Science, technology and innovation

Introduction

The Lisbon strategy launched in March 2000 and covering a period of 10 years emphasised the importance of research and development (R & D) and innovation in the European Union. Five years later, the Lisbon strategy was renewed by the initiative on 'Working together for growth and jobs', which put science, technology and innovation back at the heart of EU, national and regional policies in order to take targeted action in the main area of 'Knowledge and innovation for growth'.

After the end of the Lisbon strategy and the recent economic crisis, a new strategy for the EU was called for. Based on the Commission communication entitled 'Europe 2020: a strategy for smart, sustainable and inclusive growth', in March 2010 the European Council agreed on the following components of this new strategy, which will be formally adopted in June 2010.

Europe 2020 sets three mutually reinforcing priorities:

- smart growth: developing an economy based on knowledge and innovation;
- sustainable growth: promoting a more resource-efficient, greener and more competitive economy;
- inclusive growth: fostering a high-employment economy delivering social and territorial cohesion.

Seven flagship initiatives have also been proposed to support these priorities. One of them — the 'Innovation Union' initiative — aims to re-focus R & D and innovation policy on the challenges facing society, such as climate change, energy and resource efficiency, health and demographic change.

Based on a number of data sources available at Eurostat, this chapter presents statistics and indicators designed to compare trends in, and the structure of, science, technology and innovation (STI) in European regions and their position relative to other regions. The domains covered are: R & D; patents; high technology; human resources in science and technology (HRST). More regional indicators on science, technology and innovation are available on the Eurostat website under 'Science and technology'.

Research and development

Twenty-seven of the 260 regions shown on Map 8.1 spend the equivalent of more than 3 % of their GDP on R & D. These regions are thus above the R & D-intensity target set by the Barcelona Council in 2002 and maintained in the Europe 2020 strategy. More than 40 % of the EU's total R & D expenditure is generated in these, the most R & D-intensive, regions.

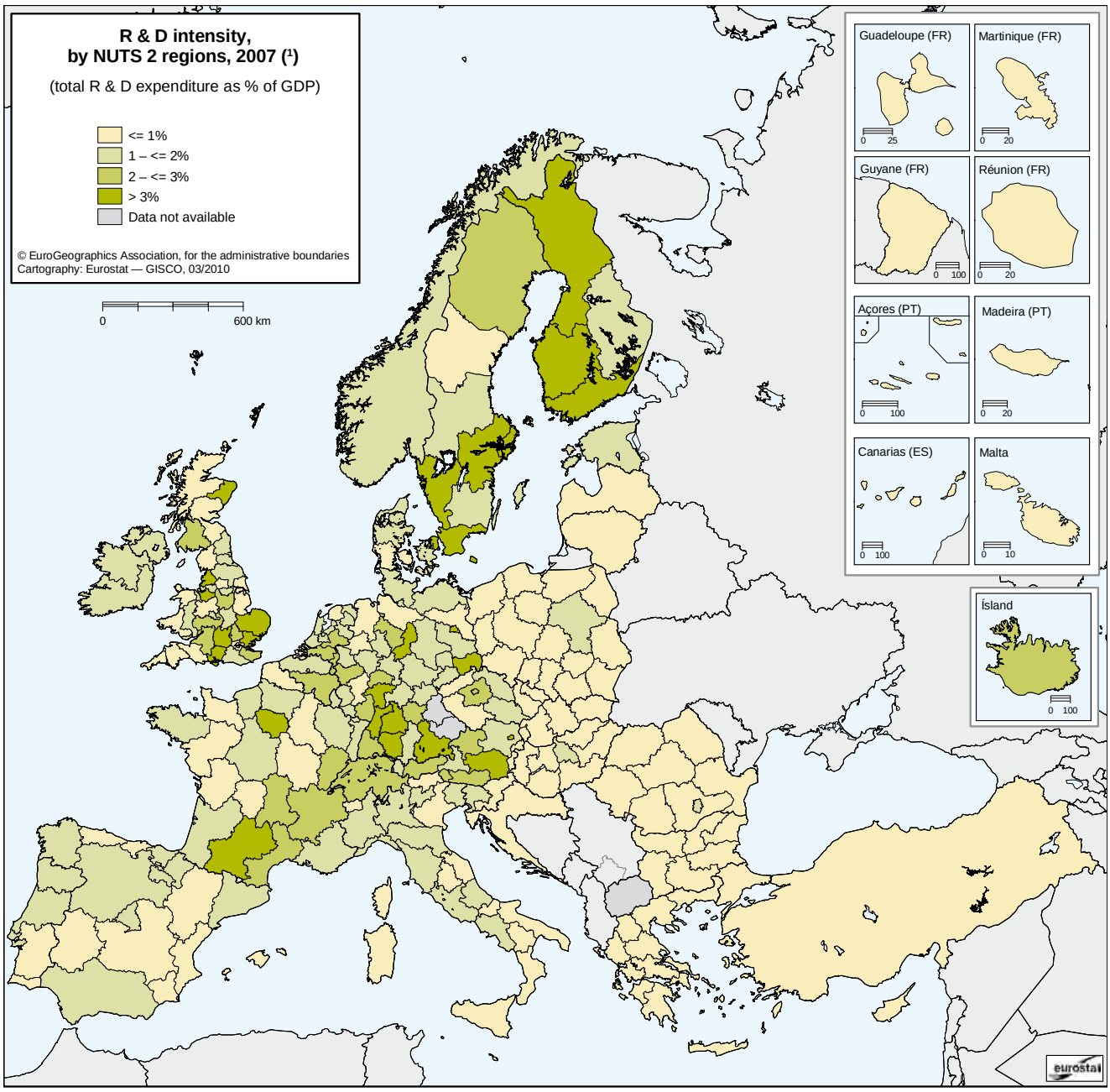
A cluster of four research-intensive regions can be found in south-western Germany: Stuttgart (5.85 %), Karlsruhe (3.72 %), Tübingen (3.80 %) and Darmstadt (3.11 %). These regions are also very important in absolute terms, as together they generate around 8 % of the total R & D expenditure in the EU. Another leading region in terms of R & D is Oberbayern (4.32 %), to the east of the four-region cluster, which contributes another 3 % to the EU total. Further north, Braunschweig (6.77 %), in the middle of Germany, is the most R & D-intensive region on the map. East of Braunschweig, two more major R & D regions are located: Dresden (4.12 %) and Berlin (3.36 %).

East Anglia (5.72 %), in the most eastern part of England, and Essex (4.66 %), just south of it, are the third and seventh most R & D-intensive regions in the UK. Together these two regions generate around 3 % of the EU total. Other R & D-intensive regions in the UK are, starting from the south, Hampshire and the Isle of Wight (3.41 %), Berkshire, Buckinghamshire and Oxfordshire (3.3 %), Cheshire (4.55 %), Lancashire (3.2 %) and North Eastern Scotland (3.11 %), which is also the only one of the 27 most R & D-intensive regions where the higher education sector generates more R & D expenditure than the business enterprise sector.

Eight of the most R & D-intensive regions are located in the Nordic countries. These regions are, starting from the south, Hovedstaden (the region surrounding the capital København) in Denmark (5.09 %), Sydsverige (4.91 %), Västsverige (4.47 %), Östra Mellansverige (3.79 %) and Stockholm (4.19 %) in Sweden, and Etelä-Suomi (3.39 %), Länsi-Suomi (3.68 %) and, finally, Pohjois-Suomi (5.38 %) in Finland which is the fourth most R & D-intensive region on the map.

In France the most R & D-intensive region is Midi-Pyrénées (4.15 %), just north of the Iberian Peninsula. In absolute terms, Île de France

Map 8.1: R & D intensity, by NUTS 2 regions, 2007 (1)
(total R & D expenditure as % of GDP)



(1) Greece and Italy, 2005; France and Switzerland, 2004; Netherlands, 2003; Belgium, départements d'outre-mer (FR9) and Croatia, by NUTS 1 regions; Turkey, Norway and Switzerland, national level; Niederbayern (DE22) and Oberpfalz (DE23), confidential data; Ireland, provisional data; Netherlands and United Kingdom, estimates; Sweden, in some cases researchers are allocated to the head office.

Source: Eurostat (rd_e_gerdreg).

(3.11 %), which includes the French capital, is the leading region in the EU with almost 8 % of the EU's total expenditure on R & D. Two more regions with relatively high R & D intensity are located in Austria: Steiermark (3.77 %) and Wien (3.62 %).

Between 2003 and 2007 nine of the regions for which data are available increased their R & D intensity by more than half a percentage point: Praha (up by 0.68) in the Czech Republic, Stuttgart (1.17), Dresden (1.01) and Detmold (0.52) in Germany, La Rioja (0.54) and Comunidad Foral de Navarra (0.54) in Spain, Lisboa (0.72) in Portugal, Pohjois-Suomi (0.65) in Finland and Sydsverige (0.68) in Sweden.

Map 8.2 provides an overview of the regional distribution of the share of researchers in total employment (measured in headcount). Researchers are the core category directly employed on R & D activities. They are 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'. The highest intensity of researchers (share of researchers out of all persons employed), more than 1.8 %, was found in 25 of the regions shown on Map 8.2. With six regions in this group of front-runners, the United Kingdom was the leading country, followed by Germany with five regions, Finland with three and Sweden and Norway with two each. Austria, Belgium, the Czech Republic, France, Portugal, Slovakia and Iceland each had one top region.

In 2007, North Eastern Scotland (United Kingdom) was the region with the highest share of researchers in total employment, with 4.58 %, well above the EU-27 average (0.99 %). Intensity of researchers was more than three times higher than the EU-27 average in four other regions: Inner London (United Kingdom) with 3.40 %, Wien (Austria) with 3.07 %, Trøndelag (Norway) with 3.05 % and Praha (Czech Republic) with 3.03 %. Fifteen out of the 25 regions performing well in terms of share of researchers also had the highest R & D intensity, with above 3 %, as shown on Map 8.1. The regions with relatively high concentrations of both researchers and R & D expenditure were North Eastern Scotland (United Kingdom), Wien (Austria) and Pohjois-Suomi (Finland).

Intensity of researchers ranged between 1.2 % and 1.8 % in 39 European regions. Again, most of them were located in the United Kingdom (11), followed by another nine regions in Germany. In the vast majority of European regions the share of researchers did not exceed 0.6 % of all persons employed. Nineteen EU Member States and Norway reported at least one region with intensity of researchers below 0.6 %.

Looking at national differences, the spread between the regions with the highest and lowest proportions of researchers in total employment was particularly wide in the United Kingdom (4.47 percentage points between North Eastern Scotland and Highlands and Islands) and the Czech Republic (2.88 percentage points between Praha and Severozápad). Ireland was the country with the narrowest regional disparities in intensity of researchers (0.16 percentage points).

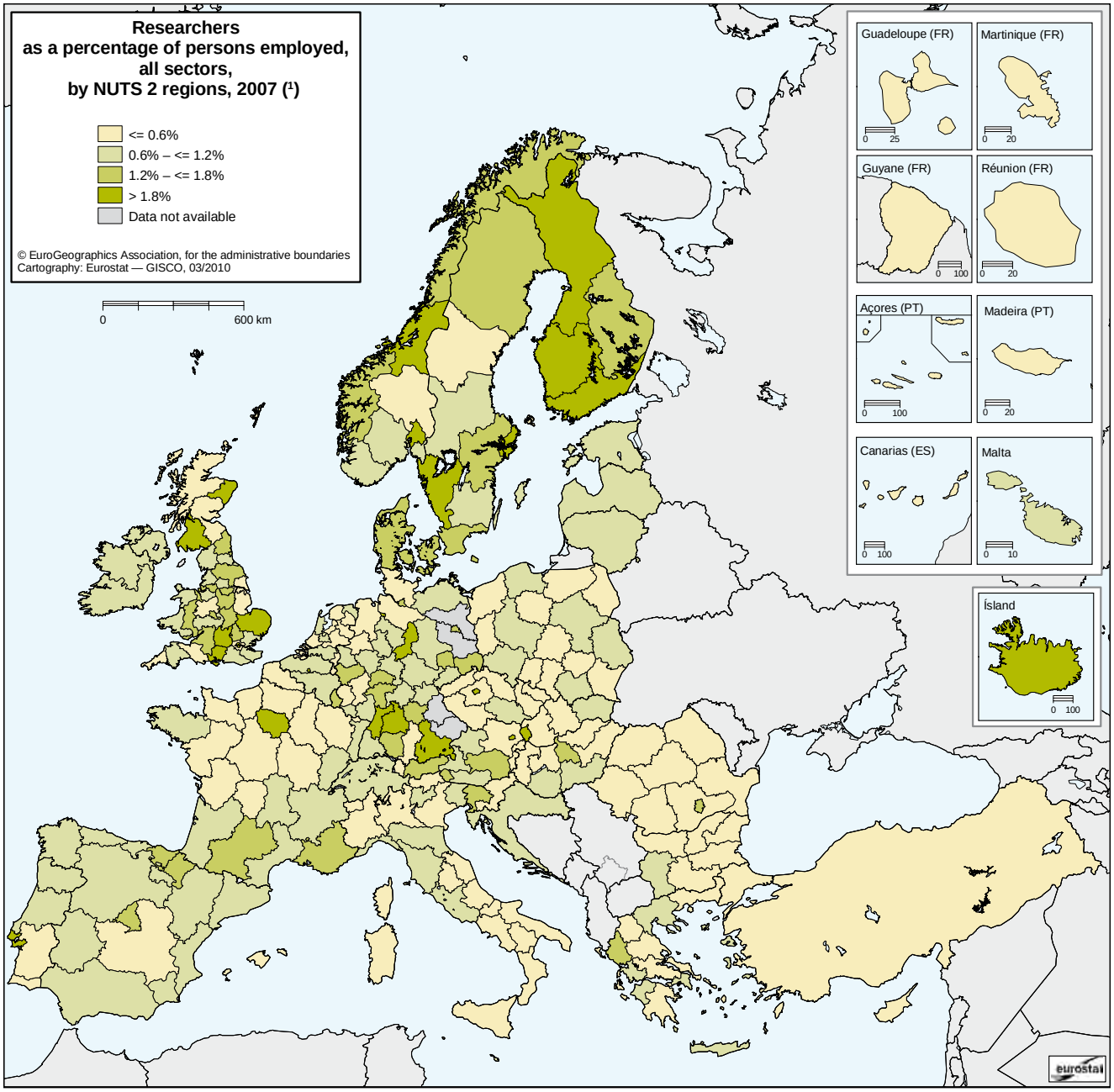
Human resources in science and technology

Science and technology have been recognised as key fields for European development. It is therefore extremely important for policymakers at regional level (and also at EU and national levels) to analyse the stock of highly qualified people who are actively participating in science and technology activities and technological innovation.

One way to measure the concentration of highly qualified people in the regions is by looking at human resources in science and technology (HRST). HRST includes persons who have completed tertiary (i.e. university) education (HRSTE) and/or are employed in a science and technology occupation (HRSTO). The stock of HRSTO can be used as an indicator of development of the knowledge-based economy in the EU.

As Map 8.3 shows, HRSTO are mostly concentrated in urban regions, in particular around the capitals. In 2008, 12 of the 25 leading regions were capital regions, where there is often a high concentration of highly qualified jobs, for example due to the presence of the head offices of companies and government institutions. Capitals are often big cities with large higher education facilities and a large number of highly educated people. This makes these and the surrounding regions attractive places to open science- and technology-related businesses. At the same time,

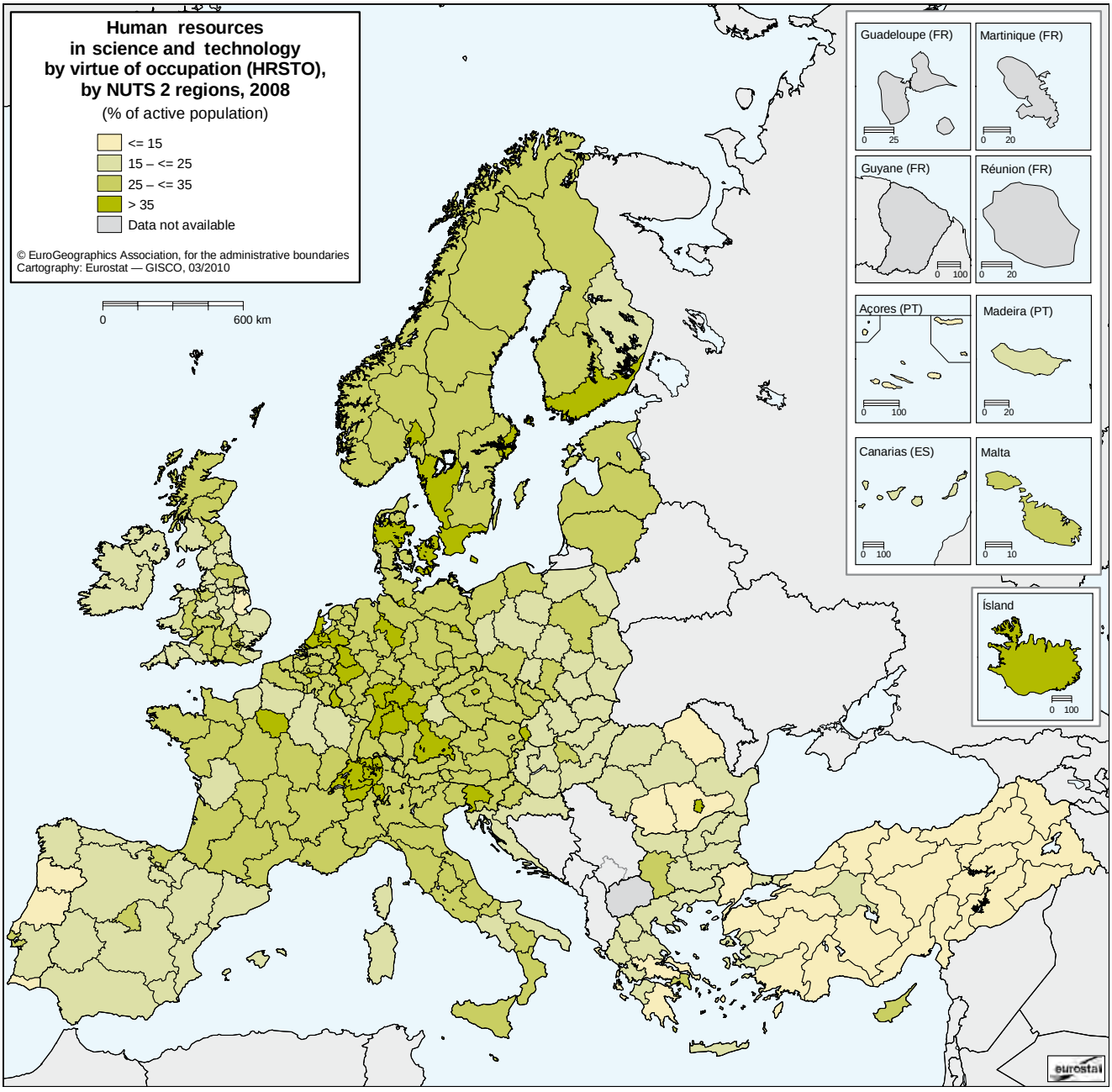
Map 8.2: Researchers as a percentage of persons employed, all sectors, by NUTS 2 regions, 2007 (1)



(1) Greece and Italy, 2005; Switzerland, 2004; Netherlands, 2003; France, 2001; Denmark, Croatia, Turkey and Switzerland, national level; Belgium and départements d'outre-mer (FR9), by NUTS 1 regions; Luxembourg, Netherlands and United Kingdom, national estimates; Ireland, provisional data; Niederbayem (DE22), Oberpfalz (DE23), Brandenburg - Nordost (DE41) and Brandenburg - Südwest (DE42), confidential data; Sweden; in some cases researchers are allocated to the head office.

Source: Eurostat (rd_p_persreg).

Map 8.3: Human resources in science and technology by virtue of occupation (HRSTO), by NUTS 2 regions, 2008 (1)
(% of active population)



Source: Eurostat (hrst_st_rcat).

highly skilled people are often attracted to larger cities, as they are more likely to find a job that meets their requirements in a region where there are many companies.

This urban concentration of human resources employed in science and technology can also be seen by looking at two of the three large regional clusters with shares of HRSTO exceeding 35 % in 2008. The first of these clusters stretches from Switzerland into central and south-eastern Germany. In general, the regions in this cluster are very densely populated. This also applies to the regions in the second distinct cluster, which spans the Benelux countries and the western border regions of Germany. The third cluster is in the Scandinavian countries, where the regions — apart from the capital regions — are very sparsely populated. The regions with the second-, third- and fourth-highest shares of HRSTO are also found in Scandinavia: they are Stockholm in Sweden (48 %), Hovedstaden (København) in Denmark (47 %) and Oslo og Akershus in Norway (47 %). The highest share, however, is reported in Praha (Czech Republic), where 53 % of the labour force are HRSTO. For comparison, HRSTO made up 28 % of the active population in the EU in 2008. Amongst the top 10 regions, the share of HRSTO in the active population increased most in Bratislavský kraj (Slovakia) (by 6.0 percentage points from 2004 to 2008), Nordwestschweiz in Switzerland (5.1), Oberbayern in Germany (4.8) and Praha in the Czech Republic (4.7).

Based on R & D intensity, sectors of economic activity can be subdivided into more specific subsectors for the purposes of analysing employment in science and technology. For manufacturing industries, four groups have been identified, depending on the level of R & D intensity: high, medium-high, medium-low and low-technology sectors. Similarly, services were also classified into knowledge-intensive and less knowledge-intensive services. Within both these groups the following breakdowns are used: high-tech knowledge-intensive services, market high-tech and low-tech knowledge-intensive services, knowledge-intensive financial services and others.

High-tech knowledge-intensive services and high-tech manufacturing are the two subsectors of greatest importance for science and technology in terms of generating relatively high added value, providing new jobs and contributing to competitive growth. Consequently, these two sectors are often analysed jointly as high-tech sectors. The NACE Rev. 2 classification defines high-tech knowledge-intensive services as including motion picture, video and television programme production, sound recording and music publishing activities, programming and broadcasting, telecommunications, computer programming and related activities, information service activities and research and development. High-tech manufacturing covers manufacture of pharmaceutical products and pharmaceutical preparations and of computers and electronic and optical products.

Some 68.0 % of the labour force in the EU in 2008 were employed in the services sector as a whole, but only 2.6 % in high-tech knowledge-intensive services. In addition, 16.9 % were employed in manufacturing, but only 1.1 % in high-tech manufacturing. Together, the high-tech sectors generated 3.7 % of total employment, with two thirds working in high-tech knowledge-intensive services and the other third in high-tech manufacturing.

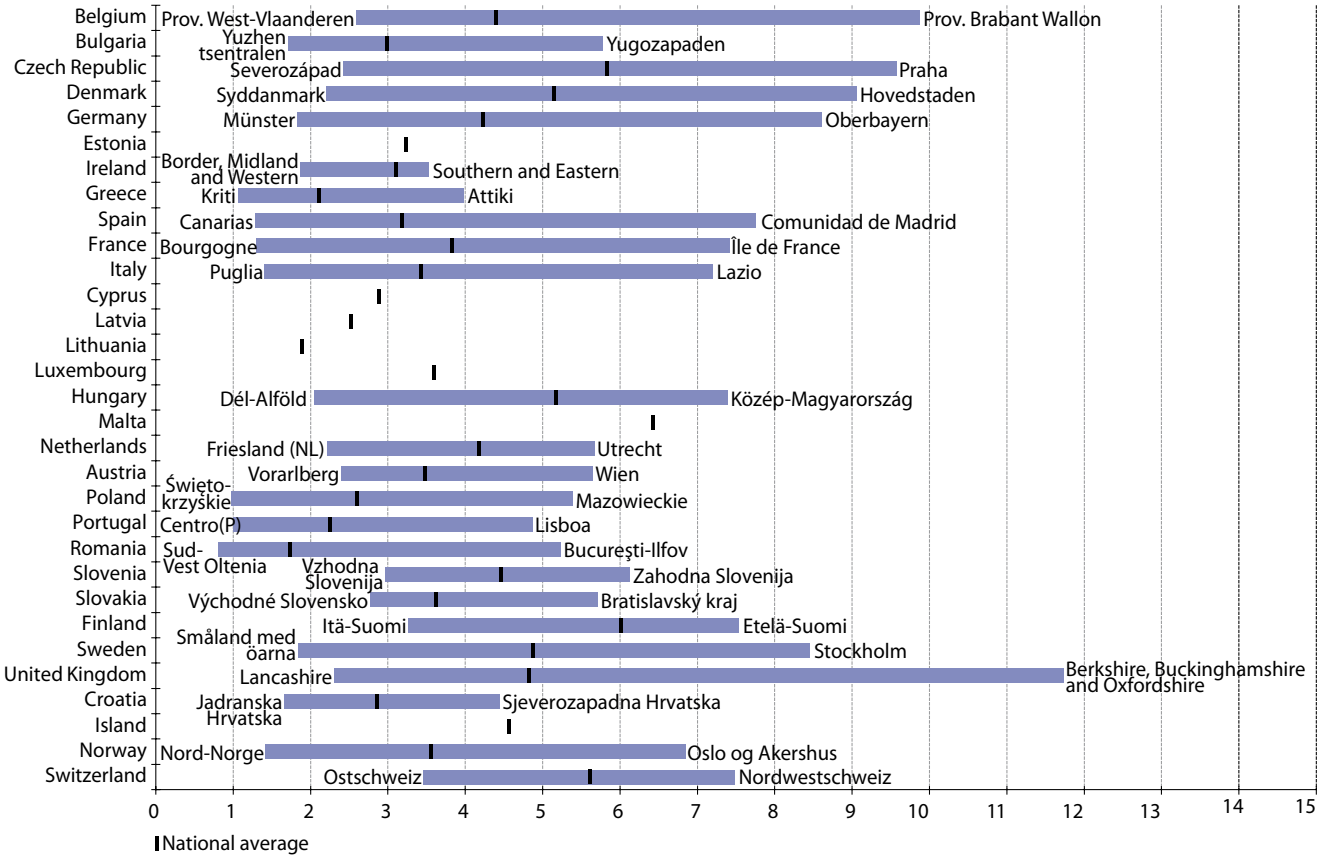
Figure 8.1 shows the regional disparities in high-tech sectors as a share of total employment. It indicates the national average for each country and the regions with the lowest and highest shares of employment in high-tech sectors.

As can be seen from the figure, the highest and lowest national and regional shares vary significantly from one country to another. Moreover, significant disparities can be observed at regional level within and between countries.

With regard to the national averages, 15 of the 33 countries observed recorded values higher than the EU-27 average (3.7 %), with rates of more than 5.0 % in Malta, Finland, Switzerland, Denmark and Hungary. At the other end of the scale, the lowest national shares of high-tech sectors in total employment (below 2.5 %) were reported in Latvia, Portugal, Greece, Lithuania and Romania.

Note that six European Union countries (Estonia, Cyprus, Latvia, Lithuania, Luxembourg and Malta), one candidate country (the former Yugoslav Republic of Macedonia) and two EFTA countries (Iceland and Liechtenstein) are each classified as a single NUTS 2 region covering the entire country. Consequently, their national and regional figures at NUTS level 2 are identical.

Figure 8.1: Employment in high-tech sectors as a share of total employment, highest and lowest NUTS 2 region within each country, 2008 (1)



(1) High-tech sectors = high-technology manufacturing plus high-tech knowledge-intensive services (KIS). Data lack reliability due to small sample size, but are publishable in region with the smallest share in Bulgaria, Greece, Netherlands, Austria, Poland, Romania, Hungary and Norway. Turkey, data not available. Data for the following regions cannot be published, due to small sample size, Severoiztochen (BG33), Yugoiztochen (BG34), Niederbayern (DE22), Unterfranken (DE26), Brandenburg - Nordost (DE41), Bremen (DE50), Kassel (DE73), Mecklenburg-Vorpommern (DE80), Trier (DEB2), Saarland (DEC0), Chemnitz (DED1), Leipzig (DED3), Sachsen-Anhalt (DEE0), Anatoliki Makedonia, Thraki (GR11), Dytiki Makedonia (GR13), Thessalia (GR14), Ipeiros (GR21), Ionia Nisia (GR22), Sterea Ellada (GR24), Peloponnisos (GR25), Voreio Aigaio (GR41), Notio Aigaio (GR42), La Rioja (ES23), Ciudad Autónoma de Melilla (ES64), Limousin (FR63), Corse (FR83), Valle d'Aosta/Vallée d'Aoste (ITC2), Molise (ITF2), Zeeland (NL34), Burgenland (AT11), Opolskie (PL52), Algarve (PT15), Alentejo (PT18), Região Autónoma dos Açores (PT20), Região Autónoma da Madeira (PT30), Åland (FI20), Cumbria (UKD1), East Yorkshire and Northern Lincolnshire (UKE1), Lincolnshire (UKF3), Cornwall and Isles of Scilly (UKK3), North Eastern Scotland (UKM5) and Highlands and Islands (UKM6).

Source: Eurostat (htec_emp_reg2).

At regional level, urban regions, especially capital regions or regions close to capitals, often exhibit high shares of employment in high-tech sectors. Berkshire, Buckinghamshire and Oxfordshire (United Kingdom), in close proximity to London, stand out with 11.7 % of the labour force in high-tech sectors. No other region had a share above 10 %, the next closest being Brabant Wallon (Belgium) with 9.9 % and Hovedstaden (Denmark) with 9.1 %. By contrast, the lowest shares (1 % and lower) were reported in Sud-Vest Oltenia (Romania), Świętokrzyskie (Poland) and Centro (Portugal). Generally, the countries with the top regions in terms of high-tech employment usually also showed the biggest regional disparities, as can be observed in the United Kingdom, Belgium, Denmark, Germany, Sweden, Spain or France. On the other hand, in Portugal, the Netherlands, Austria, Slovenia, Slovakia, Greece, Croatia and Ireland the regional disparities in employment in high-tech sectors were only minor. At the same time, in these countries the highest regional rates were close to the EU average.

Patents

The usefulness of patent statistics as indicators to measure the output of R & D is widely recognised in academic circles. Moreover, patent statistics are increasingly being used by decision-makers in innovation policy or in patent offices in order to monitor trends and assess the inventive and innovative performance of a country or region. The current emphasis on innovation as a source of

industrial competitiveness has raised awareness of patenting. The aim of patents is to protect R & D output, but they are just as significant as a source of technical information, which can help to avoid unnecessarily reinventing and redeveloping ideas.

Patent statistics at regional level are based on applications to the European Patent Office (EPO). The data are regionalised by linking postcodes or city names to the nomenclature of territorial units for statistics (NUTS).

However, any analysis of patent statistics should also take into consideration the limitations of such indicators. For instance, not all inventions are systematically patented. Moreover, a patent is an intellectual property right for inventions of a technical nature and there are other ways to protect intellectual property. Another drawback is that not all patents have the same intrinsic value and that only a small proportion of them lead to technological breakthroughs.

Another aspect can also skew interpretation of regional patent statistics: the place of residence of the inventor — which is used by the major producers of patent statistics for the distribution of patent applications — and the place where the invention took place (e.g. research institute) are not necessarily in the same NUTS region. Figure 8.2 shows regional disparities in patent applications to the EPO per million inhabitants by country and the national average. In Germany significant disparities were observed in 2005 between the leading region of Stuttgart in the south and the lowest-ranked region of Mecklenburg-Vorpommern in the east. Regional discrepancies were even wider in the Netherlands between the regions of Noord-Brabant and Zeeland. By contrast, discrepancies between regions were much smaller in Finland and Sweden, where the national averages were much closer to the top regions in terms of patent applications than in countries such as the Netherlands, Germany or Austria.

Map 8.4 illustrates regional patenting activity in high technology in the EU and provides an overview of regional performance in high-tech patent applications. In most European countries, national patenting is concentrated in specific regions. Regions that are active in patenting are often bunched close together to form economic clusters. This is the case, for example, in the southern part of Germany, the south-east of France and the north-west of Italy. In general, the most active patenting regions are situated in the Nordic countries and at the centre of the EU-27.

In the field of high technology, however, patenting clusters are more difficult to detect, as very few regions recorded more than 100 high-tech patent applications to the EPO per million inhabitants. Finland is the only EU Member State where more than two regions submitted over 100 patent applications to the EPO per million inhabitants.

As shown in Figure 8.3, biotechnology patenting can also be measured at regional level. Seven of the top 15 regions in biotech patenting in the EU were in Germany, two in France, two in the United Kingdom and one each in the Netherlands, Denmark, Italy and Spain. The Danish capital region of Hovedstaden led the field in 2005, with 138 biotech patent applications, followed by Île de France with 127 and Oberbayern (Germany) with 104.

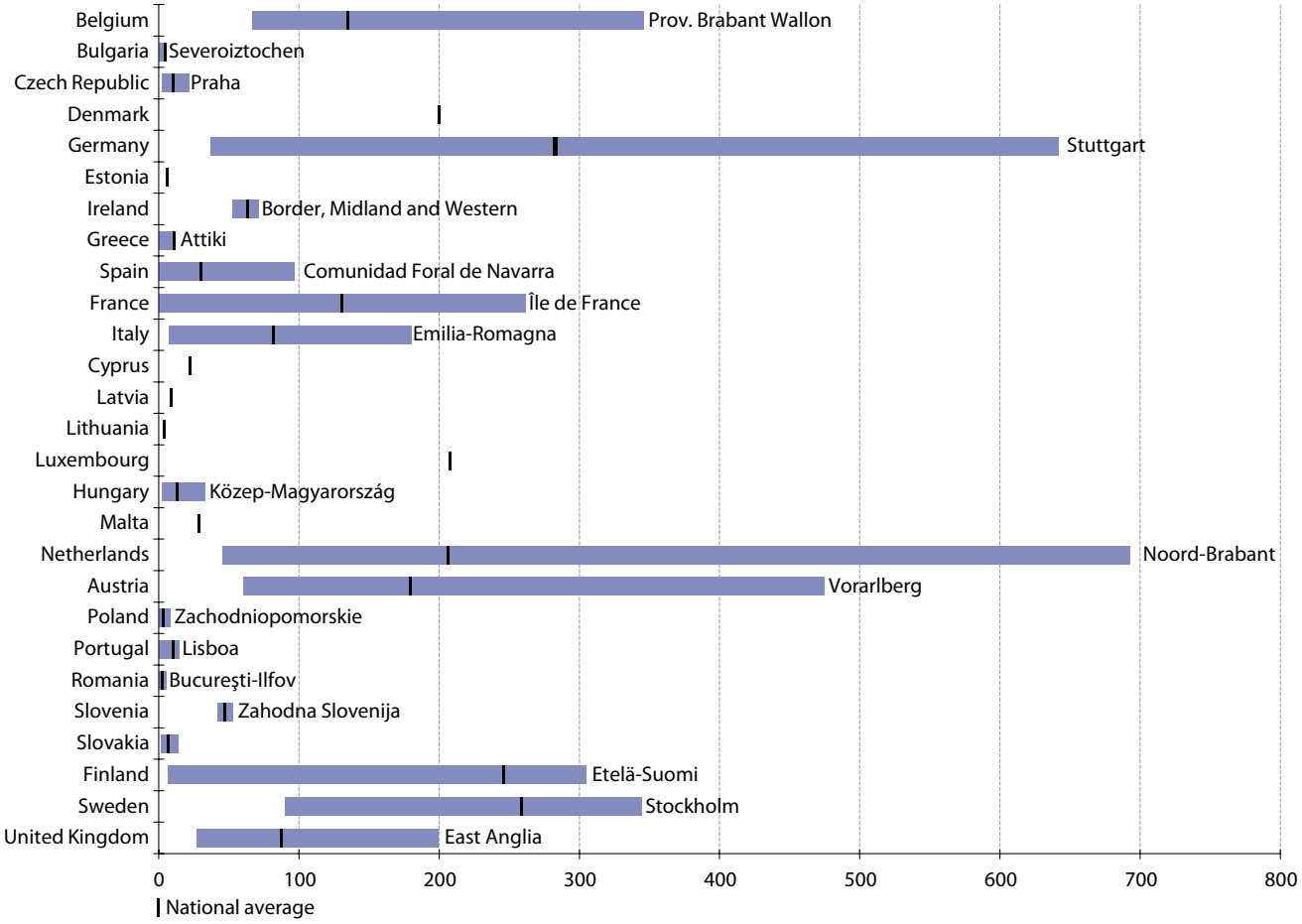
Conclusion

The economic crisis has been largely to blame for blowing some European regions off course away from growth and economic sustainability. This fact underlines the need for relevant and meaningful indicators on science, technology and innovation. Such indicators are of paramount importance for informing policymakers about where European regions stand and can help them take the measures necessary to put all regions back on the path towards greater knowledge and growth. This information also helps to draw clear comparisons of how regions are evolving, both at European level and worldwide.

Based on the relevant statistics and indicators, this yearbook spotlights which European regions are performing better than others in research and development activities and those that need support.

Data on high-tech industries and knowledge-intensive services, patents and human resources in science and technology were also used extensively to complete this regional picture.

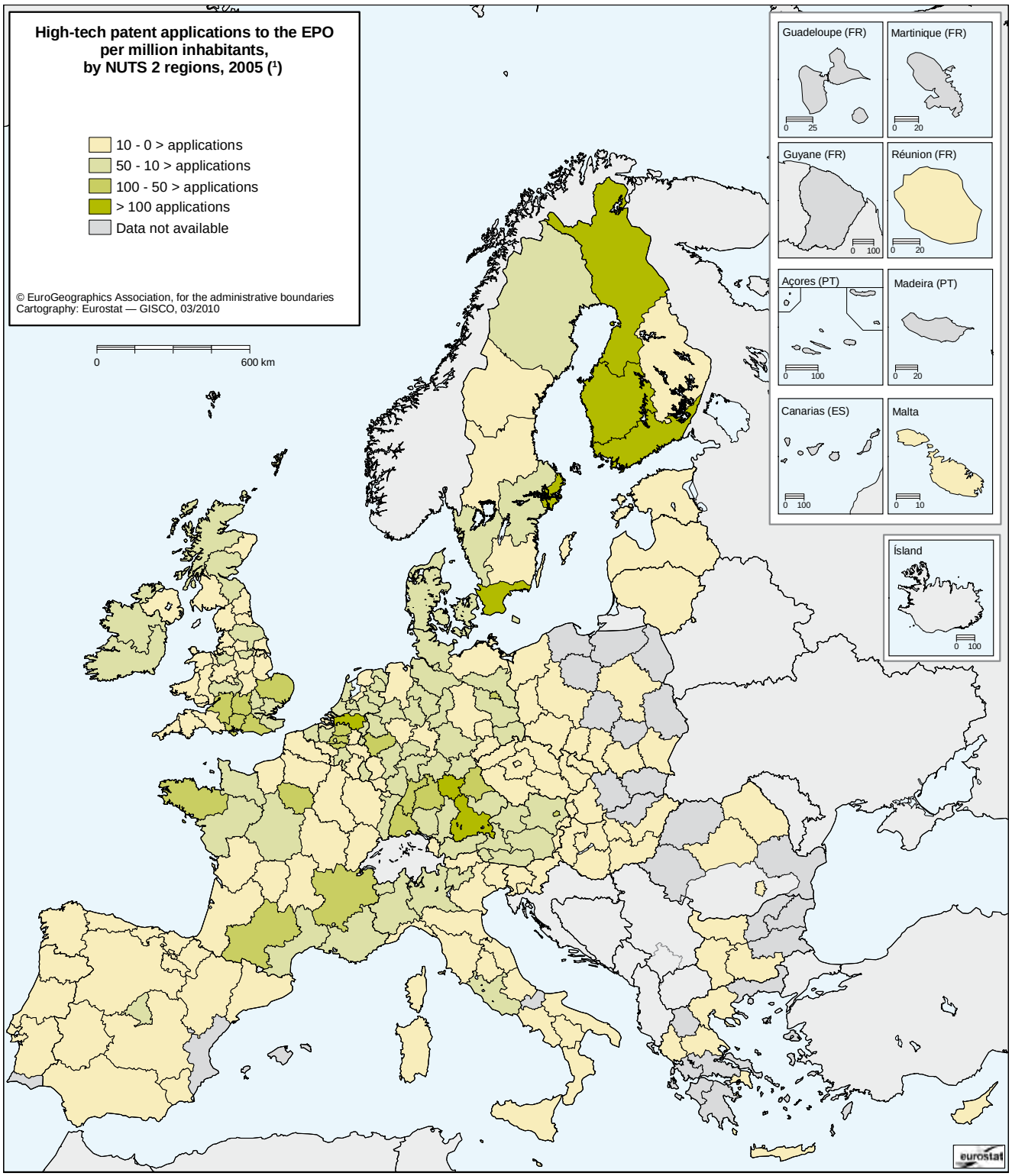
Figure 8.2: Patent applications to the EPO per million inhabitants, highest and lowest NUTS 2 region within each country, 2005 (1)



(1) Denmark, regional population data for 2005 missing.

Source: Eurostat (pat_ep_rtot).

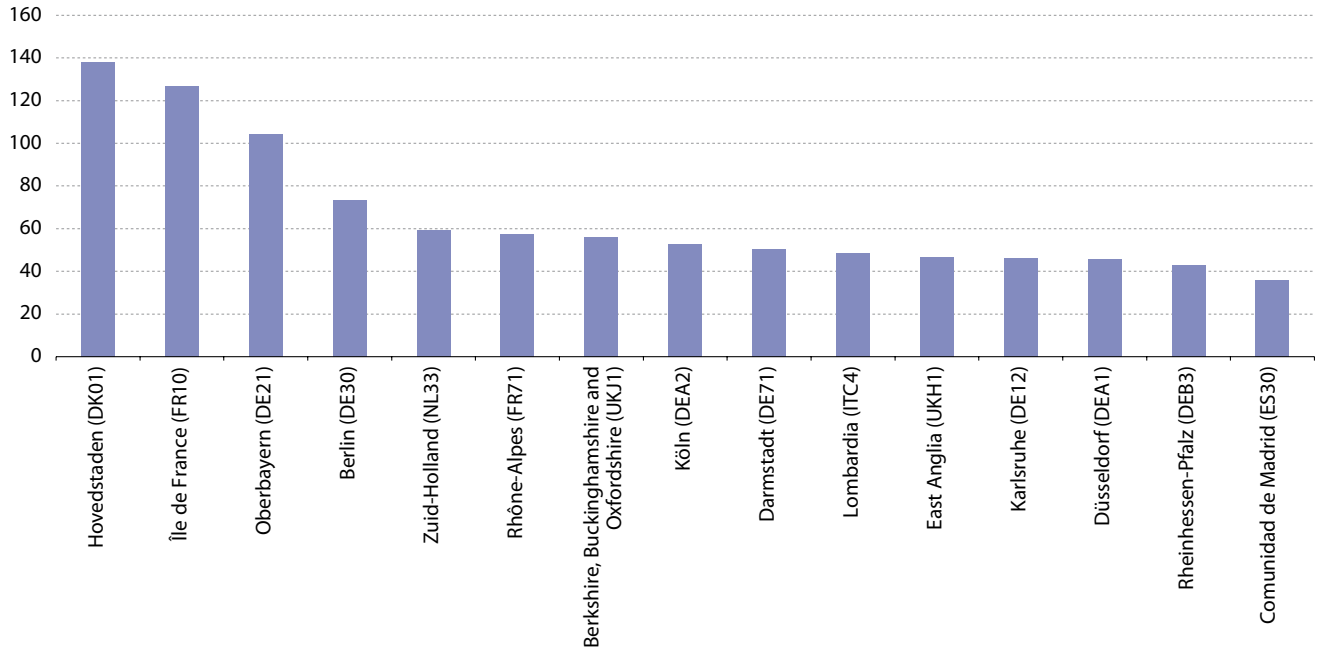
Map 8.4: High-tech patent applications to the EPO per million inhabitants, by NUTS 2 regions, 2005 (1)



(1) Denmark, national level; London (UKI), no breakdown by NUTS 2 regions.

Source: Eurostat (pat_ep_rtec).

Figure 8.3: Top 15 regions in terms of biotechnology patent applications to the EPO, total number, by NUTS 2 regions, EU-27, 2005



Source: Eurostat (pat_ep_rbio).

Methodological notes

The data in the maps and tables in this chapter are, wherever possible, broken down by NUTS 2 regions. Data are extracted from the 'Science, technology and innovation' domain and, more specifically, from the sub-domains 'Research and development', 'Human resources in science and technology', 'High-technology industries and knowledge-intensive services' and 'Patents'.

Statistics on research and development are collected by Eurostat to meet the requirements of Commission Regulation (EC) No 753/2004, which specifies the data sets, breakdowns, frequency and transmission deadlines. The method for national R & D statistics is defined in further detail in the *Frascati manual*: *proposed standard practice for surveys on research and experimental development* (OECD, 2002), which is also used by many non-European countries.

The statistics on **human resources in science and technology (HRST)** are compiled annually, based on microdata extracted from the EU Labour Force Survey (EU LFS). The basic method employed for these statistics is laid down in the *Canberra manual*, which covers all HRST concepts.

The data on **high-technology industries and knowledge-intensive services** are compiled annually, based on data collected from a number of official sources (EU LFS, structural business statistics, etc.). The high-technology employment aggregates are defined in terms of R & D intensity, calculated as the ratio of R & D expenditure on the relevant economic activity to its value added, and based on the statistical classification of economic activities in the European Community (NACE). Revision of the NACE from Rev. 1.1 to Rev. 2 led to changes in the definitions of high-technology and knowledge-intensive sectors. The statistics in this chapter are based on NACE Rev. 2.

Finally, the data on **patent applications to the EPO** are compiled on the basis of microdata received from the European Patent Office (EPO). The data reported include the patent applications filed at the EPO during the reference year, classified by the inventor's region of residence and in accordance with the international patents classification of applications. Patent data are regionalised using procedures linking postcodes and/or place names to NUTS 2 regions. Patent statistics published by Eurostat are almost exclusively based on the EPO's Worldwide Statistical Patent Database (Patstat) developed by the EPO in 2005, using its patent data collection and its knowledge of patent data. The data are largely taken from the EPO's master bibliographic database (DocDB), also known as the 'EPO Patent Information Resource'. It includes bibliographic details on patents filed at 73 patent offices worldwide and contains more than 50 million documents. It covers a large number of fields included in patent documents, such as application details (claimed priorities, application and publication), categories of technology, inventors and applicants, titles and abstracts, patent citations and texts of non-patent literature.