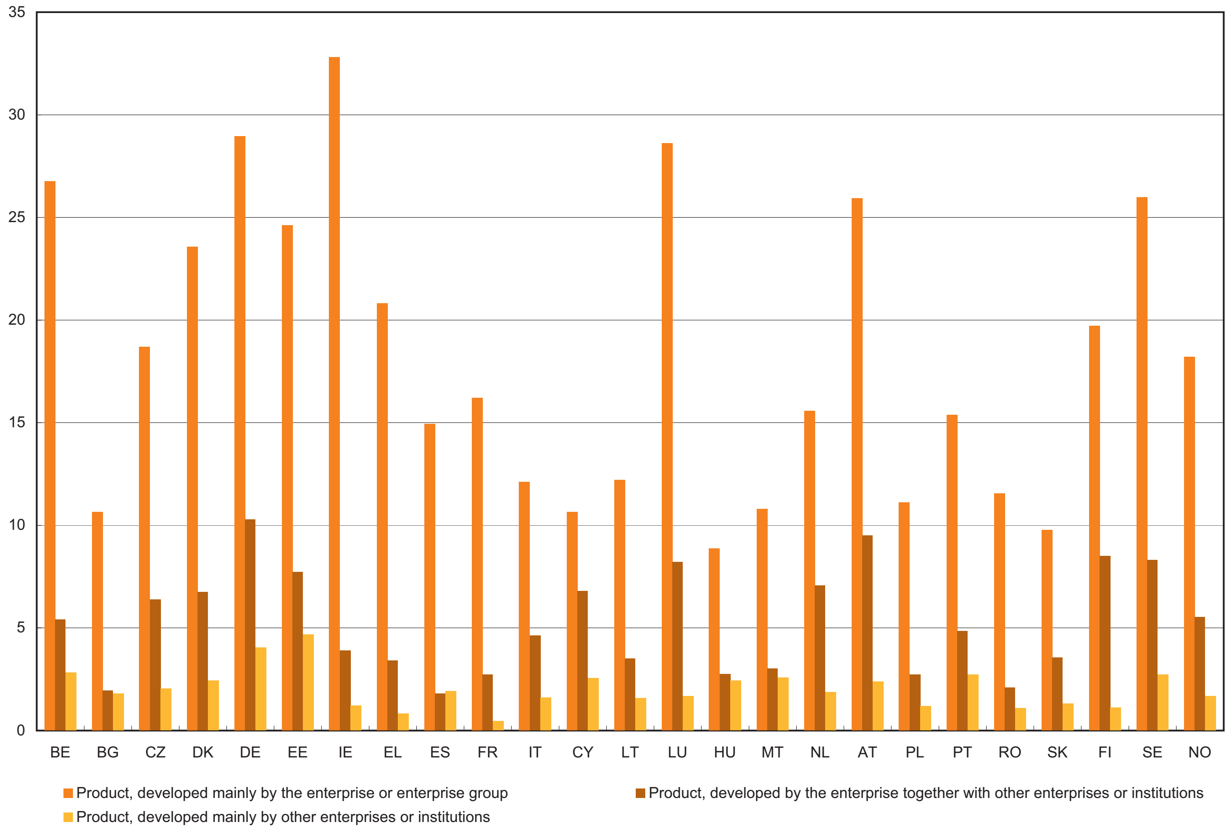
In most EU Member States the novel innovators are both product and process innovators. The highest proportions can be found in Ireland with 29%, in Austria with 28% and in Luxembourg with 24%. Only three countries are exceptions to this rule. In Spain, Italy and Cyprus the percentages of novel process innovators are higher than the percentages of product and process innovators.

Conversely, comparing the percentages of novel product innovators with novel process innovators produces a rather mixed picture. In 10 countries there are more product innovators and in 15 more process innovators. In most cases the differences between the two groups are less than ten percentage points. Cyprus can be singled out as an exception. Whereas only 1% of the innovative enterprises in Cyprus are novel product innovators, 26% are novel process innovators.

The relatively high percentages of enterprises that are both product and process innovators show that in many cases both types of innovation are linked. There are obviously spill-over effects.

The percentages in Figure 5.24 do not add up to 100%, because they are ratios of all enterprises and only the shares of the innovative enterprises are presented in this figure.

Figure 5.25 **Breakdown of product innovators by who developed the product innovation, as a percentage of all enterprises, by country, EU-27 and Norway — 2004**



Data missing/confidential for LV, SI and UK.

The innovative enterprises were asked who developed the product innovations. Three options were given:

- mainly by the enterprise or enterprise group;
- by the enterprise together with other enterprises or institutions;
- mainly by other enterprises or institutions.

Figure 5.25 shows that the majority of innovative products were developed “intra-muros” in every country. The shares range from 33% in Ireland to 9% in Hungary.

For product innovations developed together with other enterprises or institutions the shares are significantly lower. The 10% recorded in Germany is the highest share. In all the other countries the shares are lower. The lowest value was found in Spain with 2%.

The third option – innovative products developed mainly by other enterprises or institutions – was ticked far less. Only between 5% (Estonia) and less than 1% (Greece and France) chose this answer.

The percentages are relative to all enterprises and show only the innovative enterprises that are also product innovators. Only they were asked to reply to this question. These enterprises constitute a subgroup of between 14% and 43% of all enterprises. The percentages vary across countries.

Figure 5.26 shows the results of the answers to the same question once again, but this time only the distribution inside the subgroup is taken into account.

The majority of the product innovators developed the product within their own enterprise or group. The figures ranged from more than 80% in Ireland to more than 50% in Cyprus. Whereas in Cyprus 34% of the product innovators developed their product together with other enterprises or institutions, in most countries the percentage was lower, mostly between 10% and 20%. The proportion of product innovators who answered that their product was mainly developed by other enterprises or institutions varied between 5% and 10% in most cases. The highest percentage was found in Hungary with 17%.

Figure 5.26 **Breakdown of innovative enterprises who developed the product innovation, as a percentage of all enterprises, by country, EU-27 and Norway — 2004**

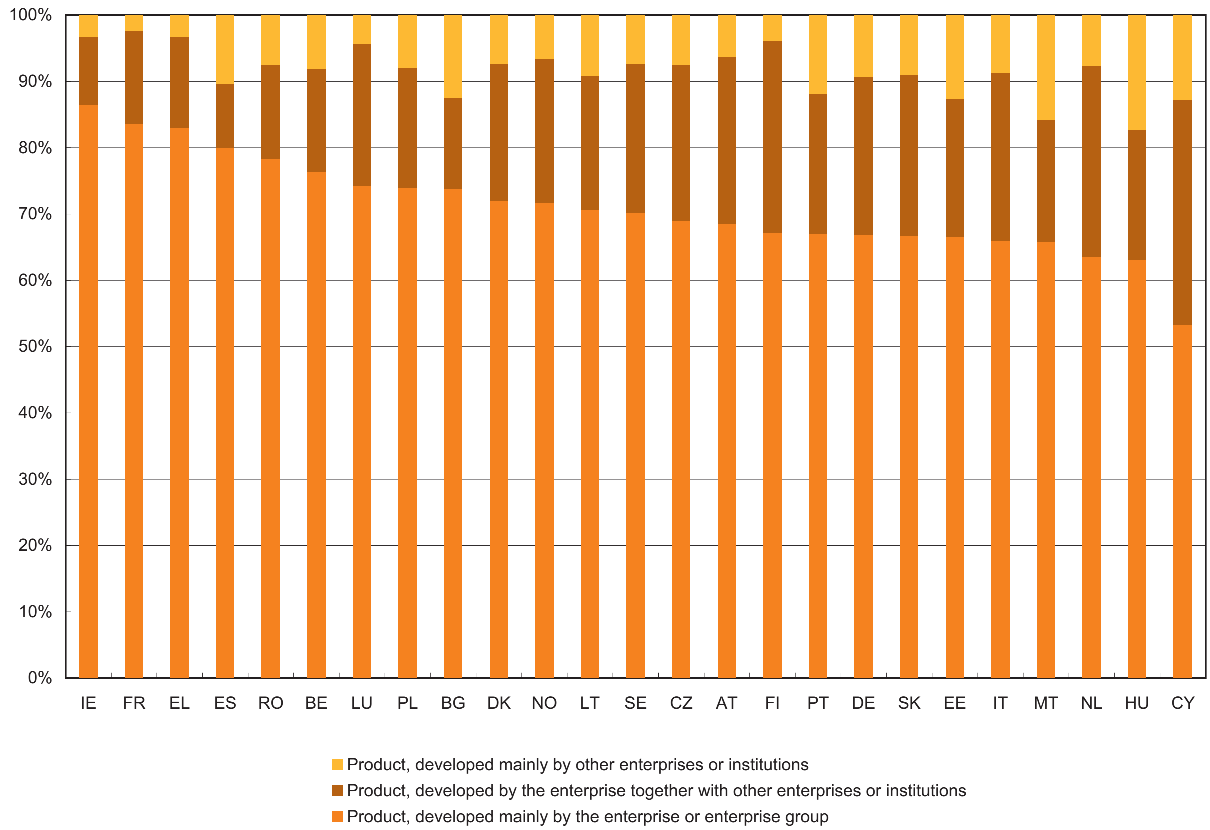


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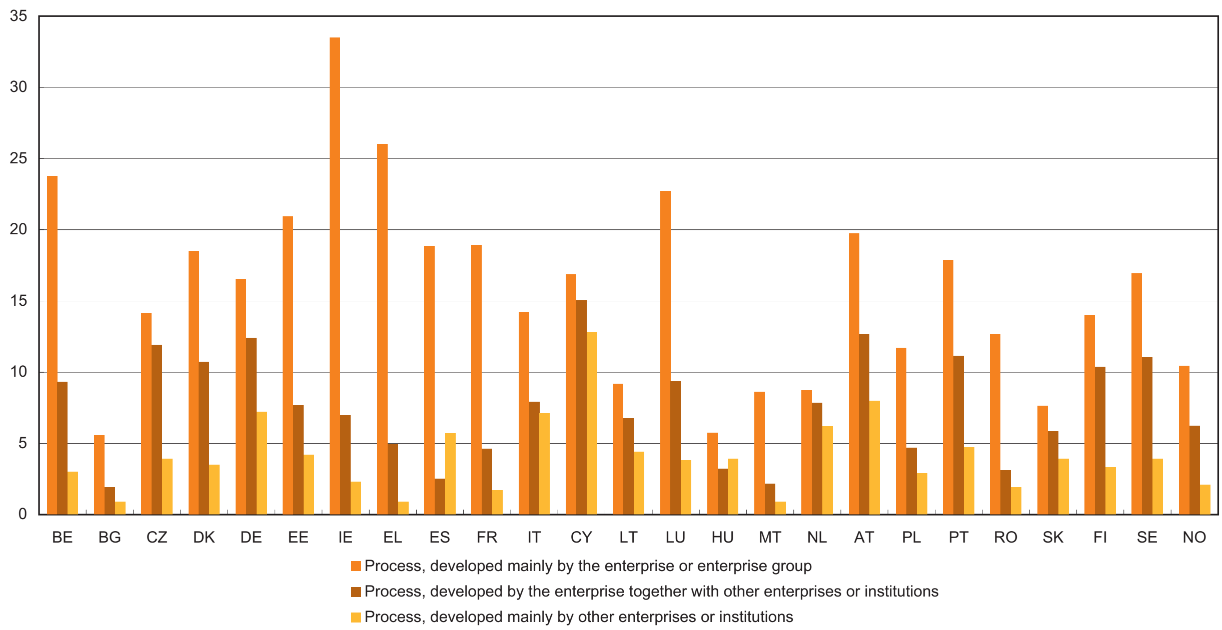
Figure 5.27 **Breakdown of process innovators by who developed the process innovation, as a percentage of all enterprises, by country, EU-27 and Norway—- 2004**



Missing/confidential Data missing/confidential for LV, SI and UK..

Like Figure 5.25, Figure 5.27 takes a closer look at the subgroup of process innovators and tries to find out who developed the process innovations.

Ireland ranks first with 34% of all enterprises developing a process innovation mainly within their own enterprise or group. It is followed by Greece and Belgium with 26% and 24% respectively.

On development of innovative processes together with other enterprises, Cyprus leads with 15% of all enterprises, followed by Austria with 13% and Germany with 12%.

13% of the innovative enterprises in Cyprus declared that their innovative processes had been developed mainly by other enterprises or institutions. In every other country this was the case for fewer than 10% of the innovative enterprises.

As a general rule, the highest scores were reported for innovative enterprises that developed a process innovation in-house or inside their group, followed by those that developed a process innovation in collaboration with other enterprises or institutions. The scores for enterprises that outsourced process innovation are rather low. The only exceptions to this rule are Spain and Hungary, where outsourcing scored higher than collaboration.

Showing the results of the CIS as percentages of all enterprises allows better comparability of data from countries with different sized economies. This method avoids putting the largest EU economies, such as Germany, France and the United Kingdom, top because of their economic weight.

If the analysis of the results focuses solely on innovative enterprises, countries with higher proportions of innovative enterprises are more likely to come out on top. This must be taken into account when analysing the results, in order to avoid a country's weight in a subgroup masking information.

Table 5.28 Turnover of innovative enterprises related to new or significantly improved products which are new to the enterprise (but not new to the market), as a percentage of total turnover of innovative enterprises, by sector, EU-27 and selected countries — 2004

	All NACE - Core NACE	Total industry (excluding construction)	Manufacturing	Services - Core G_to_K	K: Core coverage (NACE 72, 74.2 and 74.3)	74 Core: Other business services (NACE 74.2, 74.3)
BE	11.2	13.2	14.3	9.8	7.2	8.1
BG	11.8	6.8	7.6	20.1	4.6	3.9
CZ	12.7	14.0	14.9	10.5	13.9	10.1
DK	8.5	11.0	12.2	5.7	7.1	3.2
DE	11.2	14.6	16.1	7.7	13.5	14.1
EE	11.6	15.1	18.8	8.6	15.0	15.8
IE	6.5	8.8	8.8	2.7	: c	: c
EL	12.5	12.9	15.2	12.0	10.4	2.8
ES	15.7	13.0	14.6	18.7	13.5	13.2
FR	8.1 u	10.5 u	11.3 u	5.2 u	9.0 u	8.6 u
IT	8.7	8.7	9.3	8.7	: c	: c
CY	5.1	2.4	3.0	6.1	9.5	8.9
LV	3.7	4.7	6.0	2.9	4.0	3.0
LT	8.6	11.1	12.2	4.4	7.5	3.3
LU	12.5	12.0	13.0	12.7	11.4	6.9
HU	5.0	5.6	6.4	3.8	2.7	0.5
MT	14.1	18.5	: c	5.6	11.1	0.0
NL	6.9	8.5	9.0	5.2	6.7	6.5
AT	7.2	8.7	9.2	5.6	: c	0.0
PL	8.8	10.7	12.2	5.3	3.2	3.6
PT	8.3	8.5	9.7	8.1	9.3	7.6
RO	20.9	19.3	22.7	25.0	26.2	13.0
SI	12.2	12.9	: c	9.8	: c	: c
SK	10.6	11.4	8.1	8.6	4.1	0.5
FI	6.7	6.9	7.1	6.2	12.0	10.5
SE	6.9	5.7	5.3	8.5	14.0	: c
UK	10.3	13.1	14.3	9.2	16.3	11.6
IS	11.5	6.0	3.1	18.2	10.5	0.0
NO	8.9	6.5	13.7	14.2	15.8	18.0

Table 5.28 tries to shed some light on the impact on turnover of new or significantly improved products which are new to the enterprise but not new to the market. Without drawing any distinction by economic sector, the impact is very diverse: the highest rate was recorded for Romania (21%), followed by Spain and Malta with 16% and 14% respectively. At the other end of the scale lay Latvia (4%), Hungary (5%) and Cyprus (5%).

The results are somewhat different when broken down by economic sector.

For “total industry” Romania is in first place with 14%, Malta (12%) second and Slovenia (10%) third.

For “manufacturing” Malta (12%) is followed by Romania (12%) and the Czech Republic (9%).

For “services” Luxembourg leads with 10%, Spain ranks second with 9% and Bulgaria third with 8%.

Sector K (Core coverage) includes K 72 “Computer and related activities”, K 74.2 “Architectural and engineering activities and related technical consultancy” and K 74.3 “Technical testing and analysis”. For these sectors the scores are very low.

Figure 5.29 **Turnover of innovative enterprises related to new or significantly improved products which are new to the market, as a percentage of total turnover of innovative enterprises, in manufacturing and in services, by country, EU-27 and selected countries — 2004**

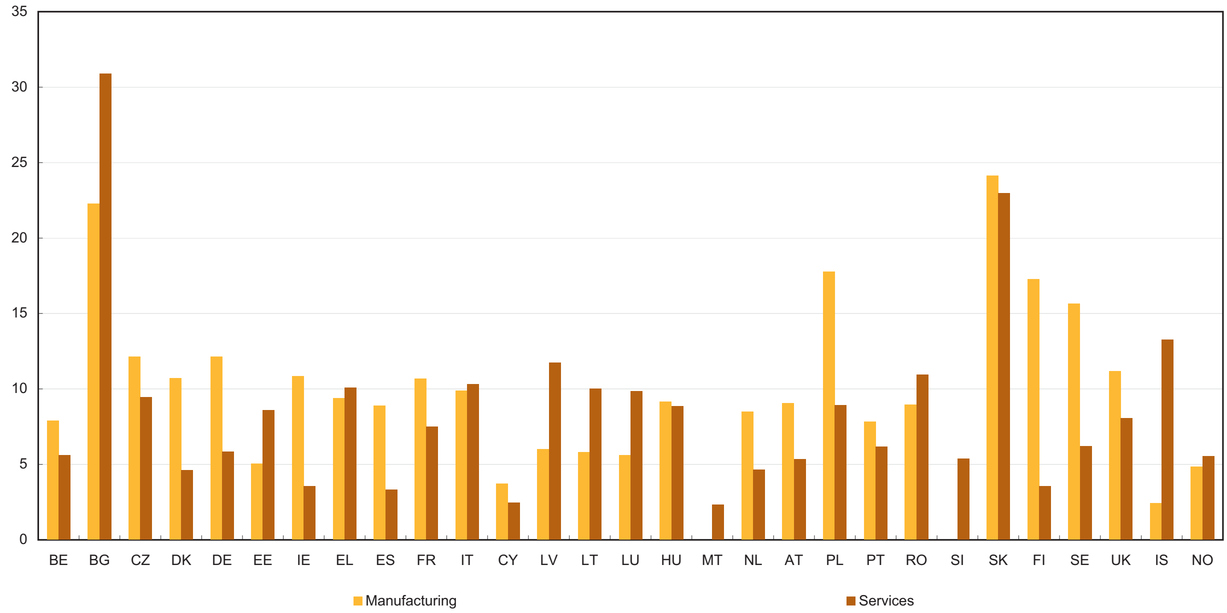


Figure 5.29 shows the turnover of innovative enterprises related to new or significantly improved products which are new to the enterprise (as Table 5.28 also does), but this time for products that are also new to the market.

It compares manufacturing with the services sector. For most countries the results do not exceed 10%, and in many cases they are substantially lower.

Bulgaria recorded a very high result for turnover in new or significantly improved products new to the enterprise and new to the market with 31% for the services sector. Readers must take into account that the figures shown are ratios. A high result does not necessarily mean that the absolute turnover in these products is high. The absolute value can be quite low if the turnover of the innovative enterprises is low.

Bulgaria and Slovakia are the only countries where both sectors pass the 20% mark, but as Bulgaria has the lowest proportion of innovative enterprises out of all the EU countries (16%) the turnover of those enterprises can also be assumed to be low.

In Slovakia, the proportion of innovative enterprises is slightly higher, on 23%, but nevertheless lower than in many other EU countries. To a lesser extent, the same reasoning may be applied to Slovakia, which has a comparatively low proportion of innovative enterprises but high results for relative turnover.

No real trend can be distilled from comparison of the results for manufacturing with those of the services sector. In 17 countries the results for manufacturing are higher and in ten this is the case for services. For some countries, such as Greece, Italy, Hungary and Norway, the results for the two sectors are very close. By contrast, in Finland, Iceland, Sweden, Poland and Bulgaria the differences between manufacturing and the services sector are significant, with 14%, 11% and 9% respectively for the last three of these countries.

Innovation activity and expenditure

Intramural expenditure on R&D is greater than extramural...

The enterprises surveyed were asked if *they had undertaken creative work within their enterprise to increase their stock of knowledge and had used it to devise new and improved products and processes (including software development*). In this case their innovation activity was intramural (in-house).

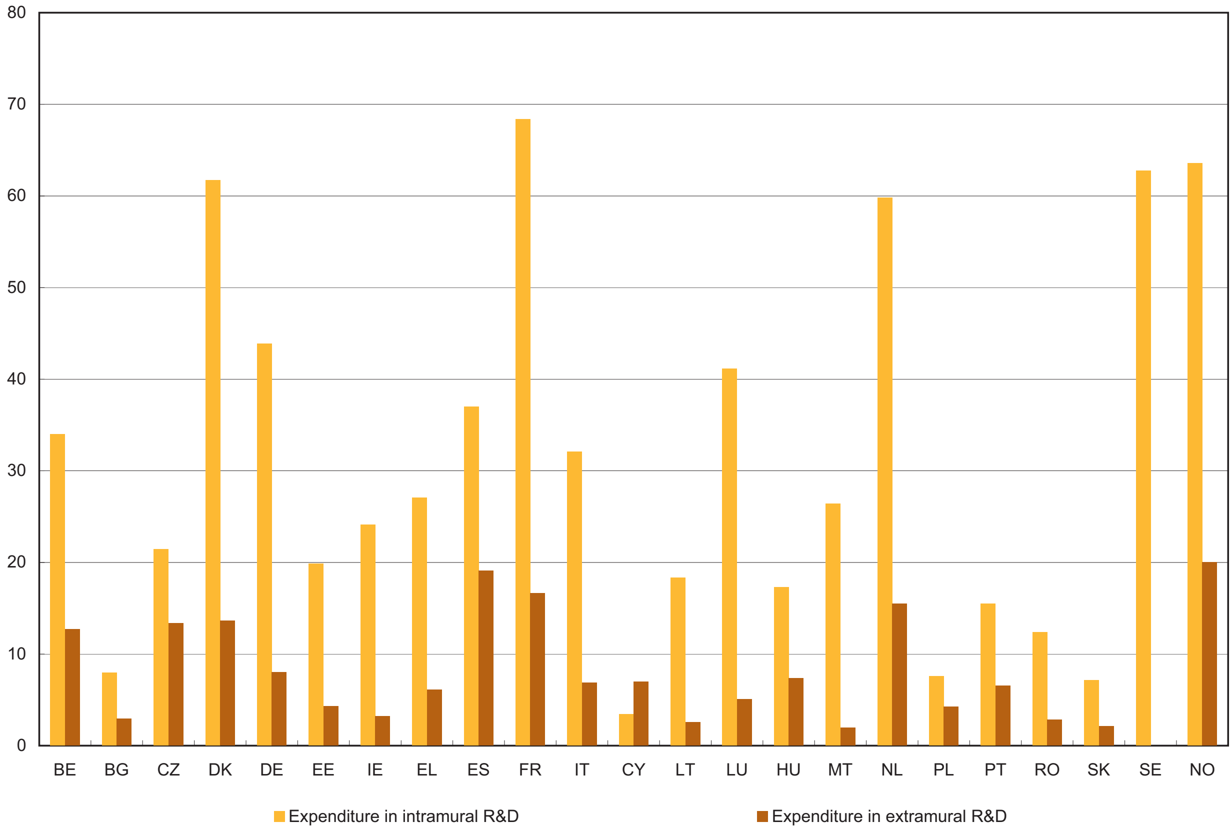
If these activities were performed by other companies (including other enterprises in the same group) or by public or private research organisations and purchased by the enterprise, the innovation activity is considered extramural.

Figure 5.30 compares the shares of intramural and extramural expenditure on R&D as percentages of total innovation expenditure.

In almost every country in the figure, the intramural expenditure is significantly higher than the extramural. The only exception is Cyprus, where the opposite is the case.

In five European countries the share of intramural expenditure on R&D exceeded 50% of total innovation expenditure, namely in Denmark (62%), France (68%), the Netherlands (60%), Sweden (63%) and Norway (64%).

Figure 5.30 **Intramural extramural expenditure on R&D by innovative enterprises, as a percentage of total innovation expenditure, by country, EU-27 and Norway — 2004**



Data missing/confidential for LV, AT, SI, FI and UK.

Whereas in France and Norway more than 80% of the total innovation expenditure was covered by intra- and extramural expenditure on R&D, in other countries both categories together did not even add up to 10%, as, for example, in the case of Slovakia.

To complete the analysis of innovation expenditure, two other categories have to be taken into account. One is expenditure on acquisition of advanced machinery, equipment and computer hardware or software to produce new or significantly improved products and processes.

The other is purchases or licensing of patents and non-patented inventions, know-how and other types of knowledge from other enterprises or organisations. All four categories are shown in Table 5.31.

… but acquisition of machinery, equipment and software seems essential for many countries

In 2004 acquisition of machinery, equipment and software played a major role for many of the enterprises surveyed. Most of the new Member States (from the 2004 and 2007 enlargements) but also Greece and Portugal spent more than 60% of their total innovation expenditure on this category.

The highest shares were recorded In Bulgaria, Cyprus, Poland and Slovakia, where more than 80% of the innovation expenditure was on acquisition of machinery, equipment and software.

The Czech Republic is the only new Member State in Table 5.3.1 where expenditure on acquisition of machinery, equipment and software fell short of the 50% mark. Nevertheless, it was still the category with the highest percentage.

These results are not very surprising because of the need for the new Member States to modernise their general equipment. This modernisation may take several years, but the shares of innovation expenditure spent on this category can be expected to decrease in the future as more funds will be spent on R&D.

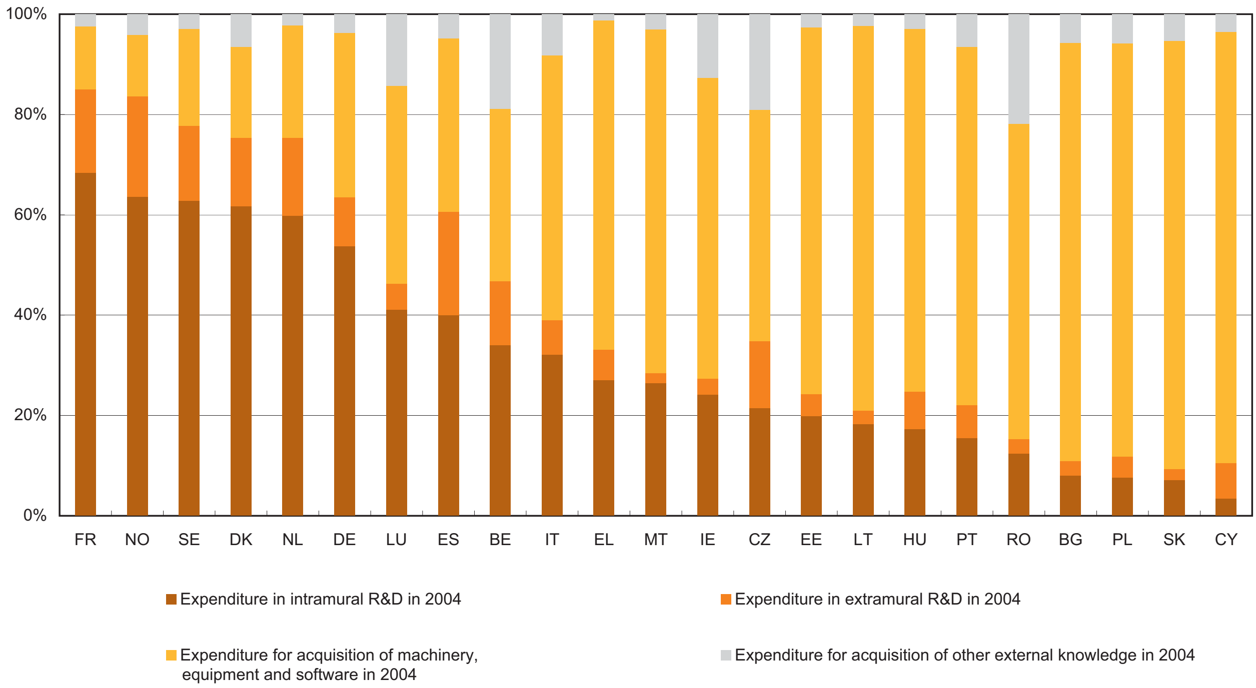
It must be added that capital expenditure on buildings and equipment specifically for R&D are included in intramural expenditure on R&D.

Table 5.31 **Breakdown of innovation expenditure into four categories, as a percentage of total innovation expenditure, by country, EU-27 and Norway — 2004**

	Expenditure in intramural R&D in 2004	Expenditure in extramural R&D in 2004	Expenditure for acquisition of machinery, equipment and software in 2004	Expenditure for acquisition of other external knowledge in 2004
BE	34.0	12.7	34.3	18.9
BG	8.0	3.0	83.3	5.7
CZ	21.5	13.4	46.1	19.1
DK	61.7	13.6	18.1	6.5
DE	43.9	8.0	26.7	3.0
EE	19.9	4.3	73.2	2.6
IE	24.1	3.3	59.9	12.7
EL	27.1	6.1	65.6	1.2
ES	37.0	19.1	32.0	4.5
FR	68.4	16.7	12.5	2.4
IT	32.1	6.9	52.8	8.2
CY	3.4	7.0	86.0	3.5
LV	:	:	:	:
LT	18.4	2.6	76.7	2.4
LU	41.1	5.1	39.5	14.3
HU	17.3	7.4	72.4	2.9
MT	26.4	2.0	68.5	3.1
NL	59.8	15.5	22.3	2.3
AT	:	:	:	:
PL	7.6	4.3	82.3	5.8
PT	15.5	6.6	71.4	6.5
RO	12.4	2.9	62.9	21.8
SI	: c	: c	: c	: c
SK	7.1	2.2	85.4	5.3
FI	:	:	:	:
SE	62.8	: c	19.2	3.0
UK	:	:	:	:
NO	63.6	20.0	12.2	4.1

Germany: “Total innovation expenditure” is the sum of all expenditure in 2004 on “innovation activities” which means intramural R&D, extramural R&D, acquisition of machinery, equipment and software, acquisition of other external knowledge, training, market introduction of innovations and other preparations).
Spain: “Total innovation expenditure” includes expenditure on training, market introduction of innovations and other preparations.

Figure 5.32 Breakdown of innovation expenditure into four categories, as a percentage of total innovation expenditure, by country, EU-27 and Norway — 2004



Data missing/confidential for LV, AT, SI, FI and UK.

Expenditure on acquisition of other external knowledge played only a minor role in most countries. Romania, on 22%, is the only country with a share over 20%; many countries do not even reach 10% in this category. By contrast, Greece recorded the lowest share with only 1%.

Looking at Figure 5.32, which displays the figures from Table 5.31 as a bar chart, a clear correlation can be seen between expenditure on intramural R&D and expenditure on acquisition of machinery, equipment and software.

The countries with a high share of intramural R&D expenditure have a low share of expenditure on acquisition of machinery, equipment and software and vice versa. The other two categories are at a relatively low level in every country.

Looking at the different categories of innovation expenditure reveals some facts on the use of funds by the innovative enterprises. Another interesting aspect is to look at the number of innovative enterprises engaged in intramural and extramural R&D.

In most countries 40% or more of all enterprises engaged in innovation activities undertook intramural R&D during the period from 2002 to 2004 (see Figure 5.33).

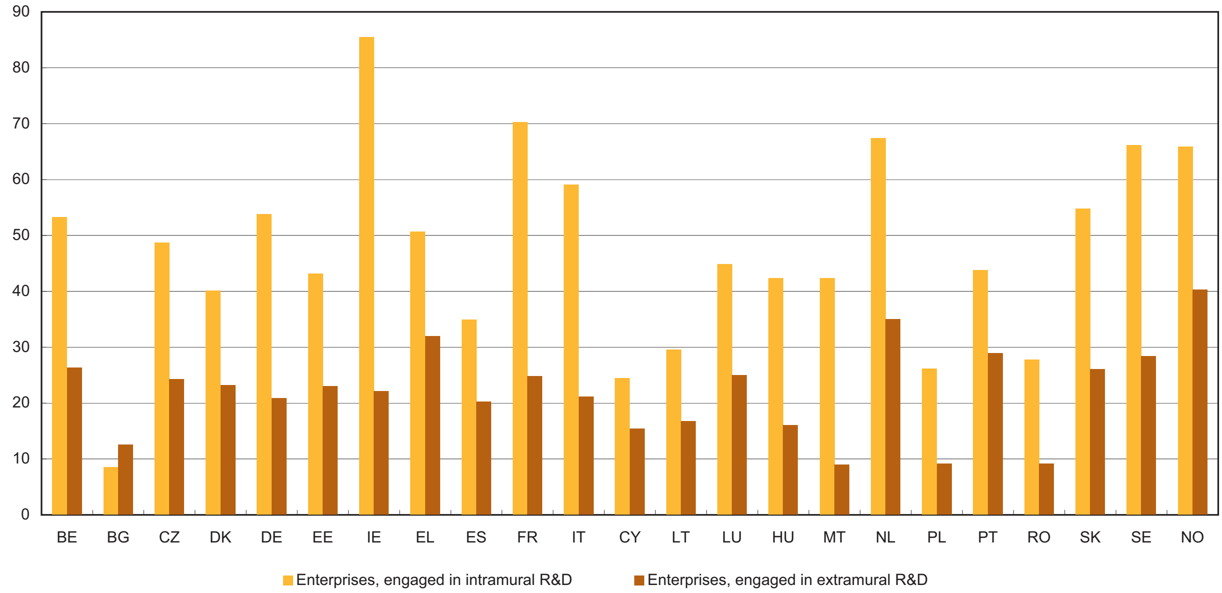
Ireland and France recorded the highest proportions of innovative enterprises engaged in in-house R&D, with 86% and 70% respectively. The Netherlands ranked third with 67%. At the other end of the scale came Bulgaria, Poland and Romania, with 9%, 26% and 28% respectively.

Innovative enterprises were generally less likely to be engaged in extramural R&D, with shares of around 20%.

With the exception of Bulgaria, the innovative enterprises in every country give priority to intramural R&D.

The proportions of innovative enterprises engaged in extramural R&D vary between 9% in Malta, Bulgaria and Poland and 40% in Norway. The Netherlands was the Member State with the highest percentage of innovative enterprises engaged in extramural R&D, on 35%.

Figure 5.33 Innovative enterprises engaged in intramural and extramural R&D, as a percentage of innovative enterprises, by country, EU-27 and Norway — 2004



Data missing/confidential for LV, AT, SI, FI and UK.

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Looking in more detail at intramural R&D (see Figure 5.34), it is possible to split the data between continuous and occasional involvement in this activity.

The Netherlands led with a very high 48% of all its innovative enterprises continuously engaged in intramural R&D. France ranked second with 37% and Belgium third with 36%.

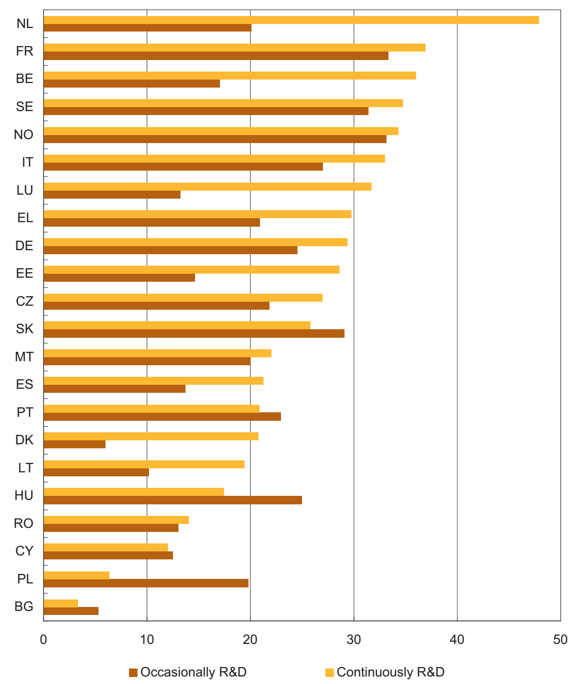
Sweden, Norway, Italy and Luxembourg also recorded over 30% of innovative enterprises continuously engaged in intramural R&D.

Turning to innovative enterprises occasionally engaged in intramural R&D, France ranked first (33%) and Norway second, also with 33%, followed by Sweden with 31%.

In most countries the proportion of innovative enterprises continuously engaged in intramural R&D is higher than that occasionally engaged. In the Netherlands the difference between the proportion of innovative enterprises engaged continuously and those engaged only occasionally in intramural R&D stood at 28 percentage points.

However, for Slovakia, Portugal, Hungary, Cyprus, Poland and Bulgaria the opposite is the case. In Poland the proportion of innovative enterprises occasionally engaged in in-house R&D is about 13 percentage points higher than the proportion engaged continuously.

Figure 5.34 Breakdown of occasional and continuous intramural R&D, as a percentage of innovative enterprises, by country, EU-27 and Norway — 2004



Data missing/confidential for IE, LV, AT, SI, FI and UK.

Table 5.35 Enterprises engaged in innovation activities, as a percentage of innovative enterprises, by country, EU-27 and Norway — 2004

	Enterprises, engaged in intramural R&D	Enterprises, engaged in extramural R&D	Enterprises, engaged in acquisition of machinery, equipment and software	Enterprises, engaged in acquisition of other external knowledge
BE	53.3	26.4	73.4	19.6
BG	8.6	12.6	65.9	24.5
CZ	48.7	24.3	75.6	24.3
DK	40.1	23.2	63.2	35.6
DE	53.8	20.9	72.9	23.5
EE	43.2	23.0	82.6	35.9
IE	85.5	22.2	71.4	23.7
EL	50.6	32.0	91.6	14.7
ES	34.9	20.3	66.6	12.6
FR	70.2	24.9	60.0	23.9
IT	59.1	21.1	90.6	20.2
CY	24.5	15.5	97.7	33.4
LV	:	:	:	:
LT	29.6	16.8	86.5	27.2
LU	45.0	25.0	75.7	24.3
HU	42.4	16.1	75.5	17.3
MT	42.4	9.0	49.3	13.2
AT	:	:	:	:
NL	67.4	35.0	63.8	24.8
PL	26.2	9.2	90.7	7.8
PT	43.8	29.0	86.0	24.8
RO	27.7	9.1	78.9	12.8
SI	: c	: c	: c	: c
SK	54.8	26.1	77.3	23.7
FI	:	:	:	:
SE	66.1	28.4	65.5	41.1
UK	:	:	:	:
NO	65.9	40.3	30.4	21.9

Table 5.35 displays the percentages of innovative enterprises broken down by four categories of innovative activities.

In most countries the innovative enterprises are mainly engaged in acquisition of machinery, equipment and software. The figures range from 60% (France) up to 98% (Cyprus). Only Malta (49%) and Norway (30%) fell short of the 60% mark.

As an enterprise can be engaged in more than one innovation activity at the same time, some countries that have relatively high percentages for engagement in acquisition of machinery, equipment and software have even higher percentages for engagement in intramural R&D. These are Ireland with 86%, France with 70%, the Netherlands with 67% and, to a lesser extent, Sweden with 66%. With the exception of Ireland, these were also among the countries that showed high innovation expenditure on intramural R&D (see Table 5.31).

Comparison between innovation expenditure and innovation activities points to the following outcomes:

Although in many countries around two thirds of all innovative enterprises are involved in acquisition of machinery, equipment and software, this does not necessarily lead to high expenditure in this category.

By contrast, heavy involvement in intramural R&D often goes hand in hand with high expenditure in this category. This can be explained by the fact that a large part of expenditure on intramural R&D consists of salaries of researchers and highly skilled employees.

The highest percentages of innovative enterprises engaged in extramural R&D can be found in Greece (32%), the Netherlands (35%) and Norway (40%).

For innovative enterprises engaged in acquisition of external knowledge, scores over 30% were recorded in Denmark (36%), Estonia (36%) and Cyprus (33%).

Heavy involvement in one of the last categories of innovation activities mentioned does not necessarily result in a higher share of expenditure in the same category. Taking Denmark as an example, 36% of the innovative enterprises in Denmark declared that they were engaged in acquisition of external knowledge, but only 7% of their innovation expenditure was spent on this category (see Table 5.31).

How do innovative manufacturing establishments acquire knowledge and technology:

Findings from the 2005 Survey of Innovation

The 2005 Survey of Innovation asked innovative manufacturing establishments questions related to how they acquired knowledge and technology for innovation and from whom. This article analyses the two thirds of manufacturing establishments that were innovative – that is they introduced a new or significantly improved product or process during the three reference years, 2002 to 2004 – and sheds light on their purchases of knowledge and technology, the importance of information sources and their collaborative partners. In order to develop new and significantly improved products and processes, firms acquire knowledge and technology from various external sources and by various methods. In the most general terms, firms have three different options when acquiring knowledge and technology from outside the firm. They can purchase the knowledge and technology, they can acquire information relevant to their innovation activities or they can enter into collaborative arrangements to jointly develop innovative products and processes with partners. .

[…] From the results presented above, it can be concluded that suppliers are very important for the acquisition of knowledge and technology by innovative manufacturing establishments in terms of sources of information, purchases of knowledge and technology, and collaborative partners. In general, market actors, including clients, were used more frequently for acquiring knowledge and technology than public institutional sources. This being said, public institutions were found to be of some importance as sources of information by between one third and one half of innovating firms. They were also collaborating partners in innovation for between 10% and one third of establishments that entered into such arrangements. Further work needs to be done to better understand the conditions under which innovative manufacturing establishments acquire their knowledge and technologies from actors other than their suppliers and clients with whom they have on-going and market relations. The results of this study show that the acquisition of knowledge and technology from suppliers and clients is very widespread, with only a relatively small percentage of innovators not being involved with their suppliers and clients. Further analysis could examine whether size, geographical location, type of industry, innovation intensity or absorptive capacity play a significant role in firms' acquisition of knowledge and technology from market actors who are not clients or suppliers and from public institutions.

Source: Innovation Analysis Bulletin, Vol. 9, no. 1 (May 2007), Statistics Canada

Table 5.36 Innovative enterprises which received public funding for innovation activities, as a percentage of innovative enterprises, by source of funds and by country, EU-27 and Norway — 2004

	Enterprise that received any public funding	Enterprise that received funding from local or regional authorities	Enterprise that received funding from central government (including central government agencies or ministries)	Enterprise that received funding from the European Union	Enterprise that received funding from the 5th or 6th Framework Programme
BE	22.8	15.9	9.2	3.6	2.2
BG	4.9	0.5	1.4	3.9	1.2
CZ	15.9	2.3	10.9	4.5	3.2
DK	15.0	2.1	8.7	6.5	3.4
DE	14.1	7.7	7.6	4.0	3.2
EE	9.7	0.6	8.2	1.8	0.5
IE	:	:	:	:	:
EL	29.0	5.5	19.9	19.7	7.8
ES	25.9	18.7	10.3	3.7	1.4
FR	20.4	8.0	15.1	5.1	1.8
IT	38.6	25.7	14.9	3.3	1.2
CY	35.5	0.3	33.8	3.1	1.0
LV	:	:	:	:	:
LT	12.7	2.1	7.5	5.4	0.6
LU	24.8	3.0	22.4	1.8	1.2
HU	27.3	2.6	25.5	4.3	1.9
MT	16.7	2.1	14.6	2.8	: c
NL	37.5	6.6	32.5	5.6	2.2
AT	33.9	20.6	24.7	9.3	2.6
PL	12.4	:	:	:	:
PT	11.1	1.1	6.8	5.2	2.9
RO	10.8	2.3	3.2	7.3	1.1
SI	: c	: c	: c	: c	: c
SK	12.1	3.4	5.1	5.3	0.6
FI	35.1	6.6	31.2	8.4	4.3
SE	:	:	:	:	:
UK	:	:	:	:	:
NO	43.5	1.7	42.8	1.9	1.7

In 2004 between 5% (Bulgaria) and 44% (Norway) of the enterprises engaged in innovation activities declared that they had received public funds. In the new Member States (from the 2004 and 2007 enlargements) never more than 20% the proportion of all innovative enterprises which had received public funds was never more than 20%, with the exceptions of Cyprus and Hungary which reported 36% and 27% respectively in 2004. In several of the "old" EU-15 Member States more than 30% of the innovative enterprises replied that they had received public funds, namely Italy with 39%, the Netherlands with 38%, Austria with 34% and Finland with 35%.

Enterprises have the possibility to apply for public funds from different national and European authorities. In many countries the majority of innovative enterprises received funding from their central government. However, there are exceptions. In Belgium, Estonia, Spain and Italy more innovative enterprises received funding from regional or local authorities.

In some countries the European authorities played a bigger role in public funding of innovative enterprises than the central government. This was the case in Bulgaria and in Slovakia. In many countries the proportion of innovative enterprises that received funding from the European Union was higher than the proportion turning to local or regional authorities.

The role of public funding is often a controversial subject in economic literature. On the one hand, there is a consensus about the stimulating effect of public funding on innovative activities. On the other, there is always apprehension about the possibility of crowding out private financing.

Indeed, public funding is necessary for R&D and innovation but must be targeted and follow set objectives that private funding cannot achieve. Untargeted subsidies should be avoided.

Innovation in Bulgaria: some improvement but much more to be done
(Extract from press release)

The latest report on the innovation performance of the Bulgarian economy paints a mixed picture. Bulgarian enterprises are displaying few signs of innovation, links between research and innovation remain weak, and human and financial resources are lacking. On a more positive note, Bulgaria's gross innovation product has increased, and the entrepreneurship and business environment continues to improve.

The report, by the Applied Research and Communications Fund of Sofia, analyses the state of the national innovation system and makes recommendations for enhancing innovation performance. The report is known as Innovation.bg 2007.

Among the key conclusions in this year's report are:

- the market component of the Bulgarian innovation system is at an early stage of development, and innovation is not widespread in Bulgarian enterprises;
- innovation and research products are being developed independently of one another;
- the national innovation system is being developed and influenced predominantly by the integration and financing of European innovation networks;
- the major barriers to innovation in Bulgaria are the lack of financing and qualified personnel;
- performance has started to improve, and this turnaround is the perfect time for renewed efforts to boost performance further.

Three recommendations are targeted primarily at the Bulgarian Government. More political, administrative and financial resources should be channelled into formulating and implementing the national innovation policy, the paper states. More effort should also be made to improve coordination between strategy documents, policies and administrative and financial instruments.

Having noted the crucial role that EU funds play in driving Bulgarian innovation, the report calls on the Bulgarian authorities to direct these funds towards more complex, longer term projects at national and regional level, rather than use them for the shorter term direct financing of enterprises. These longer term projects should also be implemented in coordination with other EU programmes, such as the Seventh Framework Programme (FP7) for research and technological development and the Competitiveness and Innovation Framework Programme (CIP). […]

Source: Cordis FP7 newsroom, 12-09-2007

5

Sources of information and cooperation for innovation activities

Knowledge transfer is made up of a combination of information and cooperation

Information plays a key role in innovation, so it is vital to identify the most important sources of information for innovative enterprises.

Sources of information can be split into four main groups: internal sources, market sources, institutional sources and other sources. Each of these main groups consists of one or more sub-groups (see below).

After identifying the sources of information and the use made of them by innovative enterprises, different forms of collaboration will be analysed.

Sources of information, main groups and sub-groups

Internal sources	Market sources			
Within your enterprise or enterprise group	Suppliers of equipment, materials, components, or software	Clients or customers	Competitors or other enterprises in your sector	Consultants, commercial labs, or private R&D institutes

Institutional sources		Other sources		
Universities or other higher education institutions	Government or public research institutes	Conferences, trade fairs, exhibitions	Scientific journals and trade/technical publications	Professional and industry associations

Besides and closely linked to information, another key topic has emerged in the ongoing discussion on innovation: **knowledge transfer**.

There is no doubt that knowledge creation, the main business of higher education, is essential. However, if this knowledge is to be useful it has to be applied to the walks of life where it can make a difference. Knowledge needs to be transferred.

The main way in which knowledge is transferred from higher education to the wider world is via the expertise and experience built up by graduates. However, small companies which could benefit from the knowledge of a highly skilled graduate but have a small workforce are reluctant to take on graduates.

Knowledge is transferred whenever the findings or works of academics are disseminated more widely. There are many ways in which this can be done. One key way that knowledge can be spread is via the training that higher education offers to industry.

Creating stronger links between universities and businesses is a major aim of Europe's innovation policy. One step in this direction is commercialisation of research. This is the process of getting ideas which have a commercial application out of the laboratories and into the marketplace. Commercialisation does not exclusively concern technology. Creative arts and social sciences also have the potential to generate profitable commercial activity.

Brussels, 4 April 2007 – COM(2007) 161 final
GREEN PAPER
The European Research Area: New Perspectives (presented by the Commission)
{SEC(2007) 412}

Knowledge transfer must improve in order to accelerate the exploitation of research and the development of new products and services. To that end, European universities and other public research institutions should be given incentives to develop skills and resources to collaborate effectively with business and other stakeholders, both within and across borders. A major hindrance is the inconsistent, and often inadequate, rules and approaches for managing intellectual property rights (IPR) resulting from public funding. The Commission has identified good practice and models of knowledge-sharing between the public research base and industry which will serve to inspire further action at both EU and national levels.

Table 5.37 The three most used sources of information, as a percentage of innovative enterprises, by country, EU-27 and Norway — 2004

	Within the enterprise or enterprise group	Suppliers of equipment, materials, components or software	Clients or customers
BE	54.7	30.0	38.9
BG	33.1	26.7	33.1
CZ	39.4	23.2	32.1
DK	56.2	27.6	32.4
DE	53.3	21.6	35.0
EE	34.1	22.6	25.6
IE	64.3	36.4	49.9
EL	46.2	42.6	25.5
ES	45.1	30.2	19.6
FR	54.5	20.3	25.6
IT	36.3	21.8	13.8
LV	:	:	:
CY	85.9	50.6	22.1
LT	32.2	15.8	19.1
LU	64.9	36.8	36.6
HU	41.7	23.4	28.2
MT	48.6	21.5	27.8
NL	45.0	20.9	27.0
PL	48.0	19.7	32.5
PT	8.3	11.9	17.9
RO	38.0	37.6	30.9
SI	: c	: c	: c
SK	37.1	23.7	30.1
FI	56.9	15.8	38.1
SE	:	:	:
UK	:	:	:
NO	52.1	20.0	35.0

Whereas in most of the countries surveyed between 40% and 50% of innovative enterprises use information available inside their enterprise or group, there are exceptions to this (see Table 5.37). In Cyprus 86% of innovative enterprises make use of internal sources while, at the other end of the scale, in Lithuania only 32% of innovative enterprises do so. The second figure is significantly lower but nevertheless still close to one in three innovative enterprises.

Use of market sources varies significantly, depending on the source considered. Table 5.37 shows the results for only two market sources: suppliers and clients or customers. The others are less used by innovative enterprises.

Nearly one out of every two innovative enterprises in Ireland declares that its clients or customers are highly valuable sources of information, whereas in Italy this is the case for just 14% of innovative enterprises.

In Cyprus more than 50% of innovative enterprises obtain information from their suppliers of equipment, materials, components or software, whereas in Finland only 16% use this source.

The CIS 4 questionnaire differentiates two institutional sources of information: universities or other higher education institutes and government or public research institutes. As these sources of information are quoted less frequently than internal or market sources in almost every country, these data are not shown in the table above. The same is the case for the three other sources of information: conferences, trade fairs and exhibitions; scientific journals and trade/technical publications; and professional and industrial associations.

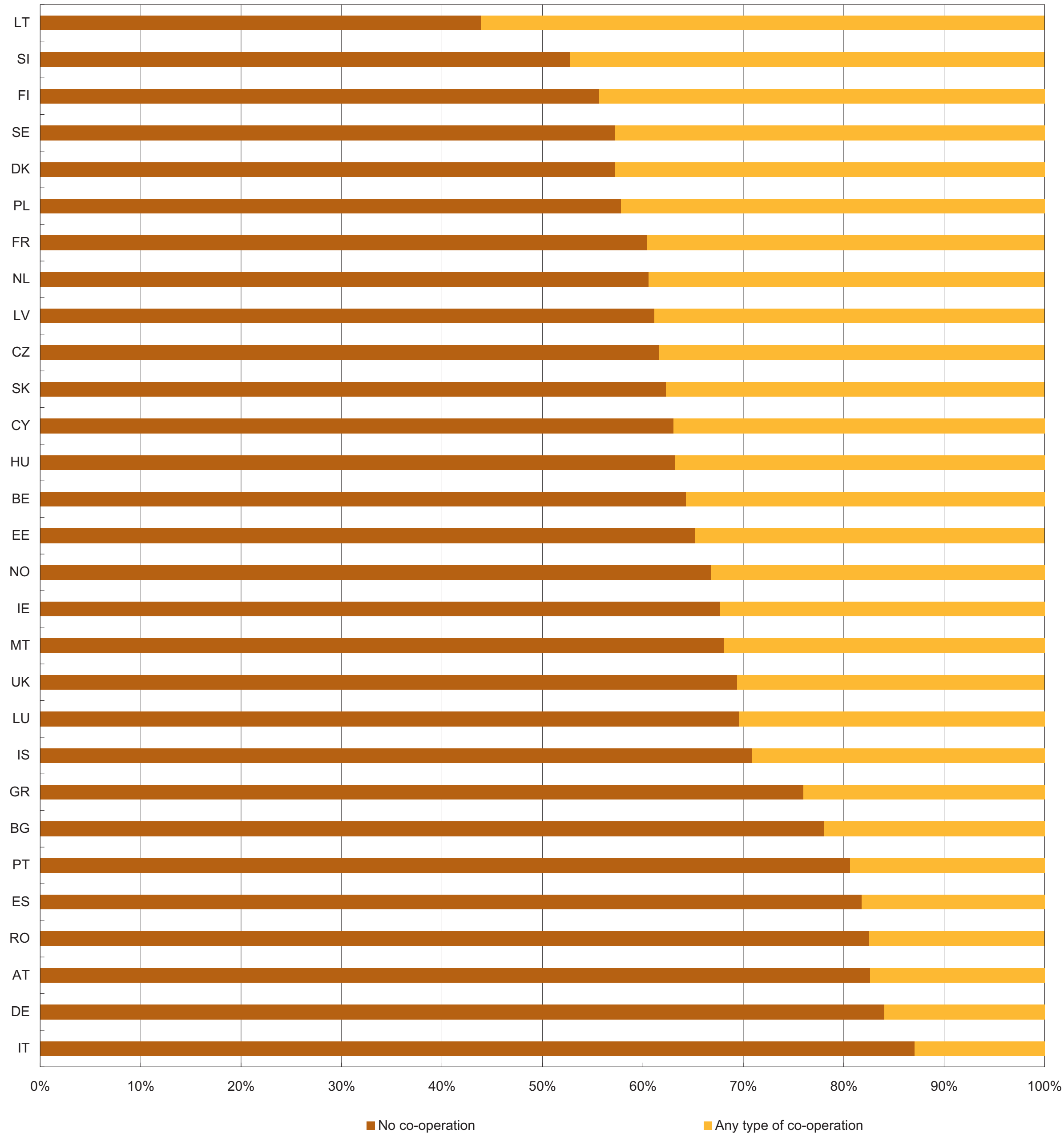
The absence of institutional sources among the top three sources of information shows that the link between science and industry is markedly weak in Europe and needs to be strengthened. One aim along with others that national governments and European institutions are trying to achieve by funding research programmes at universities and public research entities is to create a kind of domino effect. Active and successful public research should stimulate research in the business enterprise sector. Without any doubt, commercial research commissioned from universities is a key way of linking university expertise and industry. It helps researchers to export their ideas and inventions from the laboratory to the global market. However, there should also be some interaction between the public and private sectors. Commercial gains from research should help to finance public research.

Brussels, 4 April 2007 —
COMMUNICATION FROM THE COMMISSION TO THE COUNCIL, THE EUROPEAN PARLIAMENT, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Improving knowledge transfer between research institutions and industry across Europe: embracing open innovation – Implementing the Lisbon agenda – {SEC(2007) 449}

CONCLUSION: Interactions between the public research base and industry have been gradually increasing over the past decade. These can vary from contractual research to collaborative research or even to structured partnerships. Most of these interactions involve the transfer of knowledge between the stakeholders concerned and enhance the socio-economic impact of publicly funded research, e.g. by creating new useful products, new jobs and sometimes new companies. The analysis and policy orientations set out in this Communication constitute a starting point for discussions on a common European framework for knowledge transfer in order to create a level playing field and a more coherent European landscape for knowledge transfer. Furthermore, the voluntary guidelines presented in the accompanying Commission Staff Working Document are intended to help research institutions identify shared interests with industry and facilitate mutually beneficial knowledge transfer arrangements. These guidelines will become a living document, complemented by additional work to be undertaken by a group of high-level industry and academic actors. This group will be launched in 2007 and will provide advice on other actions which it could take to promote knowledge transfer in Europe. In addition, cooperation between Member States and the Community level will also continue in the context of the Lisbon strategy for growth and jobs. Major policy initiatives in this area taken by Member States should be reflected in the National Reform Programmes, and the exchange of good practice will continue to be promoted by the Commission.

Figure 5.38 Innovative enterprises broken down into those that cooperate and those that do not, as a percentage of innovative enterprises, by country, EU-27 and selected countries — 2004



One very efficient form of knowledge transfer is cooperation. *"Innovation cooperation" means active participation with other enterprises or non-commercial institutions on innovation activities. There is no need for both partners to benefit commercially, but pure contracting-out of work with no active cooperation is excluded.* Innovative enterprises cooperate with different types of partners at rates varying between 56% in Lithuania and 13% in Italy.

Figure 5.38 shows that there is no general trend, but that the northern and eastern countries seem to cooperate more readily. Lithuania, with the highest score, is followed by Slovenia, Finland, Sweden and Denmark. The other end of the scale is made up of Bulgaria, Portugal, Spain and Romania, followed by Austria, Germany and, at the very end, Italy.

At first glance it might be surprising to find Italy — one of the larger EU Member States — at the end of the scale. How can this low level of cooperation by innovative enterprises in Italy be explained? There are several reasons: structural, economic, cultural and historical.

In Italy, there are still many small, often family-owned, enterprises. The size of Italian enterprises may explain why the proportion of innovative enterprises in that country is relatively small, on 36%. Only large enterprises or groups have the funds to invest in R&D, but there are not many of them in this country.

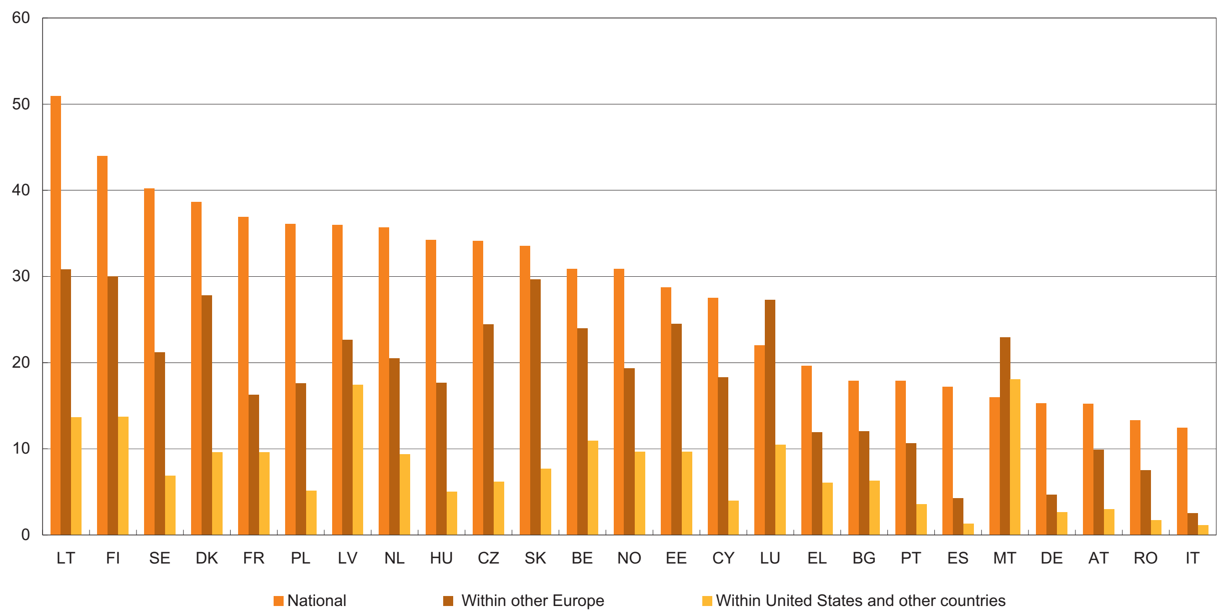
For a long time public financing of R&D was much lower in Italy than in other European countries. Research and innovation are long-term processes, but for Italian enterprises the pressure of competition is very high and they need to invest in short-term solutions. Cooperation takes time and does not necessarily produce results in the short run.

Because of the education system and the low expenditure on R&D, the number of researchers is also relatively low in Italy compared with other European countries (see also Chapters 2 and 4 of this Statistical book.) Basic research and experimental development are necessary for applied research. Research needs structures and investment over long periods. The results, however, are often available only in the long run. In many cases only products from applied research can be commercialised rapidly.

As mentioned earlier, Germany ranks last but one. The reasons for this low level of cooperation by innovative German enterprises are very different to those for Italian enterprises. Germany has the highest proportion of innovative enterprises of all EU Member States. Owing to the size of the country's economy and to its different type of entrepreneurship, Germany has numerous large enterprises. These invest substantial funds in R&D and are less interested in cooperation.

Among the top 20 groups in terms of total R&D investment seven are German and two Italian. These German groups invested nearly eight times the amount invested by the two Italian groups in 2005 (see Chapter 8, Table 8.1).

Figure 5.39 **Enterprises engaged in any type of innovation cooperation, by region of the partner, as a percentage of innovative enterprises, by country, EU-27 and Norway — 2004**



Data missing/confidential for IE, SI and UK.

The enterprises surveyed were asked to indicate where their cooperation partners were from. Figure 5.39 draws a distinction between three different regions:

- national, which means the home country of the enterprise;
- Other Europe, which includes all EU, EFTA and candidate countries;
- United States and other countries which are not included in the other two regions.

The breakdown by region reveals more about cooperation by innovative enterprises.

Unsurprisingly, a large majority of innovative enterprises find cooperation partners in their home country. There are two exceptions to this finding: Luxembourg and Malta. As they are both very small countries, their firms cooperate more with enterprises from other European countries than with businesses from their own country. Maltese enterprises even cooperate more with other non-European countries than with other Maltese enterprises. Compared with the other European countries, Malta has the highest proportion of innovative enterprises cooperating at international level. Latvia ranks second behind Malta, followed by Finland.

For national and European cooperation Lithuania and Finland always take first and second place. Sweden ranks third for the proportion of innovative enterprises cooperating at national level, whereas Slovakia is third for European cooperation.

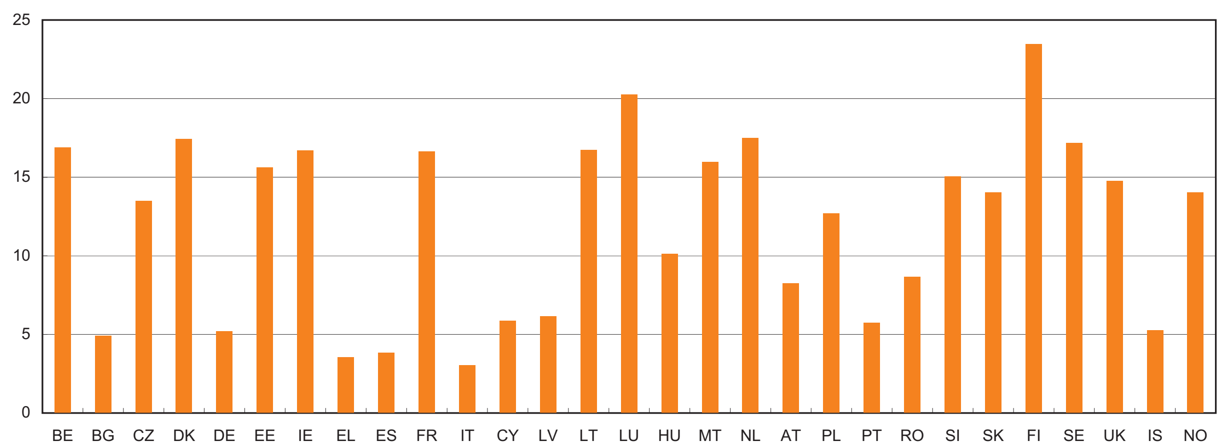
Italy can always be found at the other end of the scale for cooperation with all regions. At national level Romania ranks last, whereas Spain comes last for cooperation at European and international level.

The CIS 4 questionnaire draws a distinction between seven different partners for cooperation:

- other enterprises in your enterprise group;
- competitors or other enterprises in the same sector;
- clients or customers;
- suppliers of equipment, materials, components or software;
- universities or other higher education institutions;
- government or public research institutes;
- consultants, commercial labs or private R&D institutes.

Figures 5.40 to 5.46 show the percentages of innovative enterprises by country for each category of partner.

Figure 5.40 Cooperation partner: Other enterprises in the same group, as a percentage of innovative enterprises, by country, EU-27 and selected countries — 2004



The proportion of innovative enterprises that cooperate with other enterprises in the same group varies between 23% in Finland and 3% in Italy. In 18 of the 29 countries shown in Figure 5.40 at least 10% of the actively innovating enterprises use this form of cooperation.

In Finland more than one out of every three enterprises (34%) cooperates with competitors or other enterprises in the same sector. Behind Finland, the highest scores for this kind of cooperation were recorded in the three Baltic countries, plus Slovenia and Slovakia. The smallest score for this category of partner was found in Spain with 3%.

Figure 5.41 **Cooperation partner: Competitors or other enterprises in the same sector, as a percentage of innovative enterprises, by country, EU-27 and selected countries — 2004**

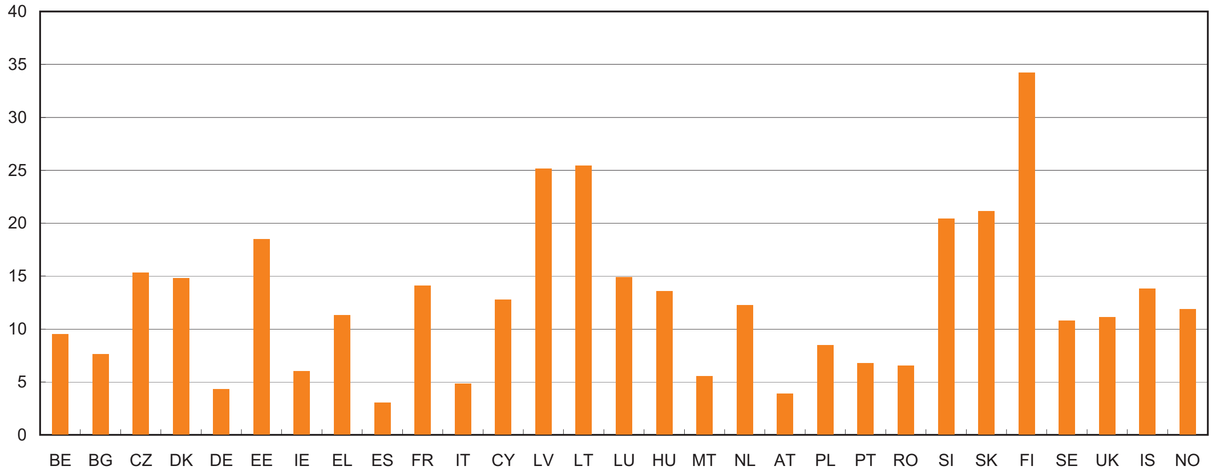
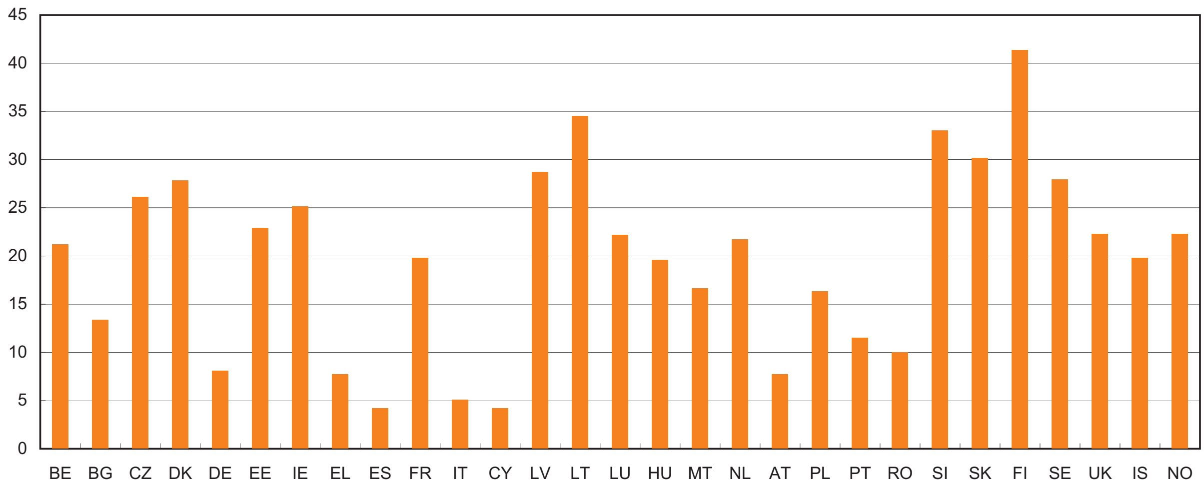


Figure 5.42 **Cooperation partner: Clients or customers, as a percentage of innovative enterprises, by country, EU-27 and selected countries — 2004**



In 15 out of 29 European countries more than 20% of the innovative enterprises cooperate with their clients or customers (see Figure 5.42). Whereas in Spain only 4% of the enterprises with innovative activities cooperate with their clients or customers, in Finland 41% do so.

The most successful form of cooperation seems to be with suppliers of equipment, materials, components or software. This time Lithuanian innovators are in the lead with 45%, followed by Finland (41%) and Slovenia (38%). In 13 EU Member States at least one out of every four innovative enterprises is cooperating with its suppliers. By contrast, the lowest figure for cooperation with suppliers (7%) was recorded in Germany.

Figure 5.43 Cooperation partner: Suppliers of equipment, materials, components or software, by country, EU-27 and selected countries — 2004

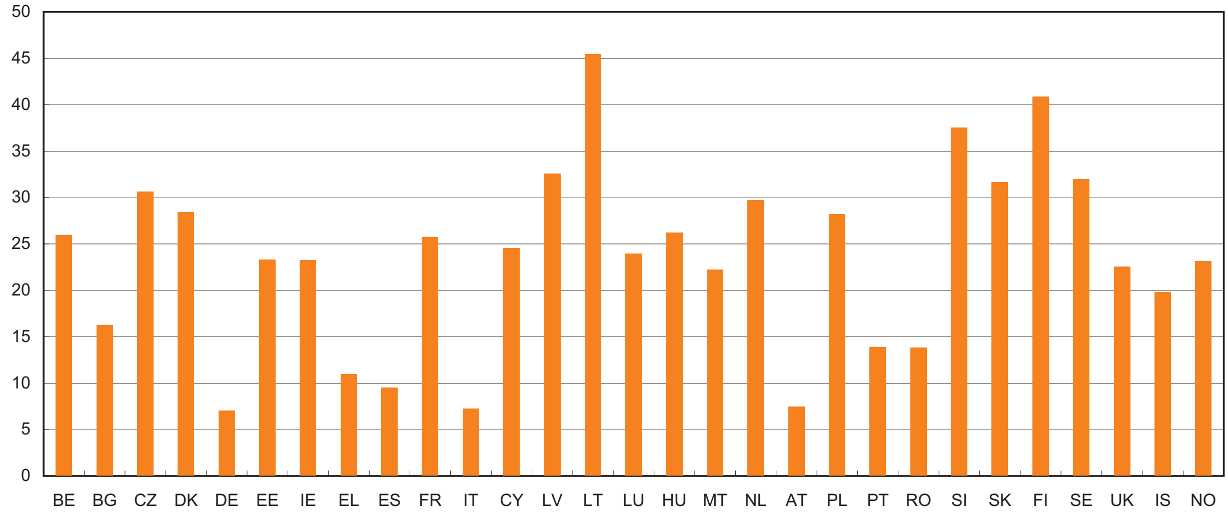
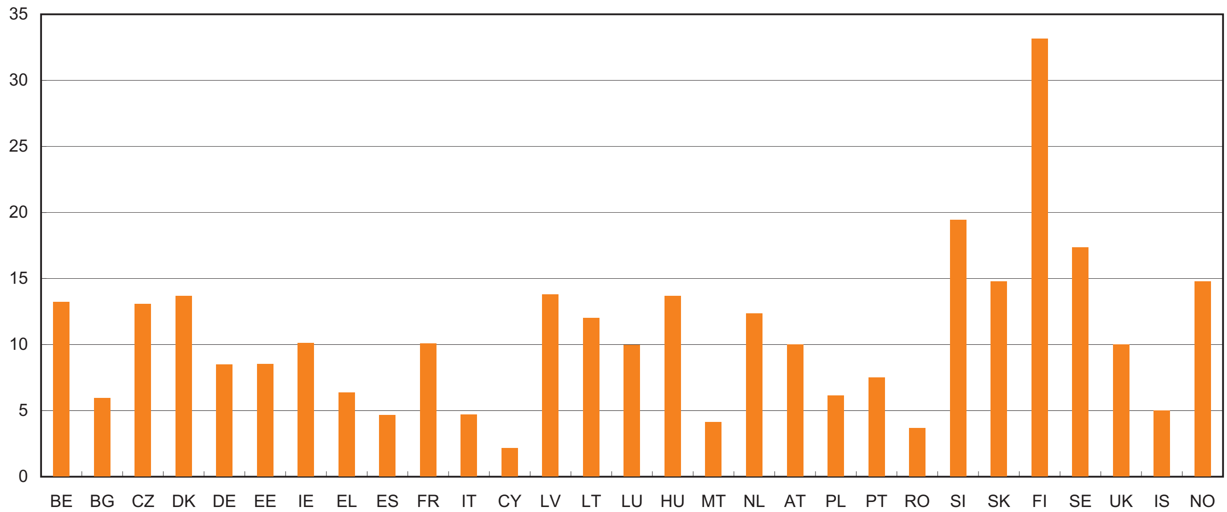


Figure 5.44 Cooperation partner: Universities or other higher education institutions, as a percentage of innovative enterprises, by country, EU-27 and selected countries — 2004



Compared with suppliers, universities or other higher education institutions are in less demand as cooperation partners. Finland's innovative enterprises – which are very active in all types of cooperation and recorded the highest scores for most categories of cooperation partner – were also in the lead for cooperation with higher education on 33%. Besides Finland, only Slovenia and Sweden pass the 15% mark. This form of cooperation is almost non-existent in Cyprus, where it is practised by just 2% of the innovative enterprises.

Worse still are the results for cooperation with government or public research institutes. 26% of Finnish innovative enterprises use this type of cooperation, as do more than 10% of the innovative enterprises and in three other Member States, but in most other countries the percentages are very low. In Italy the share of this category of partner does not even reach 2%.

Figures 5.44 and 5.45 demonstrate the weak cooperation between the public and private sectors on innovation.

Nevertheless this kind of cooperation is very important for knowledge transfer, a key component of innovation. It seems necessary to strengthen cooperation between the business enterprise sector and both the government and the higher education sectors.

Figure 5.45 **Cooperation partner: Government or public research institutes, as a percentage of innovative enterprises, by country, EU-27 and selected countries — 2004**

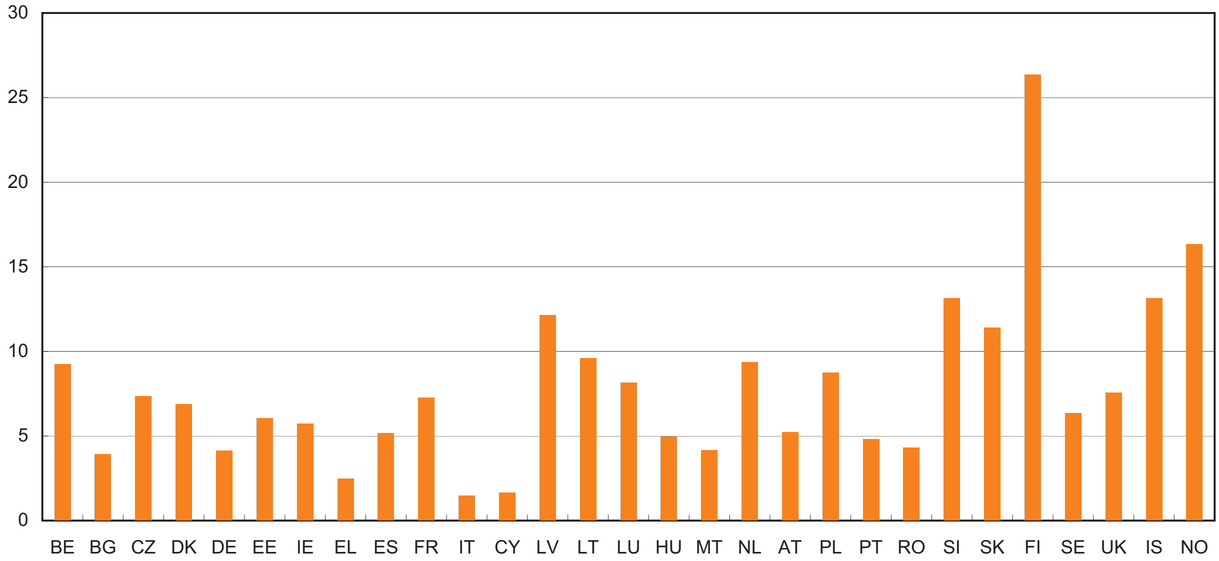
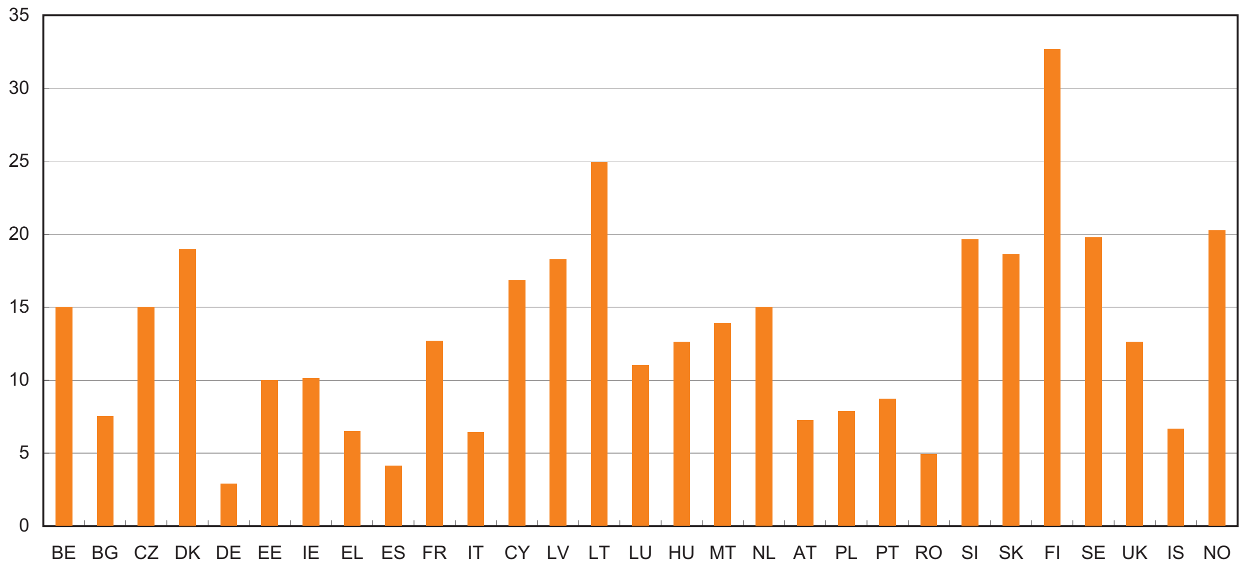


Figure 5.46 **Co-operation partner: Consultants, commercial labs, or private R&D institutes, as a percentage of innovative enterprises, by country, EU-27 and selected countries — 2004**



Inside the private sector cooperation seems to be easier because more enterprises choose consultants, commercial labs or private R&D institutes as partners. In Finland nearly one third of the innovative enterprises do so and in Lithuania one out of every four. In 11 Member States the figures reach 15% for this type of cooperation. By contrast, only 3% of German innovative enterprises are involved in this form of cooperation.

The question about the most valuable method of cooperation (Table 5.47) is not a real poll. In many countries suppliers of equipment, materials, components or software received the highest number of votes, but not in all. In Germany and Ireland innovative enterprises preferred to cooperate with their clients and customers. Maltese innovative enterprises were more inclined to cooperate with other enterprises in their group.

To summarise the results on cooperation and the different methods, it should be said that the innovative enterprises do cooperate but could do to a much greater degree. As the situation with cooperation varies along with the methods and across countries, it needs to be studied in detail. It is important to identify the barriers to cooperation in order to introduce the necessary reforms and other action to encourage cooperation.

Table 5.47 Most valuable method of cooperation by partner, as a percentage of innovative enterprises, by country, EU-27 — 2004

	Other enterprises within your enterprise group	Competitors or other enterprises of the same sector	Clients or customers	Suppliers of equipment, materials, components or software	Universities or other higher education institutions	Government or public research institutes	Consultants, commercial labs, or private R&D institutes
BE	9.7	1.7	8.3	10.3	2.3	0.5	2.5
BG	2.4	0.7	6.7	9.3	0.8	0.2	2.0
CZ	6.6	1.6	12.1	12.8	2.0	0.7	2.6
DK	2.6	1.0	5.5	6.0	1.5	: c	1.6
DE	1.1	1.0	3.1	1.5	2.0	0.8	0.5
EE	8.2	4.1	9.7	10.3	1.1	0.3	1.1
IE	6.6	0.2	10.3	7.7	1.8	0.6	2.3
EL	1.8	5.1	4.4	5.6	3.6	0.3	2.8
ES	2.6	1.4	1.6	6.7	2.0	2.3	1.6
FR	9.6	3.6	6.9	12.1	2.2	1.9	3.2
IT	:	:	:	:	:	:	:
CY	2.5	8.5	1.7	14.9	0.7	0.3	8.4
LV	3.5	2.8	12.4	15.8	1.3	1.4	1.7
LT	9.6	2.4	9.9	25.4	1.6	1.5	5.7
LU	8.8	1.5	5.5	10.8	1.2	1.0	1.9
HU	5.8	2.9	7.3	13.8	3.8	0.7	2.5
MT	15.3	2.1	11.1	12.5	: c	2.1	3.5
NL	8.9	1.3	8.5	14.7	1.4	1.9	2.7
AT	:	:	:	:	:	:	:
PL	8.3	2.1	6.8	16.8	1.8	4.1	2.3
PT	3.0	0.9	4.3	4.7	2.6	1.1	2.7
RO	1.9	0.5	2.9	6.2	1.3	: c	0.7
SI	: c	: c	: c	: c	: c	: c	: c
SK	6.0	2.0	11.3	15.3	0.6	0.5	2.1
FI	:	:	:	:	:	:	:
SE	6.2	1.2	11.6	17.2	2.5	0.5	3.5
UK	:	:	:	:	:	:	:

Effects of innovation during 2002-2004

Innovative enterprises give priority to improving the quality of goods and services

The CIS 4 questionnaire drew a distinction between three groups of effects of innovation, each with at least two different items. The innovative enterprises surveyed were asked to indicate the appropriate degree of importance for the nine effects listed. This analysis takes into account only the effects ranked highly important.

- **Product oriented effects**
  - o Increase range of goods or services
  - o Enter new markets or increase market share
  - o Improve quality of goods or services
- **Process-oriented effects**
  - o Improve flexibility of production or service provision
  - o Increase capacity of production or service provision
  - o Reduce labour costs per unit output
  - o Reduce materials and energy per unit output
- **Other effects**
  - o Reduce environmental impacts or improved health and safety
  - o Meet regulatory requirements

TThe picture at national level is multi-faceted (see Table 5.48). More specifically, for innovative enterprises in 17 of the 27 EU Member States, *improve quality of goods and services* recorded the highest vote. Greece led with close to 60% of innovative enterprises, while Latvia was at the other end of the scale with only 7%.

Increase range of goods and services took first place as a highly important effect of innovation in six countries – the Czech Republic (41%), Germany (38%), Estonia (35%), Ireland (41%), Finland (25%) and Sweden (31%).

Portugal and Latvia had the highest percentages of innovative enterprises that *identified reduce material and energy consumption per unit output* as highly important – 26% and 19% respectively. Romanian innovative enterprises, on the other hand, did not feel in the least concerned, recording 0% for this indicator.

For French innovative enterprises the most important effects of innovation were *enter new markets or increase market share*. In comparison with the other countries, France led in terms of its share of innovative enterprises, with 53% considering *increase range of goods and services* a highly important factor, 59% for *enter new markets or increase market* share' and 35% for *reduce labour costs per unit output*.

Nearly 65% of the innovative enterprises in Cyprus chose *improve flexibility of production or service provision* as the most important effect of innovation.

At the same time, close to 30% of enterprises in Cyprus also identified r*educe environmental impact or improve health and safety* as highly important; this was by far the highest percentage out of all the countries.

Meet regulatory requirements was ranked highest of all the effects of innovation by innovative enterprises in Cyprus, with 47%.

Table 5.48 Effects identified by enterprises as highly important for their innovation activities, as a percentage of innovative enterprises, by country, EU-27 and selected countries — 2004

	Product oriented effects			Process oriented effects				Other effects	
	Increased range of goods and services	Entered new markets or increased market share	Improved quality in goods or services	Improved flexibility of production or service provision	Increased capacity of production or service provision	Reduced labour costs per unit output	Reduced materials and energy per unit output	Reduced environmental impacts or improved health and safety	Met regulation requirements
BE	34.8	33.3	46.6	24.7	25.8	16.6	8.8	13.3	14.4
BG	42.8	32.9	45.6	22.8	23.4	18.9	17.0	20.7	26.7
CZ	40.6	25.7	40.0	26.8	25.3	16.9	13.7	15.5	8.0
DK	25.2	19.8	26.7	21.9	18.4	14.5	6.7	8.7	12.6
DE	38.0	31.7	37.7	27.5	20.0	15.1	9.5	10.3	10.4
EE	35.2	33.2	34.2	22.2	22.9	15.2	12.2	9.1	15.6
IE	40.7	32.8	32.7	22.1	23.5	19.3	10.2	11.1	13.8
EL	36.6	29.7	58.8	43.0	40.0	13.7	9.3	21.2	18.6
ES	28.1	19.6	35.2	25.2	32.5	12.7	7.1	16.2	23.0
FR	52.6	58.6	49.5	30.9	32.3	34.9	15.9	19.1	29.1
IT	25.4	15.2	34.1	18.7	23.2	18.1	4.4	14.7	19.5
CY	26.6	17.1	29.7	64.7	56.8	27.0	8.2	29.8	46.8
LV	10.5	17.7	7.1	15.5	13.6	18.5	19.4	14.9	14.3
LT	24.1	20.8	27.9	19.6	21.1	9.3	5.9	8.8	20.8
LU	48.2	34.5	53.2	37.6	30.3	16.2	7.6	15.3	37.6
HU	31.5	19.6	35.2	20.9	21.9	4.1	6.3	13.2	19.4
MT	21.5	19.4	21.5	17.4	15.3	6.9	4.9	11.8	18.8
NL	38.8	33.2	46.9	34.0	30.5	20.9	12.8	12.3	14.3
AT	25.4	20.8	35.3	23.1	19.0	7.0	4.9	8.2	13.5
PL	33.4	26.7	35.1	21.1	23.2	15.0	12.0	19.2	25.4
PT	9.7	15.4	9.5	8.8	6.1	18.0	25.8	12.7	12.5
RO	17.1	29.1	37.1	28.6	32.3	15.5	0.0	17.7	14.9
SI	38.1	32.2	49.6	30.8	31.0	28.4	17.2	18.6	15.5
SK	34.1	25.3	34.8	27.1	24.5	6.8	8.8	12.2	13.7
FI	25.3	21.7	24.2	15.9	17.1	13.0	5.9	7.2	9.8
SE	31.2	19.8	29.3	16.3	21.6	17.9	7.1	9.7	12.9
UK	37.1	36.5	40.9	23.7	23.2	:	:	15.5	25.7
IS	30.6	19.3	23.4	16.0	15.3	13.8	5.7	2.9	7.2
NO	23.1	16.2	23.6	13.6	13.4	10.0	4.3	8.1	12.4

5

Factors hampering innovation activities

Table 5.49 **Highly important hampering effects, as a percentage of innovative enterprises, by country, EU-27 and selected countries — 2004**

	Cost factors			Knowledge factors				Market factors		Reasons not to innovate	
	Lack of funds within your enterprise or enterprise group	Lack of finance from sources outside your enterprise	Innovation costs too high	Lack of qualified personnel	Lack of information on technology	Lack of information on markets	Difficulty in finding cooperation partners for innovation	Markets dominated by established enterprises	Uncertain demand for innovative goods or services	No need to innovate due to prior innovations	No need to innovate because no demand for innovations
BE	18.8	11.2	19.3	13.6	2.9	5.7	6.2	14.8	9.7	2.0	3.2
BG	24.0	20.9	25.9	9.0	6.2	6.2	11.2	15.1	14.5	3.7	4.7
CZ	22.0	11.6	18.0	10.1	1.9	3.6	3.0	19.0	11.6	2.6	3.4
DK	21.2	9.0	12.4	6.7	2.7	3.5	2.7	9.2	11.7	3.5	4.7
DE	12.3	11.4	19.4	4.6	1.5	3.3	3.2	7.1	4.7	6.6	6.5
EE	28.2	19.3	21.1	23.2	3.6	3.2	5.8	16.3	10.5	5.4	6.1
IE	24.3	12.5	19.1	18.3	4.7	12.7	4.5	12.5	12.6	1.5	1.1
EL	31.8	32.3	39.5	23.4	17.6	18.0	24.0	22.1	24.0	4.8	6.5
ES	29.3	26.6	39.8	16.2	11.2	9.3	12.0	19.6	20.8	5.6	10.6
FR	29.9	9.6	27.9	14.9	4.0	5.8	10.1	15.5	15.9	3.1	5.1
IT	19.4	18.8	25.6	10.6	4.5	4.5	10.0	13.3	12.5	4.9	3.5
CY	26.9	23.8	30.7	15.2	4.7	3.4	9.1	10.9	9.2	3.1	2.0
LV	15.8	18.8	16.6	22.4	39.9	35.0	28.8	19.6	22.8	36.6	42.8
LT	24.6	18.8	21.8	13.7	7.0	7.7	7.9	19.1	10.9	5.1	1.6
LU	12.0	5.3	10.2	12.1	0.7	2.9	4.7	14.8	12.0	69.7	65.5
HU	27.5	19.6	26.3	7.5	1.8	3.5	4.8	14.7	15.0	1.5	2.7
MT	14.6	9.7	18.1	9.0	2.8	8.3	5.6	14.6	16.7	4.2	2.8
NL	17.5	9.3	11.9	6.9	3.8	3.8	2.8	4.5	8.3	2.4	1.6
AT	18.8	15.3	19.3	10.8	3.9	4.5	8.0	12.3	9.0	3.3	3.6
PL	30.9	26.2	32.3	7.3	4.7	4.6	:	:	16.5	:	:
PT	13.5	15.2	9.4	24.7	33.3	31.1	21.1	21.0	19.0	27.1	24.7
RO	8.0	30.3	29.9	14.2	7.3	0.0	15.9	21.2	16.1	5.4	4.2
SI	31.1	24.1	23.6	19.8	4.6	8.9	10.7	25.9	9.0	1.3	5.3
SK	23.7	16.5	21.4	8.3	2.3	4.1	7.1	14.2	11.7	:	:
FI	14.4	10.1	10.7	9.4	3.9	5.5	7.1	7.8	9.4	4.7	3.6
SE	21.3	12.6	14.5	9.2	2.9	3.6	5.1	19.4	12.2	1.8	2.7
UK	:	:	22.4	10.4	3.3	4.6	:	13.0	12.8	:	:
IS	20.5	16.5	19.1	12.9	: c	4.5	9.8	15.8	11.7	4.8	6.2
NO	13.5	11.7	16.5	6.0	2.7	2.9	2.1	5.6	8.3	0.9	1.1

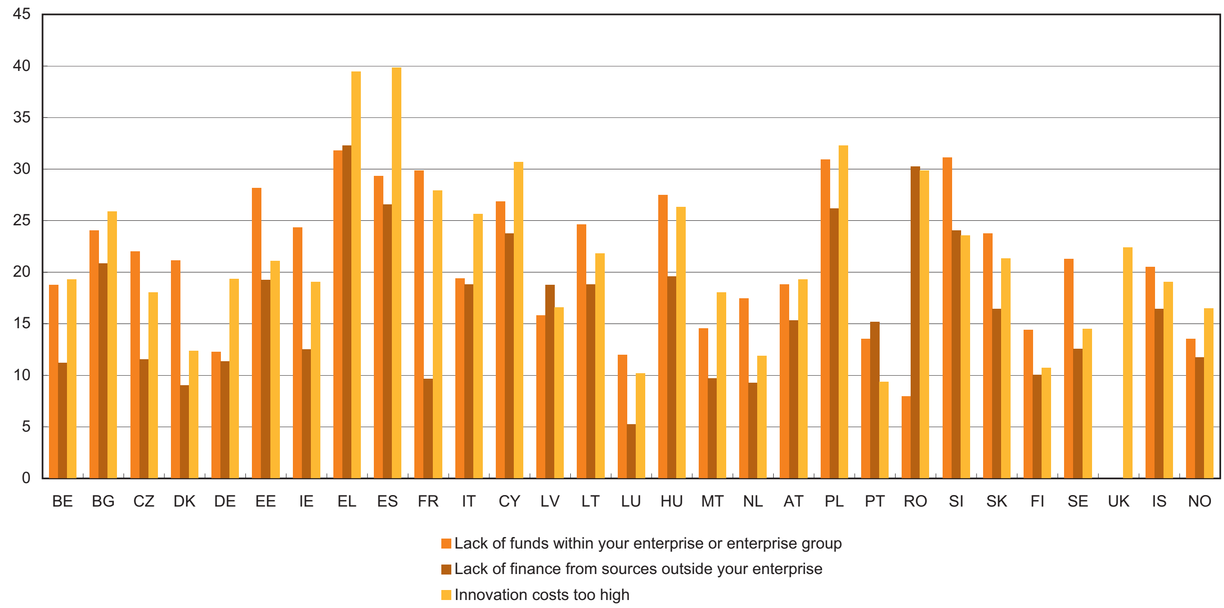
For policymakers it is important to understand the barriers to innovation. Political intervention can only be successful if it is targeted. But, as will be seen later, not all barriers are situated outside the enterprise. There are some obstacles that the enterprise has to overcome itself.

All the enterprises were asked to classify eleven factors hampering innovation in order of importance. These factors fell into the four groups listed below::

- **Cost factors**
  - o Lack of funds within your enterprise or group.
  - o Lack of finance from sources outside your enterprise.
  - o Innovation costs too high.
- **Knowledge factors**
  - o Lack of qualified personnel.
  - o Lack of information on technology.
  - o Lack of information on markets.
  - o Difficulty in finding cooperation partners for innovation.
- **Market factors**
  - o Market dominated by established enterprises.
  - o Uncertain demand for innovative goods or services.
- **Reasons not to innovate**
  - o No need due to prior innovations.
  - o No need because of no demand for innovations.

The last group of hampering factors concerns non-innovative more than innovative enterprises. For this reason, the results are not shown in Table 5.49, but only in Figure 5.53.

Figure 5.50 Cost factors rated as highly important factors hampering innovation, as a percentage of innovative enterprises, by country, EU-27 and Norway — 2004



Cost factors are usually considered highly important factors hampering innovation. This analysis will take a closer look at the three different factors and also differentiate between countries.

In 14 of the 27 EU countries more than 20% of the innovative enterprises considered the fact that innovation costs are too high as a highly important factor hampering innovation. In Spain close to 40% shared this opinion, whereas in Portugal the figure did not reach the 10% mark.

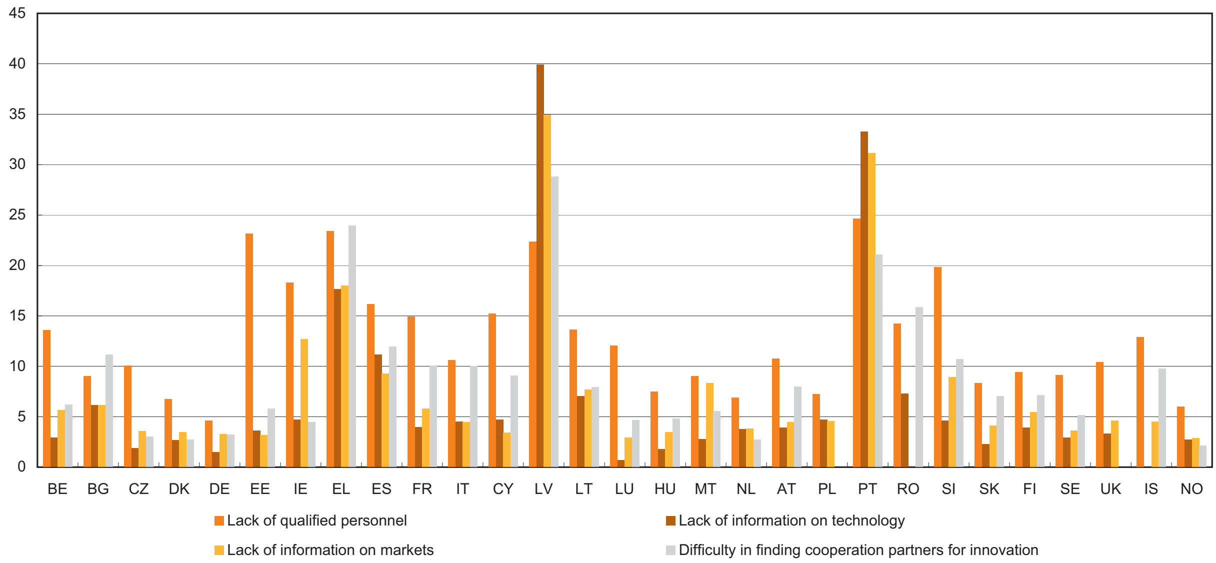
The other two cost factors concern the sources of funds. If costs are hampering innovation, the problem could be lack of financial resources. This lack can be located either inside the enterprise or outside.

Lack of financial resources seems to be a real concern for innovative enterprises in Greece, where the scores for both sources of funds were higher than 30%. Whereas lack of funds within the enterprise or group was considered a highly important hampering factor by 8% of the innovative enterprises in Romania, lack of finance from outside the enterprise was chosen by only 5% of the innovative enterprises in Luxembourg.

Even if the spreads across countries of the proportions of innovative enterprises that choose one of these factors or the other as highly important are similar, lack of funds within the enterprise or group seems more important than lack of outside sources. Fifteen EU countries reported percentages higher than 20% for the first cost factor but only seven countries for the second.

Figure 5.51

Knowledge factors rated as highly important factors hampering innovation, as a percentage of innovative enterprises, by country, EU-27 and Norway — 2004



Knowledge and innovation are strongly linked. Knowledge can be transferred by various means, such as human resources, information and cooperation.

At first glance, knowledge factors seem to be less often considered highly important factors hampering innovation. A closer look at country level and at each individual factor is necessary for a deeper analysis.

Out of the four knowledge factors ”lack of qualified personnel“ scored highest in most countries (see Figure 5.51). In Portugal nearly one out of every four innovative enterprises rated ”lack of qualified personnel“ a highly important hampering factor. The innovative enterprises in Estonia, Greece and Latvia also reached the 20% mark for this hampering factor. By contrast, in Germany lack of qualified personnel does not seem to be a real hurdle. Fewer than 5% of the German innovative enterprises chose this as a highly important hampering factor.

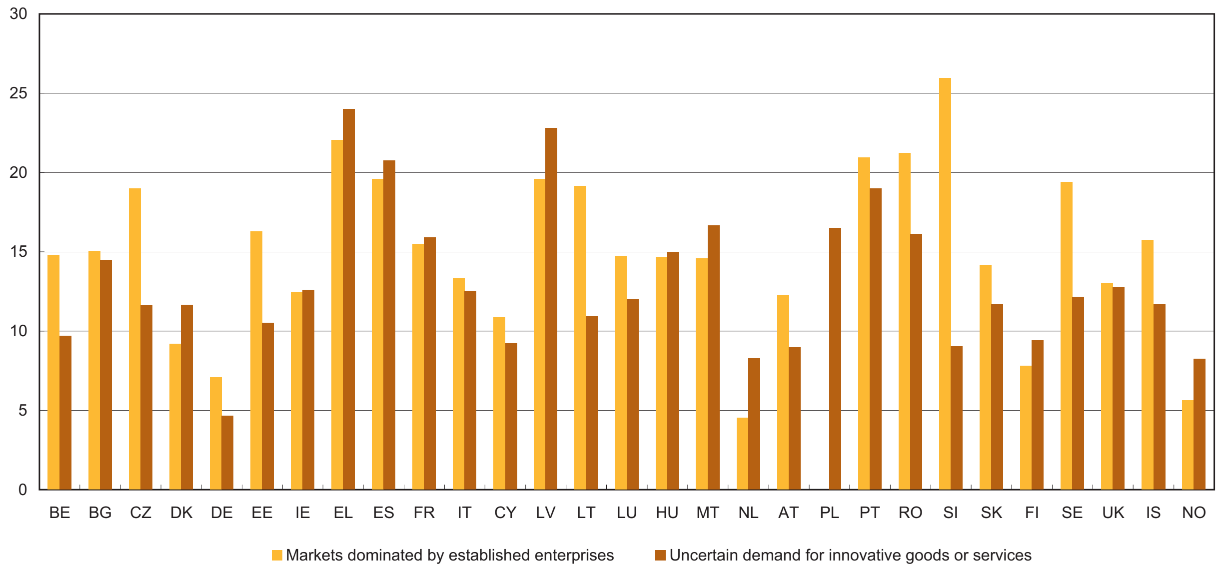
For two other knowledge factors – ”lack of information on technology“ and ”lack of information on markets“ – Latvia and Portugal came out highest. They both recorded over 30% for both these factors, whereas most of the other countries did not even attain 10%.

The last knowledge factor is the ”difficulty in finding cooperation partners for innovation“. Cooperation is one of the key components in the Community Innovation Survey. The degree and different types of cooperation were shown in Figures 5.38 to 5.46 and in Table 5.47. The highest scores for this factor can be found in Latvia (29%), Greece (24%) and Portugal (21%). Indeed these countries might be able to cooperate more. The proportion of their innovative enterprises actively engaged in cooperation were: Latvia (39%), Greece (24%) and Portugal (19%).

In most of the other countries, a low proportion of innovative enterprises rated difficulty in finding cooperation partners a significant barrier to innovation. In some countries there seem to be no major difficulties with arranging cooperation because many innovative enterprises there are already actively cooperating.

In others the situation is different. In Germany, for example, few innovative enterprises declared that they were actively involved in cooperation but also few considered that this lack of cooperation hampered innovation. It seems that the act of cooperating is not perceived in the same way in every country.

Figure 5.52 **Market factors rated as highly important factors hampering innovation, as a percentage of innovative enterprises, by country, EU-27 and Norway — 2004**



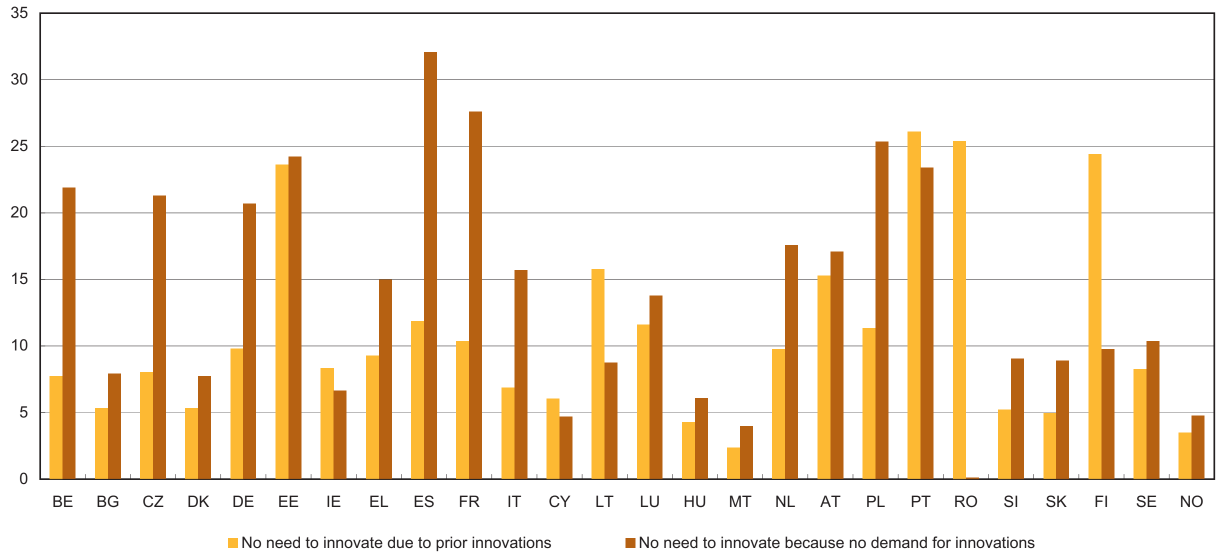
As shown in Figure 5.52, market factors can also be considered highly important barriers to innovation. At national level more or less 15% of the innovative enterprises felt affected by these two factors.

The results vary significantly across countries. Whereas in the Netherlands fewer than 5% of the innovative enterprises rated “markets dominated by established enterprises” highly important, in Slovenia close to 26% did.

The spread was comparable for “uncertain demand for innovative goods or services”. Around 5% of German innovative enterprises found this factor highly important, but in Greece 24%.

In general, market domination seems to play a slightly more fundamental role than uncertain demand as a market factor hampering innovation.

Figure 5.53 Reasons not to innovate rated as highly important factors hampering innovation, as a percentage of non-innovative enterprises, by country, EU-27 and Norway — 2004



Missing data: LV, UK.

By contrast to the three previous figures, which displayed the results for the factors rated as highly important for hampering innovation by innovative enterprises, Figure 5.53 shows the results for two reasons that seem to be important barriers to innovation by non-innovative enterprises.

These reasons for non-innovation may be either prior innovations or no demand for innovations. The spread of the results is relatively wide across countries. Whereas in Malta only 2% of the non-innovative enterprises considered prior innovations a highly important reason not to innovate, in Portugal 26% did. The spread is almost broader for the second reason. While in Romania almost no non-innovative enterprises chose this reason, almost one out of every three non-innovative enterprises in Greece considered the lack of demand a highly important reason.

In 19 out of the 26 European countries in the figure lack of demand for innovation scored higher than prior innovations.

Intellectual property rights

How enterprises protect their innovations

All the enterprises surveyed were asked for information about their innovation activities that led to intellectual property rights (IPR) during the three years 2002 to 2004. The CIS 4 questionnaire split the forms of protection into:

- patent applications;
- registration of an industrial design;
- registration of a trademark; and
- copyright claims.

The proportions of innovative enterprises that applied for a patent varied between 22% for France and 1% for Cyprus. Ten of the 23 European countries in Figure 5.54 reached the 10% mark.

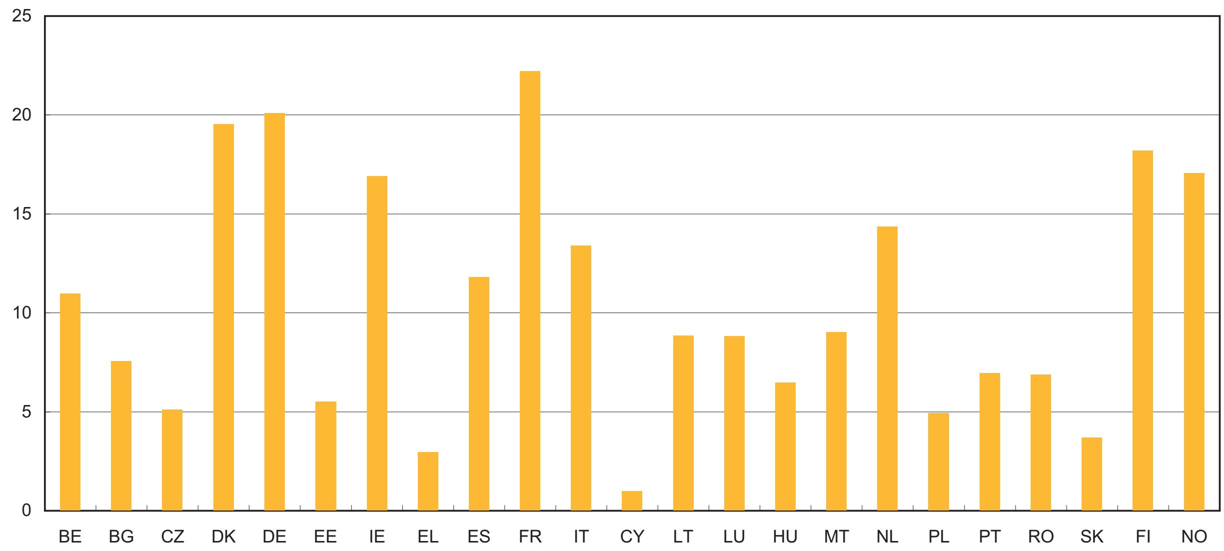
Patents protect the technical and functional aspects of products and processes. An invention is patentable if it meets the criteria of industrial applicability, novelty, inventiveness and patentable subject matter. Patenting is a relatively expensive procedure that requires a certain amount of administrative records for filing.

Brussels, 4 April 2007 – COM(2007) 161 final
GREEN PAPER

The European Research Area: New Perspectives (presented by the Commission)
{SEC(2007) 412}

Patenting remains excessively complicated and costly in Europe, and fragmented litigation fails to provide sufficient legal certainty. Given the deadlock in negotiations on the Community patent, other options are being examined, including improving the current European patent system. The objective should be to offer cost-effective European patenting, mutually recognised with the other major patenting systems worldwide and backed by a coherent pan-European litigation system. In addition, a number of R&D-specific issues, such as the grace period, joint ownership regimes and the research exception, should also be addressed in order to ensure consistent treatment across the EU.

Figure 5.54 **Innovative enterprises that applied for a patent, as a percentage of innovative enterprises, by country, EU-27 and Norway — 2004**



Data missing/confidential for LV, AT, SI, SE and UK.

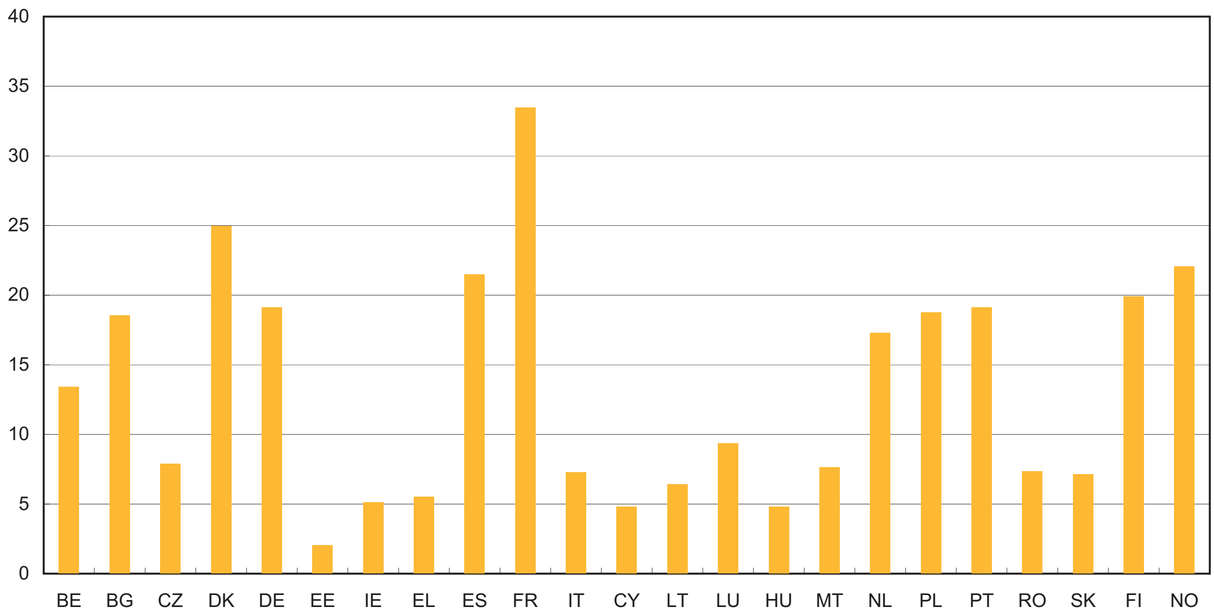
Registered trademarks protect signs or combinations of signs that identify the goods and services of individual traders.

Trademarks are generally distinctive symbols, pictures or words that sellers affix to distinguish and identify the origin of their products. The owner of a trademark has exclusive rights to use it on the product which it was intended to identify and, often, on related products.

During the three years 2002 to 2004 about one third of all innovative enterprises in France registered a trademark. They were the most active users of this form of protection. In 10 European countries more than 15% of the innovative enterprises registered a trademark during the reference period.

Although more use is made of this method than of applying for a patent, in Estonia only 2% of the innovative enterprises used it.

Figure 5.55 Innovative enterprises that registered a trademark, as a percentage of innovative enterprises, by country, EU-27 and Norway — 2004



Data missing/confidential for LV, AT, SI, SE and UK.

Office for Harmonisation in the Internal Market (OHIM) (Trade Marks and Designs)

The OHIM is the official authority carrying out the procedures for the Community trade marks since 1996 and for the Community registered design from 2003. These intellectual property rights are valid in all the countries of the EU.

Trade marks and designs belong to the world of private company law. The OHIM is both an agency of the European Community and an industrial property office with its technical function: the registration of industrial property rights.

As a service agency, the Office has to place its clients, that is to say the undertakings that file their trade marks and their designs with the OHIM, at the centre of the overall mechanism of the Office and it has to provide them with the best service at the best price.

The Community trade mark and the Community registered design are the gateway to a single market. Their unitary nature means that formalities and management can be kept simple: a single application, a single administrative centre and a single file to be managed.

A uniform law applies to trade marks and designs, thereby providing strong and unique protection throughout the European Union. The simplification results in considerably reduced costs as compared with the overall costs of national registration in all countries of the European Union.

The size of the OHIM today, the speed at which it has grown and the way it became self-financing from its second year of operation are proofs of the success of the system at the service of the single market.

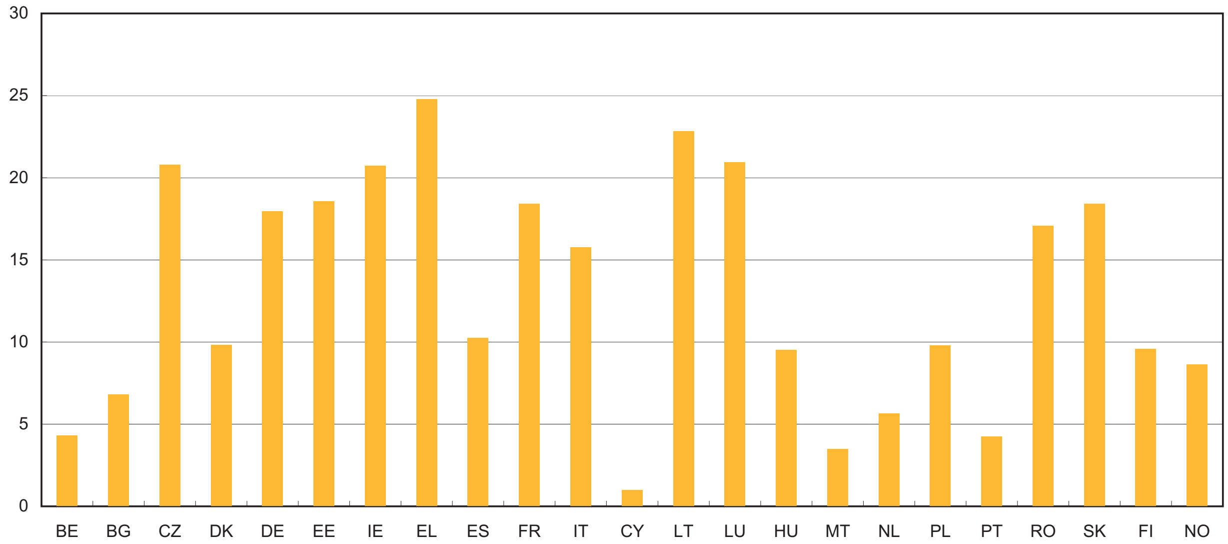
Source: http://europa.eu/agencies/community_agencies/ohim/index_en.htm

Registered industrial designs protect the visual appearance or eye appeal of useful articles.

Industrial designs are linked with all the human aspects of machine-made products and their relationship with people and the environment. For the product's human factors the designer has to take into account engineering, safety, form, colour, maintenance and cost. Professional industrial designers deal with both consumer and industrial products. In order to achieve these ends, designers must be involved in four major design and research activities: human behaviour, the human-machine interface, the environment and the product itself. Industrial design can involve numerous areas, such as furniture, houseware, appliances, transport, tools, farm equipment, medical/electronic instruments, the human interface and recreational support equipment.

Whereas in Greece nearly one out of every four innovative enterprises registered an industrial design over the reference period, in Cyprus only 1% of the innovative enterprises used this form of protection.

Figure 5.56 **Innovative enterprises that registered an industrial design, as a percentage of innovative enterprises, by country, EU-27 and Norway — 2004**



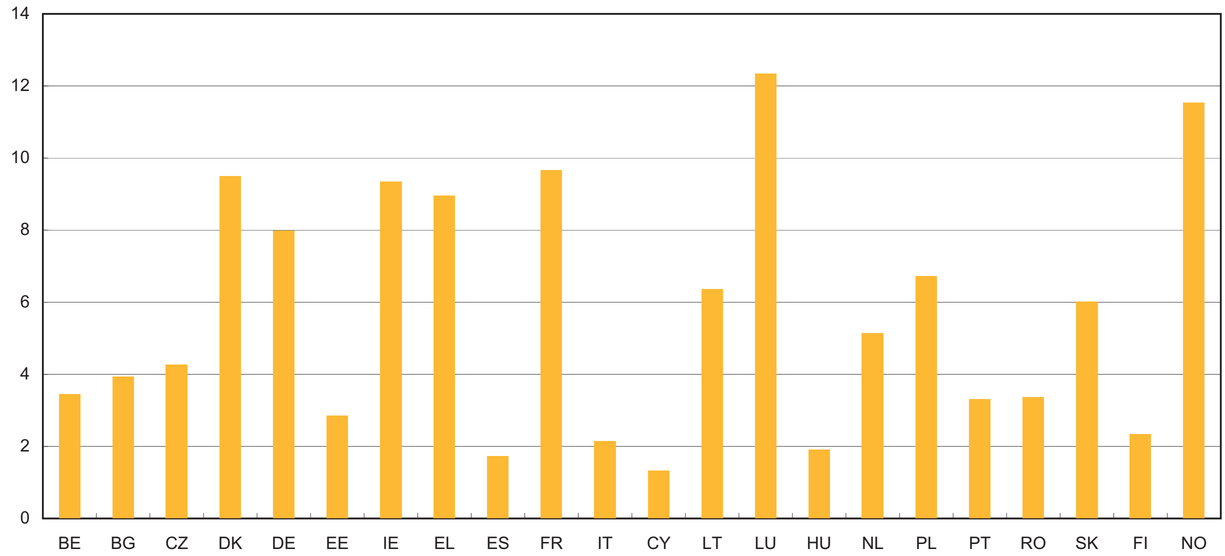
Data missing/confidential for LV, AT, SI, SE and UK.

Industrial property: Commission adopts necessary measures for linking EU design registration system with WIPO international system

The European Commission adopted two Regulations which are necessary to give effect to the accession of the European Community to the Geneva Act of the Hague Agreement concerning the international registration of industrial designs. The adoption follows the Council's approval of the EC accession to the international design registration system of the World Intellectual Property Organisation (WIPO) on 18 December 2006. The EC accession will allow EU companies, with a single application, to obtain protection of a design not only throughout the EU with the Community Design, but also in the countries which are members of the Geneva Act.

Source: OHIM news release, 25/07/2007

Figure 5.57 Innovative enterprises that claimed copyright, as a percentage of innovative enterprises, by country, EU-27 and Norway — 2004



Data missing/confidential for LV, AT, SI, SE and UK.

Copyright protects artistic creations, such as literature, art, music, sound recordings, films, broadcasts and computer programs.

The copyright defines general conditions for producing, monopolising, distributing and using particular cultural information. The copyright gives the holder the exclusive right to protect his or her interests in artistically creative work.

Since the creation of the Internet and all the new technological possibilities which it opened up to copy different kinds of creative work, copyright has assumed growing importance in the public debate.

For the enterprises surveyed, claiming copyright is a less important method of protection. Nevertheless, more than 12 of the innovative enterprises in Luxembourg claimed at least one copyright between 2002 and 2004. By contrast, only 1% of the innovative enterprises in Cyprus claimed at least one copyright over the same period.

Organisational and marketing innovations

Organisational innovations

Organisational innovations involve a significant change in business practices, workplace organisation or external relations, intended to improve the firm's innovative capacity or performance, such as the quality or efficiency of workflows. Organisational innovations usually involve changes to more than one part of the firm's supply chain and are less technology-dependent than process innovations.

Organisational innovations *do not include*:

- changes of management strategy, unless accompanied by significant organisational changes; or
- introduction of new technology that is used by only one division of a firm (for example, in production). These are usually process innovations.

Knowledge management systems

- Establishment of formal or informal teams to improve access to and sharing of knowledge from different departments, such as marketing, research, production, etc.;
- Introduction of quality control standards for suppliers and subcontractors;
- Supply management systems to optimise allocation of resources, from sourcing inputs to final delivery of products.

Changes to work organisations

- Reduction in the number of layers of management;
- Change in responsibilities, such as giving substantially more control and responsibility over work processes to production, distribution or sales staff;
- Creation of a new division, for example by splitting management of marketing and production into two divisions.

Changes in external relations

- First use of outsourced research or production if it requires a change in how workflows are organised within the firm.

Marketing innovations

Marketing innovations cover significant changes in how an enterprise markets its goods and services, including changes to design and packaging.

Marketing innovations *do not include*:

- routine or seasonal changes, such as clothing fashions;
- advertising, unless based on use of new media for the first time.

Innovative design & packaging

- Novel designs of existing products, such as flash card memory sticks designed to be worn as jewellery;
- New designs for consumer products, such as appliances designed for very small apartments;
- Adapting packaging to specific markets (e.g. different covers and typeface for children's and adult versions of the same book).

New sales methods

- Bundling existing goods or services in new ways to appeal to market segments;
- Developing trademarks for new product lines;
- Targeting marketing on sub-populations using personalised information. This information can be collected from individuals who visit websites for information or join frequent user or buyer reward schemes;
- Product seeding via opinion leaders, celebrities or particular groups that are fashion- or product trend-setters;
- First use of product placement on television, in books, films, etc.;
- Media programming for a specific institution, such as closed circuit television for hospitals that contain educational programming to stimulate sales of specific products;
- In-store sales accessible only to holders of the store's credit card or reward card.

Table 5.58 Innovative and non-innovative enterprises that introduced organisational and/or marketing innovations, as a percentage of innovative and non-innovative enterprises, by country, EU-27 and Norway — 2004

	Innovative enterprises			Non-innovative enterprises		
	Enterprise introduced organisational and/or marketing innovations	Enterprise introduced organisational innovation	Enterprise introduced marketing innovation	Enterprise introduced organisational and/or marketing innovations	Enterprise introduced organisational innovation	Enterprise introduced marketing innovation
BE	68.3	58.2	38.9	23.7	19.5	8.9
BG	52.4	41.0	38.2	7.8	6.0	3.7
CZ	69.3	62.8	38.8	22.9	20.4	8.7
DK	80.9	75.8	30.6	44.4	38.5	10.5
DE	72.1	64.9	33.4	40.4	35.8	9.8
EE	72.1	61.6	42.2	25.0	20.4	8.0
IE	69.6	64.2	36.7	:	:	:
EL	71.9	65.0	38.7	31.1	25.8	13.2
ES	60.2	56.6	24.6	14.2	13.1	3.9
FR	70.9	61.4	37.0	28.8	25.2	9.3
IT	58.7	52.3	30.9	26.2	21.7	10.8
CY	74.9	59.4	51.7	40.4	29.7	25.0
LV	:	:	:	:	:	:
LT	69.9	58.9	36.8	14.1	11.5	5.6
LU	81.6	75.6	45.4	43.7	41.0	13.7
HU	60.8	49.5	36.8	17.4	12.6	9.2
MT	69.4	57.6	44.4	16.5	12.2	9.4
NL	57.0	48.0	27.8	18.4	16.6	5.2
AT	76.0	69.2	42.2	:	:	:
PL	69.7	57.4	51.2	13.2	9.0	8.1
PT	72.6	66.1	37.6	27.5	24.2	9.4
RO	70.6	28.9	5.0	19.6	12.9	1.3
SI	:	:	:	:	:	:
SK	61.8	54.8	30.0	12.6	11.6	3.0
FI	:	:	:	:	:	:
SE	:	:	:	:	:	:
UK	:	:	:	:	:	:
NO	66.0	42.7	48.5	17.6	13.2	8.9

As observed earlier, process and product innovations are linked. Many product innovators are also process innovators and vice versa. The same applies to organisational and marketing innovations; they are also linked. Innovating enterprises often introduce more than one innovation and these may concern different domains of the enterprise.

In general, the proportion of innovative enterprises that introduced organisational innovations is higher than the proportion that introduced marketing innovations. Consequently, the proportion of innovative enterprises that introduced organisational and/or marketing innovations is the highest but is lower than the sum of the enterprises that introduced organisational innovations plus the enterprises that introduced marketing innovations because some of these enterprises introduced both.

Cross-country comparison reveals large differences between countries. More than half the innovative enterprises in Cyprus (52%) introduced marketing innovations, but in Romania only 5%. More than three out of every four innovative enterprises in Luxembourg replied that they had introduced organisational innovations. By contrast, less than one third of the innovative enterprises in Romania declared the same. Luxembourg led with 82% of its innovative enterprises having introduced marketing and/or organisational innovations. Bulgaria is at the other end of the scale with 52%. The figure for Bulgaria is lower but is nevertheless still more than half of all innovative enterprises.

Non-innovative enterprises – which means enterprises that introduced neither a product nor a process innovation during the reference period (2002 to 2004) – did introduce organisational and/or marketing innovations. The figures are lower than for innovative enterprises but nevertheless significant.

Denmark's non-innovative enterprises led, with 44% of them having introduced marketing and/or organisational innovations. Denmark was followed by Luxembourg, Germany and Cyprus, all also with scores higher than 40%.

Whereas in Luxembourg more than four out of every ten non-innovative enterprises introduced organisational innovations, in Cyprus one in four introduced marketing innovations.

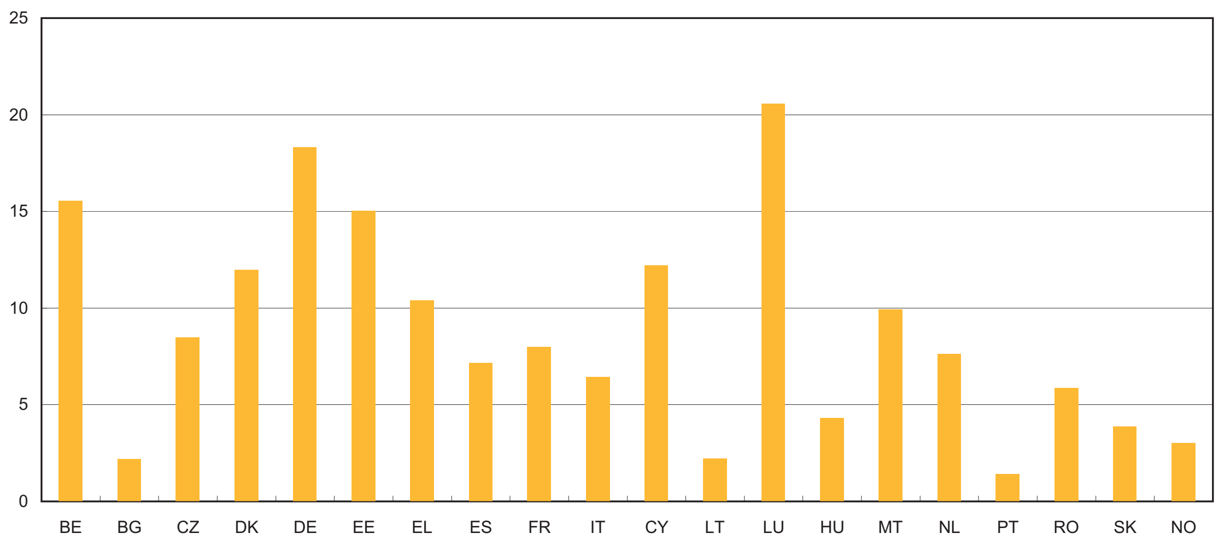
The enterprises surveyed were asked to evaluate the importance of four different effects of organisational innovation:

- reduced time to respond to customer or supplier needs;
- improved the quality of goods or services;
- reduced costs per unit output;
- improved employee satisfaction and/or reduced rates of employee turnover.

Between 21% (Luxembourg) and 1% (Portugal) of the innovative enterprises considered "reduced time to respond to customer or supplier needs" a highly important effect of organisational innovation.

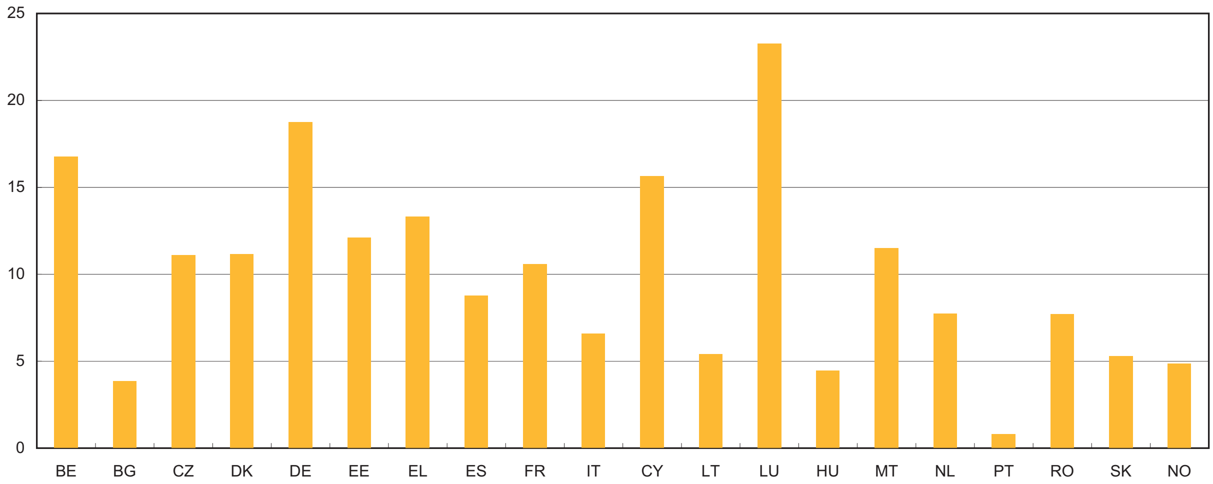
In general, this effect is not so important because only eight out of the 20 countries in Figure 5.59 reached the 10% mark. Most innovative enterprises seem to regard time savings more as a positive collateral effect of innovation which do not play a large part in the enterprise's overall innovation strategy.

Figure 5.59 **Reduced time to respond to customer or supplier needs: innovative enterprises that rate this as a highly important effect of organisational innovation, as a percentage of all enterprises, by country, EU-27 and Norway — 2004**



Data missing/confidential for IE, LV, AT, SI, FI, SE and UK.

Figure 5.60 **Improved quality of goods or services: innovative enterprises that rate this as a highly important effect of organisational innovation, as a percentage of all enterprises, by country, EU-27 and Norway — 2004**



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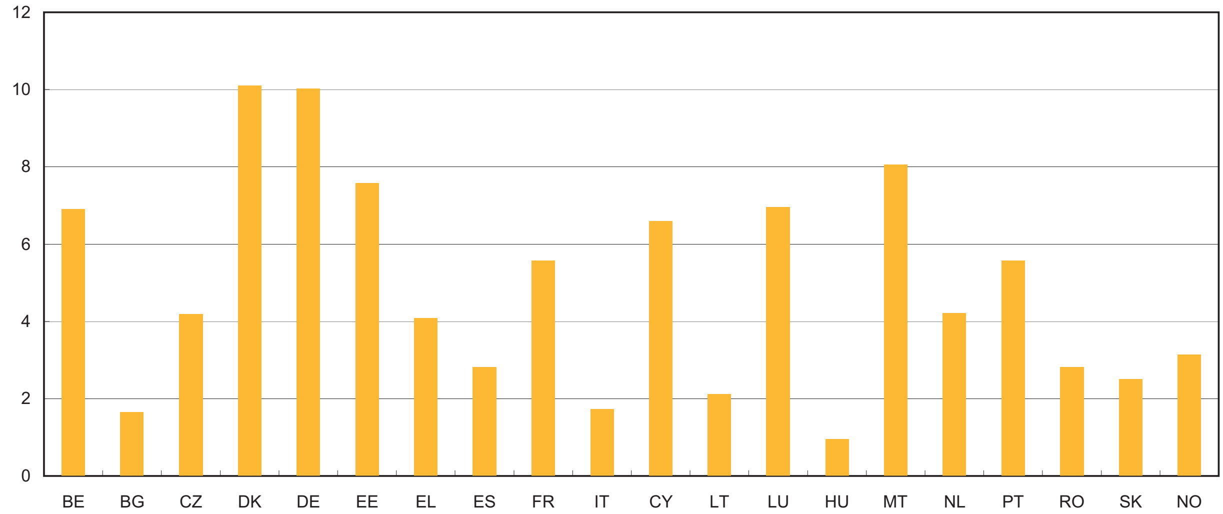
"Improved quality of goods and services" seems to be rated as a highly important effect of organisational innovation by more innovative enterprises than "reduced time to respond to customers and suppliers". The percentages of innovative enterprises selecting this answer vary between 23% for Luxembourg and 1% for Portugal. In the majority of the countries in Figure 5.60 at least 10% of the innovative enterprises rated this effect highly important.

This result is in line with the figures in Table 5.48 where innovative enterprises were asked to evaluate the same effect, but in that case as a result of product and/or process innovation.

The quality of their goods and services seems to be of primary importance to many innovative enterprises. This is not surprising because the core activity of any enterprise is to produce goods or to provide services.

The key objective of innovation is to improve the quality of goods and services. But improving the output of the enterprise is not the ultimate aim: it is also a way to make more profits, to get to more clients and to safeguard the future of the enterprise.

Figure 5.61 **Reduced costs per unit output: innovative enterprises that rate this as a highly important effect of organisational innovation, as a percentage of all enterprises, by country, EU-27 and Norway — 2004**

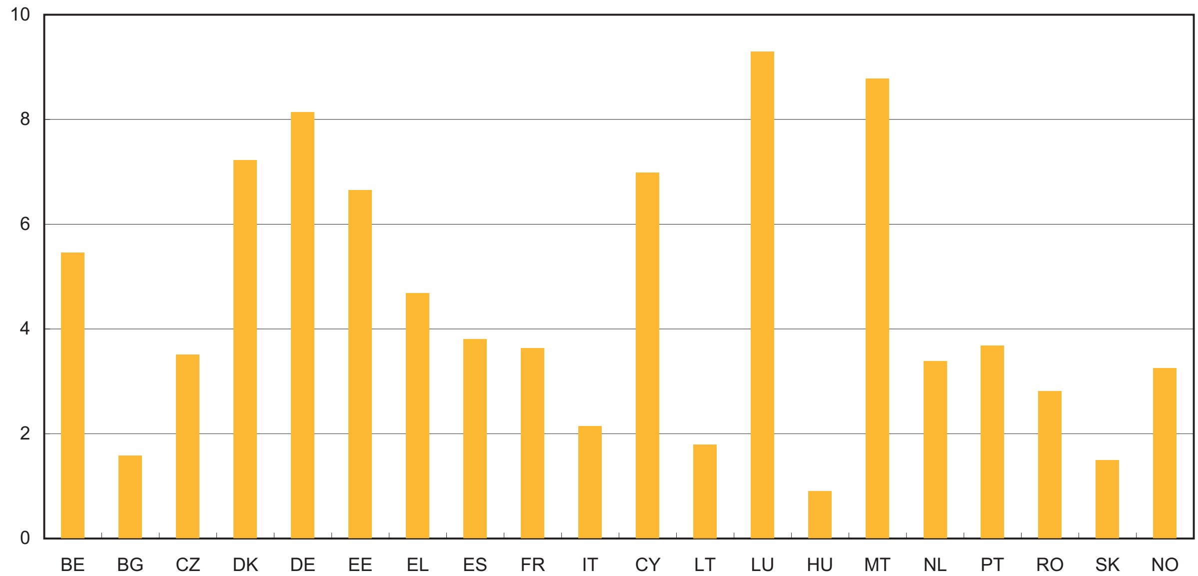


Data missing/confidential for IE, LV, AT, SI, FI, SE and UK.

"Reduced costs per unit output" seems to be a less important effect of organisational innovation for innovative enterprises than the two effects discussed earlier. Danish and German innovative enterprises felt the most concerned by this effect, because 10% of them chose it. The lowest score can be found in Hungary with 1%.

The percentages shown are calculated in relation to all enterprises, but only the results for the innovative enterprises are taken into account in the figure. As not all innovative enterprises introduced organisational innovations, the figures are not very high.

Figure 5.62 **Improved employee satisfaction and/or reduced rates of employee turnover: innovative enterprises that rate this as a highly important effect of organisational innovation, as a percentage of all enterprises, by country, EU-27 and Norway — 2004**



Data missing/confidential for IE, LV, AT, SI, FI, SE and UK.

The results for "improved employee satisfaction and/or reduced rates of employee turnover" are very close to those on "reduced costs per unit output". Once again, the highest proportion of innovative enterprises is in Luxembourg with 9% and the lowest in Hungary with 1%.

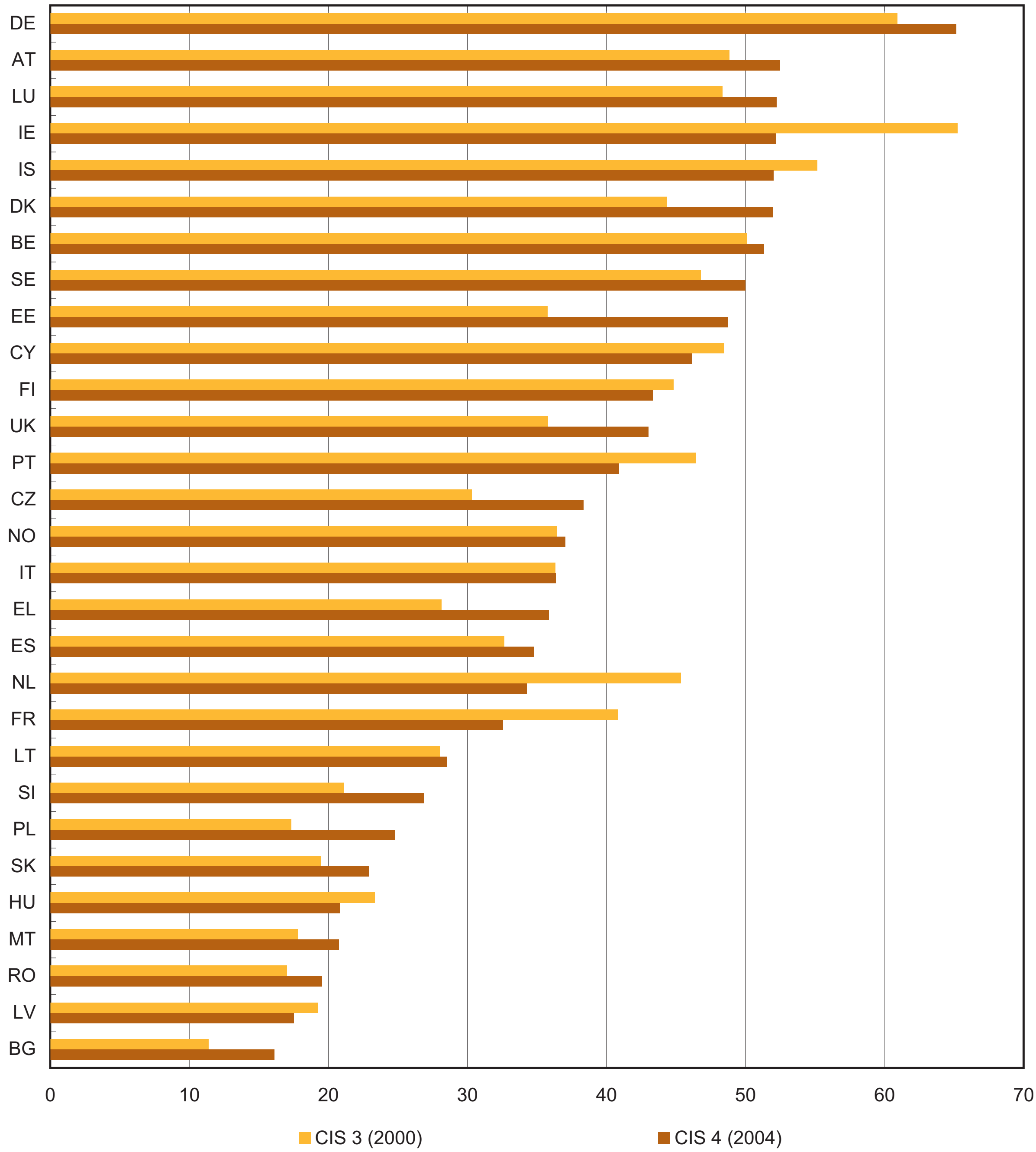
These results are not very surprising because these effects do not really concern the enterprises' main objective of maximising the profit from selling goods and services. These effects are often considered collateral effects rather than priorities.

5.5 Comparison between CIS 3 and CIS 4

This section compares the fourth Community Innovation Survey (CIS 4) with the third (CIS 3), taking a closer look at some of the main results of the two surveys.

The CIS data produced are based on harmonised survey questionnaires which were not fully identical between CIS 3 and CIS 4. To a certain extent, this hampers the comparability of the results between CIS 3 and CIS 4.

Figure 5.63 **Enterprises with innovation activity in CIS 3 (2000) and in CIS 4 (2004), as a percentage of all enterprises, by country, EU-27 and selected countries — 2000 and 2004**



The European innovation landscape shows marked contrasts, as can be seen from the proportions of innovative enterprises in 2004, which ranged from 16% in Bulgaria to 65% in Germany.

The proportion of innovative enterprises increased in most EU Member States from 2000 to 2004. By contrast, in Ireland and the Netherlands it fell by about 10 percentage points. In 2004 in seven EU Member States (Germany, Austria, Luxembourg, Ireland, Denmark, Belgium and Sweden) at least half of all enterprises were engaged in innovative activities.

Table 5.64 Novel innovators in CIS 3 (2000) and in CIS 4 (2004) by type of innovator, as a percentage of all enterprises, by country, EU-27 and selected countries — 2000 and 2004

	CIS 3 - 2000			CIS 4 - 2004		
	Product and process innovators	Product innovators only	Process innovators only	Product and process innovators	Product innovators only	Process innovators only
BE	21.2	19.1	9.7	23.0	12.0	13.2
BG	4.1	5.7	1.1	7.2	7.2	1.2
CZ	11.5	11.9	5.2	19.8	7.3	10.1
DK	20.8	15.8	5.1	19.2	13.6	13.6
DE	22.5	19.7	11.4	23.3	20.1	12.9
EE	15.3	11.4	7.7	22.5	14.6	10.3
IE	:	:	:	29.3	8.6	13.4
EL	9.7	9.4	8.2	21.8	3.3	10.1
ES	11.9	9.8	10.0	13.0	5.7	14.1
FR	14.2	14.4	7.0	13.1	6.3	12.2
IT	16.3	8.3	10.0	12.2	6.2	17.0
CY	16.6	7.3	21.9	18.8	1.2	25.9
LV	9.4	4.4	4.7	:	:	:
LT	11.6	9.4	6.7	10.9	6.4	9.5
LU	18.0	17.1	9.6	24.1	14.4	11.8
HU	8.3	8.5	4.2	8.1	6.0	4.8
MT	4.3	5.2	3.7	8.4	5.3	2.0
NL	21.0	16.7	4.6	14.3	10.2	8.4
AT	17.1	17.6	8.4	27.6	10.2	12.8
PL	:	:	:	10.4	4.7	9.0
PT	14.7	13.2	16.4	17.4	5.5	16.3
RO	12.7	2.5	1.8	13.0	1.8	4.6
SI	12.8	5.6	1.8	:c	:c	:c
SK	4.5	10.7	2.0	10.1	4.5	7.2
FI	18.1	17.0	5.4	18.8	10.9	9.1
SE	13.0	19.5	7.2	21.3	15.7	10.6
UK	9.3	12.2	7.6	:	:	:
IS	28.5	17.2	5.5	:	:	:
NO	19.4	10.3	2.8	12.8	12.6	6.3

Comparing the results of CIS 3 and CIS 4 for novel innovators reveals a slightly upward overall trend in the proportions of product and process innovators.

However, separate comparisons for product and process innovators suggest that the trend is different.

Whereas the numbers of process innovators mostly increased from 2002 to 2004, for many countries the opposite is the case for product innovators.

5

Table 5.65 Enterprises which introduced new or improved products for the market, as a percentage of innovative enterprises by size-class, CIS 3 (2000) and CIS 4 (2004), by country, EU-27 and selected countries — 2000 and 2004

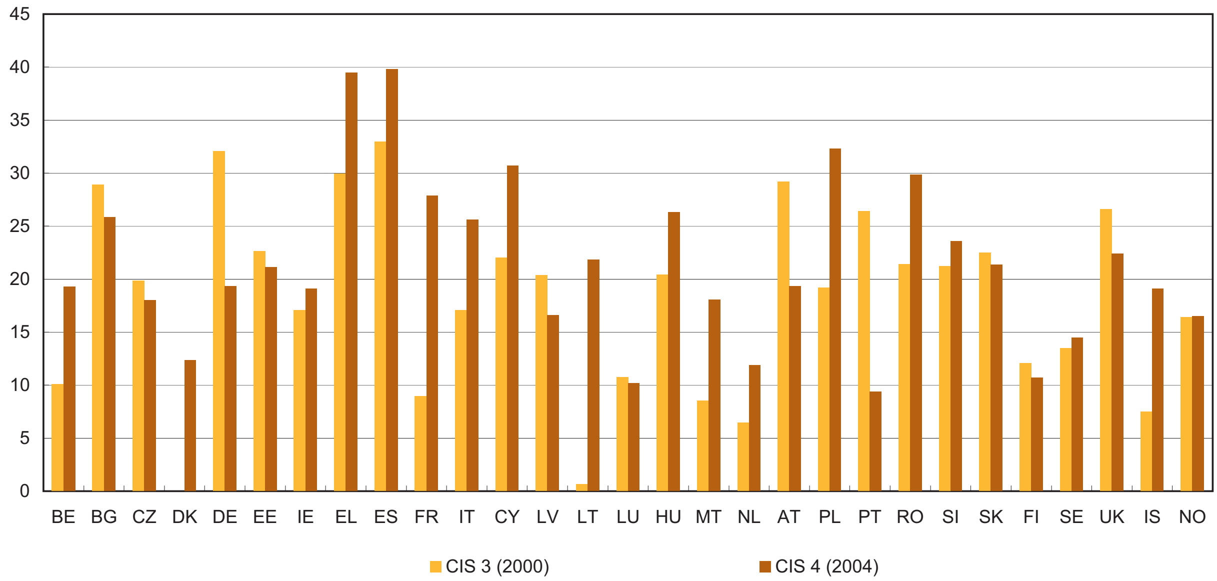
	CIS 3 - 2000				CIS 4 - 2004			
	Total	10 to 49 employees	50 to 249 employees	More than 250 employees	**Total**	10 to 49 employees	50 to 249 employees	More than 250 employees
BE	**36.1**	32.3	42.2	52.3	**40.7**	38.5	44.0	53.1
BG	**53.6**	53.3	52.5	59.5	**56.4**	57.6	52.9	58.6
CZ	**38.2**	35.2	41.2	46.3	**41.5**	39.0	44.4	48.3
DK	**50.9**	45.2	62.7	66.7	**47.7**	46.2	49.3	58.0
DE	**30.5**	26.8	33.5	45.2	**26.9**	22.7	31.7	42.1
EE	**38.6**	39.0	35.7	45.0	**41.9**	43.7	35.4	44.7
IE	**31.7**	:	:	:	**44.5**	38.0	57.2	62.8
EL	**40.1**	40.3	38.7	44.3	**44.4**	43.3	47.6	54.2
ES	**34.0**	33.1	34.8	45.2	**20.9**	18.0	28.2	43.2
FR	**34.7**	28.3	37.7	49.0	**38.6**	34.1	43.3	57.9
IT	**54.7**	53.1	60.5	64.7	**31.1**	28.7	37.8	52.2
CY	**13.5**	11.0	20.8	24.1	**14.6**	11.6	21.7	40.9
LV	**44.8**	43.8	46.5	45.6	**34.5**	33.8	36.4	34.1
LT	**46.0**	45.5	46.8	47.0	**34.5**	30.9	38.4	43.8
LU	**39.9**	:c	28.5	:c	**51.6**	51.4	48.8	64.2
HU	**35.4**	38.5	23.5	39.0	**36.3**	36.5	33.9	40.7
MT	**53.7**	56.3	56.1	35.0	**25.0**	25.0	25.0	25.0
NL	**41.8**	39.8	43.4	51.8	**48.3**	47.5	48.3	56.8
AT	**28.3**	19.8	35.4	62.5	**48.4**	47.3	47.1	64.7
PL	**:**	:	:	:	**46.4**	44.8	47.6	50.4
PT	**43.4**	39.2	48.6	70.0	**30.1**	27.3	35.8	44.6
RO	**80.4**	81.4	79.0	80.1	**27.9**	25.1	29.2	36.2
SI	**60.7**	67.4	56.4	57.1	**46.6**	40.8	50.1	58.1
SK	**41.5**	36.5	46.3	49.1	**41.6**	39.7	42.6	45.1
FI	**62.7**	62.3	62.7	64.9	**49.6**	47.4	52.2	58.0
SE	**37.0**	39.5	26.9	43.9	**52.4**	52.8	49.9	56.5
UK	**27.5**	26.7	27.8	33.3	**47.8**	47.3	48.2	51.9
IS	**21.1**	19.8	22.8	32.0	**77.6**	82.4	59.6	89.5
NO	**38.5**	39.6	33.4	41.6	**36.5**	37.6	32.5	38.6

In 2004 almost 36% of the enterprises engaged in innovation in the EU-27 brought new or significantly improved goods or services onto the market. But the EU average masks national differences. The figure varied between 15% in Cyprus and 56% in Bulgaria.

Comparing the results from CIS 3 and CIS 4 reveals that in 15 EU Member States the relative proportion increased. Among these, the United Kingdom, Austria and Sweden recorded the highest growth in the numbers of innovative enterprises which brought new or improved products onto the market, ranging from 15 to 20 percentage points.

At EU-27 level, there is a positive correlation between the size of an enterprise and its propensity to innovate: 49% of all large enterprises with 250 or more employees and 40% of all enterprises with 50 to 249 employees had brought new or improved products onto the market, whereas for enterprises with 10 to 49 employees the figure was only 33%. Small and medium-sized enterprises need to join forces with other enterprises much more. Small enterprises never show higher rates. This correlation holds true in many Member States, but in some of them small businesses brought more innovative products onto the market than medium-sized enterprises. This was the case in Bulgaria, Estonia, Luxembourg, Hungary, Austria and Sweden.

Figure 5.66 Enterprises with innovation activity in CIS 3 (2000) and in CIS 4 (2004), Innovation costs too high as a highly important factor hampering innovation activities, as a percentage of innovative enterprises, by country, EU-27 and selected countries — 2002 and 2004

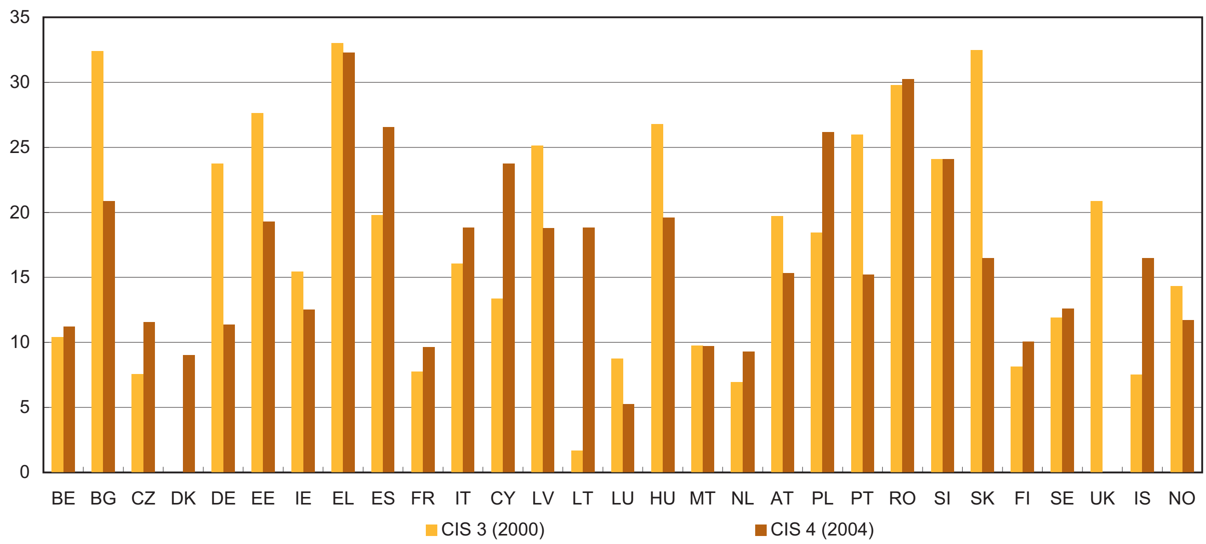


CIS 4 reveals two factors that hamper innovation in the EU most. The first is that innovation costs are too high and the second lack of finance from sources outside the enterprise.

In 2000 “innovation costs too high” was perceived as the highest barrier to innovative enterprises in Spain (33%), Germany (32%) and Greece (30%). Four years later this factor had become even more important in Spain (40%) and Greece (39%), which were followed by Poland (32%). In general, comparing the results of CIS 3 and CIS 4, this factor seems to be gaining importance for innovative enterprises. Growth of 10 percentage points or more was observed in Lithuania (21%), France (19%), Poland (13%) and Denmark (12%). But in Germany (-13%) and Portugal (-17%) far fewer enterprises felt hampered by this factor.

As for the second factor, in 2000 the highest proportions of innovative enterprises hampered by “lack of finance from sources outside the enterprise” were found in Bulgaria (32%), Greece (33%) and Slovakia (32%). Looking at the results from CIS 4, innovative enterprises in Bulgaria, Germany, Portugal and Slovakia were less concerned by lack of finance for innovation.

Figure 5.67 Enterprises with innovation activity in CIS 3 (2000) and in CIS 4 (2004), Lack of finance from sources outside the enterprise as a highly important factor hampering innovation activities, as a percentage of innovative enterprises, by country, EU-27 and selected countries — 2002 and 2004



5.6 European Innovation Scoreboard (EIS) 2006

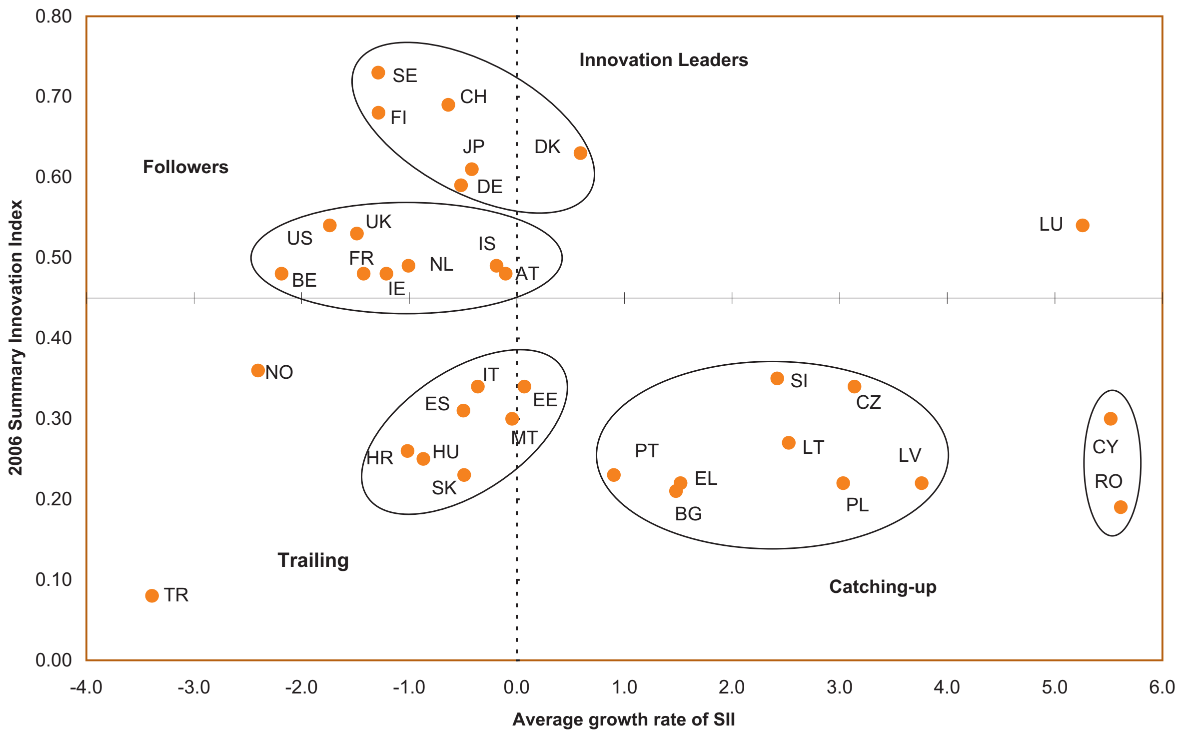
The European Innovation Scoreboard (EIS) is a statistical instrument developed by the European Commission to evaluate the innovation efforts undertaken by the EU Member States and to make them comparable.

Most of the indicators included in the EIS are based on raw data from Eurostat. Seven of the 25 indicators analysed in the EIS 2006 are based on data from the Community Innovation Survey (CIS).

The core of the EIS 2006, which covers 32 European countries plus the United States and Japan, is an analysis of the Summary Innovation Index (SII). This index is based mainly on Eurostat data. To calculate the index, 25 indicators covering different aspects of innovation are used.

Fifteen of them are innovation input indicators (e.g. innovation drivers, knowledge creation, innovation and entrepreneurship); the other ten are based on innovation outputs (e.g. applications and intellectual property). The SII tries to reflect the complexity of innovation and to measure it in a realistic way.

Figure 5.68 **Summary innovation Index (SII) in 2006 and average growth rate of SII, EU-27 and selected countries**



Doted lines show EU25 mean performance.

Source: European Innovation Scoreboard 2006

The SII 2006, combined with the average growth rate of the SII over five years, allows both current innovation performance and trends to be evaluated for each country. Most of the countries fall into four main groups with similar characteristics in terms of their actual and estimated innovation capacity.

These are:

- The *innovation leaders* – Sweden, Switzerland, Finland, Denmark, Japan and Germany. These countries display the highest results in the SII 2006; however, only Denmark recorded a positive average growth rate in the SII.
- The *innovation followers* – the United States, the United Kingdom, Iceland, France, the Netherlands, Belgium, Austria and Ireland. These countries are also more innovation-efficient than the EU-25 average but the trend is declining.
- The *catching-up countries* – Slovenia, the Czech Republic, Lithuania, Portugal, Poland, Latvia, Greece and Bulgaria. On the one hand, these countries show SII results below the EU-25 average; on the other, they record positive average SII growth rates.
- The *trailing countries* – Estonia, Spain, Italy, Malta, Hungary, Croatia and Slovakia. Their SII results are below the EU-25 average and their growth rates are decreasing, with the exception of Estonia.

Cyprus and Romania have relatively low SII results but seem to be catching up rapidly.

The innovation performance and trends observed for Luxembourg, Norway and Turkey are very different, so they do not fit into any of these groups.

Taking into account current innovation performance and the trends for all European countries, there seems to be a process of convergence. Many countries with SII results higher than the EU-25 average have declining average SII growth rates, whereas more than half of the countries with an SII below the EU-25 average have increasing average SII growth rates.

The EIS 2006 also shows that the innovation gap between the EU-25 and the United States is continuing to decrease, narrowing from 0.14 index points in 2002 to 0.08 in 2006.

The innovation gap with Japan is wider and tending to decline less. In 2006 it was about 0.16 index points, not much lower than the 0.17 index points in 2002.

The EU-25 has made considerable progress on some indicators, such as broadband penetration rate, new patent applications to the European Patent Office and new Community trademarks and designs.

At the same time, other indicators have not improved at all – for example, venture capital investment, exports of high-tech products and the population with tertiary education.

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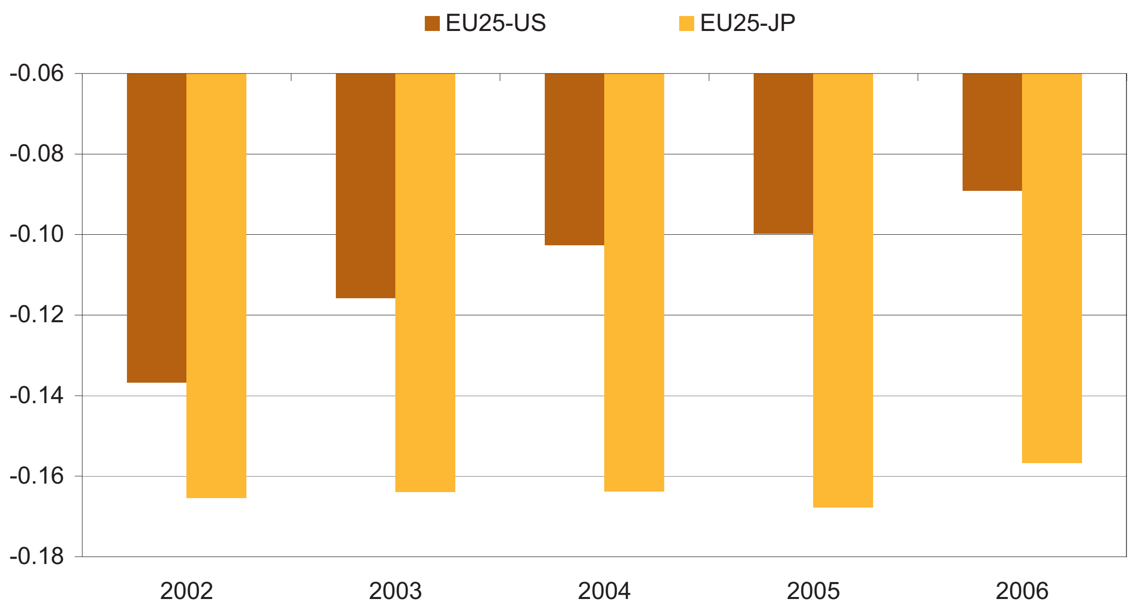
Figure 5.69 **Innovation gap between EU-25 and United States and EU-25 and Japan**



Source: European Innovation Scoreboard 2006

Table 5.70 — **EIS 2006 indicators by sub-group**

	INPUT – Innovation drivers	
1.1	S&E graduates per 1000 population aged 20-29	Eurostat
1.2	Population with tertiary education per 100 population aged 25-64	Eurostat, OECD
1.3	Broadband penetration rate (number of broadband lines per 100 population)	Eurostat
1.4	Participation in life-long learning per 100 population aged 25-64	Eurostat
1.5	Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)	Eurostat
	INPUT – Knowledge creation	
2.1	Public R&D expenditures (% of GDP)	Eurostat, OECD
2.2	Business R&D expenditures (% of GDP)	Eurostat, OECD
2.3	Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures)	Eurostat, OECD
2.4	Share of enterprises receiving public funding for innovation	Eurostat (CIS 4)
	INPUT – Innovation & entrepreneurship	
3.1	SMEs innovating in-house (% of all SMEs)	Eurostat (CIS 3)
3.2	Innovative SMEs co-operating with others (% of all SMEs)	Eurostat (CIS 4)
3.3	Innovation expenditures (% of total turnover)	Eurostat (CIS 4)
3.4	Early-stage venture capital (% of GDP)	Eurostat
3.5	ICT expenditures (% of GDP)	Eurostat
3.6	SMEs using organisational innovation (% of all SMEs)	Eurostat (CIS 4)
	OUTPUT – Application	
4.1	Employment in high-tech services (% of total workforce)	Eurostat
4.2	Exports of high technology products as a share of total exports	Eurostat
4.3	Sales of new-to-market products (% of total turnover)	Eurostat (CIS 4)
4.4	Sales of new-to-firm products (% of total turnover)	Eurostat (CIS 4)
4.5	Employment in medium-high and high-tech manufacturing (% of total workforce)	Eurostat
	OUTPUT – Intellectual property	
5.1	EPO patents per million population	Eurostat
5.2	USPTO patents per million population	Eurostat, OECD
5.3	Triadic patent families per million population	Eurostat, OECD
5.4	New community trademarks per million population	OHIM
5.5	New community designs per million population	OHIM

Source: European Innovation Scoreboard 2006

PART3

Chapter 6 - Patents

6.1 Introduction

Converting technological knowledge into economic growth and welfare is one of the keys to boosting the competitiveness of any country in the modern economy. This is a complex process, and evaluating how countries perform in developing and commercialising technology is no easy task.

Patents statistics have made rapid progress in recent times. They are increasingly used by decision makers in innovation policy or in patent offices in order to monitor developments in their fields. The Worldwide Patent Statistics Database (PATSTAT) recently developed by the European Patent Office (EPO) offers a unique tool for analysts and producers of patents data and indicators.

PATSTAT

PATSTAT was developed by patent information experts at the EPO's Vienna sub-office, and includes patent data from 73 offices world-wide and post-grant data from about 40 offices. It was developed specifically with the needs of policy makers, academics, analysts and Intellectual Property (IP) institutions in mind. Researchers working in this field have previously had to assemble data sets from various and disparate sources and were obliged to perform extensive "cleaning" of the data, which was costly and time-consuming. The PATSTAT dataset addresses these issues, efficiently harmonising data, resolving issues over family members and addressing such problems as applications from one applicant appearing under several different names. The database also contains related information on citations, procedural information and legal status, which are all of interest to statisticians.

Updates to the PATSTAT database will be released twice a year (in March and September), and will be available to any user committing to non-commercial use.

Source: Giovanna Oddo, IPR Helpdesk Bulletin, No 30, Nov-Dec. 2006

An invention has to meet several conditions if it is to be patentable. It must be new, involve an inventive step, be capable of industrial application and not be "excluded". "Excluded" inventions are discoveries, scientific theories or mathematical methods, aesthetic creations such as literary, dramatic or artistic works, schemes or methods for performing a mental act, playing a game or doing business, presentations of information or computer programs.

A patent is an intellectual property right for inventions of a technical nature. A patent is valid for one country if it is granted by a national patent office and generally for 20 years. A patent application to the EPO can be valid in several countries and at most in all of the Contracting States of the European Patent Convention. As of March 2007, the Convention is in force in 32 countries (all EU Member States plus Switzerland, Iceland, Liechtenstein, Monaco and Turkey). In addition to the Contracting States, five other countries have concluded a so-called extension agreement with the EPO. These states can also be designated in a European patent application.

Although patents do not cover every kind of innovation, they do include a large proportion of them. There are good reasons why patents have become one of the most widely used sources of data in the construction of indicators of inventive output, for example because they provide detailed information in relatively long time-series or because they are closely linked to invention.

Nevertheless, patent indicators also have several shortcomings and should therefore be combined with other Science & Technology (S&T) output indicators in order to obtain a full picture of innovation activities in individual countries and regions. Two major drawbacks are that not all inventions are patented and that not all patents have the same value. It is widely recognised that the value distribution of patents is skewed: a few patents have a high value, whereas a greater number have lower values. However, as there are no generally recognised, easily applicable methods for measuring the value of patents, this chapter does no more than count the number of patents meeting various criteria. Another drawback is that only some of the patents granted are applied commercially and/or lead to major technological improvements.

This chapter analyses the structure and development of patenting in the EU-27, Iceland, Liechtenstein, Norway, the candidate countries, Japan and the United States. Priority is given to data on patent applications to the EPO. Nearly all indicators for patents granted by the United States Patent and Trademark Office (USPTO) are also available from Eurostat. It this edition few USPTO data are shown owing to space constraints.

The chapter starts with a glance at the "triadic patent families" and then focuses on performance at national level, using EPO and some USPTO data. The analysis covers the period from 1993 to 2003 for the EPO data, whereas the USPTO and triadic patent family time-series cover the period from 1991 to 2000. Patent statistics are very sensitive to the type of data collected and to the methods used in counting the patents. Data from the period following the reference years are not comparable because they are incomplete. The EPO data refer to patent applications by priority year whereas the USPTO data are for patents granted by priority year. The "priority year" is the year in which the first application was submitted. In general, inventors first apply for a patent from their national patent office. They then also have 12 months to apply to another patent office, such as the EPO or the USPTO.

Although not all applications are granted, each application nevertheless represents the inventor's technical efforts. Patent applications can therefore be considered as an appropriate indicator of inventive activities. It takes, on average, just over four years for a patent to be granted by the EPO. In an effort to provide data promptly, Eurostat has therefore chosen patent applications in preference to patents granted. In the United States, until recently, only information on patents granted was published and therefore no data on applications are presented in this chapter. The USPTO takes between two and five years to grant patents. Triadic patent families are counted on the basis of the earliest priority year, i.e. the year in which a patent was first applied for from any patent office. They refer to applications to the EPO and to the Japanese Patent Office (JPO), and to patents granted by the USPTO.

When interpreting the data at international level, readers should bear in mind that, thanks to "home advantage", European countries dominate the European patent system, whereas the United States dominates the US patent system. At the same time, figures may also be influenced by the countries' industrial structures as different industries have a different propensity to patent. Some of these problems are less visible in the triadic patent family indicators as they only take into account patents that have been applied for from the EPO and the JPO, and those granted by the USPTO. Besides improving the international comparability of patent indicators, triadic patent family data also balance the differences in the value of the patents associated with the other indicators. This is because patenting in all three offices is very costly, owing not only to administrative fees but also to translation costs. Under these circumstances, patentees will proceed with such applications only if they deem it worthwhile, i.e. if the expectation of having the patent granted and the expected return from protection through sales or licences in the designated countries are high enough. Because of differences in data processing methods, direct comparisons between the EPO, the USPTO and triadic patent family data are not advisable.

For further explanations on the methodology used, please refer to the methodological notes or to the section on patent statistics on the Eurostat webpage.

Enhancing the patent system in Europe

Conclusion of the Communication from the Commission to the European Parliament and the Council

The Commission strongly believes that an improved patent system is vital if Europe is to fulfil its potential for innovation. For this reason, the Commission has set out its proposals for the way forward for a reform of the patent system in Europe and is proposing supporting measures in this Communication. The purpose of this Communication is to revitalise the debate on the patent system in Europe, in a way which encourages Member States to work towards consensus and real progress on this issue. Making the Community patent a reality and at the same time improving the existing fragmented patent litigation system would make the patent system significantly more accessible and bring cost savings for all who have a stake in the patent system. In parallel supporting measures to maintain and, where necessary, improve the quality and efficiency of the current system, together with targeted measures to improve SME access, should ensure that Europe's patent system will play its role in boosting innovation and competitiveness in Europe. The EU must also engage actively with its international partners to increase awareness of IP issues and proper and balanced enforcement of them. By providing the basis for Member States to agree concrete actions, the Commission aims to provide a solid basis for progress on patent reform in other areas, especially as regards the Community patent and the litigation system.

The Commission will work with the Council and Parliament to build consensus on the way forward. When broad consensus is achieved, the Commission will take the necessary steps for implementing the agreed strategy and make relevant proposals.

Further information at: http://ec.europa.eu/internal_market/indprop/patent/index_en.htm

Source: European Commission, Brussels, 3.4.2007, COM(2007) 165 final

6.2 Triadic patent families

High concentration of triadic patent families

A patent is a member of the triadic patent family if and only if it has been applied for and filed at the European Patent Office (EPO) and at the Japanese Patent Office (JPO), and if it has been granted by the US Patent and Trademark Office (USPTO). Data on patent families are generally less biased as the "home advantage" disappears to a certain extent. These data also emphasise the value of such triadic patents, which is supposedly higher than the value of other patent applications or patents granted. Looking at the geographical distribution of triadic families (see Figure 6.1), the shares of the EU and Japan in 2000 were respectively 27% and 32% of all triadic patent families counted. The biggest share was held by the United States with 34% and the smallest (only 7%) by the rest of the world. Triadic patent family applications and grants are therefore concentrated in the three main economies.

The picture is quite different when triadic patenting activity is set in relation to the population (see Figure 6.2).

Looking at triadic patent families per million inhabitants, Japan led by a wide margin during the 1991-2000 observation period. The United States ranked second, followed by the EU-27. Whereas the trend was stable for the United States and the EU-25, the indicator for Japan fell in the early 1990s before recovering. In 2000, the EU-27 registered 19.5 triadic patent families per million inhabitants, having fallen below the 20 mark after 1999. With 88.2 triadic patent families per million inhabitants, Japan achieved more than twice the figure recorded in the United States (41.8).

Figure 6.1 **Distribution of triadic patent families, as a percentage of total, EU-27, Japan, the United States and other — 2000**

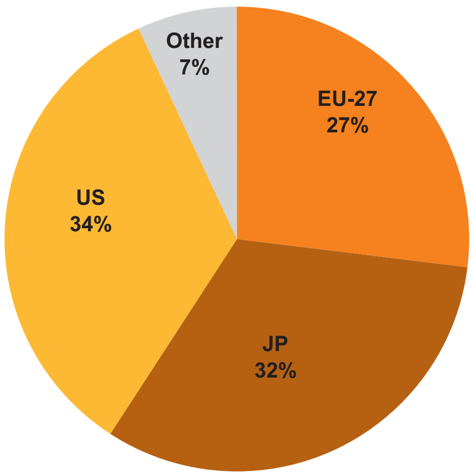
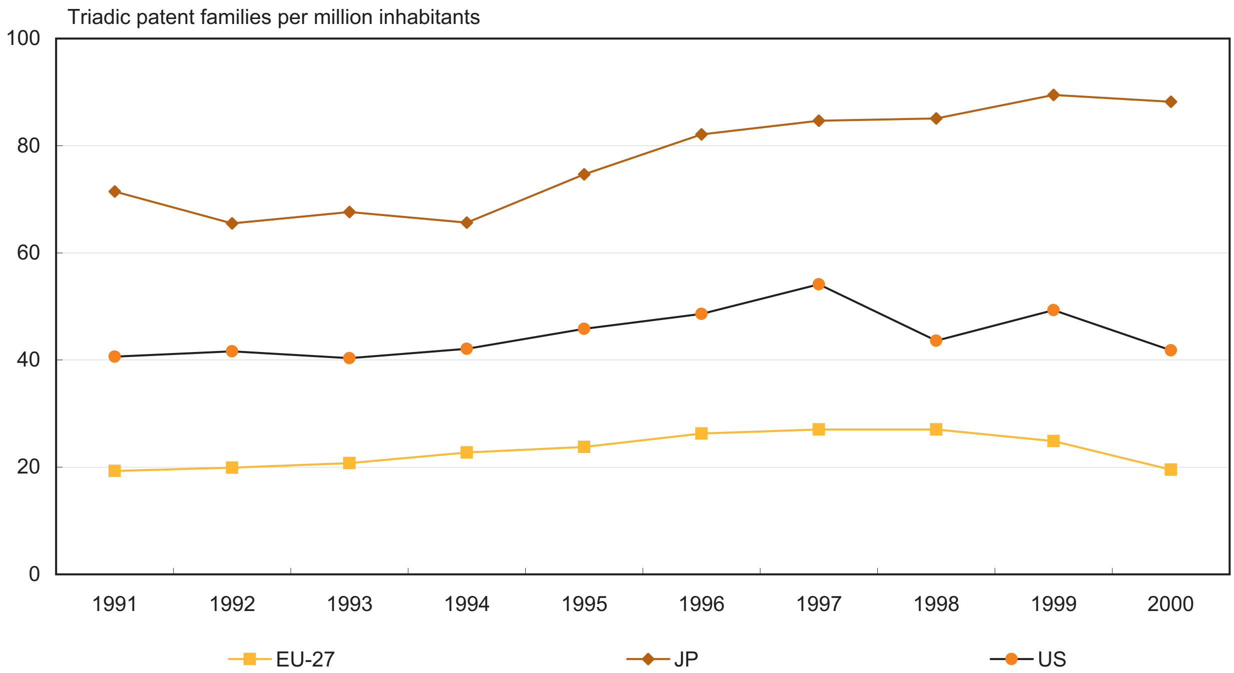


Figure 6.2 Triadic patent families per million inhabitants, EU-27, Japan and the United States — 1991 to 2000



6.3 Total patent applications to the EPO and patents granted by the USPTO

Germany was the best performing European country in terms of patent applications in 2003

The intensity of patenting activity is very different in each country. As explained in the introduction, patenting procedures differ in Europe and in the United States. The USPTO statistics are based on patents granted and the EPO statistics on applications for patents. Given the different underlying methodologies, data relating to these two patent offices should not be compared.

With 62 250 patent applications to the EPO in 2003, the EU-27 was the most active world economy in patenting. Amongst the EU Member States, Germany was the undeniable leader, with 25 728 patent applications, followed by France (9 202) and the United Kingdom (7 217). Germany also led in relative terms. With 11.9%, the country recorded the highest ratio of patent applications as a percentage of GDP out of all EU Member States. In terms of this ratio, Finland ranked second and Sweden third with respectively 10.9% and 9.5% of GDP. None of the new Member States (2004 and 2007) reached the average EU-27 ratio of 6.2% of GDP.

The best-performing non-EU countries in patent applications to the EPO were Israel (15.6% of GDP), Switzerland (10.9%) and South Korea (10.0%)

The USPTO is the national patent office for American inventors. This explains the lower numbers recorded for the EU Member States. Besides the United States (77 585 patents granted) some other countries were very active in patenting as the numbers of patents granted by the USPTO show: Japan (35 013), Taiwan (5 177) and Canada (3 216).

Table 6.3 Patent applications to the EPO: total number and as a percentage of GDP, EU-27 and selected countries - 2003 and Patents granted by the USPTO: total number and as a percentage of GDP, EU-27 and selected countries — 2000

	Patent applications to the EPO 2003		Patents granted by the USPTO 2000	
	Total	As a % of GDP	Total	As a % of GDP
EU-27	**62 250**	**6.2**	**23 723**	**2.6**
EU-25	**62 191**	**6.2**	**23 716**	**2.6**
BE	1 496	5.4	550	2.2
BG	34	1.9	4	0.3
CZ	163	2.0	28	0.5
DK	1 270	6.7	382	2.2
DE	25 728	11.9	10 509	5.1
EE	21	2.5	1	0.2
IE	306	2.2	145	1.4
EL	123	0.8	14	0.1
ES	1 274	1.6	288	0.5
FR	9 202	5.8	3 235	2.2
IT	5 002	3.7	1 694	1.4
CY	12	1.0	1	0.1
LV	14	1.4	6	0.7
LT	20	1.2	6	0.5
LU	90	3.5	36	1.6
HU	192	2.6	54	1.0
MT	4	0.8	2	0.5
NL	3 956	8.3	1 307	3.1
AT	1 581	7.0	556	2.6
PL	160	0.8	20	0.1
PT	78	0.6	14	0.1
RO	26	0.5	3	0.1
SI	101	4.0	24	1.1
SK	44	1.5	7	0.3
FI	1 591	10.9	614	4.6
SE	2 547	9.5	1 172	4.5
UK	7 217	4.5	3 050	2.0
IS	44	4.6	20	2.1
LI	25	:	10	:
NO	533	2.7	203	1.1
EEA30	**62 852**	**6.1**	**23 956**	**2.6**
CH	3 113	10.9	1 253	4.7
HR	81	3.1	14	0.7
TR	133	0.6	12	0.1
AU	1 958	4.2	706	1.7
CA	2 736	3.6	3 216	4.1
CN	1 898	1.3	398	0.3
IL	1 587	15.6	884	6.7
IN	1 003	:	301	:
JP	27 987	7.5	35 013	6.9
KR	5 400	10.0	3 837	6.9
RU	641	1.7	226	0.8
TW	572	2.1	5 177	15.7
US	48 786	5.0	77 585	7.3

Looking at the 1993, 1998 and 2003 data, almost all European countries significantly increased national patenting per million inhabitants. The only exception is Sweden, where the number of patent applications per million inhabitants rose strongly from 165 in 1993 to 296 in 1998, but then slipped back slightly to 285 in 2003. Compared with 1998, Sweden lost first place at EU level in 2003. Amongst the EU-27 countries, Germany ranked first in 2003 with 312 patent applications to the EPO per million inhabitants, followed by Finland with 306 and Sweden with 285. The number was even higher in Switzerland with 426 patent applications to the EPO per million inhabitants (see Figure 6.4). Most of the new EU Member States remain at a rather low level of national patenting measured in terms of EPO patent applications per million inhabitants. Slovenia was an exception to the rule with 50 patent applications per million inhabitants in 2003.

Figure 6.4 **Patent applications to the EPO per million inhabitants, EU-27 and selected countries (with at least 10 patent applications per million inhabitants in 2003) — 1993, 1998 and 2003**

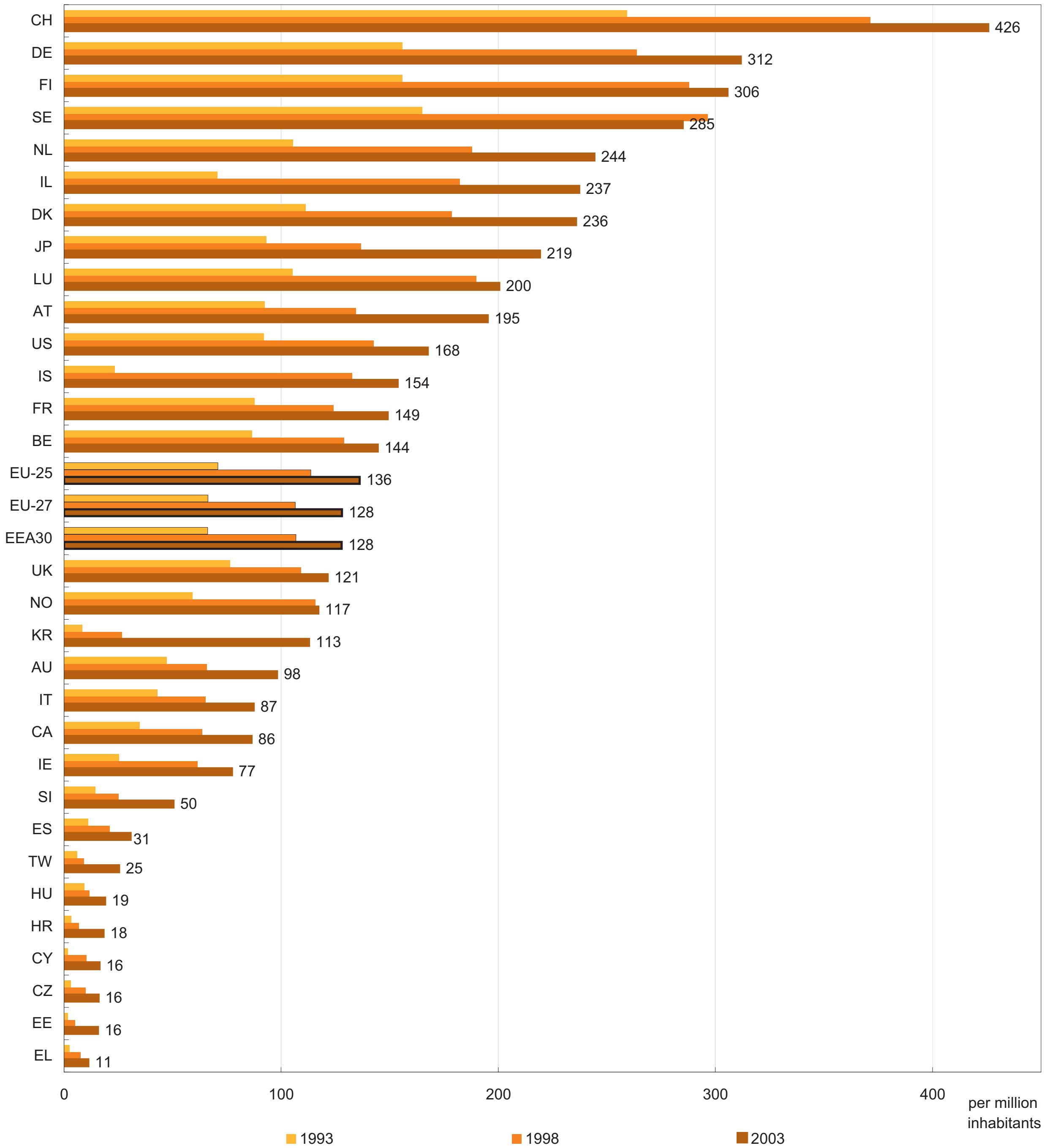


Table 6.5 Breakdown of patent applications to the EPO by IPC section, total number and as a percentage of total, EU-27 and selected countries — 2003

	Total	IPC section: Human necessities	Performing operations; transporting	Chemistry; metallurgy	Textiles; paper	Fixed constructions	Mechanical engineering; lighting; heating; weapons; blasting	Physics	Electricity
EU-27	62 250	15.6	20.9	13.4	1.9	4.5	10.7	17.0	16.1
EU-25	62 191	15.6	20.9	13.4	1.9	4.5	10.7	17.0	16.1
BE	1 496	16.9	17.8	27.2	2.8	5.3	6.4	12.3	11.4
BG	34	20.7	11.8	11.8	:	8.9	8.9	20.8	17.0
CZ	163	18.3	18.2	23.4	8.2	8.9	7.5	8.3	7.2
DK	1 270	26.8	13.5	18.0	0.6	6.5	8.5	11.2	14.9
DE	25 728	12.2	23.7	13.0	2.1	4.0	13.6	16.3	15.1
EE	21	20.6	:	30.0	:	:	4.7	27.5	17.1
IE	306	29.0	14.6	8.1	:	2.6	2.4	23.1	20.2
EL	123	21.4	16.7	8.4	0.8	6.9	12.6	18.0	15.2
ES	1 274	23.8	25.0	13.7	1.8	7.3	8.5	10.6	9.3
FR	9 202	17.0	19.0	13.2	1.2	3.9	10.2	16.8	18.7
IT	5 002	20.2	27.7	10.3	3.4	5.5	12.4	9.6	10.7
CY	12	19.2	28.5	8.5	:	8.5	17.1	4.3	13.8
LV	14	43.8	16.1	40.1	:	:	:	:	:
LT	20	5.0	5.0	18.3	:	:	5.0	65.6	1.2
LU	90	1.7	35.9	14.6	1.4	6.5	21.4	10.5	8.1
HU	192	28.6	14.3	20.7	0.5	3.7	7.0	10.4	14.9
MT	4	:	28.6	:	14.3	:	:	57.1	:
NL	3 956	13.0	13.9	12.4	1.1	4.3	4.2	32.1	19.0
AT	1 581	15.8	22.4	12.8	3.2	7.7	11.3	12.0	14.8
PL	160	18.1	18.9	14.6	1.2	7.8	13.2	13.0	13.1
PT	78	13.0	25.6	17.4	3.7	5.1	13.0	14.1	8.1
RO	26	21.5	4.4	7.8	:	19.6	9.1	14.7	22.8
SI	101	21.6	14.9	19.0	:	8.9	8.4	9.6	14.7
SK	44	22.2	11.6	18.4	1.5	9.1	12.6	11.9	12.6
FI	1 591	7.9	15.2	9.4	5.7	2.5	3.7	18.5	37.1
SE	2 547	17.0	20.4	9.3	1.9	4.3	10.1	14.7	22.4
UK	7 217	20.1	15.1	15.9	0.9	4.8	7.0	21.3	14.9
IS	44	25.2	4.5	20.8	:	2.3	5.6	34.0	7.5
LI	25	21.5	15.3	16.3	:	8.1	26.5	8.3	4.1
NO	533	21.4	16.5	9.8	0.2	11.0	10.2	16.5	14.5
EEA30	62 852	15.6	20.8	13.3	1.9	4.5	10.7	17.0	16.1
CH	3 113	21.2	20.8	13.9	3.0	4.3	7.1	18.5	11.1
HR	81	35.3	12.8	19.4	:	11.1	7.4	8.2	5.7
TR	133	20.6	8.2	8.8	11.3	3.8	25.6	11.3	10.4
AU	1 958	24.0	17.5	14.3	0.6	8.1	7.4	18.9	9.2
CA	2 736	17.1	13.7	16.3	0.7	4.1	7.2	18.2	22.8
CN	1 898	19.0	10.5	13.3	1.0	3.2	5.4	15.6	31.9
IL	1 587	31.5	8.8	11.4	0.3	1.9	3.1	24.7	18.5
IN	1 003	24.7	5.8	48.6	0.7	0.6	1.7	11.7	6.2
JP	27 987	9.3	14.9	16.9	1.1	0.7	7.8	24.0	25.3
KR	5 400	13.0	8.1	9.3	2.8	2.0	7.7	22.7	34.4
RU	641	19.3	17.3	18.3	0.5	3.7	9.8	16.1	15.0
TW	572	20.1	22.1	7.6	2.1	4.0	6.9	18.9	18.3
US	48 786	22.9	12.4	16.1	0.8	2.0	4.8	22.8	18.1

Patents are classified in accordance with the International Patent Classification (IPC). The IPC is based on a multilateral treaty administered by the World Intellectual Property Organisation (WIPO), i.e. the Strasbourg Agreement concerning the International Patent Classification. In the IPC, each invention is assigned to an IPC class, depending on its function, intrinsic nature or field of application. The IPC is therefore a combined function/application classification system in which function takes precedence. A patent may cover several technical aspects and therefore be assigned to several IPC classes. If a patent spans several technological fields, it is assigned to the first IPC code indicated on the patent. The IPC is divided into sections, classes, sub-classes, groups and sub-groups. The eighth edition of the IPC, which entered into force on 1 January 2006, divides technology into eight sections with approximately 70 000 sub-divisions. In this publication, only the eight IPC sections are shown. Further details on the various sections' contents are available in the methodological notes.

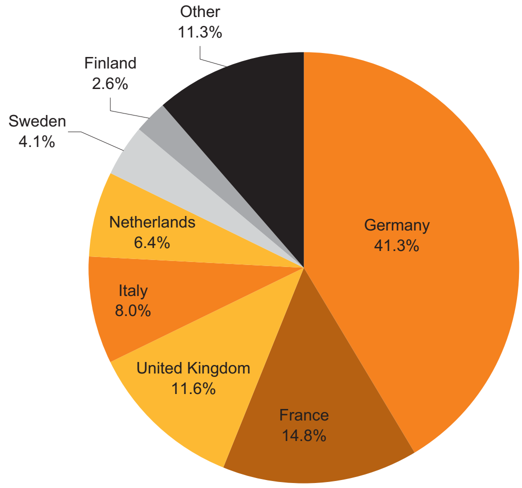
Table 6.5 shows patent applications by IPC section. The following analysis only takes into account countries with more than 100 patent applications to the EPO. In many countries one IPC section accounted for more than 25% of all national applications. Israel, Ireland, Hungary and Denmark specialised in patenting linked to IPC section A - Human necessities. Section B - Performing operations; transporting - was the most important IPC section for Italy, Spain, Germany, Austria and Taiwan. Nearly one out of two Indian patent applications dealt with an invention in IPC section C - Chemistry; metallurgy. Belgium and the Czech Republic lodged more than 20% of their national patent applications in this IPC section. In contrast, patenting is less frequent in IPC sections D - Textiles; paper, E - Fixed constructions, and F - Mechanical engineering; lighting; heating; weapons; blasting.

At EU-27 level, Germany always had the highest absolute number of patent applications in all IPC sections, followed by France and the United Kingdom. In four IPC sections, Germany surpassed even the United States.

Section D - Textiles; paper - was an exception, with Italy taking a higher profile and having the second highest score of all European countries in this IPC section. For the Netherlands, IPC section G - Physics - was the most significant. Finland lodged the highest national share of all patent applications to the EPO in IPC section H - Electricity. Electricity was also the most important IPC section for the three Asian countries: South Korea, China and Japan.

6

Figure 6.6 **Member States' patent applications to the EPO, as a percentage of total EU-27 applications — 2003**



Patenting in the European Union is highly concentrated in just a few Member States. In 2003 Germany was undeniably the Member State generating the largest number of patent applications (see also Table 6.3). More than 40% of all patent applications by the EU-27 came from a German inventor. France followed in second place, with about 15%, and the United Kingdom ranked third, with 12% (see Figure 6.6). These three countries accounted for two thirds of all patent applications to the EPO from the EU-27. The EU-27 aggregate is highly influenced by the German figures.

Patent applications to the EPO can also be broken down by economic activity, using the NACE classification. This breakdown is based on the concordance tables between the IPC and the NACE created by the Fraunhofer Institute for Systems and Innovation Research in Karlsruhe (Germany). As one criterion for patents is usability for industrial application, all NACE codes to which patent applications are allocated are exclusively those of manufacturing industries.

In 2003, the two main manufacturing activities concerned by patenting were DL - Manufacture of electrical and optical equipment, followed by DG - Manufacture of chemicals, chemical products and man-made fibres. Two other sections (DM - Manufacture of transport equipment, and DK - Manufacture of machinery and equipment n.e.c.) took nearly the same shares of patent output, with around 10%. Patenting activity in all the other branches of manufacturing was less significant (see Table 6.7).

Table 6.7 Breakdown of patent applications to the EPO by economic activity (NACE), total number and as a percentage of total, EU-27 and selected countries — 2003

	Total	Food products; beverages and tobacco	Textiles and textile products	Leather and leather products	Wood and wood products	Pulp, paper and paper products; publishing and printing	Coke, refined petroleum products and nuclear fuel	Chemicals, chemical products and man-made fibres	Rubber and plastic products	Other non-metallic mineral products	Basic metals and fabricated metal products	Machinery and equipment n.e.c.	Electrical and optical equipment	Transport equipment	Not elsewhere classified
EU-27	**62 250**	**2.4**	**0.5**	**0.2**	**0.1**	**1.2**	**1.5**	**22.0**	**2.2**	**1.7**	**5.1**	**12.5**	**34.9**	**13.6**	**1.8**
EU-25	**62 191**	**2.4**	**0.5**	**0.2**	**0.1**	**1.2**	**1.5**	**22.0**	**2.2**	**1.7**	**5.1**	**12.5**	**34.9**	**13.6**	**1.8**
BE	1 496	4.4	0.5	0.1	0.2	1.5	2.2	33.1	2.7	2.5	4.8	10.2	27.4	8.8	1.4
BG	34	5.9	0.4	0.1	0.1	1.2	0.9	24.2	3.2	1.9	6.0	9.1	35.6	9.4	2.1
CZ	163	2.5	0.5	0.3	0.2	1.3	2.4	30.5	2.0	2.3	6.8	16.1	21.6	10.1	2.8
DK	1 270	4.9	0.5	0.1	0.1	1.3	1.2	32.9	1.9	1.9	4.5	10.0	31.0	8.5	1.2
DE	25 728	1.9	0.5	0.2	0.1	1.2	1.5	20.3	2.2	1.8	5.5	13.5	32.9	16.7	1.5
EE	21	1.3	0.3	0.1	0.0	0.7	3.9	24.6	0.9	1.2	4.5	6.5	46.6	6.5	2.9
IE	306	2.2	0.5	0.1	0.1	1.4	1.2	22.3	1.8	1.4	3.1	8.1	47.4	7.2	2.2
EL	123	3.9	0.4	0.1	0.1	1.1	1.0	23.3	2.5	2.2	5.6	12.4	35.1	9.4	2.5
ES	1 274	3.6	0.7	0.2	0.4	1.5	1.2	25.4	2.9	2.1	5.7	13.5	26.3	12.9	3.4
FR	9 202	2.2	0.5	0.2	0.1	1.1	1.4	22.6	2.3	1.6	4.7	10.8	36.5	13.8	1.8
IT	5 002	2.8	0.6	0.3	0.2	1.5	1.6	21.4	3.0	1.9	6.3	16.1	27.4	13.5	3.0
CY	12	1.5	0.4	0.3	0.1	1.0	0.7	15.0	3.4	3.0	4.9	12.0	25.8	26.4	5.4
LV	14	7.2	0.5	0.4	0.1	1.1	2.0	33.3	1.3	3.0	5.7	13.8	11.1	7.7	12.8
LT	20	4.3	0.1	0.0	0.0	0.5	1.2	18.5	0.7	0.9	1.6	5.1	58.8	7.8	0.4
LU	90	2.3	0.5	0.2	0.1	1.5	1.3	14.8	6.2	3.0	8.9	16.3	22.9	21.2	0.8
HU	192	2.8	0.6	0.1	0.1	1.4	1.8	35.6	1.9	1.0	4.0	8.9	30.3	9.5	2.0
MT	4	0.6	0.3	0.0	0.0	1.4	0.6	11.1	1.4	3.1	5.4	10.6	43.1	21.4	0.6
NL	3 956	3.3	0.4	0.1	0.1	1.2	1.5	19.8	1.6	1.7	3.6	10.2	47.6	7.3	1.3
AT	1 581	1.7	0.6	0.3	0.2	1.4	1.4	19.0	2.5	2.5	7.1	14.4	32.0	13.0	3.8
PL	160	5.4	0.5	0.1	0.1	1.7	2.1	22.7	2.2	2.5	5.8	13.6	29.5	10.8	2.9
PT	78	2.7	0.8	0.2	0.1	1.5	1.1	28.2	2.1	1.9	6.7	10.4	27.2	15.8	1.4
RO	26	1.5	0.4	0.2	0.0	0.9	1.5	23.2	1.4	2.4	6.0	15.6	33.0	10.8	2.8
SI	101	2.3	0.4	0.3	0.3	2.3	1.1	32.1	2.1	1.4	5.2	10.2	29.2	10.7	2.3
SK	44	4.2	0.5	0.2	0.1	1.2	1.6	26.8	2.3	3.0	5.8	10.3	28.9	12.2	3.0
FI	1 591	1.5	0.4	0.1	0.1	1.5	1.1	15.0	1.3	1.4	3.9	10.9	52.9	8.1	1.1
SE	2 547	1.8	0.4	0.2	0.1	1.3	1.0	18.6	1.7	1.6	5.1	12.0	40.3	13.6	2.0
UK	7 217	2.7	0.4	0.2	0.1	1.2	1.7	26.5	2.0	1.5	4.2	10.4	36.9	9.7	2.1
IS	44	3.8	0.4	0.5	0.0	1.2	0.8	30.4	1.6	0.9	2.4	12.3	36.5	4.9	1.9
LI	25	1.1	0.5	0.2	0.1	1.3	1.1	17.5	2.4	4.3	9.0	15.9	28.1	17.5	0.8
NO	533	3.4	0.4	0.2	0.2	1.0	2.6	21.7	1.7	1.4	4.9	15.9	31.9	11.3	3.2
EEA30	**62 852**	**2.4**	**0.5**	**0.2**	**0.1**	**1.2**	**1.5**	**22.0**	**2.2**	**1.7**	**5.1**	**12.5**	**34.9**	**13.6**	**1.8**
CH	3 113	3.0	0.6	0.1	0.2	1.6	1.4	25.5	2.1	1.9	5.2	13.0	33.8	9.3	2.0
HR	81	4.3	0.7	0.1	0.1	1.8	0.9	39.5	2.1	1.4	4.6	7.6	24.7	11.5	0.8
TR	133	3.1	0.4	0.2	0.1	0.8	0.9	21.1	1.8	1.8	5.2	20.0	30.0	11.7	2.9
AU	1 958	2.9	0.6	0.2	0.2	1.6	1.4	25.1	2.2	2.2	5.7	12.1	32.9	9.4	3.0
CA	2 736	2.3	0.4	0.1	0.1	1.1	1.3	25.0	1.7	1.5	3.9	9.6	40.8	9.6	1.9
CN	1 898	2.4	0.4	0.2	0.1	1.0	1.1	22.2	1.2	1.2	3.5	8.7	47.2	7.9	2.5
IL	1 587	2.5	0.5	0.1	0.1	1.4	0.8	27.9	1.0	1.1	3.0	6.6	47.4	6.0	1.3
IN	1 003	6.1	0.3	0.0	0.1	0.9	2.1	59.9	1.1	1.0	2.0	3.9	18.7	3.3	0.3
JP	27 987	1.7	0.4	0.1	0.1	1.0	1.4	20.4	1.5	1.7	4.0	9.3	46.0	11.0	1.1
KR	5 400	1.7	0.4	0.2	0.1	0.7	0.9	15.2	1.2	1.4	3.2	10.1	54.8	7.8	2.1
RU	641	2.5	0.5	0.2	0.1	1.2	2.6	26.5	1.6	1.9	5.1	11.6	32.8	10.8	2.5
TW	572	1.8	0.7	0.4	0.1	1.4	1.0	16.4	1.8	1.6	6.7	10.8	39.7	12.9	4.7
US	48 786	2.5	0.4	0.1	0.1	1.2	1.5	27.7	1.4	1.5	3.3	8.1	42.5	7.5	1.6

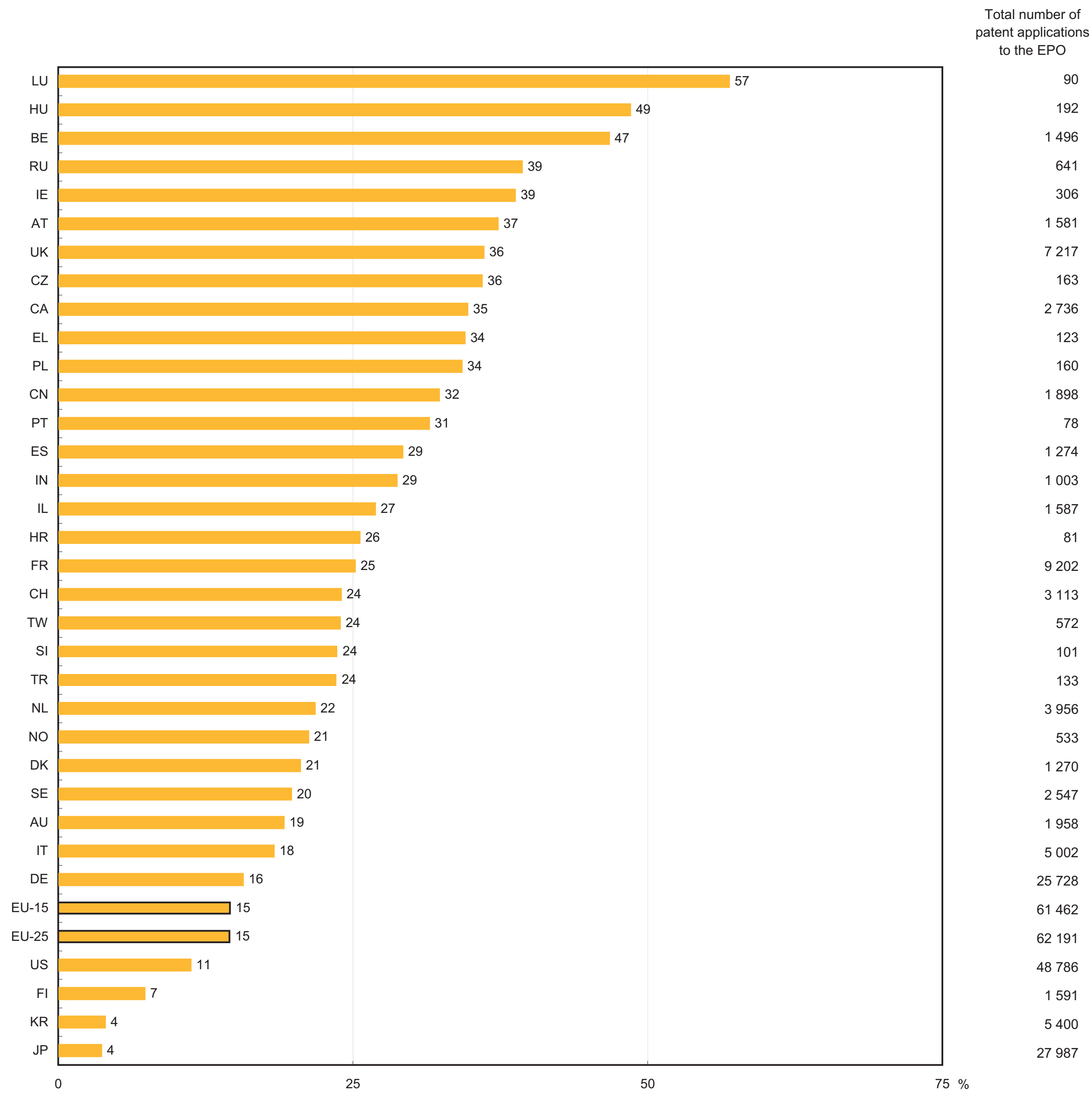
Foreign ownership

Foreign ownership of domestic inventions in patent applications is one of three indicators of international cooperation in patenting. The two others are domestic ownership of foreign inventions in patent applications and patent applications with foreign co-inventors. These indicators simply count each patent application from both the inventor country or countries and the applicant country or countries.

The total number of patent applications from each country therefore consists of all applications in which the country is involved, whether as an applicant or as an inventor. Therefore, the total number of cases of international cooperation is not equal to the sum of the number of cases per partner country since several partner countries can be involved in any case of cooperation. Also, these patent indicators should not be compared with previous ones, where fractional counting rather than simple counting was applied. Furthermore, these indicators should not be added across countries, as this would mean counting the same patent more than once. Data on foreign ownership measure the number of patents invented within (or applied for by) a given country that involve at least one foreign applicant (or a foreign inventor).

Figure 6.8 shows foreign ownership of domestic inventions in patent applications to the EPO, as a percentage of all applications to the EPO from countries that submitted more than 50 patent applications in 2003. Luxembourg had the highest rate by far with 57%, followed by Hungary with 49% and Belgium with 47%. The Russian Federation with 39% and Canada with 35% were the non-European countries with the highest rates of foreign ownership of domestic inventions in patent applications to the EPO. The lowest rate at EU level was recorded in Finland, with only 7%. The United States, South Korea and Japan were also situated at this end of the scale with respectively 11%, 4% and 4%.

Figure 6.8 Foreign ownership of domestic inventions in patent applications to the EPO, as a percentage of all national applications, selected countries (with at least 50 patent applications to the EPO in 2003) — 2003



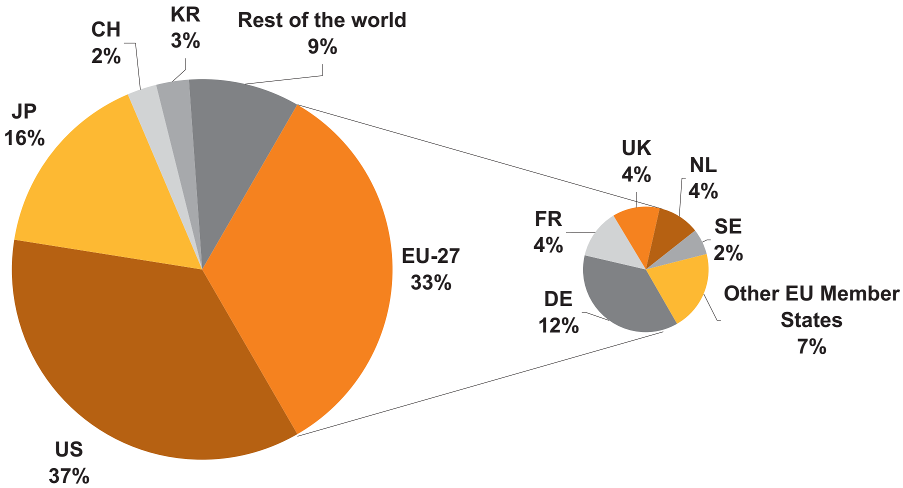
The Patent Cooperation Treaty (PCT) was signed in Washington on 19 June 1970 and came into force on 1 June 1978. The PCT allows for the filing of an international application to have the same effect as a national application in each of the contracting states (March 2007: 137) designated in the application.

In the cases in which the EPO is designated, the patent is known as a Euro-PCT patent. The PCT system is superimposed on the national and European systems, but patents are always granted nationally.

All PCT applications are centralised through the World Intellectual Property Organisation (WIPO). In March 2007, 184 States were members of the WIPO.

For a patent application filed via the Euro-PCT route, two phases are identified: the international phase and the national or regional (European) phase. During the international phase, a search is carried out and, eighteen months after the priority date (the date of the first application at any patent office), the application is published. When the international search report is finalised, the applicant has to choose between three alternatives: transferring the application to a national or regional patent office among those designated in the application (in which case it will enter the national or regional phase); electing an international preliminary examination; or withdrawing the application. If the application enters the regional or national phase, formal search and substantive examination are undertaken, ending with the application being either granted, refused, or withdrawn by the applicant.

Figure 6.9 Breakdown of PCT applications designating the EPO by main countries — 2003



6

Extracts from the summary of the PATSTAT database review workshop
Organised by the OECD Patent Statistics Taskforce Geneva – 21 May 2007

On 21 May 2007, the OECD (Organisation for Economic Cooperation and Development) Patent Statistics Taskforce arranged for a workshop to review the status of the EPO Worldwide Patent Statistical Database (PATSTAT). The production and distribution of this database is a contribution by the European Patent Office (EPO) to the Taskforce.

The workshop was hosted by the World Intellectual Property Organisation (WIPO) Patent Cooperation Treaty (PCT) section at their headquarters in Geneva, Switzerland. The workshop was attended by 40 participants, from 22 organisations, drawn from national patent offices, government statistical and research organisations and academic research institutes in mainly Europe and America.

The database is provided with a suggested standard data model, such that all users can then exchange their methods and research algorithms between themselves. Clearly with the increase in computing power, most researchers are now in a position to set up their own databases in their organisations. Previously this advantage was restricted to organisations with large computing departments and budgets. Several small organisations have successfully set up PATSTAT and completed analysis work with it. A clear message from the attendees was the motivation of PATSTAT users to increase their reliance on PATSTAT and to encourage the database provider to add more data.

The feedback concerned five main issues:
- (a) Data quality
- (b) Format and delivery of data
- (c) Extensions to the data model
- (d) Derived data
- (e) Meta-data and documentation.

The European Patent Office explained that a wide range of data products is available from the Patent Information section at the EPO. Further details and the product price list are available from patentdata@epo.org

6.4 High-tech patent applications

The IPC makes it possible to aggregate patents allocated to certain IPC classes into technological fields. One of these fields is “high technology”.

Most of the high-tech patent applications to the EPO came from Germany (3 635) in 2003, followed by France (1 980) and the United Kingdom (1 526). In terms of high-tech patent applications per million inhabitants, Finland led by a wide margin, with 126 applications. Sweden ranked second with 63 and the Netherlands third with 56. Countries with fewer than 100 high-tech patent applications are not taken into consideration in the analysis set out below. 17.4% of all patent applications by the EU-27 concerned high technology. The leaders were Finland (41.1%) and the Netherlands (23.0%).

The annual average growth rates were always higher for high-tech patent applications than they were for total patent applications. This is true for both observation periods (1993 to 1998 and 1998 to 2003) and also for most of the EU countries. Some countries performed better than others, however, and surpassed the EU-27 average. In Finland (29.9%) and in Sweden (35.6%), the growth rates of high-tech patent applications were particularly high in the first period. In the second observation period, Spain (11.9%) and Austria (20.0%) caught up. In contrast, Sweden was the only Member State with a negative growth rate (-1.2%) in the second observation period.

Looking at the annual average growth rates of total patent applications to the EPO, Spain (14.0%), the Netherlands (12.9%), Finland (13.5%) and Sweden (12.8%) recorded significantly higher rates than the EU-27 average (10.2%) between 1993 and 1998. In the second period (1998 to 2003) only Spain (9.0%) and Austria (8.1%) performed well above the EU-27 average (4.0%), which also slipped back considerably.

Figure 6.11 shows the high-tech patent applications to the EPO per million inhabitants in 1993, 1998 and 2003, and confirms the upward trends mentioned previously for all countries except Sweden in 2003.

In 1993 the three best performers at EU level in terms of high-tech patent applications per million inhabitants were Finland (30), the Netherlands (19) and Sweden (15). Five years later Finland (110) was still in the lead, but Sweden (67) ranked second and the Netherlands (48) third.

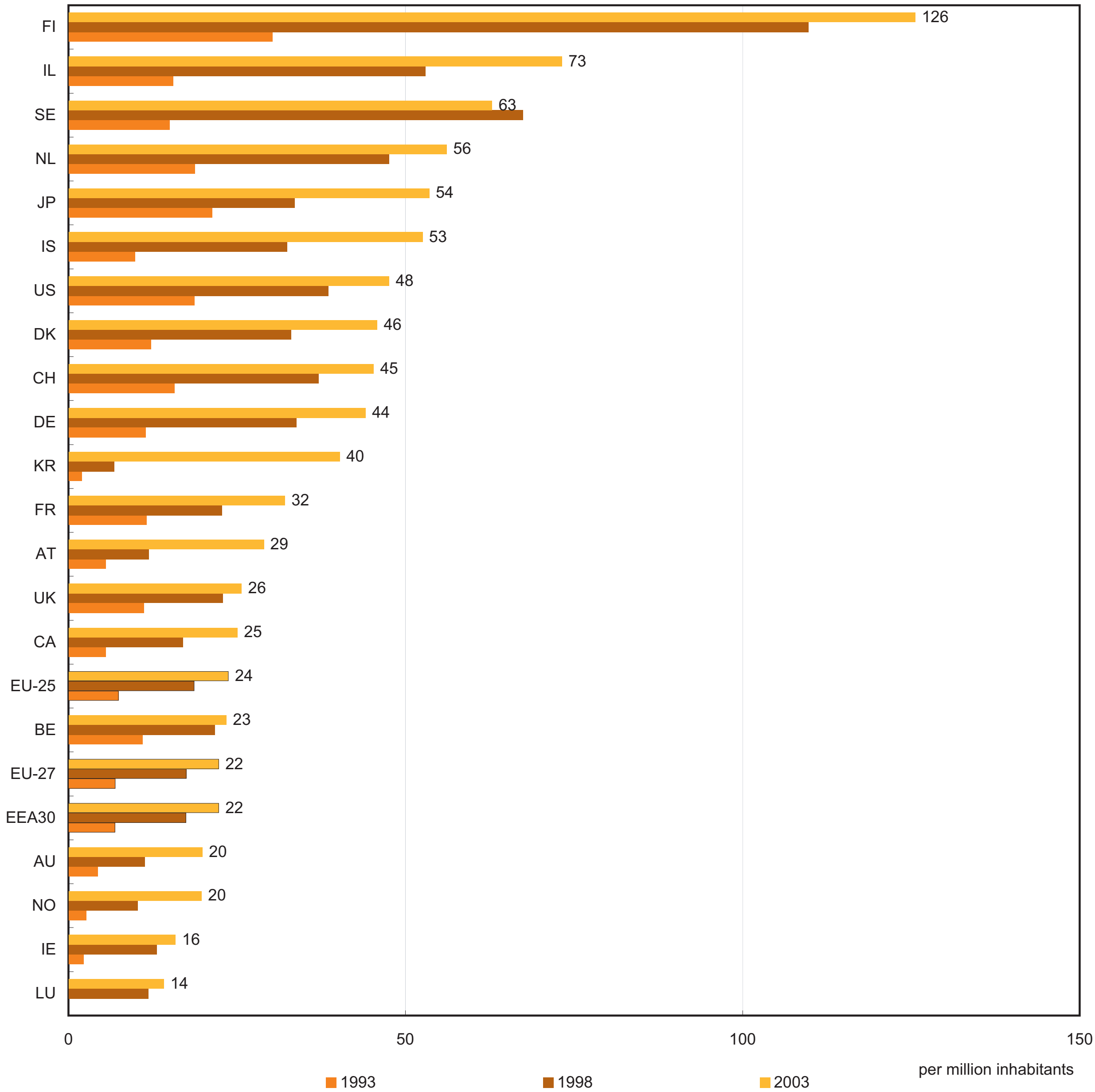
In 2003 the ranking of the three best-performing EU countries was still the same: Finland (126), Sweden (63) and the Netherlands (56), but Sweden had lost some ground.

When taking into account the non-EU countries, Israel ranked second in 2003 with 73 high-tech patent applications per million inhabitants. Japan and the United States had 54 and 48 high-tech patent applications per million inhabitants respectively, outperforming the EU-27 average of 22.

Table 6.10 High-tech patent applications to the EPO and annual average growth rates, EU-27 and selected countries — 1993 to 2003

	High-tech patent applications in 2003			Annual average growth rates in %			
				High-tech patents		All patents	
	Total	Per million inhabitants	As % of all patents	1993-98	1998-2003	1993-98	1998-2003
EU-27	**10 840**	**22**	**17.4**	**20.6**	**5.3**	**10.2**	**4.0**
EU-25	**10 834**	**24**	**17.4**	**20.6**	**5.2**	**10.2**	**4.0**
BE	242	23	16.2	14.9	1.8	8.6	2.6
BG	3	0	9.6	1.7	15.2	7.0	7.4
CZ	10	1	6.2	61.6	-1.8	26.1	10.0
DK	246	46	19.4	22.5	7.1	10.4	6.1
DE	3 635	44	14.1	24.5	5.6	11.4	3.5
EE	8	6	37.6	24.4	31.7	20.9	25.0
IE	63	16	20.5	43.0	5.4	20.3	6.2
EL	21	2	16.8	25.3	32.0	25.6	9.1
ES	165	4	12.9	25.5	11.9	14.0	9.0
FR	1 980	32	21.5	14.9	7.8	7.6	4.4
IT	481	8	9.6	10.4	8.1	8.8	6.2
CY	4	5	30.9	:	:	46.9	11.4
LV	1	0	7.3	:	4.6	59.0	6.1
LT	2	1	9.6	:	:	7.3	69.9
LU	6	14	7.0	:	4.8	14.1	2.3
HU	34	3	17.8	19.2	14.6	4.9	9.8
MT	:	:	:	:	:	38.0	-6.9
NL	908	56	23.0	21.1	4.1	12.9	6.1
AT	235	29	14.8	16.9	20.0	8.1	8.1
PL	23	1	14.2	32.2	27.5	11.9	21.5
PT	15	1	18.7	-6.0	44.3	5.6	19.6
RO	3	0	10.1	:	14.2	24.0	-0.2
SI	9	4	8.6	14.1	15.6	11.7	15.1
SK	5	1	11.4	:	11.4	33.7	13.3
FI	654	126	41.1	29.9	3.0	13.5	1.4
SE	562	63	22.0	35.6	-1.2	12.8	-0.6
UK	1 526	26	21.1	15.7	2.7	7.7	2.5
IS	15	53	34.2	27.9	11.4	42.8	4.2
LI	2	59	8.1	-12.9	14.9	18.4	-10.4
NO	90	20	16.8	32.2	14.6	15.0	0.9
EEA30	**10 947**	**22**	**17.4**	**20.6**	**5.3**	**10.3**	**4.0**
CH	331	45	10.6	19.3	4.7	8.0	3.4
HR	4	1	4.4	14.9	12.3	14.3	21.2
TR	13	0	9.9	88.8	17.0	66.1	20.3
AU	396	20	20.2	22.4	13.3	8.2	9.6
CA	793	25	29.0	26.6	9.0	14.2	7.2
CN	703	1	37.0	54.0	57.1	32.7	40.4
IL	490	73	30.9	31.1	9.2	24.0	7.8
IN	164	:	16.4	38.0	47.2	39.8	45.8
JP	6 834	54	24.4	9.7	10.1	8.2	10.2
KR	1 924	40	35.6	28.5	43.8	27.4	34.5
RU	108	1	16.8	24.8	7.4	12.8	3.7
TW	119	5	20.8	24.2	24.2	9.4	23.6
US	13 845	48	28.4	16.7	6.0	10.2	4.9

Figure 6.11 High-tech patent applications to the EPO per million inhabitants, selected countries (with at least 10 high-tech patent applications per million inhabitants in 2003) — 1993, 1998 and 2003



The aggregate "high-tech patent applications" can be broken down into six groups:

- AVI Aviation;
- CAB Computer and automated business equipment;
- CTE Communication technology;
- LSR Lasers;
- MGE Micro-organism and genetic engineering;
- SMC Semi-conductors.

Taking into account only countries with 100 or more high-tech patent applications to the EPO, in every EU Member State, 35% or more of the high-tech patent applications were concentrated in the "Communication technology" group. Finland was the most specialised in this area as 70.9% of its high-tech patent applications were linked to this group. Only 36.5% of Belgian high-tech patent applications were made in the area of "Communication technology", but Belgium was very active in two other groups - "Micro-organism and genetic engineering" (25.5%) and "Computer and automated business equipment" (24.4%). With a share of 26.1% in the latter, Spain also stood above the EU-27 average in the group "Micro-organism and genetic engineering" (12.4%). In "Aviation", France scored 3.9%, whereas the EU-27 average was only 2.4%. Austria was more dynamic than the other countries in patenting activities related to "Lasers". Belgium and Austria displayed shares that were above the EU-27 average of 8.7% in the "Semi-conductors" group, with 12.3% and 12.4% respectively.

Nearly one in two of the high-tech patent applications made by Australia, China and Taiwan can be classified in the high-tech group "Computer and automated business equipment". More than 60% of Japanese and Korean high-tech patent applications were involved with "Communication technology".

Table 6.12 Breakdown of high-tech patent applications to the EPO by high-tech group, total number and as a percentage of total, EU-27 and selected countries — 2003

	Total	High-tech group as a percentage of total					
		Aviation	Computer and automated business equipment	Communication technology	Lasers	Micro-organism and genetic engineering	Semi-conductors
EU-27	**10 840**	**2.4**	**29.9**	**45.5**	**1.1**	**12.4**	**8.7**
EU-25	**10 834**	**2.4**	**29.9**	**45.5**	**1.1**	**12.4**	**8.7**
BE	242	1.2	24.4	36.5	0.0	25.5	12.3
BG	3	0.0	46.2	0.0	7.7	30.8	15.4
CZ	10	19.9	10.0	11.6	0.0	58.5	0.0
DK	246	1.6	16.3	41.6	1.5	36.4	2.6
DE	3 635	3.0	30.1	41.0	1.3	12.7	11.9
EE	8	0.0	37.8	25.2	0.0	16.8	20.2
IE	63	0.0	42.9	32.9	3.7	2.8	17.7
EL	21	2.4	30.3	56.3	0.0	9.3	1.6
ES	165	1.8	29.2	39.5	1.5	26.1	1.9
FR	1 980	3.9	29.3	47.9	1.0	10.0	7.8
IT	481	2.2	31.1	42.3	1.8	11.7	11.0
CY	4	27.6	0.0	44.8	0.0	27.6	0.0
LV	1	100.0	0.0	0.0	0.0	0.0	0.0
LT	2	52.1	0.0	0.0	0.0	34.9	13.0
LU	6	0.0	68.4	31.6	0.0	0.0	0.0
HU	34	2.9	19.1	65.2	0.0	12.7	0.0
MT	:	:	:	:	:	:	:
NL	908	0.5	36.5	40.4	0.3	10.4	11.9
AT	235	0.9	24.5	47.9	2.5	11.8	12.4
PL	23	8.8	32.2	30.7	0.0	19.7	8.6
PT	15	0.0	20.6	24.0	6.9	41.6	6.9
RO	3	0.0	48.4	41.9	0.0	0.0	9.7
SI	9	0.0	7.7	69.2	0.0	11.5	11.5
SK	5	0.0	30.0	70.0	0.0	0.0	0.0
FI	654	0.6	23.2	70.9	0.2	3.7	1.4
SE	562	0.7	20.7	67.6	0.5	8.4	2.0
UK	1 526	1.8	36.0	41.0	1.3	14.2	5.8
IS	15	0.0	27.5	22.0	0.0	50.5	0.0
LI	2	0.0	0.0	0.0	0.0	50.0	50.0
NO	90	1.1	27.2	56.1	0.0	14.5	1.1
EEA30	**10 947**	**2.4**	**29.9**	**45.5**	**1.1**	**12.5**	**8.6**
CH	331	2.0	31.4	38.8	2.8	18.1	6.9
HR	4	0.0	55.9	37.2	0.0	7.0	0.0
TR	13	0.0	34.8	40.5	0.0	17.1	7.6
AU	396	0.3	47.8	21.8	0.9	25.1	4.2
CA	793	1.3	29.0	49.9	1.0	15.8	3.0
CN	703	0.7	18.7	64.0	0.0	12.7	3.9
IL	490	1.2	36.6	41.8	1.6	14.4	4.3
IN	164	0.0	51.2	21.1	0.6	24.5	2.7
JP	6 834	0.3	30.5	37.8	1.3	10.3	19.8
KR	1 924	0.1	20.5	62.5	0.8	5.3	10.8
RU	108	9.2	27.3	38.0	2.2	13.7	9.7
TW	119	0.0	48.1	21.4	0.0	9.6	21.0
US	13 845	1.1	39.6	32.3	1.1	14.9	11.0

The technological field of Information and Communication Technology (ICT) can be divided into four sub-categories:
- Consumer electronics;
- Computers, office machinery;
- Other ICT;
- Telecommunications.

In 2003 the three major economies led in terms of their total number of ICT patent applications to the EPO.

In the EU-27, patenting in the ICT group "Consumer electronics" played a minor role but the shares of patent applications in the three other groups were nearly equal, making up a share of around 30% each. This global picture hides discrepancies at national level, however. In the Netherlands, the second-largest ICT group for patenting was "Consumer electronics".

With respectively 58% and 53% of all their ICT patent applications being made in the ICT group "Telecommunications", Finland and Sweden specialised in this group. China specialised in the same group whereas close to half of all the ICT patent applications made by India, Australia and Taiwan concerned "Computers, office machinery".

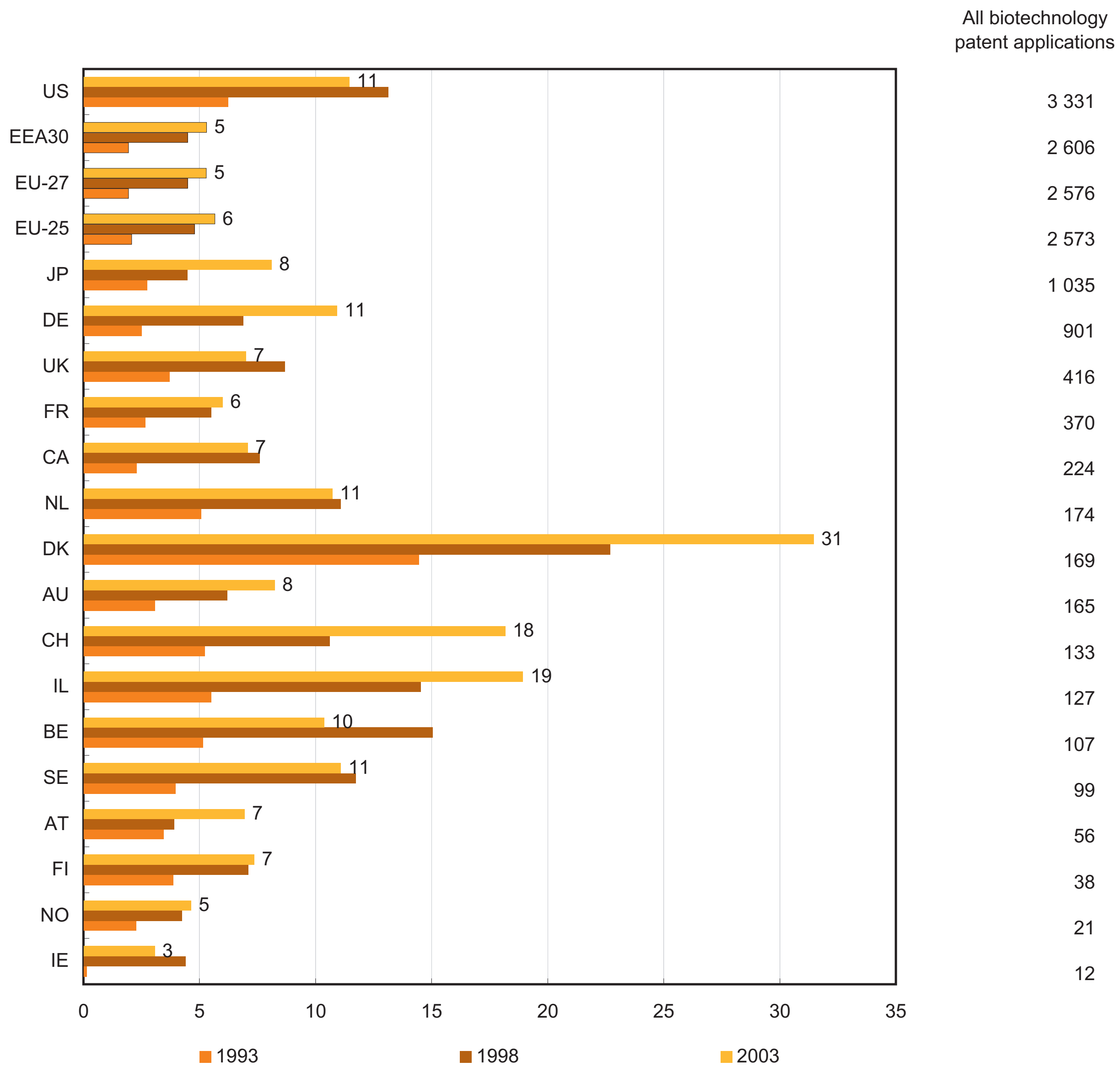
Figure 6.13 **Breakdown of ICT patent applications to the EPO by sub-category, as a percentage of total, EU-27 and selected countries (with at least 10 ICT patent applications in 2003) — 2003**

Another interesting field is biotechnology. Taking the absolute figures of biotechnology patent applications to the EPO in 2003, the United States led, followed by the EU and Japan.

The ratio per million inhabitants reveals a very different ranking. Denmark led by a wide margin, followed by Israel and Switzerland.

A closer look at the results for 1993, 1998 and 2003 reveals a heterogeneous picture. Whereas all countries display increasing ratios when 1993 and 1998 figures are compared, the comparison of 1998 with 2003 figures brings no common trend to light. In some countries the ratio increased, while in others, it stagnated.

Figure 6.14 Biotechnology patent applications to the EPO, total number and per million inhabitants, EU-27 and selected countries (with at least 10 biotechnology patent applications in 2003) — 1993, 1998 and 2003



PART3

Chapter 7 - High-tech industries and knowledge based services

7.1 Introduction

In the industrialised world, creating, exploiting and commercialising new technologies is absolutely essential if a country is to stay competitive vis-à-vis other countries. High-technology sectors are key drivers for economic growth, productivity and welfare, and are generally a source of high value added and well-paid employment.

Technology-intensive enterprises are often referred to as high-technology - or high-tech - companies. They are vital to the competitive position of nations because:

- They are associated with innovation and hence tend to gain a larger market share, create new product and service markets, and use resources more efficiently. Environmental aspects play a more and more important role in this context.

- They are linked to high value-added production and success in foreign markets, which helps to support higher returns to the workers they employ.

- The industrial R&D they perform has spill-over effects which benefit other commercial sectors by generating new products and processes, often leading to productivity gains, business expansion and the creation of high-wage jobs.

This chapter explores Europe's performance in high-technology industries and knowledge-intensive services by looking at the different facets in using statistics on enterprises (value added, production value, etc.), on venture capital investments, on high-tech trade, on employment and on R&D personnel and expenditure.

Firstly, Section 7.2 takes a closer look at structural statistics on enterprises by analysing the performance of high-tech industries and high-tech knowledge-intensive services sectors in 2003.

The next section presents a financial aspect with statistics on Venture Capital Investment (VCI) both at the early stage and at the expansion and replacement stage.

Section 7.4 describes the pattern of international high-tech trade, which makes up a considerable proportion of total trade in many advanced economies.

The employment situation in high-tech manufacturing and high-tech knowledge-intensive services sectors, both at national and at regional level, is analysed in Section 7.5. In this context regional data are analysed at NUTS 2 level.

The final section sheds light on R&D expenditure and personnel in the high-tech manufacturing sectors.

High technology: Multi-approaches and multi-sources

Two main approaches are used to identify technology-intensive industries and products. These are:

The sectoral approach classifies manufacturing industries and services according to their technological intensity (R&D expenditure/value added). This approach is based on NACE rev. 1.1 at 3-digit level (due to data availability, in some cases, the classification can only be made on NACE rev. 1.1 at 2-digit level).

The product approach was devised to complement the sectoral approach. It opens the way to far more detailed analysis of trade and competitiveness. High-tech products are defined according to their high value of R&D intensity (R&D expenditure/total sales). This approach is based on SITC Rev 3.

For detailed definitions of high-tech products, high-tech manufacturing and high-tech knowledge-intensive service sectors (see Methodological Notes).

Data	*Source*	*Approach*
Enterprises in high-tech industries and knowledge-intensive services	Structural Business Statistics (SBS)	Sectoral approach (NACE at 3-digit level)
Trade in high-tech products	COMEXT/COMTRADE	Product approach
Employment in high-tech industries and in knowledge-intensive services	Labour Force Survey (LFS)	Sectoral approach (NACE at 2-digit level)
R&D in high technology	Research and development (R&D)	Sectoral approach (NACE at 2-digit level)

Source: Eurostat - NewCronos, metadata on high-tech industries and knowledge-intensive services, 2007

7.2 Enterprises in high-tech industries and knowledge-intensive services

High-tech sectors are defined according to their notable value of R&D intensity. High-tech manufacturing comprises, for example, manufacturers of pharmaceuticals and medicinal products, communication equipment and computers whereas high-tech knowledge-intensive services (KIS) cover activities relating to post and telecommunications, computer and related activities, as well as research and development. Table 7.1 uses different economic statistics to monitor the performance of these sectors (see also Methodological Notes).

In 2003, the EU-27 had approximately 138 000 high-tech manufacturers and 545 000 high-tech KIS.

High-tech manufacturers were most numerous in Italy (with over 33 000), followed by Germany (20 000), France (17 000) and Poland (15 000). These four countries together were responsible for more than 60% of European high-tech manufacturers.

However, as regards turnover in the high-tech manufacturing sector, the ranking was quite different. France led with a total turnover of EUR 147 billion, followed by Germany (EUR 143 billion) and the United Kingdom (EUR 92 billion). One of the main reasons for this is that, even though there were more enterprises in Italy, the whole high-tech manufacturing sector was smaller than in the other main European countries (in terms of number of persons employed, turnover, etc.).

The ranking was the same for the total production value generated by this sector. For France, this is mainly due to “aircraft and spacecraft” and to a lesser extent to enterprises that are active in the “pharmaceuticals, medicinal chemicals and botanical” sectors.

In terms of the value added generated by high-tech manufacturers, Germany was well ahead, at almost EUR 47 billion.

The United Kingdom registered the most enterprises in the high-tech KIS sector – 134 000 – making up almost one quarter of the EU-27 total. This was followed by Italy, with almost as many enterprises in KIS as Germany and France put together.

However, when it came to turnover, production value and value added, it is striking that the figures for the United Kingdom were practically twice those of Italy. As for high-tech manufacturers, this is due to the fact that the total number of persons employed was much lower in Italy.

The high-tech KIS sectors in Germany and France were also ahead of Italy both in terms of turnover, production value and value added and in terms of the number of persons employed.

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Table 7.1 Economic statistics on high-tech sectors, EU-27 — 2003

	High-tech manufacturing					High-tech knowledge-intensive services				
	Number of enterprises	Turnover in EUR million	Prod. value in EUR million	Value added in EUR million	Gross invest. in tangible goods in EUR million	Number of enterprises	Turnover in EUR million	Prod. value in EUR million	Value added in EUR million	Gross invest. in tangible goods in EUR million
EU-27	**137 748 s**	**:**	**:**	**:**	**:**	**545 031 s**	**777 255 s**	**719 622 s**	**388 618 s**	**:**
BE	1 887	15 020	15 554	6 279	:	13 982	22 814	22 440	11 167	2 172
BG	1 247	526	494	156	:	3 514	1 527	1 460	848	349
CZ	8 288	:	6 817	1 296	349	25 035	6 917	6 342	3 489	557
DK	1 085	9 261	9 240	4 007	394	7 802	14 285	14 170	6 931	1 000
DE	19 987	143 358	125 240	46 918	5 203	53 335	148 362	129 666	79 130	8 587
EE	250	:	:	:	:	872	683	656	325	58
IE	309	30 458	30 036	8 714	810	4 971	16 326	11 607	7 408	481
EL	:	:	:	:	:	:	:	:	:	:
ES	7 826	22 850	21 227	6 538	1 042	32 680	51 341	41 458	25 695	3 791
FR	16 635	147 185	135 542	35 757	3 947	52 920	114 626	111 805	57 194	6 023
IT	33 447	59 482	57 327	18 896	2 566	96 738	93 386	92 220	44 801	6 569
CY	85	90	89	37	6	231	538	525	429	97
LV	212	:	:	:	:	1 097	763	711	456	106
LT	363	379	384	125	49	1 348	972	897	403	99
LU	59	:	:	:	:	1 095	2 210	1 964	1 211	:
HU	5 685	13 887	12 940	2 715	663	24 932	7 374	5 027	2 896	648
MT	:	:	:	:	:	684	314	312	230	67
NL	3 055	:	:	:	:	22 890	40 094	38 658	20 912	:
AT	1 751	10 816	9 629	3 961	578	13 667	14 965	11 069	7 354	1 178
PL	15 398	7 789	7 095	2 498	378	:	:	:	:	:
PT	1 162	4 730	4 542	1 124	269	3 194	9 149	8 769	4 260	871
RO	1 610	922	830	327	130	9 598	3 278	3 054	1 691	591
SI	913	2 022	1 882	908	202	2 787	1 797	1 537	807	228
SK	442	1 166	1 113	229	64	1 385	1 867	1 690	916	267
FI	1 289	28 816	17 401	7 398	330	5 155	12 453	11 722	5 142	1 233
SE	3 359	24 535	25 471	6 518	947	31 184	28 244	26 119	11 710	1 794
UK	11 404	92 178	80 451	32 958	2 941	133 935	182 970	175 744	93 210	13 740

EU-27 excludes missing countries.
Exceptions to the reference year: 2002: LU, MT, PL and SE; High-tech manufacturing in LT; High-tech KIS in CY.
2001: High-tech manufacturing in CY.

Industry and research institutions – Working together towards a knowledge economy

The need to share knowledge between research institutions and industry has become increasingly evident in recent years. Historically, research institutions were perceived as a source of new ideas and industry offered a natural route to maximising the use of these ideas. However, the past decade has seen a significant change in the roles of both parties.

Many companies are developing open innovation approaches to R&D, combining in-house and external resources, and aiming to maximise economic value from their intellectual property, even when it is not directly linked to their core business. In particular, they have begun to treat public research as a strategic resource.

In parallel, it has become clear that research institutions need to play a more active role in their relationship with industry in order to maximise the use of their research results. This new role requires specialist staff to identify and manage knowledge resources with business potential, i.e. how best to take a new idea to market, ensure appropriate resources (funding, support services, etc.) to make it happen, and to obtain adequate buy-in by all stakeholders.

Source: European Commission, 2007

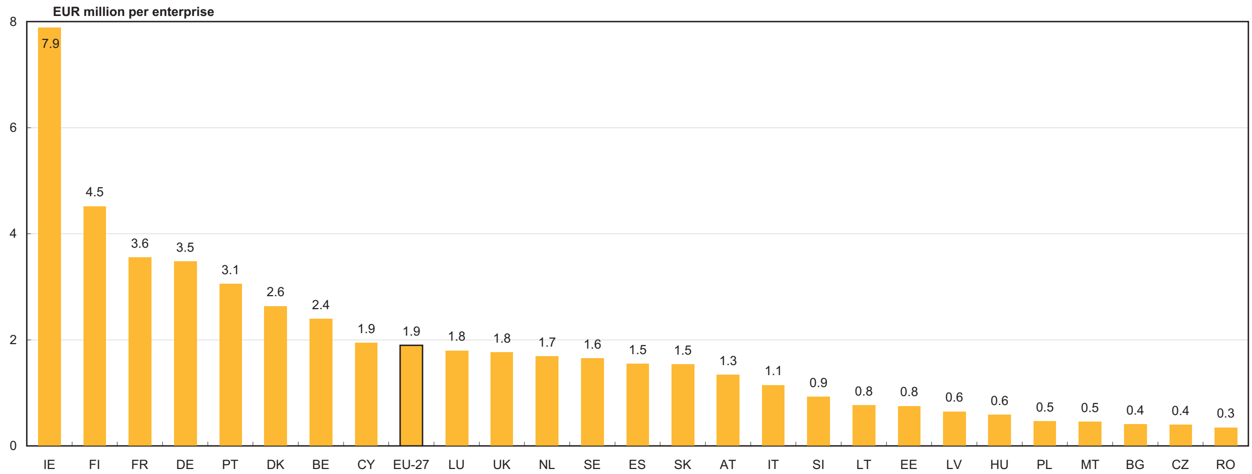
The average European enterprise in all high-tech sectors (high-tech manufacturing and high-tech KIS) generated a production value of EUR 1.9 million. However, looking at the individual Member States, the production value per enterprise gives a very varied picture of the situation.

Ireland was well in the lead with an average production value per enterprise of EUR 7.9 million. However, the high figures for the production value in Ireland show to what extent data are influenced by foreign ownership of enterprises, outsourcing of activities and accounting practices of multinational companies.

Seven other Member States are listed with production values per enterprise above the EU-27 average of EUR 1.9 million: these are Finland, France, Germany, Portugal, Denmark, Belgium and Cyprus.

Apart from Cyprus (EUR 1.9 million) and Slovakia (EUR 1.5 million), the production value per enterprise in the high-tech sectors was below EUR 1 million for all new Member States (2004 and 2007 enlargements).

Figure 7.2 Production value per enterprise in EUR million, total high-tech sectors (1), EU-27 — 2003



(1) Total high-tech sectors include high-tech manufacturing and high-tech KIS sectors. Exceptions are:
High-tech KIS only: EE, LV, LU, MT and NL;
High-tech manufacturing only: PL.
Eurostat estimate: EU-27.
Exceptions to the reference year:
2002: LU, MT, PL and SE; High-tech manufacturing in LT; High-tech KIS in CY.
2001: High-tech manufacturing in CY.

7.3 Venture capital investments

Venture capital investment (VCI) is defined as private equity raised for investment in companies.

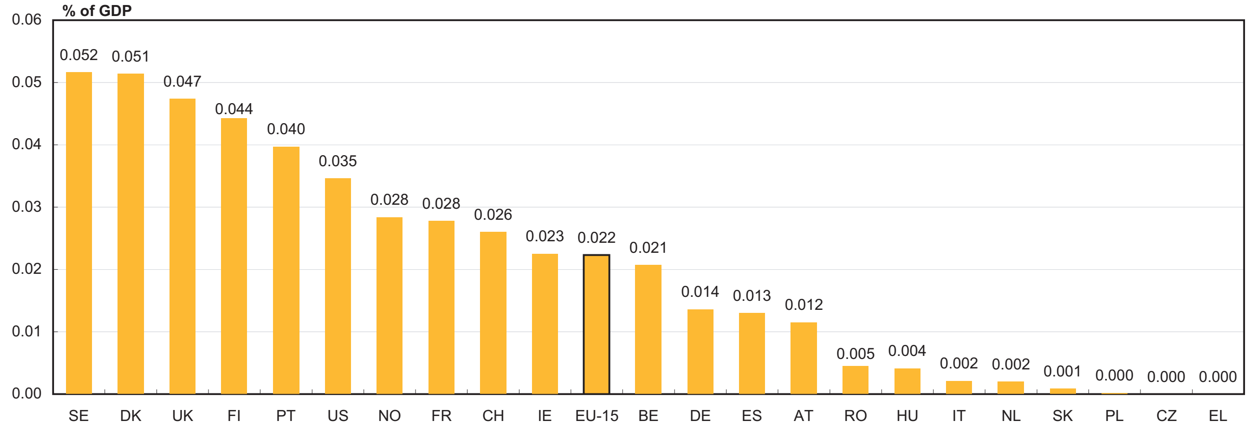
Venture capital investments are generally used to finance start-ups and fast-growing enterprises. These investments are often risky, but where they succeed they can yield a substantial return. For smaller and medium-sized enterprises, having access to venture capital investment is regarded as crucial for their growth and employment.

The venture capital investment data are broken down into two investment stages: early stage and expansion and replacement stage (see Methodological Notes).

Venture capital investment at an early stage is made at the seed and start-up stages of a business, (i.e. before or when a business is launched), whereas venture capital investment at the expansion and replacement stage supports enterprises at a later stage of their business development. Expansion capital helps to fund the growth and expansion of a company, which may or may not break even or trade profitably, whereas replacement capital means the purchase of existing shares in a company from another private equity investment organisation or from other shareholder(s).

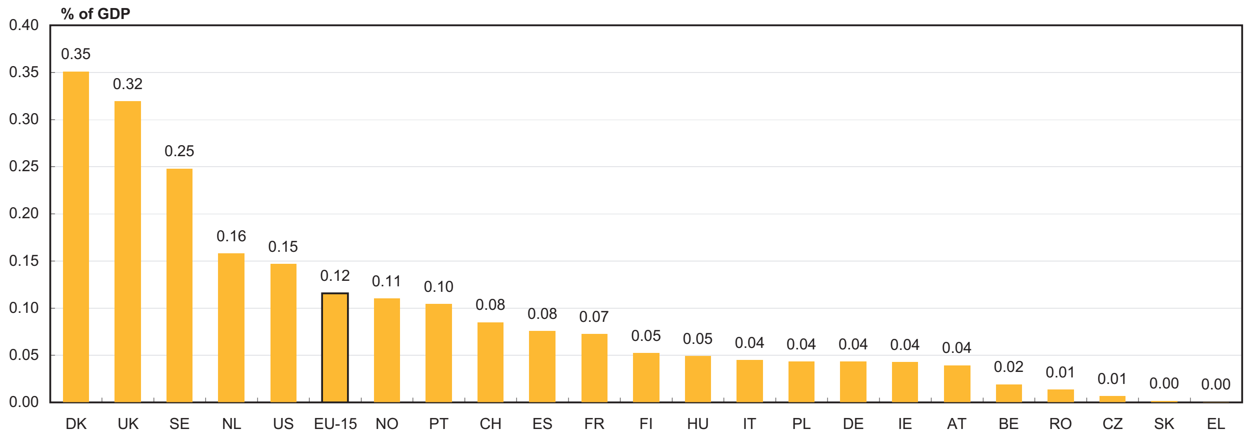
For the EU-15, venture capital investment at the early stage amounted to 0.022% of GDP in 2005, which was approximately five times less than the value at the expansion and replacement stage (0.12% of GDP). However, the European average conceals major differences between Member States. Denmark, Sweden and the United Kingdom were the three leading countries for both stages.

Figure 7.3 Venture capital at early stage as a percentage of GDP, EU-15 and selected countries — 2005



Eurostat estimate: EU-15.

Figure 7.4 Venture capital at expansion and replacement stage as a percentage of GDP, EU-15 and selected countries — 2005



Eurostat estimate: EU-15.

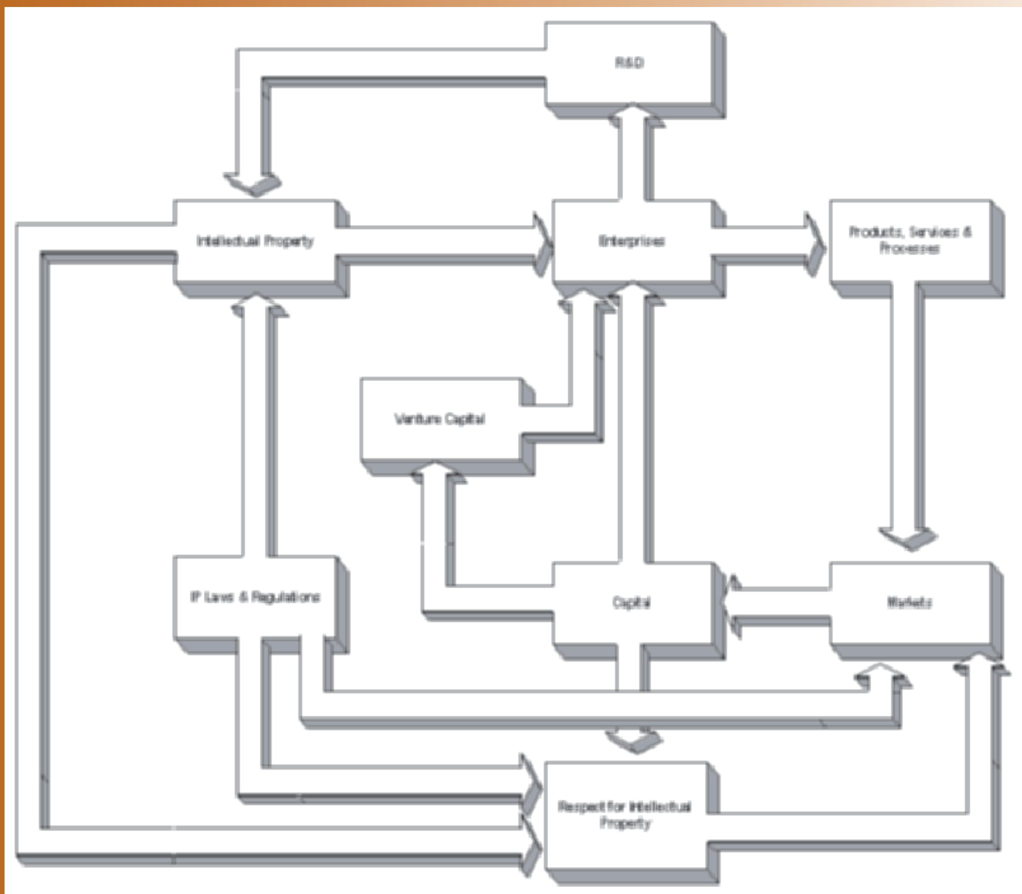
Intellectual Property – The Basis for Venture Capital Investment

While technology has been seen as one of the engines for the dramatic economic growth and productivity the United States has experienced over the last few decades, an underlying factor has been the strength of its intellectual property during that period. Intellectual property provided the basis for investors to place their resources at risk. Intellectual property is an integral part of value creation in a technology-based enterprise and as such is a critical factor in obtaining venture capital for SMEs. Appropriate use of the intellectual property system is a powerful tool for competition, stability and mitigation of risks on capital investments.

Modelling the interaction

Without the strength of intellectual property and its protection, little if any investment would be made into new or growing enterprises. The figure below is a model of the interaction of intellectual property and venture capital. This model shows that even at this simplified level a degree of complex interactions exist. However, without any of the elements shown in this model, serious constraints would be placed on this major economic driver.

Figure: Model of Interaction of Intellectual Property and Venture Capital



We should consider this model from four critical points:

1. intellectual property stimulates more intellectual property,
2. intellectual property which is indigenous leads to respect for all intellectual property,
3. intellectual property stimulates and stabilises markets, and
4. intellectual property generates capital and is impacted by capital and, in turn, impacts the availability of venture capital.

As the Figure shows, there is a feedback mechanism to the generation of additional intellectual property. This becomes evident if we look at the growth of patent applications. Economies that develop intellectual property seem to stimulate the development of additional intellectual property.

Source: World Intellectual Property Organization (WIPO), 2006

7

7.4 Trade in high-tech products

High-tech trade is a way of estimating a country's capacity to carry out R&D, to develop new knowledge, and to transform it into high-tech goods to be sold.

Two approaches exist for the calculation of high-tech trade: the sectoral approach and the product approach. As not all goods produced by high-tech industries are really high-tech products, the product approach is preferred and presented below. The term 'high-tech products' includes such miscellaneous products as pharmaceuticals, aerospace products and scientific instruments, for example (see Methodological Notes).

In 2005, the EU-27 was the leading importer and exporter of high-tech products in the world, with goods worth EUR 230 billion and EUR 198 billion respectively. However, compared with China, Japan and the United States, the EU-27 was also the one showing the largest high-tech trade deficit.

In absolute terms, Germany was the largest importer (EUR 105 billion) and exporter (EUR 115 billion) of high-tech products in the EU-27 in 2005. As a proportion of total trade, Malta and Luxembourg had the largest shares of high-tech products.

The EU-27's high-tech exports increased between 2000 and 2005 whereas high-tech imports decreased during the same period. Consequently, the EU-27's high-tech deficit decreased.

The countries with large increases in high-tech trade between 2000 and 2005 were mainly new Member States (2004 and 2007 enlargements). Looking beyond the EU borders, this was also true for Iceland and China.

Table 7.5 **High-tech trade in 2005, in EUR million, as a share of total exports, share of extra-EU-27 trade and AAGR 2000-2005 of high-tech imports and exports, EU-27 and selected countries**

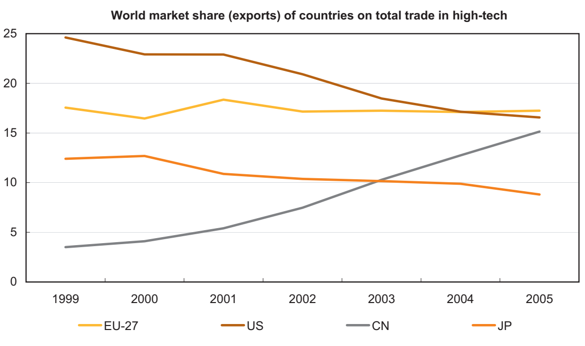
	Imports				Balance	Exports			
	EUR million	as a % of total imports	% of extra EU-27 imports	AAGR 2000-2005	EUR million	EUR million	as a % of total exports	% of extra EU-27 exports	AAGR 2000-2005
EU-27	**229 505**	**19.5**	**100**	**-1.3**	**-31 669**	**197 837**	**18.8**	**100**	**1.7**
BE	20 376	8.0	33.9	0.6	-1 433	18 943	7.1	24.8	1.4
BG	1 096	8.8	53.3	17.0	-828	268	2.9	35.9	25.6
CZ	8 550	13.9	22.2	12.1	-1 226	7 324	11.7	21.5	24.5
DK	8 844	14.6	33.0	3.3	1 322	10 166	14.9	38.4	4.9
DE	105 101	16.8	54.7	0.8	10 304	115 405	14.8	41.8	3.7
EE	1 212	14.8	33.0	9.6	-574	638	10.3	11.3	-5.9
IE	14 860	27.0	54.1	-6.2	11 175	26 036	29.5	41.7	-5.2
EL	4 189	9.6	33.8	0.9	-3 364	826	6.0	23.9	-2.7
ES	23 895	10.3	23.4	3.3	-15 148	8 747	5.7	34.8	1.9
FR	66 783	16.5	46.3	-4.8	4 259	71 042	19.1	58.2	-4.7
IT	32 430	10.5	36.2	-0.6	-11 608	20 822	6.9	45.5	-1.3
CY	687	13.5	21.7	14.5	-315	372	31.6	15.7	94.8
LV	502	7.2	18.1	11.0	-369	133	3.2	43.8	24.0
LT	1 013	8.1	23.0	21.6	-709	304	3.2	45.5	25.3
LU	5 078	28.9	76.6	17.5	662	5 739	38.0	3.9	25.2
HU	10 249	19.2	47.7	8.1	-309	9 941	19.7	29.2	7.1
MT	855	29.6	38.7	-12.7	75	930	50.8	61.8	-11.5
NL	61 163	20.9	72.8	1.2	4 970	66 133	20.3	21.0	2.8
AT	13 184	12.9	32.9	1.6	-307	12 876	12.8	40.2	4.6
PL	8 454	10.4	20.8	4.6	-6 155	2 299	3.2	29.1	18.7
PT	5 329	10.8	19.4	2.8	-3 240	2 089	6.8	65.0	7.3
RO	3 009	9.2	48.5	10.3	-2 317	691	3.1	23.5	5.8
SI	1 162	7.1	18.5	3.6	-502	660	4.3	56.4	9.2
SK	3 224	11.6	26.9	23.3	-1 583	1 641	6.4	16.0	34.8
FI	7 870	16.6	35.3	1.9	3 832	11 701	22.1	62.7	0.0
SE	12 242	13.7	32.5	-3.5	2 023	14 264	13.6	59.8	-4.2
UK	64 518	15.6	48.1	-6.9	3 888	68 406	22.1	47.7	-5.2
IS	415	10.4	:	3.1	-252	163	6.6	:	35.9
NO	5 131	11.5	:	-2.7	-2 687	2 444	2.9	:	3.4
CH	15 963	16.4	:	-1.4	5 482	21 445	21.2	:	4.0
HR	1 388	9.3	:	8.6	-825	563	8.0	:	6.6
MK	167	6.4	:	5.5	-154	13	0.8	:	4.4
TR	8 913	9.5	:	1.0	-8 117	796	1.4	:	-7.9
CN	166 367	31.4	:	26.0	7 289	173 656	28.4	:	30.8
JP	69 393	16.7	:	-3.4	31 724	101 117	21.1	:	-6.3
US	215 849	15.5	:	-5.1	-25 772	190 077	26.2	:	-5.6

EU-27 does not include intra-EU trade and therefore does not correspond to the sum of Member States.
Exceptions to the reference period 2000-2005: 2002-2005: HR and MK.

High-tech trade indicators 2006: EU-27 vs. USA, China and Japan

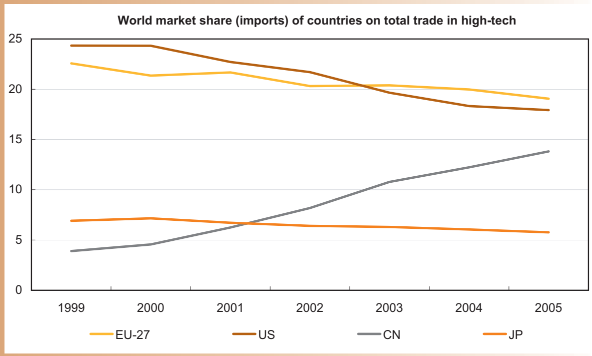
WORLD MARKET SHARE – Definition 1 (product approach)

The world market share is defined as the ratio between the export (or import) of high-tech products from the country under study and the total export (or import) of high-tech products all over the world, which is calculated as the sum of high-tech exports (or imports) of all countries (excluding intra-EU-27 exports).



EU-27 does not include intra-EU trade.

Since 2004, the EU-27 took the leadership. EU-27 was closely followed by the US. While the US and Japan are on the decrease, the EU-27 remains quite stable between 1999 and 2005. On the other hand, China is growing rapidly, catching up with Japan in 2003 and overtaking it in 2004 and 2005.



EU-27 does not include intra-EU trade.

The the EU-27 and US led the world but they are decreasing with time. Japan shows a slight decrease, but China a sharp increase thus doubling Japan.

Source: Based on European Commission, Joint Research Centre, 2007

7

China: Foreign trade in high-tech products sets record high

BEIJING, July 11 2006 - China posted a record high of 235.36 billion US dollars in imports and exports of high-tech products over the first six months, up 30.6 percent on the same period last year, reports the Ministry of Commerce.

The figure accounts for 29.6 percent of the country's total foreign trade volume of 795.74 billion US dollars.

This is the first time that both imports and exports of high-tech products have exceeded the benchmark of 100 billion US dollars. According to the report, imports of these products stood at 111.89 billion US dollars while exports came in at 123.47 billion US dollars.

About 55.2 percent of the country's imports and exports, or 439.39 billion US dollars, came from machinery and electronic products, representing year-on-year growth of 28.7 percent.

Source: Ministry of Commerce of the People's Republic of China, Chinese Government's Official web portal, July 2006

7.5 Employment in high-tech industries and in knowledge-intensive services

Performance at national level in Europe

Although data on high-tech trade are a way of estimating a country's capacity to transform new knowledge into high-tech goods (an output indicator), data on employment in high-tech sectors are much more of an input indicator, or, in other words, of the resources available and needed to create and transform this new knowledge.

Almost a third of EU-27 total employment in 2006 (32.6%) was employed in knowledge-intensive services (KIS) and only 6.6% in high-tech and medium high-tech manufacturing.

Another third of European workers (33.6%) were employed in less knowledge-intensive services and a little more than 10% in other manufacturing (low-tech and medium low-tech manufacturing).

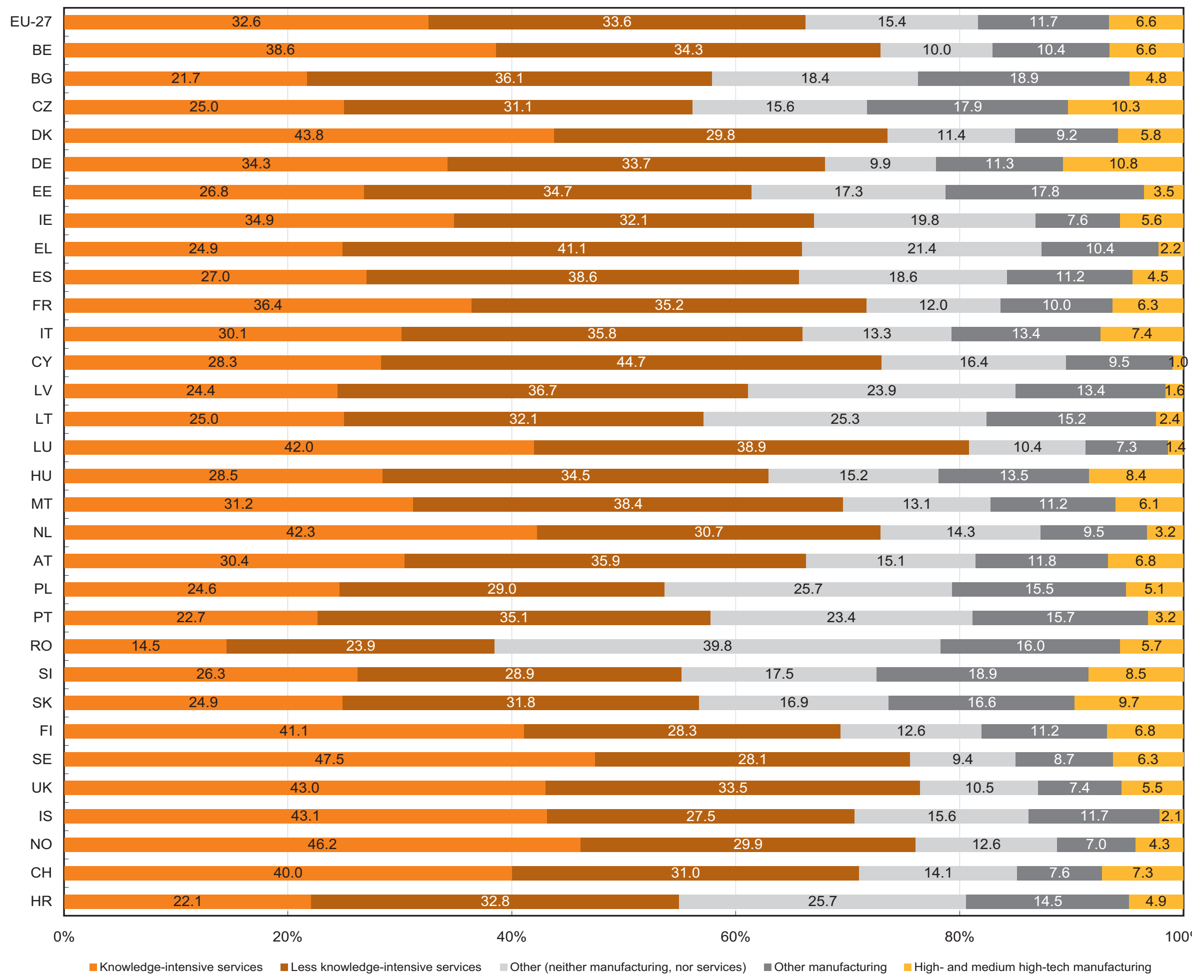
The remaining jobs (15.4%) were in other sectors of the economy, such as 'agriculture, hunting and forestry'; 'mining and quarrying'; 'electricity, gas and water supply' and 'construction'.

The knowledge-intensive services sector is particularly well developed, mainly in northern Europe. Indeed, employment in this sector provided more than 40% of total employment in Denmark, Luxembourg, the Netherlands, Finland, Sweden and the United Kingdom - also in Iceland, Norway and Switzerland.

At more than 80% of total employment (knowledge-intensive and less knowledge-intensive), the whole services sector was especially well developed in Luxembourg.

Employment in high-tech and medium high-tech manufacturing exceeded 10% of total employment only in Germany (10.8%) and the Czech Republic (10.3%). By contrast, in some countries, such as Cyprus, Luxembourg and Latvia, employment in high-tech and medium high-tech manufacturing did not reach 2% of the total. In Luxembourg, the main reason is that the country is a service economy. In Cyprus and Latvia, this is principally due to other sectors of the economy accounting for a large percentage of employment.

Figure 7.6 **Distribution of employment by sector as a percentage of total, EU-27 and selected countries — 2006**



Exceptions to the reference year: 2005: LU, IS and CH.

7

The manufacturing sector

In 2006, the total manufacturing sector added up to almost 40 million jobs in the EU-27, which is equivalent to 18.3% of EU employment. With more than 8 million, Germany had the largest European manufacturing sector in terms of employment. Eight other Member States had more than one million workers in manufacturing.

Of these 40 million workers, almost 12 million were employed in medium high-tech manufacturing and only 2.3 million in high-tech manufacturing.

In the EU-27, 30.7% of all persons employed in manufacturing sectors were female. In all individual EU-27 Member States, female employment in total manufacturing was below 50%. Nonetheless, the ratio was often higher in the new Member States (2004 and 2007 enlargements).

In medium high-tech manufacturing, the share of female employment (23.5%) was lower than in high-tech manufacturing (34.1%), where it even exceeded parity in Bulgaria, Hungary and Slovakia.

The higher percentages of women employed in high-tech manufacturing could partly be explained by the fact that jobs in this sector consist much more of precision work than work that needs physical strength and is generally carried out by men.

European employment in total manufacturing increased slightly between 2001 and 2006. This was also true of the medium high-tech manufacturing sector. However, the number of jobs in high-tech manufacturing decreased during the same period, at an annual average rate of 1.6%.

At Member State level, however, employment in this sector increased in ten Member States, this increase being the most marked in Slovakia and Poland. Where the growth or decline of employment in high-tech manufacturing is notable in some countries, this is generally due to the fact that, in absolute terms, the sector is small in these specific countries, which makes it sensitive to analysis.

Table 7.7 Employment in manufacturing in 2006, by selected sectors, in thousands, percentage of women and AAGR 2001-2006, EU-27 and selected countries

	Total manufacturing			High-tech manufacturing			Medium high-tech manufacturing		
	Total	% of women	AAGR 2001-2006	Total	% of women	AAGR 2001-2006	Total	% of women	AAGR 2001-2006
EU-27	39 144 s	30.7 s	0.6 s	2 309 s	34.1 s	-1.6 s	11 848 s	23.5 s	0.7 s
EU-25	36 348 s	29.3 s	0.5 s	2 265 s	33.9 s	-1.6 s	11 206 s	22.8 s	0.7 s
BE	719	23.8	-0.6	27	22.4	-6.1	252	22.6	1.9
BG	744	49.7	2.4	17	52.6 u	2.1	134	31.3	-0.3
CZ	1 363	37.3	0.6	76	49.6	0.6	422	34.0	3.4
DK	420	30.2	-3.2	22	45.4	-4.6	141	29.3	-2.9
DE	8 193	28.4	-1.0	650	30.4	-1.7	3 336	20.5	-0.3
EE	138	49.2	0.0	8 u	:	1.3 u	17	:	-5.3
IE	267	30.3	-2.2	53	40.9	-2.8	61	33.7	-0.9
EL	563	27.0	0.2	10	:	2.1	89	21.0	2.8
ES	3 103	24.5	0.6	86	29.5	-1.5	807	19.4	0.6
FR	4 040	28.4	-1.6	298	35.8	-2.3	1 264	24.5	-1.5
IT	4 808	28.6	-0.2	275	29.8	3.4	1 434	22.3	1.2
CY	37	31.4	-0.2	1 u	:	:	3	36.5 u	0.5
LV	161	44.7	0.5	:	:	:	16	31.6 u	1.1
LT	264	48.2	-0.7	9 u	:	0.4 u	27 u	:	-6.6 u
LU	17	18.9	-4.1	1 u	:	13.6 u	2	:	-11.4
HU	861	38.1	-2.0	97	51.6	-1.1	234	30.1	-0.1
MT	26	25.9	-4.8	5	49.4 u	-2.3	4	:	-10.9
NL	1 052	22.0	-0.8	57	21.6	-9.0	210	17.1	-3.7
AT	727	26.0	-0.3	51	31.2	-5.2	214	19.7	4.3
PL	2 985	33.0	3.8	90	42.9	14.4	651	26.5	4.1
PT	977	42.6	-2.2	23	43.4	-2.4	141	28.5	-1.9
RO	2 052	48.3	0.7	28	35.0 u	-4.3	508	35.4	0.5
SI	266	36.7	-0.9	10 u	44.7 u	4.6 u	72	33.9	0.1
SK	605	37.4	2.2	40	59.7	14.6	183	33.4	8.3
FI	444	28.7	-1.4	51	29.1	-0.5	116	19.8	-1.6
SE	664	25.0	-2.6	40	30.0	-11.9	239	23.1	-1.7
UK	3 664	25.7	-4.5	288	29.8	-7.8	1 272	20.7	-4.3
IS	22	31.0	-0.9	:	:	:	3	:	5.4
NO	266	24.5	-1.6	10	:	-9.4	90	14.0	2.7
EEA30	39 410 s	30.6 s	0.6 s	2 319 s	34.1 s	-1.6 s	11 938 s	23.4 s	0.7 s
HR	300	35.7	-0.3	8	29.6	4.7	67	20.6	5.3
CH	591	27.5	-1.5	89	31.8	-0.8	199	22.0	-0.7

Exceptions to the reference year: 2005: LU, IS and CH; high-tech manufacturing in EE.
Exceptions to the reference period: 2000-2005: LU, IS and CH; high-tech manufacturing in EE;
2002-2006: MT; 2003-2006: HR; 2004-2006: PL.

Figure 7.8 shows the proportion of employment in high-tech manufacturing and the annual average growth rate (AAGR) of this proportion between 2001 and 2006.

For the EU-27, high-tech manufacturing contributed 1.13% of total employment in 2006. This share decreased between 2001 and 2006, at an AAGR of -3.9%.

Four main groups of countries can be distinguished when combining the share in employment with its AAGR.

The first group can be seen as the leading group in terms of employment in high-tech manufacturing. In this group, the proportion of employment in high-tech manufacturing was notably higher than the EU-27 average. This group is composed of Finland, Switzerland, Hungary, Ireland and Malta. With the exception of Ireland, the AAGR in this group was higher than that of the EU-27.

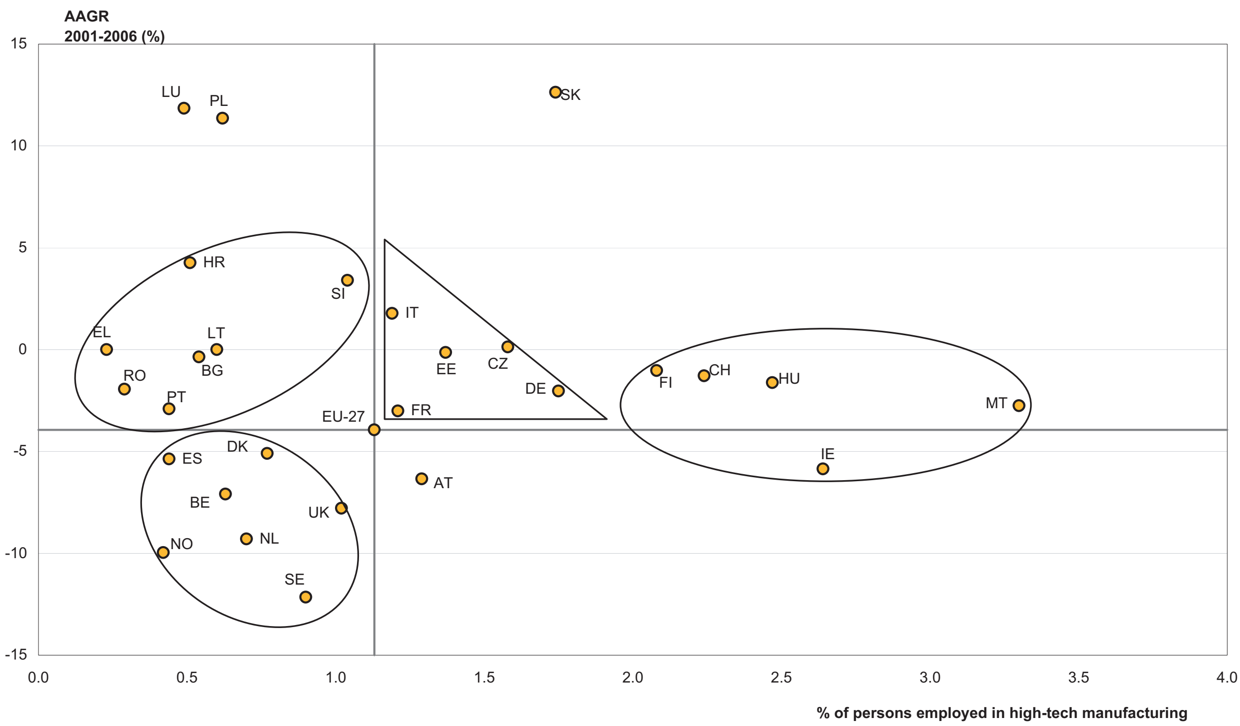
The second group – which includes Italy, France, Estonia, the Czech Republic and Germany – showed a slightly higher share of employment in high-tech manufacturing than the EU-27 average and also a somewhat higher AAGR.

In the third group of countries, the share of employment in high-tech manufacturing was below the EU average, but with an AAGR above that of the EU. These countries were lagging behind, but the gap is obviously narrowing. This group includes Greece, Portugal and five of the new Member States (2004 and 2007 enlargements).

The fourth group comprises countries where the proportion of employment in high-tech manufacturing was below average, compounded by a below average AAGR. All the countries in this group apart from Norway were EU-15 Member States, such as Spain, the Netherlands and the United Kingdom, for example.

Luxembourg, Poland and Slovakia displayed a remarkable growth rate in employment in high-tech manufacturing. For Luxembourg, and to a lesser extent for Slovakia, this is mainly due to the fact that, in absolute terms, this sector is small.

Figure 7.8 **Employment in high-tech manufacturing as a percentage of total employment in 2006 and AAGR 2001-2006, EU-27 and selected countries**



AAGR is calculated on employment expressed as a percentage of total employment.
Exceptions to the reference year:
2005: EE, LU and CH.
Exceptions to the reference period:
2000-2005: EE, LU and CH;
2002-2006: MT;
2003-2006: HR;
2004-2006: PL.
Unreliable data: EE, LT and SI.

The services sector

With two thirds of EU employment in 2006, the total services sector was responsible for more than 140 millions jobs, almost half of them in knowledge-intensive services (KIS). Germany ranked first with 25 million persons employed in services, followed by the United Kingdom. The same ranking prevails in KIS. Only one tenth of the jobs in KIS were in fact in high-tech KIS (7 million). Germany and the United Kingdom were the only Member States where employment in high-tech KIS added up to more than one million.

In the EU-27, 53.7% of persons employed in services were female. In contrast with employment in manufacturing (see Table 7.7), female employment in services exceeded parity in all Member States except in Greece, Italy, Luxembourg and Malta.

In KIS, the share of female employment (60.3%) was even higher than in total services. The only country that did not achieve parity was Malta.

By contrast, the lowest ratio of female employment was observed in high-tech KIS (33.1%), where parity was exceeded only in Latvia and Lithuania.

Employment in total services between 2001 and 2006 increased not only at EU level, but also in all individual Member States.

For employment in the KIS sector, trends were similar to those observed in total services. The only exception was Lithuania, where employment in this specific sector decreased.

Employment in high-tech KIS also increased in the EU-27, but at lower rate than total services. Nine EU Member States plus Norway experienced a drop in employment in high-tech KIS.

Table 7.9 Employment in services in 2006, by selected sectors, in thousands,percentage of women and AAGR 2001-2006, EU-27 and selected countries

	Total services			Knowledge-intensive services (KIS)			High-tech KIS		
	Total	% of women	AAGR 2001-2006	Total	% of women	AAGR 2001-2006	Total	% of women	AAGR 2001-2006
EU-27	**141 305 s**	**53.7 s**	**3.1 s**	**69 528 s**	**60.3 s**	**3.5 s**	**6 949 s**	**33.1 s**	**1.5 s**
EU-25	**135 853 s**	**53.7 s**	**3.1 s**	**67 472 s**	**60.2 s**	**3.5 s**	**6 732 s**	**32.6 s**	**1.5 s**
BE	3 074	52.9	0.8	1 629	59.5	1.2	167	30.7	0.2
BG	1 817	53.2	2.8	683	65.3	1.4	82	48.3	2.0
CZ	2 710	53.8	1.1	1 207	63.9	1.2	145	41.6	-0.9
DK	2 054	55.3	1.3	1 223	63.3	1.0	118	35.8	-2.6
DE	25 201	54.8	1.3	12 711	59.9	2.3	1 290	33.0	2.0
EE	399	60.0	3.3	174	67.9	1.5	18	:	-1.8
IE	1 351	55.3	4.4	703	61.3	5.1	78	28.0	2.0
EL	2 936	45.3	4.1	1 108	53.2	4.4	87	31.4	5.5
ES	12 927	52.6	5.6	5 325	56.4	6.1	527	34.0	4.4
FR	17 696	55.4	1.4	8 994	62.0	1.6	915	37.0	-1.0
IT	15 294	47.8	2.6	6 989	55.8	4.0	689	35.0	1.1
CY	260	52.0	4.5	101	59.8	5.6	7	32.1	5.2
LV	655	61.9	2.7	262	70.4	1.9	25	55.5	3.5
LT	858	60.4	0.6	376	69.2	-1.1	32	55.7 u	1.6
LU	157	48.1	2.5	81	52.7	4.8	6	28.8	6.0
HU	2 476	55.4	1.7	1 120	64.7	2.2	133	40.4	1.3
MT	106	38.3	1.8	47	48.3	2.8	4	:	-4.4
NL	6 010	52.6	0.9	3 483	59.1	1.6	337	25.2	0.1
AT	2 597	55.2	1.6	1 192	59.3	2.0	113	27.3	0.2
PL	7 756	55.8	3.3	3 563	65.9	3.5	343	38.6	8.4
PT	2 992	54.7	1.9	1 174	63.3	3.5	96	34.1	5.7
RO	3 635	51.4	2.5	1 374	64.1	3.0	135	47.2	-2.7
SI	535	56.3	2.8	254	62.6	3.9	28	29.9 u	2.3
SK	1 302	56.1	1.7	572	65.8	1.3	58	43.6	-1.9
FI	1 707	59.2	1.2	1 012	65.8	1.5	113	36.2	1.3
SE	3 346	56.1	1.0	2 100	62.7	1.0	224	31.6	-0.1
UK	21 609	54.6	0.9	12 154	59.7	1.4	1 187	24.2	-2.4
IS	115	56.8	1.2	70	64.6	2.7	8	37.0	3.2
NO	1 786	56.2	1.2	1 084	62.7	1.8	92	34.9	-1.7
EEA30	**143 091 s**	**53.7 s**	**3.1 s**	**70 612 s**	**60.4 s**	**3.5 s**	**7 041 s**	**33.1 s**	**1.4 s**
HR	851	54.1	1.5	342	62.4	2.5	34	46.2	1.0
CH	2 822	53.1	1.5	1 590	55.1	2.6	151	32.1	1.0

Exceptions to the reference year: 2005: LU, IS, CH.
Exceptions to the reference period: 2000-2005: LU, IS, CH; 2002-2006: MT; 2003-2006: HR; 2004-2006: PL.

Figure 7.10 outlines the proportion of employment in high-tech knowledge-intensive services and the annual average growth rate (AAGR) of this proportion between 2001 and 2006.

At EU-27 level, high-tech KIS accounted for 3.3% of total employment in 2006. Between 2001 and 2006, this share decreased at an AAGR of -0.8%.

Four main groups of countries can be distinguished when taking a combined look at the share of total employment and AAGR over the 2001-2006 observation period.

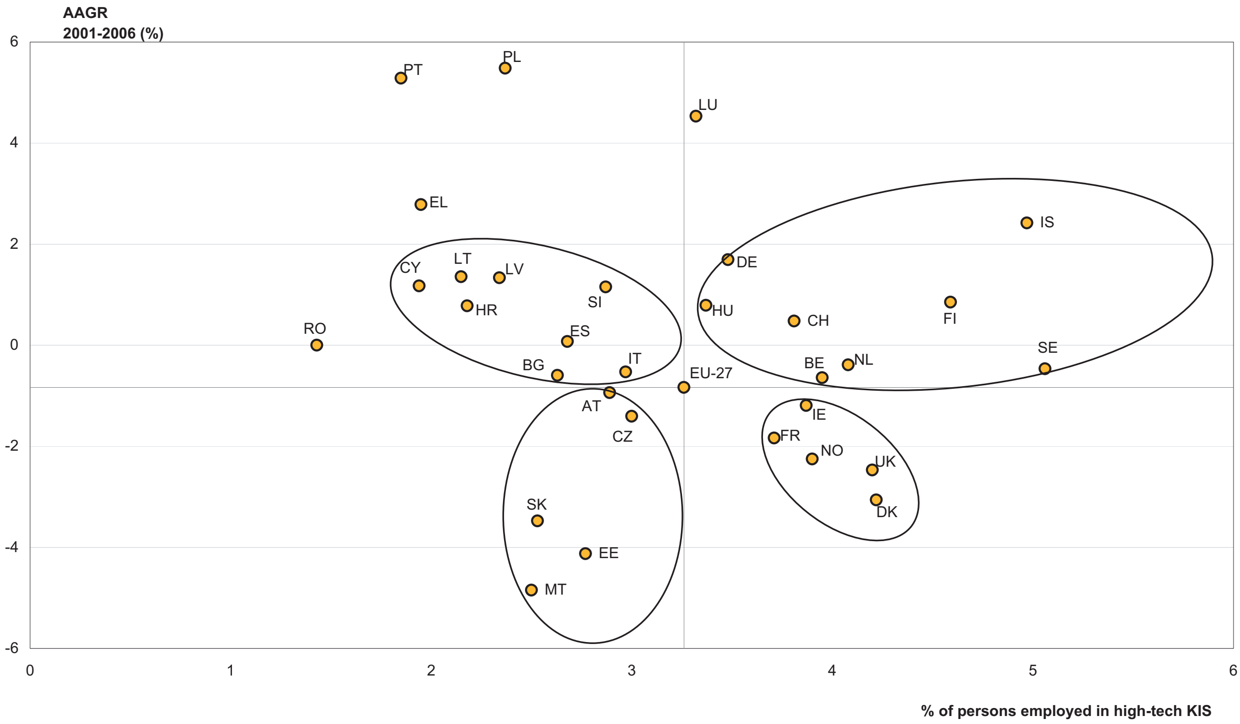
In the first group both the proportion of employment in high-tech KIS and the AAGR of this share were above the EU-27 average. It comprised northern European countries, which were the leaders within this group. Other countries such as Switzerland and Hungary were also part of this group. Luxembourg had a share of employment in high-tech KIS similar to the European average, but its growth rate was especially high.

In the second group, the share of employment in high-tech KIS was below the EU average, but the AAGR lay above that of the EU. These countries are behind but the gap is gradually closing. This group includes mainly Mediterranean countries and New Member States (2004 and 2007 enlargements). The same was also true in Portugal and Poland, with a particularly high value in growth.

The third group comprises countries where the proportion of employment in high-tech KIS was lower than the average, compounded by a below (EU) average AAGR. This group includes, namely, the Czech Republic, Austria, Estonia, Malta and Slovakia.

The fourth group, which is made up of only EU-15 Member States and includes Norway, is the 'counterpart' of the second group. In other words, the share of employment in high-tech KIS was higher than the European average but the AAGR was lower. This group, like the second group, tends to move towards the European average.

Figure 7.10 **Employment in high-tech KIS as a percentage of total employment in 2006 and AAGR 2001-2006, EU-27 and selected countries**



AAGR is calculated on employment expressed as a percentage of total employment.
Exceptions to the reference year: 2005: LU, IS, CH.
Exceptions to the reference period:
2000-2005: LU, IS, CH;
2002-2006: MT;
2003-2006: HR;
2004-2006: PL.

Performance at national level in Europe

The manufacturing sector

Figure 7.11 shows the top 20 regions in terms of employment in high-tech and medium high-tech manufacturing in 2006, both in absolute (thousands) and in relative terms (as a percentage of total employment).

In 2006, the leading region in terms of absolute employment was Lombardia (IT) with 448 000 persons employed in high-tech and medium high-tech manufacturing. This Italian region was followed by Stuttgart (DE) and Cataluña (ES).

Among the 20 leading regions in terms of absolute jobs held, more than half were German and six Italian. Denmark (the entire country is classified at NUTS 2 level) was the 14th leading 'region' in absolute terms.

Looking at Denmark in relative terms, the proportion in high-tech and medium high-tech employment amounted to only 5.8% of total employment, a situation that was similar in the regions of Île de France (FR) and Lazio (IT), which ranked 5th and 20th in absolute terms, but had respective shares of only 5.6% and 5.3% of total employment. However, Île de France was the leading region in high-tech manufacturing in absolute terms, with 79 000 persons employed.

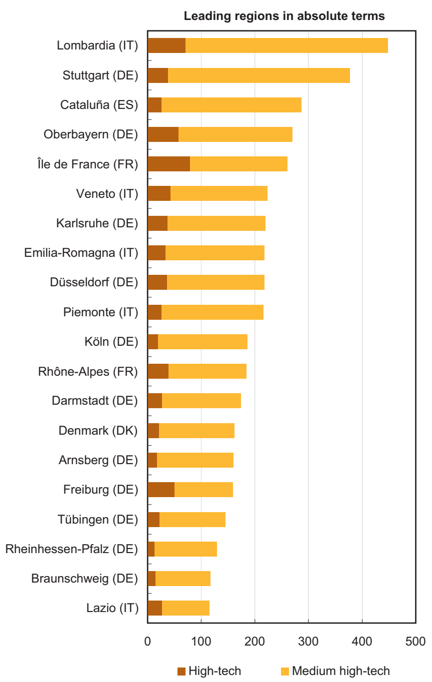
Of the top 20 leading regions in absolute terms, twelve experienced a decrease in employment in high-tech and medium high-tech manufacturing between 2002 and 2006. By contrast, in the leading Italian regions, especially Lazio, employment increased over the same period, with the exception of Piemonte (IT).

Looking at relative employment in high-tech and medium high-tech manufacturing, German regions dominated even more clearly. Indeed, the eight leading European regions in 2006 were all located in Germany. Of the German regions, Stuttgart (DE) ranked first with 19.9% of total employment in high-tech and medium high-tech manufacturing.

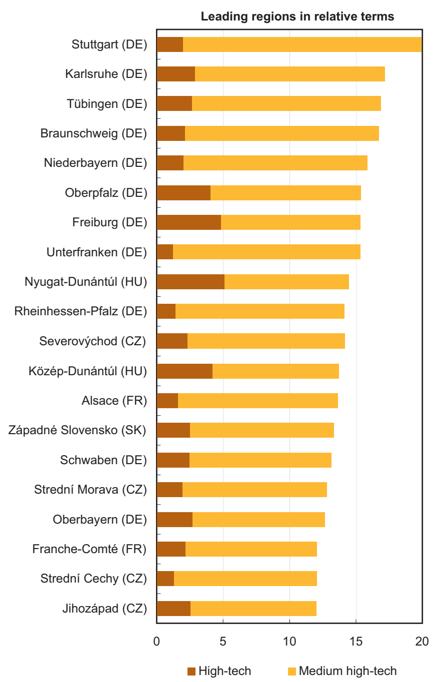
Employment in high-tech and medium high-tech manufacturing increased in relative terms between 2002 and 2006 in twelve of the top 20 regions. Moreover, six of the eight regions which experienced a decline in employment in this sector were German.

Map 7.12 sets out the share of employment taken by high-tech and medium high-tech manufacturing in 2006 across the EU-27 and EFTA regions at NUTS 2 level (see Methodological Notes). It is again obvious that German regions and regions from central Eastern Europe were clear leaders in this sector.

Figure 7.11 **Top 20 leading EU-27 and EFTA regions in terms of employment in high-tech and medium high-tech manufacturing in 2006, in thousands, as a percentage of total employment and AAGR 2002-2006**



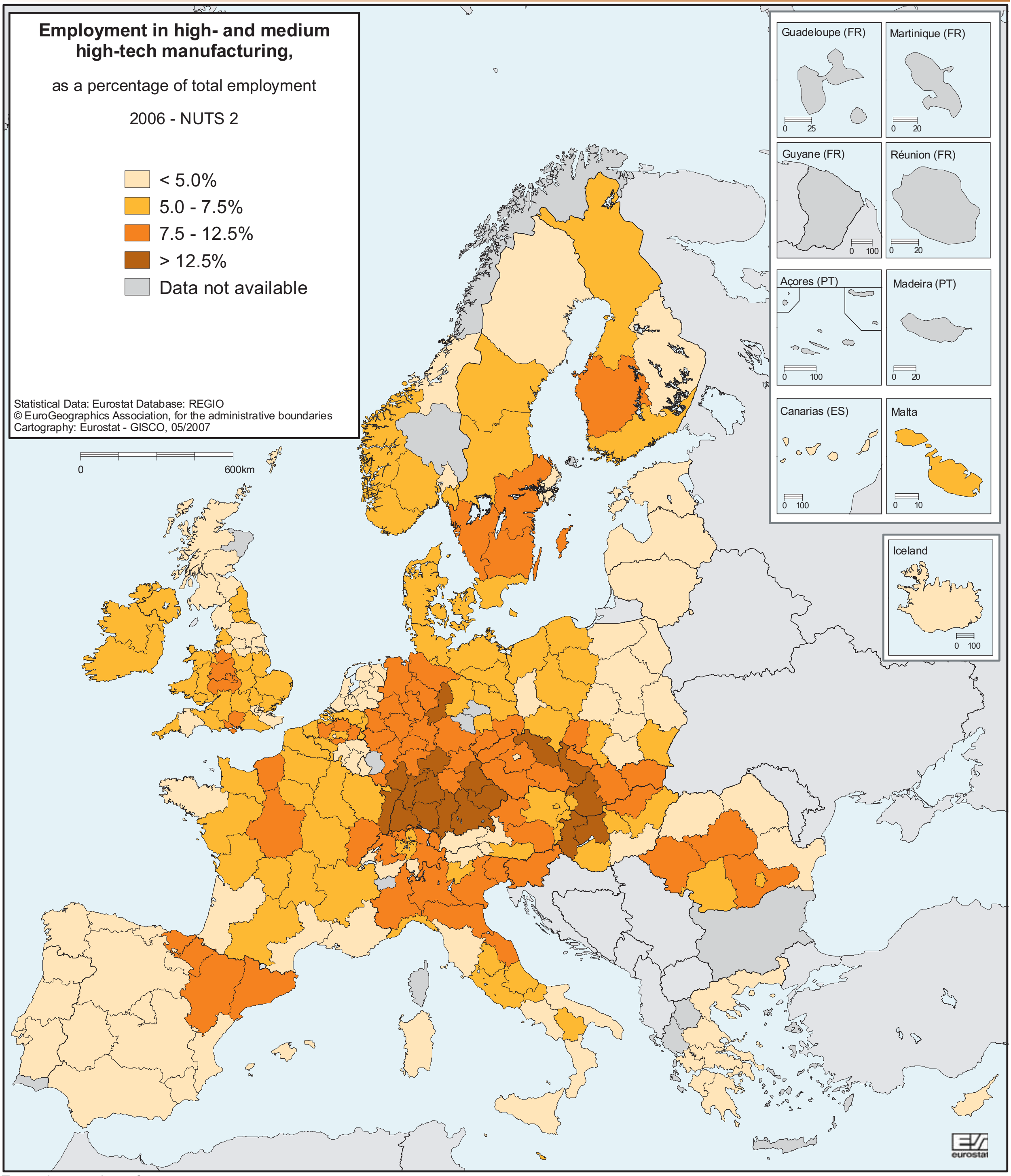
% of total employment	AAGR 2002-2006
10.5	1.0
19.9	-1.5
8.4	0.0
12.7	-1.3
5.6	-2.3
10.6	3.2
17.2	1.9
11.3	3.7
9.4	1.0
11.8	-2.1
10.0	-1.4
7.4	-2.7
9.8	-7.4
5.8	-1.6
10.3	-0.5
15.4	1.4
16.9	-2.1
14.1	-1.7
16.7	-0.8
5.3	10.2



Total in 1000s	AAGR 2002-2006
377	-1.2
220	1.5
145	-1.7
117	-0.6
92	0.5
78	3.1
159	1.1
97	0.2
62	2.5
129	-1.3
100	4.2
64	-3.2
108	1.5
112	6.1
109	-2.3
73	4.5
270	-1.1
64	-6.1
68	2.3
69	2.7

Calculated on employment expressed in thousands.

Map 7.12 Regional employment in high and medium high-tech manufacturing as a percentage of total employment — 2006



Exceptions to the reference year:
2005: LU, PL, IS and CH.
Unreliable data: See Methodological Notes.

The services sector

Figure 7.13 shows the leading regions in terms of employment in knowledge-intensive services in 2006, both in absolute and in relative terms.

Five of the 20 leading regions in absolute terms were German. Île de France (FR) was the leading region with 2.1 million jobs in KIS. With 321 000 persons employed, Île de France (FR) was also the leading region in high-tech KIS (a sub-set of KIS).

Lombardia (IT) came second with 1.4 million persons employed in total KIS. However, in relative terms, it accounted for 31.6% of total employment in the region. This was less than the EU-27 average of 32.6%. The same was also true for Cataluña (ES), Andalucia (ES) and Mazowieckie (PL).

Denmark ranked third in absolute terms, with 1.2 million people employed in KIS. This corresponded to 43.8% of total employment in the country.

Most leading regions were urban regions, nine of them capitals.

In relative terms (as a percentage of total employment), five of the 20 leading regions were located in Sweden and four in the United Kingdom.

Nine leading regions in relative terms were in fact capital regions. In the number one region, Stockholm (SE), 57% of total employment consisted of knowledge-intensive services.

Among the leading regions, both in absolute and in relative terms, employment in KIS often increased between 2002 and 2006. However, it decreased during the same period in two dominant regions, Île de France (FR) and Inner London (UK).

Map 7.14 provides an overview of the employment share taken by knowledge-intensive services in 2006 across the regions of the EU-27 and EFTA regions, at NUTS 2 level.

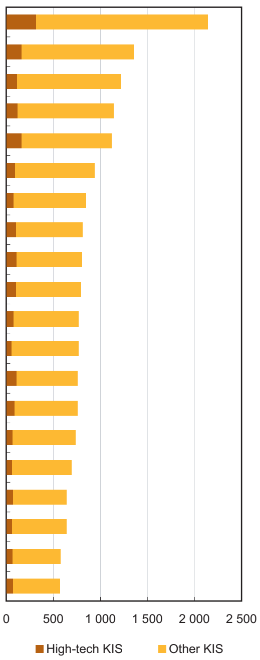
In addition to the capital regions, regions with a high proportion of employment in knowledge-intensive services were mainly located in Northern Europe.

By contrast with employment in high-tech and medium high-tech manufacturing, it should be noted that employment in KIS is underdeveloped in Eastern Europe. This was also true in southern European countries such as Spain, Portugal, Italy and Greece.

7

Figure 7.13 Top 20 leading EU-27 and EFTA regions in terms of employment in knowledge-intensive services in 2006, in thousands, as a percentage of total employment and AAGR 2002-2006

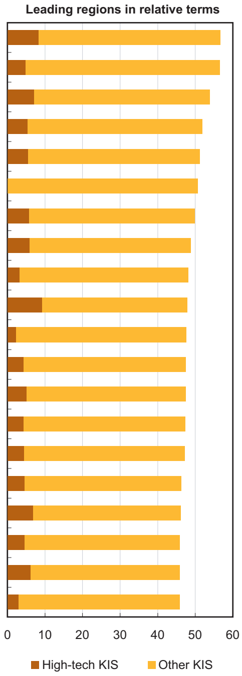
Leading regions in absolute terms



Region	% of total employment	AAGR 2002-2006
Île de France (FR)	46.1	-2.3
Lombardia (IT)	31.6	4.8
Denmark (DK)	43.8	0.4
Outer London (UK)	51.9	0.5
Comunidad de Madrid (ES)	37.9	6.4
Cataluña (ES)	27.4	7.0
Rhône-Alpes (FR)	33.9	0.6
Düsseldorf (DE)	35.2	4.1
Oberbayern (DE)	37.8	2.3
Lazio (IT)	36.7	3.9
Zuid-Holland (NL)	44.3	2.4
Andalucia (ES)	24.8	6.7
Darmstadt (DE)	42.5	3.1
Köln (DE)	40.6	4.3
Inner London (UK)	56.6	-1.7
Berlin (DE)	47.5	1.6
Surrey, E. & W. Sussex (UK)	49.9	1.6
Noord-Holland (NL)	47.1	1.9
Prov.-Alpes-Côte d'Azur (FR)	37.9	0.2
Mazowieckie (PL)	30.1	:

Calculated on employment expressed in thousand.
Exception to the reference year:
2005: Mazowieckie (PL).

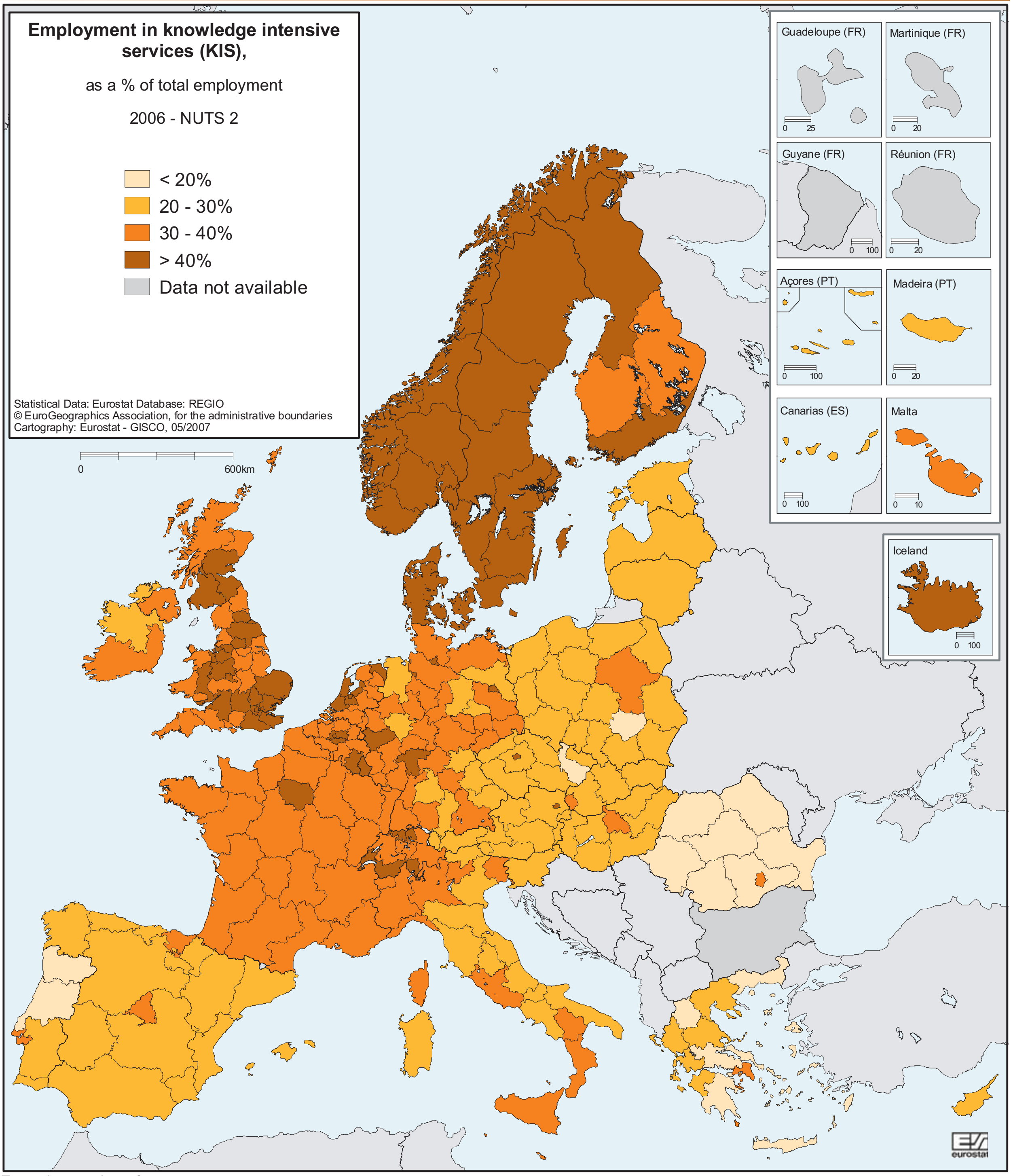
Leading regions in relative terms



Region	Total in 1000s	AAGR 2002-2006
Stockholm (SE)	556	1.1
Inner London (UK)	735	-1.7
Oslo og Akershus (NO)	300	1.9
Outer London (UK)	1138	0.5
Rég. Bruxelles-Capitale (BE)	184	2.3
Åland (FI)	7	-1.3
Surrey, E. & W. Sussex (UK)	641	1.6
Utrecht (NL)	304	3.1
Övre Norrland (SE)	117	0.6
Berks., Bucks and Oxfords. (UK)	551	2.0
Nord-Norge (NO)	107	1.1
Berlin (DE)	694	1.6
Zürich (CH)	336	3.1
Mellersta Norrland (SE)	82	-0.6
Noord-Holland (NL)	640	1.9
Sydsverige (SE)	285	0.8
Île de France (FR)	2144	-2.3
Östra Mellansverige (SE)	331	1.0
Prov. Vlaams Brabant (BE)	213	4.1
Trøndelag (NO)	92	1.1

Åland (FI): Details for high-tech KIS are not available.
Exception to the reference year:
2005: Zürich (CH).
Exception to the reference period:
2002-2005: Zürich (CH).

Map 7.14 Regional employment in knowledge-intensive services (KIS) as a % of total employment — 2006



Exceptions to the reference year:
2005: LU, PL, IS and CH.
Unreliable data: See methodological notes.

7.6 R&D in high-technology

Figure 7.15 shows the business enterprise R&D expenditure in the manufacturing sector broken down by technological intensity.

The highest share of business R&D expenditure taken by high-tech manufacturing was recorded in Greece, at 46%, followed by the Netherlands, at 41%. However, in absolute terms, spending in the Netherlands amounted to EUR 3 750 million, whereas it was only EUR 188 million in Greece.

While high-tech manufacturers in Greece accounted for a large share of business R&D expenditure in the manufacturing sector, this is exclusively due to the particular sector of activity of "Manufacturing of radio, television and communication equipment and apparatus".

The proportion of business R&D expenditure in high-tech manufacturing was also significant in Ireland and in Austria: both at 35%.

In Russia, 93% of business R&D expenditure was spent in high-tech or medium high-tech manufacturing. This was followed by Germany, which led among the Member States, with 92% spent on high-tech or medium high-tech manufacturing. Hungary and the United Kingdom followed close behind on 91%.

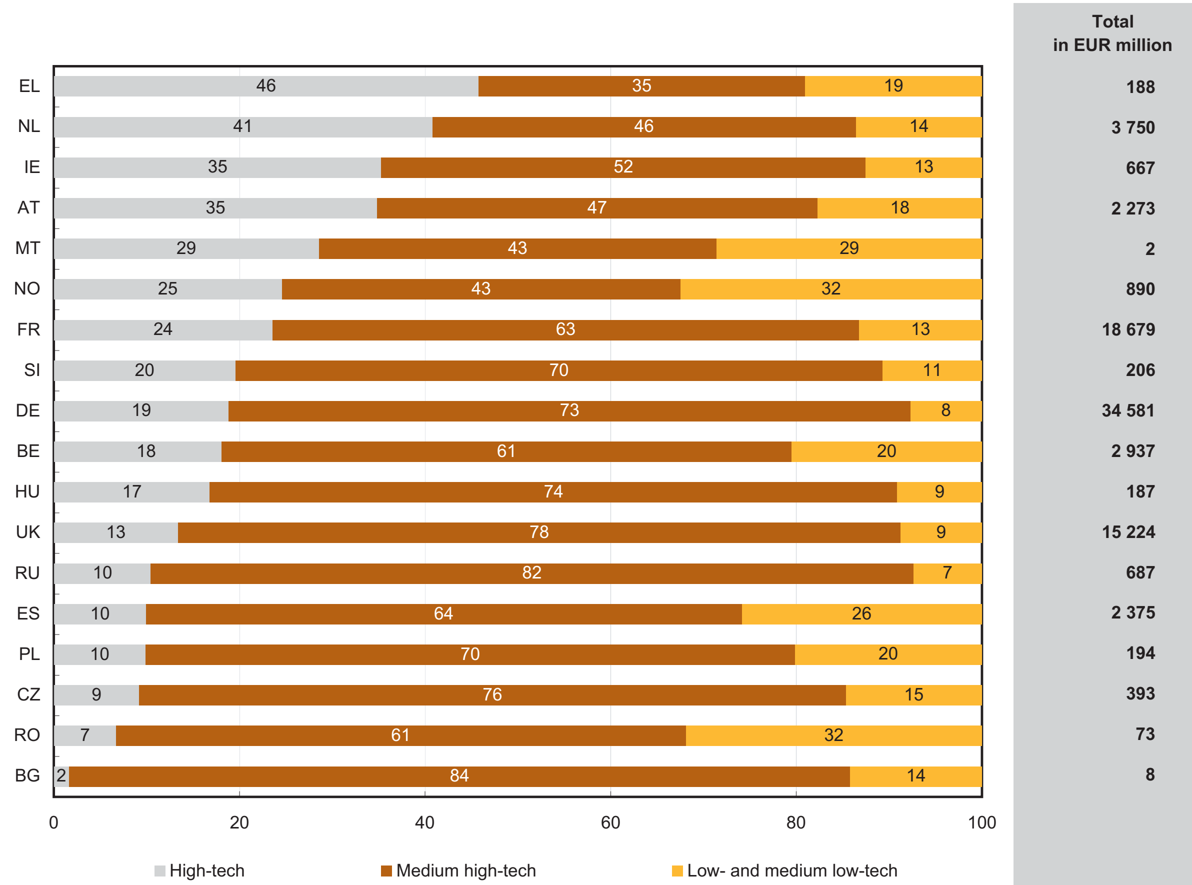
At the other end of the scale, a considerable share of R&D was performed in low-tech or medium low-tech manufacturing in Romania (32%), Norway (32%), Malta (29%) and Spain (26%).

In absolute terms, Germany was way ahead in business R&D expenditure in the manufacturing sector, at almost EUR 35 billion. This can be mainly explained by the fact that the manufacturing sector is much more developed in Germany than in France and the United Kingdom, as was reported for enterprises (Section 7.1) and employment (Section 7.5).

Germany was followed by France and the United Kingdom, at EUR 19 billion and EUR 15 billion respectively.

Business R&D expenditure in the manufacturing sector exceeded EUR 1 billion in four other Member States (for which data are available): the Netherlands, Austria, Belgium and Spain.

Figure 7.15 **Business enterprises R&D expenditure in manufacturing by technological intensity, selected countries — 2003**



Due to the unavailability of business R&D expenditure by NACE (level 2), it was not possible to calculate data by technological intensity for all Member States.
Exceptions to the reference year: 2004: SI and BE; 2002: HU, MT, AT and BG.

In 2004, R&D personnel in manufacturing enterprises across the EU-27 totalled more than 800 000 when expressed in terms of Full-Time Equivalent (FTE).

R&D personnel were mainly working in three countries: Germany, France and the United Kingdom, with 267 000, 135 000 and 119 000 respectively, expressed in FTE.

As already stated for employment (see Section 7.5) and for R&D expenditure in the manufacturing sector, Germany had as many R&D personnel as France and the United Kingdom put together. In other words, Germany alone accounted for almost a third of Europe's R&D personnel in the manufacturing sector.

In high-tech manufacturing, Germany again had most R&D staff (57 000), followed by France, the United Kingdom and Italy, with 36 000, 18 000 and 12 000 FTE respectively.

In medium high-tech manufacturing, the same countries, namely Germany, the United Kingdom and France ranked top in absolute terms, with 184 000, 85 000 and 78 000 persons FTE respectively.

Reflecting in part the economic structure of the respective country, this can be explained by the fact that more than 40% of Irish R&D personnel in the manufacturing sector were in reality employed in high-tech manufacturing. Other countries, such as Austria, Slovenia and to a lesser extent France and Portugal, also had a high share of R&D in the high-tech manufacturing sector. By comparison, in Poland, Romania and the United Kingdom, more than 70% of R&D personnel were actually employed in the medium high-tech manufacturing sector.

In 2004, more than half (52.1%) of all EU-27 R&D personnel employed in manufacturing were researchers. This share varied considerably from one country to another, with a figure of over 60% in Estonia, Ireland, Lithuania, Hungary, Malta, Poland, Romania, Finland and the United Kingdom, but below 40% in Greece, Italy and Slovenia. This was also the case in Switzerland and Croatia.

With the exception of Malta and Slovenia, the proportion of researchers among R&D personnel was higher in high-tech manufacturing than in total manufacturing. At 84.3%, Hungary had the highest proportion of researchers in high-tech manufacturing. Turkey followed closely on 84.1%.

Table 7.16 Business enterprises R&D personnel in full-time equivalent (FTE) and percentage of researchers in manufacturing sector by technological intensity, EU-27 and selected countries — 2004

	Manufacturing									
	Total		High-tech		Medium high-tech		Medium low-tech		Low-tech	
	R&D personnel	% of researchers	R&D personnel	% of researchers	R&D personnel	% of researchers	R&D personnel	% of researchers	R&D personnel	% of researchers
EU-27	816 870	52.1	:	:	:	:	:	:	:	:
EU-25	806 526	52.0	:	:	:	:	:	:	:	:
BE	22 886	46.7	4 306	51.1	12 751	46.7	3 699	41.9	2 131	46.5
BG	940	52.9	:	:	623	50.1	:	:	67	:
CZ	8 282	44.1	1 148	52.5	5 561	45.8	1 065	36.2	508	23.4
DK	17 173	54.8	:	:	:	:	:	:	:	:
DE	267 404	53.3	57 820	65.8	184 138	50.7	17 540	44.2	7 907	42.9
EE	298	64.8	86	70.9	:	:	:	:	:	:
IE	5 130	62.2	2 090	77.5	2 043	61.4	397	31.5	600	31.7
EL	5 543	30.5	:	:	2 273	44.6	407	30.9	:	:
ES	37 059	41.5	4 265	58.8	22 094	40.3	5 026	38.3	5 674	35.7
FR	135 378	47.5	36 280	66.8	77 524	41.7	12 651	35.0	8 924	36.3
IT	50 174	34.0	12 380	41.1	30 561	34.9	4 040	19.6	3 194	16.2
CY	89	59.7	:	:	:	:	:	:	:	:
LV	314	56.1	:	:	:	:	:	:	:	:
LT	459	65.1	:	:	:	:	:	:	:	:
LU	1 511	50.0	:	:	:	:	:	:	:	:
HU	4 665	61.3	744	84.3	3 368	59.3	229	56.3	324	:
MT	46	65.2	12	58.3	26	73.1	2	0.0	6	66.7
NL	33 186	42.3	:	:	16 645	48.0	2 248	43.1	:	:
AT	19 137	56.1	6 408	70.5	8 996	47.6	:	:	:	:
PL	8 929	62.1	912	71.8	6 580	61.5	794	56.0	643	62.5
PT	2 673	52.9	709	79.9	:	:	:	:	:	:
RO	9 404	60.0	486	74.7	6 589	60.0	1 643	63.5	686	41.7
SI	3 217	39.8	1 012	39.6	1 700	38.4	327	46.2	178	42.1
SK	1 025	45.3	:	:	:	:	:	:	:	:
FI	24 665	75.1	:	:	:	:	:	:	:	:
SE	38 748	55.7	:	:	:	:	:	:	:	:
UK	118 535	62.1	18 044	76.5	85 427	60.5	6 363	57.9	8 701	50.7
NO	7 071	68.2	1 762	80.3	3 285	70.9	721	62.6	1 303	48.3
CH	25 747	36.4	:	:	:	:	:	:	:	:
HR	603	36.8	44	75.0	411	36.0	33	:	115	:
TR	4 588	59.2	845	84.1	2 422	57.9	:	:	:	:

Due to the unavailability of business R&D personnel by NACE (level 2), it was not possible to calculate data by technological intensity for all Member States.
Exceptions to the reference year:
2003: BG, DE, EE, EL, IT, CY, LT, LU, PT, SE, UK, NO; 2002: FR, MT, AT, TR.
EU aggregates are estimated as the sum of available countries.

PART3

Chapter 8 - The 2006 EU Industrial R&D Investment Scoreboard

8.1 Introduction

The 2006 EU Industrial R&D Investment Scoreboard has been prepared from companies' annual reports and accounts and presents data on the top 1000 EU companies (1) and the top 1000 non-EU companies, ranked by their investment in Research and Development (R&D). The main indicators are R&D investment, net sales, operating profit, capital expenditure, number of employees and market capitalisation. The data in the 2006 Scoreboard cover the previous four financial years (2002, 2003, 2004 and 2005).

The term 'EU company' refers to an enterprise group whose ultimate parent has its registered office in a Member State of the EU. Likewise, a 'non-EU company' is one where the ultimate parent company is located outside the EU. The enterprise groups are broken down by industrial sectors, based on the Industry Classification Benchmark (ICB), jointly owned by Dow Jones & Company, Inc. and FTSE International Limited.

The ICB is a detailed and comprehensive structure for sector and industry analysis, facilitating the comparison of companies across four levels of classification (10 industries, 18 super-sectors, 39 sectors and 104 sub-sectors) and national boundaries. The 67 countries covered by the ICB also include the 27 EU Member States. Enterprise groups are assigned to the sub-sector whose definition most closely describes the nature of their business. The nature of an enterprise group's business is determined by its source of revenue or where it makes the majority of its revenue.

Data in the 2006 EU Industrial R&D Investment Scoreboard are not collected or monitored by Eurostat, but by the Commission's Industrial Research and Innovation (IRI) initiative, run jointly by the Directorate-General for Research (DG-RTD) and the Joint Research Centre (JRC) (2). Unlike the R&D data collected officially by Eurostat on all institutional sectors, the data in the 2006 EU Industrial R&D Investment Scoreboard cover only the business enterprise sector (BES).

For the sectoral breakdown of R&D statistics, however, Eurostat uses the Statistical Classification of Economic Activities in the European Community (NACE Rev.1.1.). This very detailed four-digit classification is subdivided into 17 sections, 31 sub-sections, 62 divisions, 224 groups and 514 classes. The data tables of the 2006 EU Industrial R&D Investment Scoreboard show not only the ICB codes but also the corresponding NACE codes. The industrial sectors mentioned in this chapter are, however, based on the ICB.

The enterprise group data cover all R&D investment, no matter where the investment is made. The ultimate goal is to provide recent information on industrial R&D investment by European and non-European companies so that new policy measures can be tailored more closely to attainment of the Barcelona target — i.e. that by 2010 overall EU R&D investment should approach 3% of GDP, at least two thirds of which should be from private sources.

After the data collected from the annual company reports had been validated, the information was fed into a database. This database allows updates or searches for general information at EU level, regardless of the search method or criteria used (by country, R&D variable or indicator, or information source).

The R&D investment included in the Scoreboard is the cash investment funded by the companies themselves. It excludes R&D undertaken under contract for customers, such as governments or other enterprise groups. It also excludes the share of R&D investment undertaken by any associated company or joint venture. Where part or all of R&D costs have been capitalised, the additions to the relevant intangible assets are included to calculate the cash investment and any amortisation avoided.

By contrast, Eurostat R&D statistics are based on Commission Regulation (EC) No 753/2004 of 22 April 2004 implementing Decision No 1608/2003/EC of the European Parliament and of the Council. The requirements for the R&D statistics are also consistent with those of the OECD and are based on the Frascati Manual.

The information in the Scoreboard differs therefore from other information such as the Business Enterprise R&D (BERD) data generated by the OECD, Eurostat and National Statistics Offices. The BERD data focus on R&D activity within the countries, independent of the source of funding and, at national level, exclude R&D carried out by enterprise groups in other countries. In brief, the distinction can be seen as 'funding vs activity'.

(1) The term "EU company" refers to a company whose ultimate parent has its registered office in a Member State of the EU. Likewise, the term "non-EU company" applies where the ultimate parent company is located outside the EU (see also the Annex on glossary and definitions). The term "enterprise group" is used in parallel.

(2) See: http://iri.jrc.es/.

8.2 Overview of industrial R&D investment

Enterprise group dynamics

In 2005 the number of EU companies among the 50 largest R&D investors remained the same as the previous year. The Top 50 included 18 companies each from the EU and the US, 10 from Japan (two fewer than in 2004), and 2 each from Switzerland and Korea. The two Korean enterprise groups, Samsung Electronics and Hyundai Motor, were also among the fastest growing R&D investors on the Scoreboard.

As in the year before, DaimlerChrysler led the Top 20 European companies in terms of total R&D investment, but was no longer the world's number one. At international level, DaimlerChrysler fell back to fourth place: it decreased its R&D investment only very slightly to EUR 5 646 million in 2005. The first three places are taken by the American enterprise groups Ford Motor, Pfizer and General Motors. While the national distribution in the European Top 20 was the same as in the previous year, the non-European Top 20 includes one more American enterprise group, replacing a Japanese firm.

Table 8.1 Top 20 enterprise groups in terms of total R&D investment (EUR million) — 2005

	EU		Non-EU	
1	DaimlerChrysler (DE)	5 649.0	Ford Motor (US)	6 781.9
2	Siemens (DE)	5 155.0	Pfizer (US)	6 308.9
3	GlaxoSmithKline (UK)	4 564.1	General Motor (US)	5 679.9
4	Volkswagen (DE)	4 075.0	Microsoft (US)	5 581.5
5	Sanofi-Aventis (FR)	4 044.0	Toyota Motor (JP)	5 423.9
6	Nokia (FI)	3 978.0	Johnson & Johnson (US)	5 350.9
7	BMW (DE)	3 115.0	Samsung Electronics (KR)	4 612.6
8	Robert Bosch (DE)	2 931.0	IBM (US)	4 559.2
9	AstraZeneca (UK)	2 864.5	Intel (US)	4 361.6
10	Ericsson (SE)	2 730.0	Novartis (CH)	4 108.2
11	EADS (NL)	2 367.0	Matsushita Electric (JP)	4 056.6
12	Philips Electronics (NL)	2 337.0	Sony (JP)	3 819.7
13	Renault (FR)	2 264.0	Roche (CH)	3 669.7
14	Peugeot-PSA (FR)	2 151.0	Honda Motor (JP)	3 359.7
15	BAE Systems (UK)	2 108.9	Merck (US)	3 262.1
16	Bayer (DE)	1 886.0	Motorola (US)	3 119.7
17	Alcatel (FR)	1 792.0	Hewlett-Packard (US)	2 958.6
18	Finmeccanica (IT)	1 746.0	Hitachi (JP)	2 909.5
19	Boehringer Ingelheim (DE)	1 360.0	General Electric (US)	2 903.5
20	Fiat (IT)	1 318.0	Nissan Motor (JP)	2 859.8

Source: Eurostat, based on "The 2006 EU Industrial R&D Investment Scoreboard"

Slight decline in R&D intensity due to relative high net sales growth

An average growth rate of 5.3% for EU companies in 2005 contrasted with the previous year's growth rate of 0.7% and a contraction of 2% in 2003. The growth in R&D investment by enterprise groups in the rest of the world in 2005 was 7.7%, one percent higher than the previous year.

Over the most recent three years covered (2003 to 2005), annual R&D growth was 1.7% for the 1 000 EU companies and 6.7% for the 1 000 non-EU companies. Together, the 1 000 companies from the EU and the 1 000 companies from outside the EU invested EUR 371 billion in R&D, representing around an estimated 80% of worldwide business R&D expenditure. The 1 000 EU companies accounted for almost one third (EUR 112.9 billion), compared with the EUR 257.7 billion spent by the 1 000 non-EU companies.

Net sales continued to grow in all regions at a faster pace than both R&D investment and operating earnings, which increased strongly for the EU enterprise groups. Due to the higher growth of net sales compared with R&D investment, average R&D intensity (R&D as % of sales) declined slightly worldwide. R&D investment per employee by the EU 1 000 enterprise groups is nearly half of that of the non-EU 1 000 enterprise groups.

Table 8.2 Overall performance by the companies on the Scoreboard — 2005

Factor	Non-EU 1000	EU 1000
R&D investment (EUR billion)	**257.7**	**112.9**
R&D investment per company (EUR billion)	0.26	0.11
Change in R&D investment from previous year	**7.7%**	**5.3%**
Annual change in R&D during last 3 years (2002-2005)	**6.7%**	**1.7%**
Net sales (EUR billion)	6 566.0	4 507.0
Change in net sales over previous year	**9.5%**	**7.0%**
R&D investment/employee (EUR)	12 607	6 592
Change in number of employees over previous year	3.0%	1.8%
R&D investment/net sales ratio (R&D intensity)	**3.9%**	**2.5%**
Profitability	**11.0%**	**10.8%**
Change in operating earnings over previous year	11.8%	21.2%

Source: Eurostat, based on "The 2006 EU Industrial R&D Investment Scoreboard"

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R&D concentration likely to remain high

R&D investment is concentrated in very few sectors and sub-sectors. The three main (sub-)sectors of the EU accounted for 47% of total R&D investment by the top 1 000 EU companies. The three are: automobiles & parts (sector), pharmaceuticals (sub-sector) and telecommunications equipment (sub-sector). R&D investment is slightly less concentrated for the non-EU companies. The three main (sub-)sectors are pharmaceuticals (sub-sector), automobiles & parts (sector) and computer hardware (sub-sector), which are responsible for 39% of total R&D investment by the top 1 000 non-EU companies.

When Table 8.3 is compared with Table 8.4, many differences emerge between the top 10 (sub-)sectors in the EU and outside the EU. In general, the figures for non-EU enterprise groups are higher. Non-EU enterprise groups invest more in R&D at sector level, per enterprise and also per employee. In particular, the data for market capitalisation are lower for EU enterprise groups, but this is also partly due to the non-availability of such data.

One example of the differences is illustrated by comparing the leading sectors in terms of R&D investment in the EU 'automobiles & parts' with the same sector for non-EU companies. Accounting for 23% of total R&D investment, the 'automobiles & parts' sector plays a major role in R&D in the EU. In 2005 the sector invested close to EUR 26 billion. The same sector outside the EU invested EUR 12 billion more. The gap is also visible at enterprise group level: R&D investment amounted to EUR 591 000 per enterprise group inside the EU and to EUR 733 000 per enterprise group outside.

Table 8.3 Top 10 (sub-)sectors in terms of R&D investment, by top EU enterprise group — 2005

Rank	Sub-sector	Enterprise group	R&D Investment/ sub-sector	R&D Investment/ enterprise group	R&D Investment 2005	R&D Investment Change 05/04	R&D Investment CAGR 3yrs	Employees	R&D Investment/ employee	Market Capitalisation
		#	%	€K	€m	%	%	#	€K	€m
1	Automobiles & parts	44	23.0	590.5	25 984.0	3.6	2.6	2 180 176	11.9	182 744
2	Pharmaceuticals	64	16.2	286.3	18 324.5	6.5	9.9	525 492	34.8	398 283
3	Telecommunications equipment	30	8.2	308.9	9 265.9	8.5	-4.1	219 588	42.1	125 312
4	Aerospace & defence	22	7.6	391.1	8 603.4	14.6	9.4	477 448	18.0	88 817
5	Electrical components & equipment	31	6.0	216.9	6 724.1	1.3	-3.8	755 980	8.9	110 573
6	Chemicals	49	5.7	131.9	6 462.7	-8.0	-3.2	620 901	10.4	160 968
7	Fixed line telecommunications	16	3.1	220.7	3 531.2	19.0	4.3	997 458	3.5	324 544
8	Semiconductors	26	3.0	131.8	3 427.1	9.0	11.6	110 124	31.1	35 688
9	Software	100	2.7	30.7	3 066.5	9.4	7.4	133 618	22.9	77 889
10	Industrial machinery	65	2.4	41.7	2 713.4	6.3	0.3	576 097	4.7	95 330

Source: Eurostat, based on "The 2006 EU Industrial R&D Investment Scoreboard"

Note: the number of enterprise groups may vary for each indicator (see methodological notes).

Table 8.4 Top 10 (sub-)sectors in terms of R&D investment, by top non-EU enterprise group — 2005

Rank	Sub-sector	Enterprise group	R&D Investment/ sub-sector	R&D Investment/ enterprise group	R&D Investment 2005	R&D Investment Change 05/04	R&D Investment CAGR 3yrs	Employees	R&D Investment/ employee	Market Capitalisation
		#	%	€K	€m	%	%	#	€K	€m
1	Pharmaceuticals	69	15.8	588.5	40 608.5	8.6	12.1	830 553	47.2	1 121 786
2	Automobiles & parts	52	14.8	732.8	38 107.4	6.7	7.1	2 639 262	13.4	466 337
3	Computer Hardware	59	8.3	360.5	21 270.4	6.1	1.1	1 508 917	13.6	366 734
4	Semiconductors	105	8.0	195.6	20 536.5	5.8	4.3	544 131	36.5	465 312
5	Electronical equipment	58	6.3	280.2	16 251.9	8.8	12.1	994 053	10.9	372 960
6	Software	90	5.8	167.0	15 028.3	10.6	9.6	348 727	42.6	450 703
7	Telecommunications equipment	44	5.4	315.8	13 896.4	10.7	-2.1	383 829	35.1	300 793
8	Leisure goods	25	5.1	522.1	13 053.4	3.5	6.7	776 816	16.4	162 376
9	Chemicals	74	4.1	141.5	10 467.7	4.0	2.4	795 713	12.5	342 045
10	General industrials	31	3.2	267.4	8 288.8	10.2	8.8	1 423 917	5.1	537 176

Source: Eurostat, based on "The 2006 EU Industrial R&D Investment Scoreboard"

Note: the number of enterprise groups may vary for each indicator (see methodological notes).

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R&D investment in EU countries

In 2005 just three countries (Germany, France and the UK) accounted together for around three quarters of both total R&D investment and sales and about 60% of the total number of EU Scoreboard companies. British, Dutch, Belgian, Danish and Swedish enterprise groups increased their shares of total R&D investment, while German, Italian and Finish groups saw a reduction compared with the previous year.

Ten enterprise groups from five new Member States — Czech Republic (2), Hungary (3), Poland (2), Slovenia (2) and Slovakia (1) — are included on the 2006 Scoreboard.

33% of the Scoreboard companies were British, but their R&D share amounted to only 19% and the share of sales to 29%. By contrast, only 17% of the Scoreboard companies were German but they were responsible for 34% of R&D and 26% of sales. This shows that the link between number of companies and proportions of R&D and sales is not always straightforward.

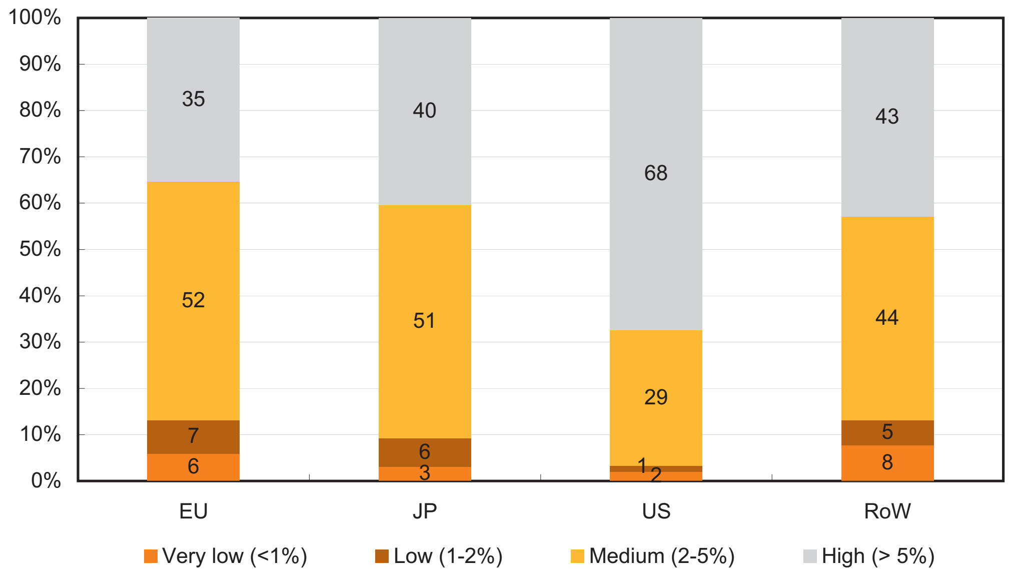
Table 8.5 Shares of R&D and sales in total for all EU enterprise groups and number of enterprise groups, by EU Member State — 2005

EU Member State	Proportion of R&D in total (%)	Proportion of Sales in total (%)	Number of enterprise groups in *Scoreboard* 2005
Germany	34.10	26.30	167
UK	19.00	28.80	327
France	18.90	19.00	112
Subtotal DE + UK + FR	*72.00*	*74.10*	*606*
Netherlands	7.50	3.90	44
Sweden	6.10	4.00	81
Finland	4.60	2.90	70
Italy	4.10	5.60	40
Denmark	1.90	1.30	37
Belgium	1.60	2.30	37
Spain	1.00	2.90	22
Austria	0.40	1.10	28
Ireland	0.35	0.40	12
Luxembourg	0.30	1.10	6
Hungary	0.10	0.02	3
Greece	0.05	0.04	6
Slovenia	0.04	0.01	1
Poland	0.02	0.16	2
Portugal	0.01	0.15	2
Czech Republic	0.01	0.12	2
Slovakia	0.01	0.01	1
TOTAL EU	100.00	100.00	1 000

Source: Eurostat, based on "The 2006 EU Industrial R&D Investment Scoreboard"

In the United States, the level of R&D intensity was the highest in 2005, with more than two thirds of the Scoreboard companies having an R&D intensity of over 5%. By contrast, in the EU only a little more that one third of the enterprise groups recorded a high R&D intensity, although more than half the EU companies had a medium R&D intensity of between 2% and 5%.

Figure 8.6 Share of R&D investment by level of R&D intensity, EU, Japan, the United States and Rest of the World — 2005

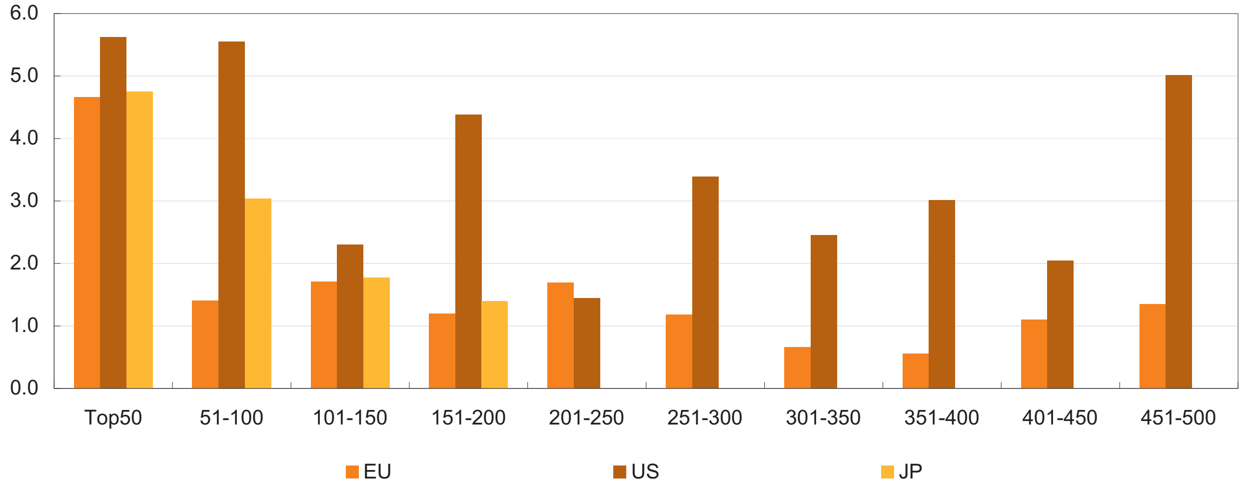


Source: Eurostat, based on "The 2006 EU Industrial R&D Investment Scoreboard"

The American companies in the Top 50 recorded the highest R&D intensity of more than 5.5% in 2005. EU and Japanese enterprise groups were nearly at the same level with more than 4.5%. R&D intensity fell steadily for the Japanese enterprise groups but much faster for those in the EU.

For the top 51 to 500 EU companies, R&D intensity varied between 1.7% and 0.6%. However, the picture is very different for US companies. The top two ranking steps (top 50 and 51-101) show almost the same high R&D intensity. R&D intensity decreases for the following steps, but surprisingly returns to a high level of 5% for the last category — 451 to 500.

Figure 8.7 **Share of R&D investment by level of R&D intensity, breakdown of 500 US, 500 European and 200 Japanese enterprise groups by ranking step — 2005**



Source: Eurostat, based on “The 2006 EU Industrial R&D Investment Scoreboard”

The breakdown by sector is different when EU enterprise groups are compared with non-EU companies. In Figure 8.8 only sectors with shares higher than 4% are shown. Smaller sectors are grouped in the category ‘others’. Whereas the sector size is comparable for pharmaceuticals & biotechnology, electronics & electrical equipment and chemicals, the other sectors exhibit fairly significant differences. For EU companies, the automobiles & parts and aerospace & defence sectors play a more important role in R&D investment than for non-EU companies. However, the opposite is true for technology hardware & equipment, software & computer services and leisure goods, where the shares of non-EU companies are higher.

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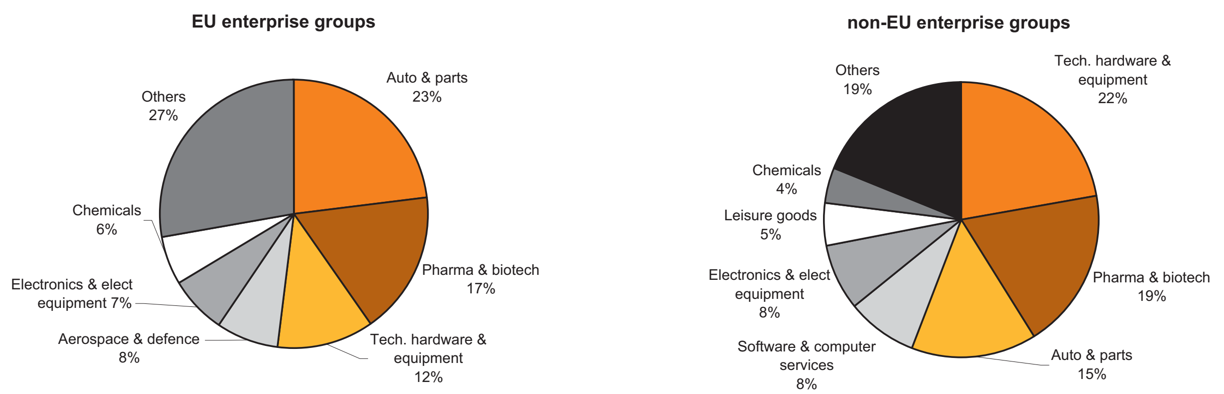
Figure 8.8 **Breakdown of Scoreboard enterprise groups, by sector — 2005**



Source: Eurostat, based on “The 2006 EU Industrial R&D Investment Scoreboard”

8.3 Other key findings

Considerable number of smaller and medium-sized EU companies in high R&D-intensive sectors

A concern raised in previous editions of the Scoreboard was the relative scarcity of smaller and medium-sized EU companies in highly R&D-intensive sectors. However, the extension of the 2006 EU Scoreboard to 1 000 companies has revealed a significant number of such firms in these sectors. Many of these enterprise groups belong to R&D-intensive sectors, especially software & computer services.

The EU enterprise groups have their registered offices in 20 Member States. New entrants are mostly from the UK (+117), Germany (+32), France (+31), Finland (+27) and Sweden (+21). In the non-EU listing, new entrants are mostly from the US (+189), Japan (+39), Taiwan (+24), Canada (+13) and Switzerland (+9). A few Member States have more than their proportional share of enterprise groups in R&D-intensive sectors (United Kingdom, Denmark, Ireland, Hungary or Sweden).

Pharmaceuticals, biotechnology and service sectors play an important role in R&D investment growth

The highest R&D growth rates by sector in 2005 and the previous four years are found in pharmaceuticals & biotechnology and in a number of services sectors (software & computer services, travel & leisure, media, health care equipment & services, and support services), which the present Scoreboard covers in more detail compared with previous editions. One of the services sectors, 'market' services, has shown a positive trend since 2000, which is also reflected in the rapid growth of the number of companies in these sectors on the Scoreboard.

The role of R&D for business performance

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The role of R&D investment as an input factor for a company and its impact on performance parameters such as profits, net sales and market share are analysed. Some descriptive statistics are presented to illustrate this issue for sectors with a high reliance on R&D. The analysis shows how the Scoreboard may be a useful tool to compare the relative performance and behaviour of enterprise groups. The relationship between R&D investment, sales and market shares is illustrated by descriptive statistics for automobiles & parts, pharmaceuticals and the car manufacturing sector. The link between R&D investment and company size and profitability is examined. Analyses of longer time-series for a sub-sample of Scoreboard companies confirm the findings.

A difficult question for a company is to establish what is the optimum level of R&D to maximise return on investment. At sector level, it seems that there is a standard set by the major R&D players in the sector. Large companies increasing their R&D intensity beyond this level may run the risk that this additional effort will be inefficient. In contrast, a higher-than-average R&D intensity in smaller firms may mean that they rely more on R&D to grow and increase market share. The analysis indicates that, at least in some sectors, enterprise groups with an R&D intensity lower than the sector-wide standard or decreasing over a long period may lose market share.

Scoreboard webpage

The electronic version of the 2006 EU Industrial R&D Investment Scoreboard is available on the Scoreboard webpage at:

http://iri.jrc.es/research/Scoreboard_2006_data.htm

Most data are also available in Eurostat's reference database NewCronos.

Annexes

Methodological Notes

This part presents, in some detail, the methodology used for the data set out in this publication. After some general information, specific details are given for the following domains:

- Government budget appropriations or outlays on R&D — GBAORD,
- R&D expenditure and personnel,
- Human Resources in Science and Technology — HRST,
- Innovation,
- Patents,
- High-tech industries and knowledge based services and
- The 2006 EU industrial R&D investment scoreboard.

1. General information

1.1 Currency

Series in current euro have been calculated by using the annual average euro-national currency exchange rate.

The Purchasing Power Standard (PPS) is a fictive 'currency' unit created to remove differences in purchasing power. Data expressed in PPS are derived from figures expressed in national currency by applying the PPS-national currency exchange rate.

Data measured in 1995 constant PPS are first corrected for inflation using the GDP deflator (a Paasche index with 1995 = 100 as base year) of the country in question before applying the PPS-national currency exchange rate.

1.2 GDP

Gross domestic product (GDP) at market prices is the final result of the production activity of resident producer units (ESA 95, 8.89). It can be defined in three ways:

- Output approach:
GDP is the sum of gross value added of the various institutional sectors or the various industries plus taxes and less subsidies on products (which are not allocated to sectors and industries). It is also the balancing item in the total economy production account.

- Expenditure approach
GDP is the sum of final uses of goods and services by resident institutional units (final consumption expenditure and gross capital formation), plus exports and minus imports of goods and services.

- Income approach
GDP is the sum of uses in the total economy generation of income account: compensation of employees, taxes on production and imports less subsidies, gross operating surplus and mixed income of the total economy.

1.3 Population

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The population on 1st January is the number of inhabitants of a given area on 1 January of the year in question (or, in some cases, on 31 December of the previous year). The population figures are based on data from the most recent census adjusted by the components of population change produced since the last census, or based on population registers.

For HRST indicators, population totals are calculated from the LFS data, thus using the same source for numerators and denominators. Population totals derived from LFS may differ from the population totals from demographic statistics used in other chapters mainly because of a different reference date and the non-inclusion of some institutionalised persons.

1.4 Employment

Employed persons are persons aged 15 and over who during the reference week performed work, even for just one hour per week, for pay, profit or family gain or were not at work but had a job or business from which they were temporarily absent because of, e.g. illness, holidays, industrial dispute and education or training.

1.5 Labour force

The labour force iis the active population; this is the sum of employed and unemployed persons as defined by the EU Labour Force Survey. Persons in employment are those who during the reference week did any work for pay or profit, or were not working but had jobs from which they were temporarily absent, including family workers. Unemployed persons comprise persons aged 15 to 74 who were:

- without work during the reference week, i.e. neither had a job nor were at work (for one hour or more) in paid employment or self-employment;

- currently available for work, i.e. were available for paid employment or self-employment before the end of the two weeks following the reference week;

- actively seeking work, i.e. had taken specific steps in the four-week period ending with the reference week to seek paid employment or self-employment or who found a job to start later, i.e. within a period of at most three months.

1.6 Annual average growth rate

Annual average growth rates (AAGR) in this publication are calculated according to the following formula:

$$AAGR_{T,\ T\text{-}n} = [(X_T/X_{T\text{-}n})^{1/n} - 1] \times 100$$

Where X = value,
T = final year,
n = period in years for which the annual growth rate is calculated.

1.7 Institutional classification by sectors

The business enterprise sector - BES

With regard to R&D, the business enterprise sector includes: all firms, organisations and institutions whose primary activity is the market production of goods or services (other than higher education) for sale to the general public at an economically significant price and the private non-profit institutions mainly serving them - *Frascati Manual, § 163*.

The government sector - GOV

In the field of R&D, the government sector includes: all departments, offices and other bodies which furnish but normally do not sell to the community those common services, other than higher education, which cannot otherwise be conveniently and economically provided, and administer the state and the economic and social policy of the community (public enterprises are included in the business enterprise sector) as well as PNPs controlled and mainly financed by government - *Frascati Manual, § 184*.

The higher education sector - HES

This sector comprises: all universities, colleges of technology and other institutes of post-secondary education, whatever their source of finance or legal status. It also includes all research institutes, experimental stations and clinics operating under the direct control of or administered by or associated with higher education establishments - *Frascati Manual, § 206*.

The private non-profit sector - PNP

This sector covers: non-market, private non-profit institutions serving households (i.e. the general public) and private individuals or households - *Frascati Manual, § 194*.

1.8 Nomenclature - NACE Rev 1.1

NACE ([1]) is the statistical classification of economic activities; it is designed to categorise data relating to "statistical units", in this case a unit of activity, for example an individual plant or group of plants constituting an economic entity such as an enterprise.

Section/sub-section	Description	NACE Rev 1.1 codes
A	Agriculture, hunting, forestry	01 to 02
B	Fishing	5
C	Mining and quarrying	10 to 14
CA	Mining and quarrying of energy producing materials	10 to 12
CB	Mining and quarrying, except of energy producing materials	13 to 14
D	Manufacturing	15 to 37
DA	Manufacture of food products, beverages and tobacco	15 to 16
DB	Manufacture of textiles and textile products	17 to 18
DC	Manufacture of leather and leather products	19
DD	Manufacture of wood and wood products	20
DE	Manufacture of pulp, paper and paper products; publishing and printing	21 to 22
DF	Manufacture of coke, refined petroleum products and nuclear fuel	23
DG	Manufacture of chemicals, chemical products and man-made fibres	24
DH	Manufacture of rubber and plastic products	25
DI	Manufacture of other non-metallic mineral products	26
DJ	Manufacture of basic metals and fabricated metal products	27 to 28
DK	Manufacture of machinery and equipment n.e.c.	29
DL	Manufacture of electrical and optical equipment	30 to 33
DM	Manufacture of transport equipment	34 to 35
DN	Manufacturing n.e.c.	36 to 37
E	Electricity, gas and water supply	40 to 41
F	Construction	45
G	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods	50 to 52
H	Hotels and restaurants	55
I	Transport, storage and communication	60 to 64
J	Financial intermediation	65 to 67
K	Real estate, renting and business activities	70 to 74
L	Public administration and defence; compulsory social security	75
M	Education	80
N	Health and social work	85
O	Other community, social and personal service activities	90 to 93
P	Activities of households	95 to 97
Q	Extra-territorial organizations and bodies	99

([1]) NACE is derived from the French "**N**omenclature statistique des **A**ctivités économiques dans la **C**ommunauté **E**uropéenne" (Statistical classification of economic activities in the European Community)

Aggregations of manufacturing based on NACE Rev. 1.1

Eurostat uses the following aggregation of the manufacturing industry according to technological intensity and based on NACE Rev. 1.1 at 3-digit level for compiling aggregates related to high-technology, medium high-technology, medium low-technology and low-technology.

Manufacturing industries	NACE Rev 1.1 codes
High-technology	**24.4** Manufacture of pharmaceuticals, medicinal chemicals and botanical products; **30** Manufacture of office machinery and computers; **32** Manufacture of radio, television and communication equipment and apparatus; **33** Manufacture of medical, precision and optical instruments, watches and clocks; **35.3** Manufacture of aircraft and spacecraft
Medium-high-technology	**24** Manufacture of chemicals and chemical product, **excluding 24.4** Manufacture of pharmaceuticals, medicinal chemicals and botanical products; **29** Manufacture of machinery and equipment n.e.c.; **31** Manufacture of electrical machinery and apparatus n.e.c.; **34** Manufacture of motor vehicles, trailers and semi-trailers; **35** Manufacture of other transport equipment, **excluding 35.1** Building and repairing of ships and boats **and excluding 35.3** Manufacture of aircraft and spacecraft.
Medium-low-technology	**23** Manufacture of coke, refined petroleum products and nuclear fuel; **25 to 28** Manufacture of rubber and plastic products; basic metals and fabricated metal products; other non-metallic mineral products; **35.1** Building and repairing of ships and boats.
Low-technology	**15 to 22** Manufacture of food products, beverages and tobacco; textiles and textile products; leather and leather products; wood and wood products; pulp, paper and paper products, publishing and printing; **36 to 37** Manufacturing n.e.c.

Please note that in a few cases (R&D, Employment in high-tech and HRST), due to restrictions of the data sources used, the aggregations are only made on a NACE 2-digit level. This means that High-technology includes the NACE codes 30, 32 and 33, Medium-high-technology 24, 29, 31, 34 and 35, Medium-low-technology 23 and 25 to 28 and Low-technology 15 to 22 and 36 to 37.

Aggregations of services based on NACE Rev. 1.1

Following a similar approach as for manufacturing, Eurostat defines the following sector as knowledge-intensive services (KIS) or as less knowledge-intensive services (LKIS):

Knowledge based services	NACE Rev 1.1 codes
Knowledge intensive services (KIS)	**61** Water transport; **62** Air transport; **64** Post and telecommunications; **65 to 67** Financial intermediation; **70 to 74** Real estate, renting and business activities**;** **80** Education; **85** Health and social work; **92** Recreational, cultural and sporting activities
High tech KIS	**64** Post and telecommunications; **72** Computer and related activities; **73** Research and development.
Market KIS (excl. financial intermediation and high-tech services)	**61** Water transport; **62** Air transport; **70** Real estate activities; **71** Renting of machinery and equipment without operator and of personal and household goods; **74** Other business activities.
Less Knowledge-Intensive Services (LKIS)	**50 to 52** Motor trade; **55** Hotels and restaurants; **60** Land transport; transport via pipelines; **63** Supporting and auxiliary transport activities; activities of travel agencies; **75** Public administration and defence; compulsory social security; **90** Sewage and refuse disposal, sanitation and similar activities; **91** Activities of membership organization n.e.c.; **93** Other service activities; **95** Activities of households as employers of domestic staff; **99** Extra-territorial organizations and bodies
Market services less KIS	**50 to 52** Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods; **55** Hotels and restaurants; **60** Land transport; transport via pipelines; **63** Supporting and auxiliary transport activities; activities of travel agencies.

1.9 Nomenclature of territorial units for statistics - NUTS

The regional data presented in this publication are broken down according to the Nomenclature of Territorial Units for Statistics - NUTS - classification, 2003 version. The NUTS was established by the Statistical Office of the European Communities (Eurostat), in co-operation with the Commission's other departments, to provide a single, uniform breakdown of territorial units for the production of regional statistics for the European Union.

The NUTS is a five-level hierarchical classification comprising three regional and two local levels. In this way, NUTS subdivides each Member State into a whole number of NUTS 1 regions, each of which is in turn subdivided into a whole number of NUTS 2 regions, and so on. In the present publication most data are presented at NUTS 2 level on the basis of the NUTS 2003 version. The exceptions have been indicated in the tables or figures.

For eight countries (Denmark, Estonia, Cyprus, Latvia, Lithuania, Luxembourg, Malta and Slovenia) the national level coincides with the NUTS 2 level, which explains their potential presence amongst the regional rankings in this publication.

Iceland and Norway are not included in the NUTS classification but do have similar statistical regions. Iceland is also classified at the statistical region level 2.

Some data are presented at NUTS 1 level. For twelve countries (Czech Republic, Denmark, Estonia, Ireland, Cyprus, Latvia, Lithuania, Luxembourg, Malta, Slovenia, Slovakia and Sweden) the national level coincides with the NUTS 1 level, which explains their potential presence amongst the regional rankings in this publication.

For Bulgaria, Romania and Croatia, the NUTS level 2 has been revised and no one-to-one correspondence is possible between the previous and the new NUTS level 2. This could explain the lack of data at NUTS level 2 for these countries in some figures of the present panorama.

2. Methodological notes by domain

2.1 Government Budget Appropriations or Outlays on R&D - GBAORD

Definition

Government budget appropriations or outlays on R&D (GBAORD) are all appropriations allocated to R&D in central government or federal budgets and therefore refer to budget provisions, not to actual expenditure. Provincial or state government should be included where the contribution is significant. Unless otherwise stated, data include both current and capital expenditure and cover not only government-financed R&D performed in government establishments, but also government-financed R&D in the business enterprise, private non-profit and higher education sectors, as well as abroad (*Frascati Manual, § 496*). Data on actual R&D expenditure, which are not available in their final form until some time after the end of the budget year concerned, may well differ from the original budget provisions. This and further methodological information can be found in the *Frascati Manual*, OECD, 2002.

GBAORD data are assembled by national authorities using data for public budgets. These measure government support to R&D activities, or, in other words, how much priority Governments place on the public funding of R&D.

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Eurostat collects aggregated data which are checked and processed, and compared with other data sources such as OECD. Then, all the necessary aggregates are calculated (or estimated).

Sources

The basic data are forwarded to Eurostat by the national administrations of Member States and other countries. Data for Japan and the United States come from the OECD – Main Science and Technology Indicators (MSTI).

Statistical data compilation

Until 2003, data on GBAORD were collected under a gentlemen's agreement. From the reference year 2004 on, data collection is based on the Commission Regulation on statistics on science and technology, No 753/2004 (OJ L 118, page 23 of 23 April 2004).

Breakdown by socio-economic objective

Government R&D appropriations or outlays on R&D are broken down by socio-economic objectives on the basis of NABS — *Nomenclature for the analysis and comparison of scientific programmes and budgets*, Eurostat 1994. The 1993 version of NABS applies from the 1993 final and the 1994 provisional budgets onwards.

The NABS socio-economic objectives are:

- 01: Exploration and exploitation of the earth
- 02: Infrastructure and general planning of land-use
- 03: Control and care of the environment
- 04: Protection and improvement of human health
- 05: Production, distribution and rational utilization of energy
- 06: Agricultural production and technology
- 07: Industrial production and technology
- 08: Social structures and relationships
- 09: Exploration and exploitation of space
- 10: Research financed from GUF
- 11: Non-oriented research
- 12: Other civil research
- 13: Defence
- **Total civil GBAORD** (sum of socio-economic objectives 01 to 12)
- **Total GBAORD** (sum of socio-economic objectives 01 to 13)

Not all countries collect the data directly by NABS. Some follow other compatible classifications (OECD, Nordforsk), which are then converted to the data compiled according to the NABS classification (see Table 8.2 of the *Frascati Manual*).

Exceptions

No data exist for Bulgaria, and therefore EU aggregates exclude Bulgaria.
No GBAORD data exist for Luxembourg before 2000, and therefore EU aggregates exclude Luxembourg before that year.
No GBAORD data exist for Cyprus before 2004, and therefore EU aggregates exclude Cyprus before that year.
No GBAORD data exist for Hungary before 2005, and therefore EU aggregates exclude Hungary before that year.

Time series

The analysis in the present Panorama covers the period 1995 to 2005, with 2005 being provisional.

2.2 R&D expenditure and personnel

Concepts and definitions

The basic concepts, guidelines for collecting data and the classifications used in compiling statistics on research and experimental development are given in the *Frascati Manual* — OECD, 2002. R&D expenditure and personnel are particularly detailed in chapters 5 and 6 respectively. Regional data are collected according to the standards defined by the *Regional Manual* — Eurostat 1996.

Research and experimental development (R&D) activities comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications. There are two basic statistical variables in this domain, namely R&D expenditure and personnel.

Sources

The basic data are forwarded to Eurostat by the national administrations of Member States and other countries. Data for China, Japan and the United States come from the OECD – Main Science and Technology Indicators (MSTI).

Statistical data compilation

Until 2003, data on R&D were collected under a gentlemen's agreement. From the reference year 2003 on, data collection is based on the Commission Regulation on statistics on science and technology, No 753/2004 (OJ L 118, page 23 of 23 April 2004).

R&D expenditure

Intramural expenditures are all expenditures for R&D performed within a statistical unit or sector of the economy during a specific period, whatever the source of funds (*Frascati Manual*, § 358).

R&D intensity
R&D intensity is R&D expenditure expressed as a percentage of GDP.
For the computation of R&D intensity at the national level (EEA countries), GDP from national accounts is used as reference data. At the regional level, GDP data are taken from the regional accounts. Both data series were extracted from NewCronos.

R&D personnel

Data on R&D personnel measure the resources going directly to R&D activities. The total R&D personnel is defined as follows:

> All persons employed directly on R&D should be counted, as well as those providing direct services such as R&D managers, administrators and clerical staff. Those providing indirect services, such as canteen and security staff, should be excluded (*Frascati Manual, § 294-296*).

Full-time equivalent - FTE

Full-time equivalent corresponds to one year's work by one person. Thus, someone who normally devotes 40% of his/her time to R&D and the rest to other activities (e.g. teaching, university administration or counselling) should be counted as only 0.4 FTE.

Personnel in head count - HC

Head count corresponds to the number of individuals who are employed mainly or partly on R&D. For purposes of comparison between different regions and periods, this indicator is often used in conjunction with employment or population variables.

Classifications

Institutional classification

Internal expenditure and R&D personnel are broken down by institutional sector, i.e. the sector in which the R&D is performed. There are four main sectors::

- The business enterprise sector - BES;
- The government sector - GOV;
- The higher education sector - HES;
- The private non-profit sector - PNP.

For definition of institutional sectors, please refer to general information.

Source of funds

R&D expenditure is subdivided into five sources of funds: Business Enterprise, Government, Higher Education, PNP and Abroad — *Frascati Manual, § 389 ff*. Since the amounts from the Higher Education and PNP sectors are small, they have been combined as "other national sources".

Field of sciences

Data on R&D expenditure and personnel may be broken down by six fields of science. The classification of field of science is based on the nomenclature suggested by UNESCO: *Recommendation concerning the International Standardisation of Statistics on Science and Technology*. These fields are: natural sciences, engineering and technology, medical sciences, agricultural sciences, social sciences and humanities.

Sector of activity

Data on R&D expenditure and personnel in the BES may be broken down by sector of economic activity on the basis of the NACE Rev 1.1(see general methodologies).

Size class of enterprise

Data on R&D personnel in the BES may be broken down by size class of enterprises. The size classes of enterprises are:

- 0 persons employed,
- 1 to 9 persons employed,
- 10 to 49 persons employed,
- 50 to 249 persons employed,
- 250 to 499 persons employed,
- 500 and more persons employed.

Type of cost

R&D expenditures include both current and capital expenditures.

- Current costs are composed of labour costs and other current costs. The current costs comprise annual wages and salaries and all associated costs or fringe benefits, such as bonus payments, holiday pay, contributions to pension funds and other social security payments, payroll taxes, etc. The other current costs comprise non-capital purchases of materials, supplies and equipment to support R&D performed by the statistical unit in a given year.

-Capital expenditures are the annual gross expenditures on fixed assets used in the R&D programmes of statistical units. They should be reported in full for the period when they took place and should not be registered as an element of depreciation.

Occupation

- Researchers: They are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, and in the management of the projects concerned (*Frascati Manual, § 301*).

- Technicians and equivalent staff: they are persons whose main tasks require technical knowledge and experience in one or more fields of engineering, physical and life sciences or social sciences and humanities (*Frascati Manual, § 306*).

- Other supporting staff: This includes skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D projects or directly associated with such projects (*Frascati Manual, § 309*).

Qualification

ISCED provides the basis for classifying R&D personnel by formal qualification. Six classes are recommended for the purposes of R&D statistics but only four are usually collected::

- ISCED level 6: holders of university degrees at Doctorate level

- ISCED level 5A: holders of basic university degrees below the Doctorate level:

- ISCED level 5B: holders of other tertiary level diplomas:

- Others: this includes holders of other post-secondary non-tertiary diplomas (ISCED level 4), holders of diplomas of secondary education (ISCED level 3) and all those with secondary diplomas at less than ISCED level 3 or with incomplete secondary qualifications or education not falling under any of the other classes.

Geographical coverage

These data are available for EU-27 Member States, candidate countries, Iceland, Norway, Switzerland, China, Japan, Russia and the United States at the national level and for European countries at the regional level NUTS level 2 (see general methodologies).

Aggregates

For both R&D expenditure and personnel, EU totals are calculated as the sum of the national data by sector. Where data are missing, estimates are first made for the country in question, reference period, institutional sector or relevant R&D variable, as appropriate. This method is not applied identically to the calculation of R&D personnel in head count (HC). The estimates for R&D personnel in full time equivalents (FTE) serve as a basis for the HC calculation. An FTE/HC ratio based on available FTE and HC personnel data at the national level is estimated for the EU aggregates, by institutional sector and by year. This ratio is then applied to the FTE data to calculate the EU totals in HC.

- EU and EEA aggregates are estimated values,
- EEA: Liechtenstein is not included.

Time series

Data are presented for the period 2000-2005. However, data series in NewCronos are available from 1981 onwards with differences in terms of availability according to variables and institutional sectors. Not all years are complete, and therefore the latest year available for each country is presented in the analysis.

Additional information on the methodology used may be found at Eurostat's reference database – NewCronos.

2.3 Human resources in science and technology

Statistics on Human Resources in Science and Technology — HRST — can improve our understanding of both the demand for, and supply of highly qualified personnel. The data presented in this publication focus on two main aspects: stocks and flows. The former serves to show the needs and the current situation of the labour force, and the latter indicates to what degree this demand is likely to be met in the future by looking at the current participation and graduation output of educational systems.

The general recommendations for the collection of HRST data are laid down in the *Canberra Manual* ([1]), where HRST is defined as a person fulfilling one of the following conditions:

- successfully completed education at the third level in an S&T field of study (ISCED '97 version levels 5a, 5b or 6) or;
- not formally qualified as above but employed in an S&T occupation where the above qualifications are normally required (ISCO '88 COM codes 2 or 3).

The conditions of the above educational or occupational requirements are considered according to internationally harmonised standards:

- the *International Standard Classification of Education* - ISCED - giving the level of formal education achievement;
- the *International Standard Classification of Occupation* - ISCO - detailing the type of occupation.

Stocks

Stocks provide information on the number of HRST at a particular point in time. In this publication, stock data relate to the employment status as well as the occupational and educational profiles of individuals in quarter 2 of any given year.

HRST stock data and their derived indicators are extracted and built up using data from the EU Labour Force Survey. The EU Labour Force Survey is based on a sample of the population. All results conform to Eurostat guidelines on sample-size limitations and are therefore not published if the degree of sampling error is likely to be high and flagged as unreliable if the degree of reliability is too small.

The basic categories of HRST are as follows:

Category	People that have/are
HRST: Human Resources in Science and Technology	• successfully completed education at the third level in a S&T field of study (ISCED '97 version levels 5a, 5b or 6); **or** • not formally qualified as above but are employed in a S&T occupation where the above qualifications are normally required (ISCO '88 COM codes 2 or 3).

([1]) Manual on the Measurement of Human Resources devoted to S&T - *Canberra Manual*, OECD, Paris, 1994.

Sub-categories of HRST	People belonging to HRST that have/are
HRSTO: Human Resources in Science and Technology — Occupation	• employed in a S&T occupation (ISCO '88 COM codes 2 or 3).
HRSTE: Human Resources in Science and Technology — Education	• successfully completed education at the third level in a S&T field of study (ISCED '97 version levels 5a, 5b or 6).
HRSTC: Human Resources in Science and Technology — Core	• successfully completed education at the third level in a S&T field of study (ISCED '97 version levels 5a, 5b or 6) **and** • are employed in a S&T occupation (ISCO '88 COM codes 2 or 3).
S&E: Scientists and Engineers	• employed in "Physical, mathematical and engineering" occupations or "life science and health" occupations (ISCO '88 COM codes 21 and 22).
HRSTU: Human Resources in Science and Technology — Unemployed	• successfully completed education at the third level in a S&T field of study (ISCED '97 version levels 5a, 5b or 6) **and** are unemployed.
NHRSTU: Unemployed non-HRST	• no education at the third level in a S&T field of study **and** are unemployed.

Note that according the Canberra Manual, § 71, the seven broad fields of study in S&T are: natural sciences, engineering and technology, medical sciences, agricultural sciences, social sciences, humanities and other fields.

Inflows

HRST inflows are the number of people who do not fulfil any of the conditions for inclusion in HRST at the beginning of a time period but gain at least one of them during the period.

The number of graduates from a country's higher education system represents the main inflow into the national stock of HRST.

HRST education inflow data are extracted from the Eurostat Education database building on the UNESCO/OECD/Eurostat questionnaire on education, which is based on the International Standard Classification of Education — ISCED. The user should note that European education systems differ between countries and that duplications of degrees might exist for some countries.

The International Standard Classification of Education - ISCED 97

Levels of tertiary education	
ISCED level 5A	• programmes that are largely theoretically based and are intended to provide sufficient qualifications for gaining entry into advanced research programmes and professions with high skill requirements.
ISCED level 5B	• programmes that are generally more practical/ technical/occupationally specific than ISCED 5A programmes.
ISCED level 6	• this level is reserved for tertiary programmes that lead to the award of an advanced research qualification. The programmes are devoted to advanced study and original research.

This publication includes the following totals and sub-totals (for ISCED 1997 version):

Title	Short name	Description	ISCED '97 subject codes
Total	Total	Sum of fields of study	
Science and Engineering	S&E	Life sciences, Physical sciences, Mathematics and statistics, Computing, Engineering and engineering trades, Manufacturing and processing, Architecture and building.	42, 44, 46, 48, 52, 54, 58.

The International Standard Classification of Occupations - ISCO (S&T occupations)

Title	ISCO subject codes	Description
Professionals	ISCO 2	• occupations whose main tasks require a high level of professional knowledge and experience in the fields of physical and life sciences, or social sciences and humanities.
Technicians and Associate professionals	ISCO 3	• occupations whose main tasks require technical knowledge and experience in one or more fields of physical and life sciences, or social sciences and humanities.

The user should note that the definition of S&T occupations deviates to a certain extent from the recommendations laid down in the Canberra Manual. In addition to ISCO major groups 2 and 3, the Canberra Manual proposes also considering the following as HRST: production and operations managers, other specialist managers, managers of small enterprises (ISCO 122, 123 and 131) who may work in the field of S&T. However, they are not included in the term HRST as used here (but they are included in HRSTE if they have successfully completed third level education).

The limitation applied here is justified, as a pilot survey conducted in 1995 tested the validity of the original definitions for HRST and the results indicated that, for the EU, the inclusion of these particular managerial occupations distorted the results significantly, due to variations between countries in the treatment and classification of managers.

Doctorate students

The term "doctorate" defines in general tertiary education programmes which lead to the award of an advanced research degree (ISCED level 6), e.g. a doctorate in economics.

For the definition of this level, the following criteria are relevant:

- Main criterion: It typically requires the submission of a thesis or dissertation of publishable quality which is the product of original research and represents a significant contribution to knowledge.
- Subsidiary criterion: It prepares graduates for faculty posts in institutions offering ISCED 5A programmes, as well as research posts in government, industry, etc.

The programmes are therefore devoted to advanced study and original research and are not based on coursework only. They usually require 3-5 years of research and coursework, generally after a Master's degree. Indicators of the number of doctorate students therefore provide an idea of the degree to which countries will have researchers at the highest level of education.

Foreign students

A foreign student is defined as someone not having the citizenship of the country in which he/she is educated. Overestimation of non-national students may occur in some countries where permanently resident second generation migrants with foreign nationalities constitute an important group of students.

Mobility

Data on job-to-job mobility can be defined as the movement of employed HRST from one job to another, during the past 12-month period. They do not include inflows into the labour market from unemployment or inactivity.
Employed HRST are those who have:

- successfully completed tertiary level education in an S&T field of study and are employed in any type of occupation or
- are not formally qualified as above but are employed in an S&T occupation.

Breakdown by sector of activity

HRST data by sector of activity are collected according to the statistical classification of economic activities in the European Community — NACE Rev. 1.1. For further information on the sector groups, please refer to the General Information part.

Breakdown by nationality

HRST data by nationality are based according the citizenship of the person. It is defined as the particular legal bond between an individual and his/her state acquired by birth or naturalisation whether by declaration, option, marriage or other means in accordance with national legislation. The following aggregates are distinguished in this publication:

- Nationals: Persons having citizenship of the country of residence.
- Non-nationals: Persons having a citizenship different to the country of residence.

Time series

Data are available in many countries from 1994 onwards, but differences exist and certain years are missing. Users should note that the existence of data in this NewCronos domain also depends on their reliability. The guidelines on the sample size reliability of the data established by the EU LFS are applied to the HRST database. Therefore, breakdowns for which quality levels are considered insufficient are either flagged as not available or unreliable.

The readers should note that, in mid-2007, HRST results would be updated in Eurostat's reference database by using a slightly different methodology compared to the data shown in this Panorama. This new methodology will take into account the changes in the EU LFS data collection process. In addition, the population of reference will be based the age group 15-74 years old and not the entire population as is the case in this publication.

Sources

Additional information on the methodology used may be found at Eurostat's reference database (http://epp.eurostat.ec.europa.eu/portal/page?_pageid=0,1136250,0_45572555&_dad=portal&_schema=PORTAL) under Science and Technology / Human Resources in Science & Technology.

2.4 Innovation

Community Innovation Survey

At European level, the **Community Innovation Survey (CIS)** data are the main source of information to study innovation drivers and company behaviour towards innovation.

The **Community Innovation Survey (CIS)** is a survey on innovation activity in enterprises covering EU Member States, candidate countries, Iceland and Norway.

The data are collected on a two-yearly basis (from 2004 onwards). The third survey (CIS 3) was implemented in 2000/2001 in most countries. The latest survey (CIS 4) was carried out in 25 Member States, candidate countries, Iceland and Norway in 2005, based on the reference year 2004.

In order to ensure comparability across countries, Eurostat, in close cooperation with the EU Member States, developed standard core questionnaires for CIS 3 and CIS 4, accompanied by a set of definitions and methodological recommendations.

CIS 3 and CIS 4 are based on the Oslo Manual (2nd edition, 1997), which gives methodological guidelines and defines the concept of innovation, and on Commission Regulation No 1450/2004. As the questionnaires for the two surveys are not fully identical, the results are sometimes not fully comparable.

STATISTICAL UNITS

The main statistical unit for both CIS 3 and CIS 4 was the **enterprise.**

The target population for CIS 3 and CIS 4 was the total population of enterprises (with 10 or more employees) engaged primarily in the following market activities: mining and quarrying (NACE 10-14), manufacturing (NACE 15-37), electricity, gas and water supply (NACE 40-41), wholesale trade (NACE 51), transport, storage and communication (NACE 60-64), financial intermediation (NACE 65-67), computer and related activities (NACE 72), architectural and engineering activities (NACE 74.2) and technical testing and analysis (NACE 74.3).

CALCULATION OF THE EU-27 AGGREGATE

The present publication only shows EU-27 data as percentages. These percentages sum up available data for all EU-27 Member States in the numerator and in the denominator, but the number of countries included in the numerator and in the denominator is always the same.

The notes below the figures and tables indicate the countries for which data are missing.

TYPE OF SURVEY

Most Member States and other countries carried out CIS 3 and CIS 4 by means of a stratified sample survey, while a number used a census or a combination of the two.

The enterprise size classes referred to in this publication are:

- **small**: 10-49 employees;
- **medium-sized**: 50-249 employees;
- **large**: 250+ employees.

The economic activities covered by this publication are based on the NACE Rev. 1.1 classification. The two sectors used are:

- **industry**, which includes mining and quarrying (NACE C), manufacturing (NACE D) and electricity, gas and water supply (NACE E); and

- **services**, which includes NACE I and J plus NACE divisions 51, 72, 74.2 and 74.3.

The CIS 3 and CIS 4 data are organised in the Eurostat reference database following broadly the same structure as the questionnaire.

REFERENCE PERIOD

CIS 3 covered the observation period 1998-2000 inclusive, i.e. the three-year period from the beginning of 1998 to the end of 2000. The reference period for CIS 3 was the year 2000.

Norway used the period 1999 to 2001 instead of 1998 to 2000. Spain used an earlier version of the CIS 3 core questionnaire than that used by the other countries. The Czech Republic, Hungary, Latvia, Lithuania and Slovakia chose 1999-2001 as the observation period, while Romania opted for 2000-2002. Slovenia used a two-year observation period (2001-2002) and Bulgaria 2001-2003.

The data for Poland are generally based on the observation periods 1998-2000 for industry and 1997-1999 for services.

CIS 4 covered the observation period 2002-2004 inclusive, i.e. the three-year period from the beginning of 2002 to the end of 2004. The reference period for CIS 4 was the year 2004.

All the countries covered collected data for this observation period; only the Czech Republic took 2003-2005 as the observation period.

DEFINITION

OSLO MANUAL 1997

Innovation: a new or significantly improved product (good or service) introduced to the market or a new or significantly improved process introduced within an enterprise. Innovations are based on the results of new technological developments, new combinations of existing technology or utilisation of other knowledge acquired by the enterprise.

Enterprises engaged in innovation activity (propensity to innovate): enterprises that introduce new or significantly improved products (goods or services) to the market or enterprises that implement new or significantly improved processes. Innovations are based on the results of new technological developments, new combinations of existing technology or utilisation of other knowledge acquired by the enterprise. The term covers all types of innovator, i.e. product innovators, process innovators and enterprises with only ongoing and/or abandoned innovation activities.

Product innovation is introduction to the market of a new good or service or of a good or service with significantly improved capabilities, such as improved software, user-friendliness, components or sub-systems.

Process innovation is implementation of a new or significantly improved production process, distribution method or support activity for goods or services. Purely organisational innovations are excluded.

Organisational innovation is implementation of new or significant changes in a firm's structure or management methods that are intended to improve the firm's use of knowledge, the quality of its goods and services or the efficiency of its workflows.

Marketing innovation is implementation of new or significantly improved designs or sales methods to increase the appeal of goods and services or to enter new markets.

Intramural (in-house) R&D: Creative work undertaken within the enterprise to increase the stock of knowledge and use it to devise new and improved products and processes (including software development).

Extramural R&D: Same activities as above, but performed by other companies (including other enterprises within the same group) or by public or private research organisations and purchased by the enterprise.

Acquisition of machinery, equipment and software: Acquisition of advanced machinery, equipment and computer hardware or software to produce new or significantly improved products and processes.

Acquisition of other external knowledge: Purchase or licensing of patents and non-patented inventions, know-how and other types of knowledge from other enterprises or organisations.

European Innovation Scoreboard 2006

The 2006 version is the sixth edition of the *European Innovation Scoreboard* (EIS). The EIS is the instrument developed by the European Commission, under the Lisbon Strategy, to evaluate and compare the innovation performance of the EU Member States.

The EIS 2006 includes innovation indicators and trend analyses for the EU-25 Member States, plus the two new Member States: Bulgaria and Romania, as well as for Croatia, Turkey, Iceland, Norway, Switzerland, the US and Japan.

The Annex includes tables with definitions as well as comprehensive data sheets for every country. The EIS report and its annexes, accompanying thematic papers and the indicators' database are available on this website. http://www.proinno-europe.eu/.

Various documents on the European Innovation Scoreboard 2006 and the scoreboard itself can be found at this address http://www.trendchart.org/scoreboards/scoreboard2006/scoreboard_papers.cfm.

The Methodology Report discusses the indicators that may be added in the next edition of the European Innovation Scoreboard.

2.5 Patents

Patents reflect part of a country's inventive activity. Patents also show the country's capacity to exploit knowledge and translate it into potential economic gains. In this context, indicators based on patent statistics are widely used to assess the inventive performance of the country or regions.

The grounds for the assumption that a patent represents a codification of inventive activity rely on the novelty, utility and inventiveness that an invention requires in order to be patented. On the basis of this assumption, Eurostat collects patent statistics to build up indicators of R&D output.

In 2005, just one single raw database – mainly compiled on the basis of input from the European Patent Office (EPO), the US Patent and Trademark Office (USPTO) and the Japanese Patent Office (JPO) – was used to produce an extended set of tables and indicators on Eurostat's webpage. The same will also be done in the years to come. The aggregated patent statistics are produced using a raw data set delivered by the OECD. This raw data set will be replaced by PATSTAT for the next data productions.

Since 2005 Eurostat has produced patent statistics using the priority year of the application and not, as previously, the year of filing. However, the data values are similar. These data are in general less extensive than the data released by Eurostat before 2005. This is because Eurostat takes into consideration all PCT applications filed to the EPO (i.e. applications made in accordance with the procedure under the Patent Cooperation Treaty), whereas the OECD data sets do so only in part. The data produced provide a better reflection of the innovation and R&D performance of an economy.

Since 2004 the interinstitutional Patent Statistics Task Force has developed the concept of a worldwide patent statistics database (PATSTAT). PATSTAT has to be understood as a single patent statistics raw database, held by the European Patent Office (EPO) and developed in cooperation with the World Intellectual Property Organisation (WIPO), the OECD and Eurostat. PATSTAT should fulfil the user needs of the various international organisations which will use this raw database for production. Designed to be sustainable over time, PATSTAT – which has been operational since 2006

– concentrates on raw data, leaving the 'production' of indicators mainly to PATSTAT users, such as the OECD, Eurostat and others.

At the end of 2007 the patent data will be updated in Eurostat's reference database, with data entirely based on PATSTAT but following a slightly different methodology compared to the data shown in this Statistical Book. This new methodology, which is also used by the OECD includes only EPO patent applications to the EPO (EPO direct) and PCT patent applications designating the EPO as the receiving office which was involved in the regional phase. The PCT patent applications which are in the international phase are no longer taken into account at this stage. This is because they were already included in the calculations of the indicators in the previous years, and so the new data are lower than the data shown before. For all further details, please see the Eurostat metadata on patent statistics posted on the webpage.

Eurostat's patents database contains data on patent applications to the European Patent Office (EPO) and patents granted by the United States Patent and Trademark Office (USPTO). In addition, Chapter 6 of this publication looks at data on triadic patent families. Owing to methodological differences in the manner of processing the data, no cross comparisons are advisable between the EPO, USPTO and patent family data. Methodological issues specific to each type of data are explained below.

Patent applications to the EPO by priority year

Data in Eurostat's EPO database refer to patent applications to the EPO by priority year, which include both applications filed directly under the European Patent Convention (EPC) and applications filed under the Patent Co-operation Treaty (PCT) and designating the EPO (Euro-PCT) for protection. The regional (national) distribution of patent applications is according to the inventor's place of residence. If an application has more than one inventor, the application is divided equally among all of them and subsequently among their regions, thus avoiding double counting.

EPO data are shown from 1993 to 2003; longer time series are available, but more recent data are not comparable, as they are incomplete due to the patenting procedure.

For further information on definitions and explanatory notes concerning EPO patent data see Eurostat's reference database NewCronos: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=0,1136250,0_45572555&_dad=portal&_schema=PORTAL under Science and Technology / Patent statistics / Patent applications to EPO by priority year.

Patents granted by the USPTO by priority year

Data on patents granted by the USPTO refer to patents granted, and not to applications as is the case for data coming from the EPO. Data in these two collections are therefore not comparable.

USPTO data are available from 1989 to 2000; longer time series are available, but more recent data are not comparable as they are incomplete due to the patenting procedure.

For further information on definitions and explanatory notes concerning EPO patent data see Eurostat's reference database NewCronos: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=0,1136250,0_45572555&_dad=portal&_schema=PORTAL under Science and Technology / Patent statistics / Patents granted by the USPTO by priority year.

Triadic patent families by priority year

A patent family is defined as a set of patents taken in various countries for protecting the same invention, i.e. related patents are grouped together in a single record to derive a unique patent family. A patent is a member of a triadic patent family if and only if it has been applied for and filed at the European Patent Office (EPO) and the Japanese Patent Office (JPO) and if it has been granted by the US Patent and Trademark Office (USPTO). Patent families, as opposed to patents, are intended to improve international comparability (the home advantage is removed; the patents are more homogeneous in terms of their value).

Data on triadic patent families are presented by priority year, i.e. the year of the first international filing of a patent. This compounds the disadvantage of traditional patent counts with respect to timeliness, and therefore latest available data refer to 2000 only.

For further methodological notes please refer to: OECD triadic patent families, OECD, 2004.

Metadata are available in Eurostat's reference database NewCronos: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=0,1136250,0_45572555&_dad=portal&_schema=PORTAL under Science and Technology Patent statistics / Triadic patent families by earliest priority year.

Patent Cooperation Treaty

The Patent Cooperation Treaty (PCT) provides the possibility to seek patent rights in a large number of countries by filing a single international application with a single patent office, and is increasingly being used for patent applications. The PCT procedure consists of two main phases: (a) an “international phase”; and (b) a PCT “national/regional phase”. In order to measure inventive activity, Eurostat has included both of these phases of PCT applications.

European Patent Convention

The European Patent Convention (EPC) is the convention on the granting of European patents. The first version of the convention entered into force on 5 October 1973. The latest version, from April 2006, is the twelfth.

Costs - mainly translation costs - are one of the problems of patent applications to the EPO. The official languages of the EPO are governed by Article 14 Languages of the European Patent Office (see http://www.european-patent-office.org/legal/epc/e/ar14.html#A14) and translations by Article 65 of the EPC Translation of the specification of the European patent (see http://www.european-patent-office.org/legal/epc/e/ar65.html#A65).

Foreign ownership

Data on foreign ownership measure the number of patents invented within (or applied for by) a given country that involve at least one foreign applicant (or a foreign inventor).

To make this definition clearer let us take as an example a patent with three inventors (one French resident, one German resident and one American resident) and two applicants (one German resident and one American resident). Combining the resident countries of inventors and applicants there are six partnerships, of which four are foreign, because they involve two different resident countries, and two are national.

International Patent Classification

Patent data follow the International Patent Classification (IPC), which assigns an invention to one or more IPC-classes according to its function or intrinsic nature or its field of application. If a patent is assigned to more than one IPC code, only the first listed is taken into account. Only the first four digits of the IPC are used for breakdowns and aggregations.

SECTION A - HUMAN NECESSITIES

AGRICULTURE
A 01 AGRICULTURE; FORESTRY; ANIMAL HUSBANDRY; HUNTING; TRAPPING; FISHING
FOODSTUFFS; TOBACCO
A 21 BAKING; EDIBLE DOUGHS
A 22 BUTCHERING; MEAT TREATMENT; PROCESSING POULTRY OR FISH
A 23 FOODS OR FOODSTUFFS; THEIR TREATMENT, NOT COVERED BY OTHER CLASSES
A 24 TOBACCO; CIGARS; CIGARETTES; SMOKERS' REQUISITES
PERSONAL OR DOMESTIC ARTICLES
A 41 WEARING APPAREL
A 42 HEADWEAR
A 43 FOOTWEAR
A 44 HABERDASHERY; JEWELLERY
A 45 HAND OR TRAVELLING ARTICLES
A 46 BRUSHWARE
A 47 FURNITURE; DOMESTIC ARTICLES OR APPLIANCES; COFFEE MILLS; SPICE MILLS; SUCTION CLEANERS IN GENERAL
HEALTH; AMUSEMENT
A 61 MEDICAL OR VETERINARY SCIENCE; HYGIENE
A 62 LIFE-SAVING; FIRE-FIGHTING
A 63 SPORTS; GAMES; AMUSEMENTS

SECTION B - PERFORMING OPERATIONS; TRANSPORTING

SEPARATING; MIXING
B 01 PHYSICAL OR CHEMICAL PROCESSES OR APPARATUS IN GENERAL
B 02 CRUSHING, PULVERISING, OR DISINTEGRATING; PREPARATORY TREATMENT OF GRAIN FOR MILLING
B 03 SEPARATION OF SOLID MATERIALS USING LIQUIDS OR USING PNEUMATIC TABLES OR JIGS; MAGNETIC OR ELECTROSTATIC SEPARATION OF SOLID MATERIALS FROM SOLID MATERIALS OR FLUIDS; SEPARATION BY HIGH-VOLTAGE ELECTRIC FIELDS
B 04 CENTRIFUGAL APPARATUS OR MACHINES FOR CARRYING-OUT PHYSICAL OR CHEMICAL PROCESSES
B 05 SPRAYING OR ATOMISING IN GENERAL; APPLYING LIQUIDS OR OTHER FLUENT MATERIALS TO SURFACES, IN GENERAL
B 06 GENERATING OR TRANSMITTING MECHANICAL VIBRATIONS IN GENERAL
B 07 SEPARATING SOLIDS FROM SOLIDS; SORTING

B 08 CLEANING
B 09 DISPOSAL OF SOLID WASTE; RECLAMATION OF CONTAMINATED SOIL
SHAPING
B 21 MECHANICAL METAL-WORKING WITHOUT ESSENTIALLY REMOVING MATERIAL; PUNCHING
B22 CASTING; POWDER METALLURGY
B 23 MACHINE TOOLS; METAL-WORKING NOT OTHERWISE PROVIDED FOR
B 24 GRINDING; POLISHING
B 25 HAND TOOLS; PORTABLE POWER-DRIVEN TOOLS; HANDLES FOR HAND IMPLEMENTS; WORKSHOP EQUIPMENT; MANIPULATORS
B 26 HAND CUTTING TOOLS; CUTTING; SEVERING
B 27 WORKING OR PRESERVING WOOD OR SIMILAR MATERIAL; NAILING OR STAPLING MACHINES IN GENERAL
B 28 WORKING CEMENT, CLAY, OR STONE
B 29 WORKING OF PLASTICS; WORKING OF SUBSTANCES IN A PLASTIC STATE IN GENERAL
B 30 PRESSES
B 31 MAKING PAPER ARTICLES; WORKING
B 32 LAYERED PRODUCTS
PRINTING
B 41 PRINTING; LINING MACHINES; TYPEWRITERS; STAMPS
B 42 BOOKBINDING; ALBUMS; FILES; SPECIAL PRINTED MATTER
B 43 WRITING OR DRAWING IMPLEMENTS; BUREAU ACCESSORIES
B 44 DECORATIVE ARTS
TRANSPORTING
B 60 VEHICLES IN GENERAL
B 61 RAILWAYS
B 62 LAND VEHICLES FOR TRAVELLING OTHERWISE THAN ON RAILS
B 63 SHIPS OR OTHER WATERBORNE VESSELS; RELATED EQUIPMENT
B 64 AIRCRAFT; AVIATION; COSMONAUTICS
B 65 CONVEYING; PACKING; STORING; HANDLING THIN OR FILAMENTARY MATERIAL
B 66 HOISTING; LIFTING; HAULING
B 67 OPENING OR CLOSING BOTTLES, JARS OR SIMILAR CONTAINERS; LIQUID HANDLING
B 68 SADDLERY; UPHOLSTERY
MICRO-STRUCTURAL TECHNOLOGY; NANO-TECHNOLOGY
B 81 MICRO-STRUCTURAL TECHNOLOGY
B 82 NANO-TECHNOLOGY

SECTION C - CHEMISTRY; METALLURGY

CHEMISTRY
C 01 INORGANIC CHEMISTRY
C 02 TREATMENT OF WATER, WASTE WATER, SEWAGE, OR SLUDGE
C 03 GLASS; MINERAL OR SLAG WOOL
C 04 CEMENTS; CONCRETE; ARTIFICIAL STONE; CERAMICS; REFRACTORIES
C 05 FERTILISERS; MANUFACTURE THEREOF
C 06 EXPLOSIVES; MATCHES
C 07 ORGANIC CHEMISTRY
C 08 ORGANIC MACROMOLECULAR COMPOUNDS; THEIR PREPARATION OR CHEMICAL WORKING-UP; COMPOSITIONS BASED THEREON
C 09 DYES; PAINTS; POLISHES; NATURAL RESINS; ADHESIVES; MISCELLANEOUS COMPOSITIONS; MISCELLANEOUS APPLICATIONS OF MATERIALS
C 10 PETROLEUM, GAS OR COKE INDUSTRIES; TECHNICAL GASES CONTAINING CARBON MONOXIDE; FUELS; LUBRICANTS; PEAT
C 11 ANIMAL OR VEGETABLE OILS, FATS, FATTY SUBSTANCES OR WAXES; FATTY ACIDS THEREFROM; DETERGENTS; CANDLES
C 12 BIOCHEMISTRY; BEER; SPIRITS; WINE; VINEGAR; MICROBIOLOGY; ENZYMOLOGY; MUTATION OR GENETIC ENGINEERING
C 13 SUGAR INDUSTRY
C 14 SKINS; HIDES; PELTS; LEATHER
METALLURGY
C 21 METALLURGY OF IRON
C 22 METALLURGY; FERROUS OR NON-FERROUS ALLOYS; TREATMENT OF ALLOYS OR NON-FERROUS METALS
C 23 COATING METALLIC MATERIAL; COATING MATERIAL WITH METALLIC MATERIAL ; CHEMICAL SURFACE TREATMENT; DIFFUSION TREATMENT OF METALLIC MATERIAL; COATING BY VACUUM EVAPORATION, BY SPUTTERING, BY ION IMPLANTATION OR BY CHEMICAL VAPOUR DEPOSITION, IN GENERAL ; INHIBITING CORROSION OF METALLIC MATERIAL OR INCRUSTATION IN GENERAL
C 25 ELECTROLYTIC OR ELECTROPHORETIC PROCESSES; APPARATUS THEREFOR
C 30 CRYSTAL GROWTH

SECTION D - TEXTILES; PAPER

TEXTILES OR FLEXIBLE MATERIALS NOT OTHERWISE PROVIDED FOR
D 01 NATURAL OR ARTIFICIAL THREADS OR FIBRES; SPINNING
D 02 YARNS; MECHANICAL FINISHING OF YARNS OR ROPES; WARPING OR BEAMING
D 03 WEAVING
D 04 BRAIDING; LACE-MAKING; KNITTING; TRIMMINGS; NON-WOVEN FABRICS

D 05 SEWING; EMBROIDERING; TUFTING
D 06 TREATMENT OF TEXTILES OR THE LIKE; LAUNDERING; FLEXIBLE MATERIALS NOT OTHERWISE PROVIDED FOR
D 07 ROPES; CABLES OTHER THAN ELECTRIC
PAPER
D 21 PAPER-MAKING; PRODUCTION OF CELLULOSE

SECTION E - FIXED CONSTRUCTIONS

BUILDING
E 01 CONSTRUCTION OF ROADS, RAILWAYS, OR BRIDGES
E 02 HYDRAULIC ENGINEERING; FOUNDATIONS; SOIL-SHIFTING
E 03 WATER SUPPLY; SEWERAGE
E 04 BUILDING
E 05 LOCKS; KEYS; WINDOW OR DOOR FITTINGS; SAFES
E 06 DOORS, WINDOWS, SHUTTERS, OR ROLLER BLINDS, IN GENERAL; LADDERS
EARTH OR ROCK DRILLING; MINING
E 21 EARTH OR ROCK DRILLING; MINING

SECTION F - MECHANICAL ENGINEERING; LIGHTING; HEATING; WEAPONS; BLASTING

ENGINES OR PUMPS
F 01 MACHINES OR ENGINES IN GENERAL; ENGINE PLANTS IN GENERAL; STEAM ENGINES
F 02 COMBUSTION ENGINES; HOT-GAS OR COMBUSTION-PRODUCT ENGINE PLANTS
F 03 MACHINES OR ENGINES FOR LIQUIDS; WIND, SPRING, WEIGHT, OR MISCELLANEOUS MOTORS; PRODUCING MECHANICAL POWER OR A REACTIVE PROPULSIVE THRUST, NOT OTHERWISE PROVIDED FOR
F 04 POSITIVE-DISPLACEMENT MACHINES FOR LIQUIDS; PUMPS FOR LIQUIDS OR ELASTIC FLUIDS
ENGINEERING IN GENERAL
F 15 FLUID-PRESSURE ACTUATORS; HYDRAULICS OR PNEUMATICS IN GENERAL
F 16 ENGINEERING ELEMENTS OR UNITS; GENERAL MEASURES FOR PRODUCING AND MAINTAINING EFFECTIVE FUNCTIONING OF MACHINES OR INSTALLATIONS; THERMAL INSULATION IN GENERAL
F 17 STORING OR DISTRIBUTING GASES OR LIQUIDS
LIGHTING; HEATING
F 21 LIGHTING
F 22 STEAM GENERATION
F 23 COMBUSTION APPARATUS; COMBUSTION PROCESSES
F 24 HEATING; RANGES; VENTILATING
F 25 REFRIGERATION OR COOLING; COMBINED HEATING AND REFRIGERATION SYSTEMS; HEAT PUMP SYSTEMS; MANUFACTURE OR STORAGE OF ICE; LIQUEFACTION OR SOLIDIFICATION OF GASES
F 26 DRYING
F 27 FURNACES; KILNS; OVENS; RETORTS
F 28 HEAT EXCHANGE IN GENERAL
WEAPONS; BLASTING
F 41 WEAPONS
F 42 AMMUNITION; BLASTING

SECTION G - PHYSICS

INSTRUMENTS
G 01 MEASURING; TESTING
G 02 OPTICS
G 03 PHOTOGRAPHY; CINEMATOGRAPHY; ANALOGOUS TECHNIQUES USING WAVES OTHER THAN OPTICAL WAVES; ELECTROGRAPHY; HOLOGRAPHY
G 04 HOROLOGY
G 05 CONTROLLING; REGULATING
G 06 COMPUTING; CALCULATING; COUNTING
G 07 CHECKING-DEVICES
G 08 SIGNALLING
G 09 EDUCATING; CRYPTOGRAPHY; DISPLAY; ADVERTISING; SEALS
G 10 MUSICAL INSTRUMENTS; ACOUSTICS
G 11 INFORMATION STORAGE
G 12 INSTRUMENT DETAILS
NUCLEONICS
G 21 NUCLEAR PHYSICS; NUCLEAR ENGINEERING

SECTION H - ELECTRICITY

H 01 BASIC ELECTRIC ELEMENTS
H 02 GENERATION, CONVERSION, OR DISTRIBUTION OF ELECTRIC POWER
H 03 BASIC ELECTRONIC CIRCUITRY
H 04 ELECTRIC COMMUNICATION TECHNIQUES
H 05 ELECTRIC TECHNIQUES NOT OTHERWISE PROVIDED FOR

IPC-NACE correspondence

The breakdown by NACE sector codes is based on the IPC-NACE concordance tables created by the Fraunhofer Institute for Systems and Innovation Research in Karlsruhe (Germany). For further information on the methodology used see Eurostat's reference database NewCronos: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=0,1136250,0_45572555&_dad=portal&_schema=PORTAL under Science and Technology / Patent statistics.

The easiest way to explain the link between the two classifications is to give an example. Let us take two patents from the IPC sector A – Human necessities. The first patent has the code IPC A24B (Manufacture or preparation of tobacco for smoking, chewing; tobacco; snuff). With the help of the concordance tables this patent is converted to NACE code DA (Manufacture of food products, beverages and tobacco). The second patent has the code A24C (Machines for making cigars or cigarettes). The NACE code for the second patent is, after conversion, DK (Manufacture of machinery and equipment n.e.c.).

NACE-ISIC correspondence

Table 6.7 in Chapter 6 of the publication shows patents by NACE sectors. The table below gives the correspondence between these NACE sectors and the divisions of the International Standard Industrial Classification (ISIC). ISIC codes are currently used at the world-wide level, whereas the NACE codes are used at the EU level.

NACE Rev. 1.1		ISIC Rev. 3.1	
DA	Manufacture of food products, beverages and tobacco	D 15	Manufacture of food products and beverages
		D 16	Manufacture of tobacco products
DB	Manufacture of textiles and textile products	D 17	Manufacture of textiles
		D 18	Manufacture of wearing apparel; dressing and dyeing of fur
DC	Manufacture of leather and leather products	D 19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
DD	Manufacture of wood and wood products	D 20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
DE	Manufacture of pulp, paper and paper products; publishing and printing	D 21	Manufacture of paper and paper products
		D 22	Publishing, printing and reproduction of recorded media
DF	Manufacture of coke, refined petroleum products and nuclear fuel	D 23	Manufacture of coke, refined petroleum products and nuclear fuel
DG	Manufacture of chemicals, chemical products and man-made fibres	D 24	Manufacture of chemicals and chemical products
DH	Manufacture of rubber and plastic products	D 25	Manufacture of rubber and plastics products
DI	Manufacture of other non-metallic mineral products	D 26	Manufacture of other non-metallic mineral products
DJ	Manufacture of basic metals and fabricated metal products	D 27	Manufacture of basic metals
		D 28	Manufacture of fabricated metal products, except machinery and equipment
DK	Manufacture of machinery and equipment n.e.c.	D 29	Manufacture of machinery and equipment n.e.c.
DL	Manufacture of electrical and optical equipment	D 30	Manufacture of office, accounting and computing machinery
		D 31	Manufacture of electrical machinery and apparatus n.e.c.
		D 32	Manufacture of radio, television and communication equipment and apparatus
DM	Manufacture of transport equipment	D 34	Manufacture of motor vehicles, trailers and semi-trailers
		D 35	Manufacture of other transport equipment
DN	Manufacturing n.e.c.	D 36	Manufacture of furniture; manufacturing n.e.c.
		D 37	Recycling

Technological fields

1. Biotechnology: The OECD definition is the application of Science & Technology to living organisms as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services. An indicative list of technologies is DNA, Proteins and molecules (the functional blocks), cell and tissue culture and engineering, process biotechnologies, sub-cellular organisms (gene therapy, viral vectors).

Patent applications/patents granted with the IPC codes (7th edition, 2000) listed below are aggregated to calculate the indicator “biotechnology patent applications/patents granted”:

A01H1/00, A01H4/00, A61K38/00, A61K39/00, A61K48/00,
C02F3/34, C07G(11/00, 13/00, 15/00), C07K(4/00, 14/00, 16/00, 17/00, 19/00), C12M, C12N, C12P, C12Q, C12S,
G01N27/327, G01N33/(53*, 54*, 55*, 57*, 68, 74, 76, 78, 88, 92).

2. High tech: Based on the data on patent applications/patents granted by IPC codes (7th edition, 2000), Eurostat has calculated data on patent applications/patents granted in high-technology fields.

The aggregation “high-tech patents” is made up as follows in the IPC. For each of the six high-tech groups the patents with the IPC codes in brackets are used.

1. Aviation - AVI [B64B, B64C, B64D, B64F, B64G];
2. Computer and automated business equipment - CAB [B41J, G06C, G06D, G06E, G06F, G06G, G06J, G06K, G06M, G06N, G06T, G11C];
3. Communication technology - CTE [H04B, H04H, H04J, H04K, H04L, H04M, H04N, H04Q, H04R, H04S];
4. Lasers - LSR [H01S];
5. Micro-organism and genetic engineering - MGE [C12M, C12N, C12P, C12Q];
6. Semi-conductors - SMC [H01L].

3. Information and Communication Technologies (ICT): The IPC codes (7th edition, 2000) listed behind each ICT sub-category are added up for the aggregation of each ICT-sub-category:

1. Telecommunications [G01S, G08C, G09C, H01P, H01Q, H01S3/(025, 043, 063, 067, 085, 0933, 0941, 103, 133, 18, 19, 25), H1S5, H03B, H03C, H03D, H03H, H03M, H04B, H04J, H04K, H04L, H04M, H04Q];
2. Consumer electronics [G11B, H03F, H03G, H03J, H04H, H04N, H04R, H04S];
3. Computers, office machinery [B07C, B41J, B41K, G02F, G03G, G05F, G06, G07, G09G, G10L, G11C, H03K, H03L];
4. Other ICT [G01B, G01C, G01D, G01F, G01G, G01H, G01J, G01K, G01L, G01M, G01N, G01P, G01R, G01V, G01W, G02B6, G05B, G08G, G09B, H01B11, H01J(11/, 13/, 15/, 17/, 19/, 21/, 23/, 25/, 27/, 29/, 31/, 33/, 40/, 41/, 43/, 45/), H01L].

2.6 High-tech industries and knowledge based service

Enterprises in high-tech industries and knowledge-intensive services

Indicators on enterprises in high-tech industries and knowledge-intensive services are extracted and aggregated on the basis of the NACE (see general information) using data from the Structural Business Statistics — SBS.

These data are available for EU-27 Member States, candidate countries, Norway and Switzerland at the national level. The data are aggregated using the definition of high-tech industries and knowledge-intensive services based on NACE rev. 1.1 at 3-digit level (see General information).

Definition of indicators

Value added at factor cost is the gross income from operating activities after adjusting for operating subsidies and indirect taxes. It can be calculated from turnover, plus capitalised production, plus other operating income, plus or minus the changes in stocks, minus the purchases of goods and services, minus other taxes on products which are linked to turnover but not deductible, minus the duties and taxes linked to production. Value added at factor cost is calculated "gross", as value adjustments (such as depreciation) are not subtracted.

Labour productivity refers to the value added at factor cost per person employed.

Production value measures the amount actually produced by the unit, based on sales, including changes in stocks and the resale of goods and services. The production value is defined as turnover, plus or minus the changes in stocks of finished products, work in progress and goods and services purchased for resale, minus the purchase of goods and services for resale, plus capitalised production, plus other operating income (excluding subsidies). Income and expenditure classified as financial or extra-ordinary in company accounts is excluded from production value. Included in purchases of goods and services for resale are services purchased in order to be rendered to third parties in the same condition.

Gross investment in tangible goods is defined as investment in all tangible goods during the reference period. Included are new and existing tangible capital goods, whether bought from third parties or produced for own use (i.e. Capitalised production of tangible capital goods), having a useful life of more than one year including non-produced tangible goods such as land. Investment in intangible and financial assets is excluded.

Gross investment in machinery and equipment covers machinery (office machines etc.), special vehicles used on the premises, other machinery and equipment, all vehicles and boats used off the premises, i.e. motor cars, commercial vehicles and lorries as well as special vehicles of all types, boats, railway wagons, etc. acquired new or second hand during the reference period. Machinery and equipment acquired through restructuring (such as mergers, take-overs, break-ups, split-offs) are excluded. Also included are all additions, alterations, improvements and renovations which prolong the service life or increase the productive capacity of these capital goods. Current maintenance costs are excluded.

Venture capital investment

Venture Capital Investment (VCI) is defined as private equity raised for investment in companies. Management buy-outs, management buy-ins, and venture purchase of quoted shares are excluded.
Data are broken down into two investment stages:

- Early stage (seed + start-up) and
- Expansion and replacement (expansion and replacement capital).

Venture capital is expressed as a percentage of GDP (Gross domestic product at market prices), which is defined in accordance with the European System of national and regional Accounts in the Community (ESA 95).

The data cover EU-15, EU-27 Member States (except for Bulgaria, Estonia, Cyprus, Latvia, Lithuania, Luxembourg, Malta and Romania), Norway and Switzerland.

The basic data are provided by the European Private Equity and Venture Capital Association (EVCA). For more information on venture capital, please refer to: http://www.evca.com

Definition of indicators

Seed is defined as financing provided to research, assess and develop an initial concept before a business has reached the start-up phase.

Start-up is defined as financing provided for product development and initial marketing, manufacturing, and sales. Companies may be in the process of being set up or may have been in business for a short time, but have not sold their product commercially.

Expansion is defined as financing provided for the growth and expansion of a company which is breaking even or trading profitably. Capital may be used to finance increased production capacity, market or product development, and/or provide additional working capital. It includes bridge financing for the transition from private to public quoted company, and rescue/turnaround financing.

Replacement capital is defined as purchase of existing shares in a company from another private equity investment organisation or from another shareholder or shareholders. It includes refinancing of bank debt.

High-tech trade

Indicators on high-tech trade are extracted and aggregated on the basis of the Standard International Trade Classification (SITC Rev3) using data from COMEXT and from COMTRADE databases.

These data are available for EU-27 Member States, candidate countries, Iceland, Norway, Switzerland, China, Japan and the United States. There are no data for Luxembourg and Belgium separately before 1999. Hence, both countries are treated together previous to that year. EU aggregates exclude intra-EU trade.

High technology groups of products are defined according to the R&D intensity of products. Nine SITC Rev3 groups of products are considered as high-tech. These are:

- Aerospace,
- Computers-Office machinery,
- Electronics-Telecommunications,
- Pharmacy,
- Scientific instruments,
- Electrical machinery,
- Chemistry,
- Non-electrical machinery and
- Armament.

Employment in high-tech industries and knowledge-intensive services

Data on employment in high-tech industries and knowledge-intensive services are extracted and aggregated on the basis of the NACE (see General information) using data from the Community Labour Force Survey — CLFS.

These data are available for EU-27 Member States, candidate countries, Iceland, Norway and Switzerland both at national level and at regional NUTS level 2 (see General information). These are aggregated using the definition of high-tech industries and knowledge-intensive services based on NACE rev. 1.1 at 2-digit level (see General information).

2.7 The 2006 EU industrial R&D investment scoreboard

The 2006 EU industrial R&D investment scoreboard has been jointly prepared by the Directorate-General for Research (DG-RTD) and the Joint Research Centre (JRC). It reports on the worldwide research and development of 2 000 top companies. The Scoreboard was compiled from companies' annual reports and accounts with the reference date of 1st August of each year. In order to maximise completeness and avoid double counting, the consolidated group accounts of the ultimate parent company are used. Companies which are subsidiaries of another company are not listed separately. Where consolidated group accounts of the ultimate parent company are not available, however, subsidiaries are included.

Definitions of indicators

1. **Research and Development (R&D)** investment in the Scoreboard is the cash investment funded by the companies themselves. It excludes R&D undertaken under contract for customers such as governments or other companies. It also excludes the companies' share of any associated company or joint venture R&D investment. Being that disclosed in the annual report and accounts, it is subject to the accounting definitions of R&D. For example, a definition is set out in International Accounting Standard (IAS) 38 “Intangible assets” and is based on the OECD “Frascati” manual.

Research is defined as original and planned investigation undertaken with the prospect of gaining new scientific or technical knowledge and understanding. Expenditure on research is recognised as an expense when it is incurred.

Development is the application of research findings or other knowledge to a plan or design for the production of new or substantially improved materials, devices, products, processes, systems or services before the start of commercial production or use. Development costs are capitalised when they meet certain criteria and when it can be demonstrated that the asset will generate probable future economic benefits. Where part or all of R&D costs have been capitalised, the additions to the appropriate intangible assets are included to calculate the cash investment and any amortisation eliminated.

2. **Sales** follow the usual accounting definition of sales, excluding sales taxes and shares of sales of joint ventures & associates. For banks, sales are defined as the “Total (operating) income” plus any insurance income. For insurance companies, sales are defined as “Gross premiums written” plus any banking income.

3. **R&D intensity** is the ratio between R&D investment and net sales of a given company or group of companies. At the aggregate level, R&D intensity is calculated only by those companies for which data exist for both R&D and net sales in the specified year. The calculation of R&D intensity in the Scoreboard is different from that in official statistics, e.g. BERD, where R&D intensity is based on value added instead of net sales.

4. **Operating profit** is calculated as profit (or loss) before taxation, plus net interest cost (or minus net interest income) and government grants, less gains (or plus losses) arising from the sale/disposal of businesses or fixed assets.

5. **One-year growth** is simple growth over the previous year, expressed as a percentage: 1yr growth = 100*((C/B)-1); where C = current year amount, and B = previous year amount. 1yr growth is calculated only if data exist for both the current and previous year. At the aggregate level, 1yr growth is calculated by aggregating only those companies for which data exist for both the current and previous year.

6. **Three-year growth** is the compound annual growth over the previous three years, expressed as a percentage: 3 yr growth = 100*(((C/B)^(1/t))-1); where C = current year amount, B = base year amount (where base year = current year - 3), and t = number of time periods (= 3). 3yr growth is calculated only if data exist for the current and base years. At the aggregate level, 3yr growth is calculated by aggregating only those companies for which data exist for the current and base years.

7. **Capital expenditure (Capex)** is expenditure used by a company to acquire or upgrade physical assets such as equipment, property, industrial buildings. In accounts capital expenditure is added to an asset account (i.e. capitalised), thus increasing the asset's base. It is disclosed in accounts as additions to tangible fixed assets

8. **Number of employees** is the total consolidated average employees or year end employees if average not stated.

9. **R&D per employee** is the simple ratio of R&D investment over employees. At the aggregate level, R&D per employee and the other non-growth statistics are calculated by aggregating only those companies for which data exist for both the numerator and the denominator.

10. **R&D employees** is the number of employees engaged in R&D activities as stated in the annual report.

11. **Market capitalisation** is the share price multiplied by the number of shares issued at a given date. Market capitalisation data have been extracted from both the Financial Times London Share Service and Reuters. These reflect the market capitalisation of each company at the close of trading on 4 August 2006. The gross market capitalisation amount is used to take account of those companies for which not all the equity is available on the market. Companies not listed on a recognised stock exchange have been distinguished separately by the use of italics.

12. **Market Spread** details sales by destination, distinguishing between Europe, North America (USA and Canada) and the Rest of the World. The definition of Europe is subject to the definitions adopted by the individual companies. In cases in which companies have defined a market spread area as EMEA (Europe, Middle East, Africa), this has been allocated to Europe. When a company has not clearly disclosed the turnover region North America but Americas, this has been allocated to North America.

13. **Industry sectors** in are based on the ICB Industry Classification System. The level of disaggregation is generally the three-digit level unless indicated otherwise.

More information is available at http://iri.jrc.es/research/scoreboard_2006.htm.

Annexes

Abbreviations & Symbols

Statistical symbols and abbreviations

© .... Copyright
® .... Registered
% .... Percentage
- .... Not applicable or real zero or zero by default
: .... Not available
0 .... Less than half of the unit used
1000s .... Thousands
1999-2004 .... Period of several calendar years (e.g. from 1.1.1999 to 31.12.2004)
b .... Break in series
:c .... Confidential
e .... Estimate
f .... Forecast
i .... More information in explanatory notes
p .... Provisional
r .... Revised
s .... Eurostat estimate
u .... Unreliable
:u .... Extremely unreliable data

Abbreviations

A

AAGR .... Annual average growth rate
AGR .... Annual growth rate
AVI .... Aviation (high-tech group, based on International Patent Classification)

B

BERD .... Expenditure on R&D in the bBusiness enterprise sector
BES .... Business enterprise sector

C

CAB .... Computer and automated business equipment (high-tech group, based on International Patent Classification)
CBSTII .... Common basis for science, technology and innovation indicators
CDH .... Careers of doctorate-holders
CD-ROM .... Compact disc read-only memory
CEC .... Commission of the European Communities
CeSTII .... Centre for Science, Technology and Innovation Indicators
CIP .... Competitiveness and Innovation Framework Programme

CIS .... Community Innovation Survey
CTE .... Communication technology (high-tech group, based on International Patent Classification)
CV .... Curriculum vitae

D

DG .... Directorate-General
DG-RTD .... Directorate-General for Research
DVD .... Digital video disc

E

EC .... European Community/Communities
ECU/EUR .... Ecu up to 31.12.1998/Euro from 1.1.1999
EEA30 .... European Economic Area (EU-27 plus IS, LI, NO)
EFRD .... European Fund for Regional Development
EFS .... European Social Fund
EFTA .... European Free Trade Association
EIS .... European Innovation Scoreboard
EIT .... European Institute of Technology
EP .... European Parliament
EPC .... European Patent Convention
EPO .... European Patent Office
ERA .... European Research Area
EU LFS .... European Union Labour Force Survey
EU-15 .... European Union (15 countries)
EU-25 .... European Union (25 countries)
EU/EU-27 .... European Union (27 countries)
EU-CC .... Candidate countries
EUR .... Euro
Eurostat .... Statistical Office of the European Communities
EVCA .... European Venture Capital Association

F

FAPESP .... Fundacão de Amparo à Pesquisa do Estado de São Paulo - State of São Paulo Research Foundation
FOS .... Field of science
FP .... Framework Programme
FP6 .... Sixth EU Research Framework Programme 2002-2006
FP7 .... Seventh EU Research Framework Programme 2007-2013
FSI .... Frank Stronach Institute
FTE .... Full-time equivalent
FTSE .... Financial Times Stock Exchange

G

G7 .... Group of Seven (France, Germany, Italy, Japan, United Kingdom, United States of America)

G8 .... Group of Eight (Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and United States)

GBAORD .... Government budget appropriations or outlays on R&D

GDP .... Gross domestic product

GERD .... Gross domestic expenditure on R&D

GISCO .... Geographical information system for the Commission - Eurostat

GOV .... Government sector

GPS .... Global positioning system

GUF .... General university funds

H

HC .... Head count

HES .... Higher education sector

HRST .... Human resources in science and technology

HRSTC .... Human resources in science and technology - Core

HRSTE .... Human resources in science and technology - Education

HRSTO .... Human resources in science and technology - Occupation

HRSTU .... Human resources in science and technology - Unemployed

I

IBCS .... Integrated Business Characteristics Strategy

IBGE .... Brazilian Institute of Geography and Statistics

ICB .... Industrial classification benchmark

ICT .... Information and communication technology

ILO .... International Labour Organisation

IPC .... International Patent Classification

IPR .... Intellectual property right

IRI .... Commission’s Industrial Research and Innovation Programme

ISBN .... International standard book number

ISCED .... International Standard Classification for Education

ISCO .... International Standard Classification of Occupation

ISIC .... International Standard Industrial Classification of all Economic Activities

IT .... Information technology

J

JPO .... Japanese Patent Office

JRC .... Joint Research Centre

K

KIC .... Knowledge and innovation Community

KIS .... Knowledge-intensive services

L

LFS ....Labour Force Survey

LKIS ....Less knowledge-intensive services

LSR ....Lasers (high-tech group, based on International Patent Classification)

M

MGE ....Micro-organism and genetic engineering (high-tech group, based on International Patent Classification)

Mio ....Million

MSTI ....Main Science and Technological Indicators - OECD

N

NABS ....Nomenclature for the analysis and comparison of science budgets and programmes

NAC..National currency

NACE ....General industrial classification of economic activities in the European Community

NewCronos ....Eurostat's statistical reference database

NHRSTU ....Unemployed non-HRST

NUTS ....Nomenclature of Territorial Units for Statistics

O

OECD ....Organisation for Economic Cooperation and Development

OHIM..Office of Harmonisation for the Internal Market

P

p.a. ....Per year *(per annum)*

PATSTAT ....Patent statistics database (provided by the EPO)

PCT ....Patent Cooperation Treaty

PNP ....Private non-profit sector

PPS ....Purchasing power standard

PSL..Personnel

R

R&D ....Research and development

RFID..Radio frequency identification

S

SBS ....Structural Business Statistics

SE ....Scientists and engineers

S&E ....Science and engineering

SII ....Summary Innovation Index

SITC ....Standard International Trade Classification

SMC ....Semi-conductors (high-tech group, based on the International Patent Classification)

SME ....Small and medium-sized enterprise

S&T .... Science and technology

T

TUG .... Graz University of Technology

U

UIS .... UNESCO Institute for Statistics
UN .... United Nations
UNESCO .... United Nations Educational, Scientific and Cultural Organisation
UOE .... Unesco/OECD/Eurostat
USPTO .... United States Patent and Trademark Office

V

VCI .... Venture capital investments
vs. .... Versus

W

WIPO .... World Intellectual Property Organisation

Countries

EU-27

BE .... Belgium
BG .... Bulgaria
CZ .... Czech Republic
DK .... Denmark
DE .... Germany
EE .... Estonia
IE .... Ireland
EL .... Greece
ES .... Spain
FR .... France
IT .... Italy
CY .... Cyprus
LV .... Latvia
LT .... Lithuania
LU .... Luxembourg
HU .... Hungary
MT .... Malta
NL .... Netherlands
AT .... Austria
PL .... Poland
PT .... Portugal

RO .... Romania
SI .... Slovenia
SK .... Slovakia
FI .... Finland
SE .... Sweden
UK .... United Kingdom

Candidate countries

FYROM .... Former Yugoslav Republic of Macedonia
HR .... Croatia
TR .... Turkey

Other countries

AU .... Australia
CA .... Canada
CH .... Switzerland
CN .... China
IL .... Israel
IN .... India
IS .... Iceland
JP .... Japan
KR .... Republic of Korea
LI .... Liechtenstein
NO .... Norway
RU .... Russia
TW .... Taiwan
US .... United States

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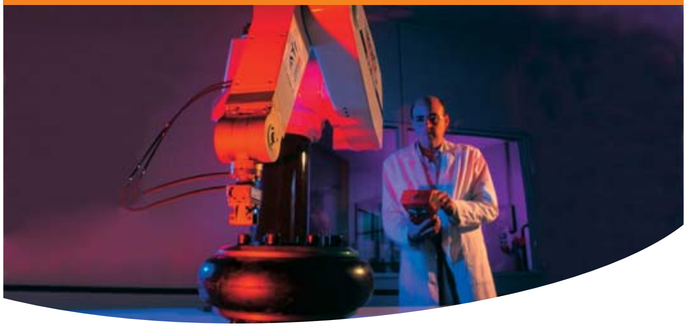

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