ISSN 1830-754X

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Science, technology and innovation in Europe

2010 edition

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Cataloguing data can be found at the end of this publication.

Luxembourg: Publications Office of the European Union, 2010

ISBN 978-92-79-14618-3
ISSN 1830-754X
doi: 10.2785/39823
Cat. No. KS-EM-10-001-EN-C

Theme: Science and technology
Collection: Statistical books

Preface

Since the Lisbon Council in March 2000, the European Union and the Member States have been sparing no effort to turn the European Union 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' by 2010.

The Lisbon Council, followed by the Barcelona Council in 2002, highlighted the importance of R&D and innovation in the European Union. To follow this up, the 2005 initiative on 'Working together for growth and jobs' gave new momentum to the Lisbon strategy.

The EU and Member States have fully recognised that science, technology and innovation, together with high-quality education and lifelong learning, are essential to turn Europe into a leading knowledge-based society, thus creating the right conditions for long-term prosperity. To achieve this, construction of the European Research Area (ERA) is at the top of the political agenda and will remain there until the ERA is fully operational.

The statistics and indicators presented in this edition of 'Science, Technology and Innovation in Europe' are in line with the Lisbon strategy and the Barcelona objectives. The aim is to map Europe's recent performance in terms of R&D, innovation, high-tech industries, knowledge-based services, patenting and human resources in science and technology.

Europe needs to realise its full vast research and development potential. A knowledge-based society is one where research, education, training and innovation are fully mobilised to fulfil the economic, social and environmental ambitions of the European Union and the expectations of its citizens. The European Commission has been very active in launching schemes to boost European research, such as EURAXESS to improve access to the labour market for scientists or the European Research Council to increase financing for researchers or the European Institute of Innovation and Technology to boost industrial competitiveness by strengthening the innovation capacity of Member States and the Community. This will be achieved by involving and integrating innovation, research and education of the highest standards.

In this context, relevant and meaningful indicators on science, technology and innovation are essential in order to gauge where Europe stands on the path to greater knowledge and growth. Numerous challenges remain, chief among which the global economic downturn, but the EU and the Member States will not relent in their efforts to achieve the goals for 2010.

Inna Steinbuka

Director for Social and Information Society Statistics

Acknowledgements

This publication was prepared by Eurostat:

- Directorate F: Social and Information Society Statistics — **Inna Steinbuka**, Director;

- Unit F-4: Education, Science and Culture — **Lene Mejer**, Acting Head of Unit.

This edition was coordinated and managed by **Bernard Félix, Tomas Meri, Sergiu Parvan, Reni Petkova, Veijo Ritola and Håkan Wilén**.

The technical work was carried out by SOGETI Luxembourg S.A. The texts and analyses, the layout of the publication and the desktop publishing were prepared by **Verónica Benéitez Pinero, Gesina Dierickx, Sébastien Evans, Sammy Sioen and Marta Zimolag**. The data processing was undertaken by **Gaëtan Châteaugiron**.

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

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

Maps

GISCO, Eurostat.

Statistical symbols and abbreviations

©	Copyright
®	Registered
%	Percent
-	Not applicable or real zero or zero by default
:	Not available
0	Less than half of the unit used
1000s	Thousands
2000-2005	Period of several calendar years (e.g. from 1.1.2000 to 31.12.2005)
b	Break in series
:c	Confidential
e	Estimate
f	Forecast
i	Further information in explanatory notes
p	Provisional
r	Revised
s	Eurostat estimate
u	Unreliable
:u	Extremely unreliable

Acronyms and abbreviations

A

AAGR	Average annual growth rate
ABR	Abroad
ABS	Australian Bureau of Statistics
AGR	Annual growth rate
AVI	Aviation (high-tech group, based on the International Patent Classification)

B

BCS	Business Characteristics Survey
BERD	Expenditure on R&D in the business enterprise sector
BES	Business enterprise sector
BRDIS	Business R&D and Innovation Survey
bn	Billion

C

CAB	Computer and automated business equipment (high-tech group, based on the International Patent Classification)
CBSTII	Common basis for science, technology and innovation indicators
CC	Candidate countries
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
COMEXT	Eurostat reference database containing external trade statistics
CTE	Communication technology (high-tech group, based on the International Patent Classification)
CV	Curriculum vitae

D

DETE	Department of Enterprise, Trade and Employment (Ireland)
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 since 1.1.1999
EEA30	European Economic Area (EU-27 plus Iceland, Liechtenstein and Norway)
EFTA	European Free Trade Association
EIS	European Innovation Scoreboard
EIT	European Institute of Innovation and Technology
EP	European Parliament
EPC	European Patent Convention
EPO	European Patent Office
ERA	European Research Area
ERA-MORE	Network of Mobility Centres
ERDF	European Regional Development Fund
ESF	European Social Fund
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 (and technology classification)
FP	(EU Research) 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 (Canada, France, Germany, Italy, Japan, United Kingdom and United States)
G8	Group of Eight (Canada, France, Germany, Italy, Japan, Russia, United Kingdom and United States)
GBAORD	Government budget appropriations or outlays on R&D
GBER	General Block Exemption Regulation
GDP	Gross domestic product
GERD	Gross domestic expenditure on R&D
GISCO	Geographical information system for the Commission — Eurostat
GOV	Government sector
GoveRD	Expenditure on R&D performed in the government sector
GPS	Global positioning system
GUF	General university funds

H

HC	Head count
HEFCE	Higher Education Funding Council for England
HERD	Expenditure on R&D performed in the higher education sector
HES	Higher education sector
HOS	Hospitals
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

IAS	International Accounting Standard
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 rights
IRI	Industrial Research and Innovation (Commission Programme)
ISBN	International standard book number
ISCED	International Standard Classification of Education
ISCO	International Standard Classification of Occupations
ISIC	International Standard Industrial Classification of All Economic Activities
IT	Information technology
ITNS	Marie Curie Initial Training Networks

J

JPO	Japan Patent Office
JRC	Joint Research Centre

K

KIC	Knowledge and innovation community
KIS	Knowledge-intensive services
KIS-IP	Knowledge-intensive services- Innovative platform

L

LFS	Labour Force Survey
LKIS	Less knowledge-intensive services
LSR	Lasers (high-tech group, based on the International Patent Classification)

M

m	Million
MER	Ministry of Education and Research
MGE	Micro-organisms and genetic engineering (high-tech group, based on the International Patent Classification)
MST	Math, Science and Technology
MSTI	Main Science and Technology Indicators — OECD

N

NABS	Nomenclature for the analysis and comparison of scientific programmes and budgets
NAC	National currency
NACE	Statistical Classification of Economic Activities in the European Community
NewCronos	Eurostat's statistical reference database
NHRSTU	Unemployed non-HRST
NIS	National innovation system
NPL	National Patent Literature
NUTS	Nomenclature of Territorial Units for Statistics

O

OECD	Organisation for Economic Cooperation and Development
OHIM	Office for Harmonisation in the Internal Market

P

p.a.	Per year (per annum)
PATSTAT	Patent statistics database (provided by the EPO)
PCT	Patent Cooperation Treaty
PhD	Philosophiæ Doctor
PNP	Private non-profit sector
PNPERD	Expenditure on R&D preformed in private non-profit sector
PPS	Purchasing power standard
PSL	Personnel

R	
Rev.	Revision
R&D	Research and development
RFID	Radio frequency identification
RTDI	Research, Technology Development and Innovation
RVCF	Regional venture capital funds
S	
SBS	Structural business statistics
SE	Scientists and engineers
SET	Strategic Energy Technology
S&E	Science and engineering
SFs	EU Structural Funds
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
STI	Science, technology and innovation
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
UPLS	United Patent Litigation System
USPTO	United States Patent and Trademark Office
V	
v.	Versus
VCI	Venture capital investment
W	
WIPO	World Intellectual Property Organisation
WP	Work Packages

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

MK	The former Yugoslav Republic of Macedonia[(1)]
HR	Croatia
TR	Turkey

Other countries

ASIOTH	Other Asian countries
AU	Australia
BR	Brazil
CA	Canada
CH	Switzerland
CN	China
HK	Hong Kong
ID	Indonesia
IL	Israel
IN	India
IS	Iceland
JP	Japan
KR	South Korea
LI	Liechtenstein
MX	Mexico
MY	Malaysia
NO	Norway
PH	Philippines
RU	Russia
SG	Singapore
TH	Thailand
TW	Taiwan
US	United States

[(1)] 'Provisional code which does not prejudge in any way the definitive nomenclature for this country, which will be agreed following the conclusion of negotiations currently taking place on this subject at the United Nations'.

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Overview and executive summary

This publication presents an analysis of Science, technology and innovation in Europe by 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 comprehensive methodological notes and lists of abbreviations and symbols.

The data and indicators in this publication focus primarily on the 27 EU Member States and the EFTA countries. Candidate countries are also considered whenever data are available. To allow comparisons with the rest of the world, data for China, South Korea, Russia, Japan and the United States are presented where possible. This publication also provides a regional analysis of the situation within the EU Member States. The data presented reflect in general the information available at Eurostat as of July 2009 (Revisions after this date have been included where necessary.) However, the extraction dates may vary across the statistical domains as not all domains are updated at the same time.

Given the numerous data sources used in this publication, the coverage of the time series differs from one indicator to another. However, the first year taken into consideration for most indicators is 1997 or 2002/2003 depending on the choice of the observation period (except for patents). As far as possible, this publication sets out to provide detailed and coherent time series.

This publication endeavours to maintain consistency with previous publications and further information has been added in response to users' requirements. All the data presented in this Statistical Book are available in Eurostat's reference database.

1. Government budget appropriations or outlays on R&D — GBAORD

Chapter 1 provides an analysis of government budget appropriations or outlays on R&D in 2007.

In 2007, GBAORD levels in the EU-27, Japan, South Korea and the United States stood at 0.67 %, 0.68 %, 0.80 % (2006 figure) and 1.03 % of GDP respectively. Between 1997 and 1999, GBAORD as a share of GDP followed similar declining trends in the United States and the EU-15. By contrast, in Japan, GBAORD as a share of GDP increased over the same period. Between 1999 and 2004, government budget appropriations or outlays on R&D as a share of GDP remained relatively stable in the European Union, while they increased slightly in Japan and quite significantly in the United States. since 2004 moderate downturns of these shares have been observed in the three main economies.

Within the EU-27, Spain recorded the highest GBAORD levels as a share of GDP (1.08 %). At the other end of the scale, GBAORD in Bulgaria, Malta and Slovakia stood at less than 0.30% of GDP.

Looking at GBAORD levels in 2000 constant PPS per inhabitant, the Unites States was by far in the lead (EUR 342), followed by four Nordic countries (Finland, Iceland, Norway and Sweden) and Spain.

Between 1997 and 2002, GBAORD in the EU-27 increased by 3.6 % per year on average. This was slightly higher than the increase of GDP, which grew by an average of 3.0 % a year. Between 2002 and 2007, the average annual growth rates of GBAORD and GDP in the EU27 stood at 0.7 % and 2.5 % respectively, meaning that government funding destined for R&D increased at a slower pace than the actual growth of GDP.

Considering the distribution of GBAORD by socio-economic objective, 'general advancement of knowledge: R&D financed from general university funds (GUF)' accounted for the largest share of GBAORD at EU-27 level, with 32.0 % of the total. In Japan too this was the main socio-economic objective, which accounted for an even higher share (34.7 %). In the United States, however, over half of all government budget appropriations or outlays on R&D in 2007 were allocated to 'defence' (57.8 %). Variations were also observed between the EU Member States in terms of their main socio-economic objectives: in 2007, 'general advancement of knowledge: R&D financed from GUF' represented the largest share of total GBAORD in 12 of the EU Member States. France was the only EU Member State where 'defence' (28.8 %) was the leading socio-economic objective.

In Belgium, Spain, Luxembourg and Finland the socio-economic objective 'industrial production and technology' account for more than 20 %. 'General advancement of knowledge: R&D financed from other sources than GUF' was the most important objective in 10 EU Member States.

2. R&D expenditure

Chapter 2 presents the latest trends in R&D expenditure. In 2007, R&D intensity (R&D expenditure as a share of GDP) stood at 1.85 % in the EU27, which is more than 1 percentage point below the 3 % target set for 2010 by Lisbon strategy and below that of Japan, 3.40 % (2006 figure), South Korea, 3.00% (2006 figure) and the United States, 2.67 %. However the EU's R&D intensity is still a bit higher than China's (1.44 %).

The business enterprise sector (BES) accounted for the largest share of R&D expenditure at EU-27 level, with 64 % of the total, followed by the higher education sector (22 %) and the government sector (13 %).

R&D intensity in the EU-27 fell by an average of -0.21 % per year between 2002 and 2007.

In 2007, the EU-27 dedicated EUR 228 billion to R&D, compared to EUR 269 billion spent by the United States and EUR 118 billion by Japan. As stated above, the bulk of R&D expenditure was spent in the business enterprise sector (BES), but this phenomenon was more tangible in South Korea (77 %), Japan (77 %), China (72 %) and the United States (72 %) than in the EU-27 (64 %).

Within the EU-27, four Member States — Germany, France, Italy and the United Kingdom — accounted for more than half of all R&D expenditure in the EU-27. Germany alone, with EUR 61.5 billion, made up more than one quarter of the total. France, the United Kingdom and Italy followed with EUR 39.3 billion, EUR 36.7 billion and EUR 16.8 billion respectively.

In 2006, the business enterprise sector (BES), the government sector (GOV) and the private non-profit sector (PNP) tended to self-finance R&D activities. However, this was not the case in the higher education sector, where R&D was mostly financed by the government sector.

In 2007, business enterprises were the primary source of financing for R&D expenditure in 15 of the EU Member States and in the remaining EU countries the government sector was the main source of R&D funding.

Luxembourg was the only country where more than three quarters of R&D activities were financed by the BES (80 %). Nevertheless, the BES also funded a substantial share of R&D activities in Finland (68 %), Germany (68 %), Sweden (64 %), Denmark (60 %), Belgium (60 %) and Switzerland (70 %). In this respect, the Czech Republic, Ireland, France, Slovenia, the Netherlands and Iceland also posted shares of over 50 %.

In most of the EU countries under review R&D expenditure was essentially directed to applied research, followed by experimental development and basic research. In the Czech Republic, Denmark, Estonia, Latvia, Hungary and Austria, more emphasis was placed on experimental development. This was also the case in Iceland, Norway and Switzerland, which devoted between 38 % and 46 % of R&D investment to experimental development. In Portugal, the distribution of R&D expenditure directed to applied research and experimental development was balanced, with 37 % to each field.

Looking at R&D expenditure by enterprise size, in most Member States, the level of R&D expenditure in the business enterprise sector was related to the size of the enterprise. As a rule, enterprises with 50 to 249 employees and enterprises with 500 or more employees tended to invest more in R&D than others.

At regional level all the 15 leading regions in terms of R&D expenditure as a share of GDP were above the 3 % target set by the Lisbon strategy. Three regions recorded R&D intensities higher than 5 %, namely Braunschweig (DE, 5.83 %), followed by Västsverige (SE, 5.40 %) and Stuttgart (DE, 5.37 %).

3. R&D personnel

In the EU, the percentage of R&D personnel in head count (HC) in relation to total employment has gradually increased between 2001 and 2006. This was also the case in Japan and South Korea. In 2006, 1.54 % of all persons employed in the EU-27 were R&D personnel.

The business enterprise sector and the higher education sector accounted for the majority of R&D employment in all countries, except in Bulgaria where the government sector counted the most of the R&D personnel.

In the EU-27, the higher education sector employed 45 % of all R&D personnel (in head count - HC), followed by the business enterprise sector (42 %), the government sector (13 %) and the private non-profit sector (1 %). Between 2001 and 2006, R&D personnel intensity, measured in head counts as a share of total employment, in the EU-27 increased at an average rate of 1.78 % per year.

A majority of R&D personnel in many of the countries under review are holders of basic university degrees at ISCED 5A level of education. This was the case in all countries except Poland and Portugal, where most R&D personnel had doctorate level (ISCED 6) qualifications. Considering the ISCED 5A level of education, no great discrepancies were noted between male and female R&D personnel. A wider gender gap was found in R&D personnel when considering the ISCED 6 level of education. In all the countries under review except Finland, the share of male R&D personnel with ISCED 6 education was higher than that of women. In Hungary and Malta, this proportion was twice as high among men than among women.

Counted as full-time equivalents (FTE), more than 2.3 million person years were recorded for R&D activities in 2007. More than half of them (1.2 million FTE) were executed in the business enterprise sector (BES). The higher education sector (HES) and the government sector (GOV) counted respectively 736 053 FTE and 342 788 FTE in R&D. The remainder, 30 365 FTE, were executed in the private non-profit sector.

Germany alone, with 493 858 made up more than 20% of all R&D personnel measured as FTE in the EU-27. This phenomenon was even more evident in the business enterprise sector, where Germany accounted for 26 % of all R&D personnel in the EU-27.

Female researchers are still to a large extent under-represented in most EU-27 countries, especially in the business enterprise sector, which counted more than four times as many male researchers than female researchers. This proportion was even higher in the Netherlands, where male researchers were about nine times more numerous than their female counterparts.

In 2007, the EU-27 devoted 161 000 purchasing power standards (PPS) in R&D expenditure per researcher in full-time equivalent. Belgium, France, the United Kingdom, Italy, the Netherlands, Austria, Germany, Sweden and Luxembourg were above the EU-27 average, together with Switzerland, the United States and Japan. In the EU, -----Luxembourg dedicated the most R&D expenditure per researcher, with PPS 239 000.

In 2006, the leading EU region in terms of R&D personnel in full-time equivalent was Île de France (FR), with 135 872 persons employed in R&D. With six regions represented in the top 15, Germany was the leading country in terms of R&D personnel in FTE. Spain, Italy and France each counted two regions in the top 15, while Belgium, Finland and Sweden each counted one region.

4. Human resources in science and technology — HRST

When taking into account all tertiary students of all ages as part of the population aged 20-29 in the EU, reveals that in 2007 more than a quarter of this population was in tertiary education. At national level, Malta recorded the lowest participation level in tertiary education (16.4 %), while Finland recorded the highest (46.7 %).

Female participation in tertiary education is high in the European Union, as in 2007 more than half of all students in the EU were women. Germany and Cyprus were the only EU Member State where women accounted for less than 50 % of all students (49.7 % in both countries).

In the EU the overall number of tertiary education students has grown by an average of 2.0 % per year between 2002 and 2007. The number of students in 'engineering, manufacturing and construction' has increased by an average of 0.8 % a year, compared with 1.1% in 'science, mathematics and computing' students.

In 2007, the proportion of foreign students in comparison to the total student population in all fields of study varied considerably from one EU Member State to another. Cyprus, with a share of 26.9 %, recorded the highest proportion of foreign students among the student population, followed by Austria with a share of 16.7%. This proportion fell to 0.6 % in Poland and 0.9 % in Slovakia.

In the EU, when relating students of all ages to the age-group 20-29 then 9.6 out of every 1000 persons were following a doctoral programme in 2007. Looking at individual Member States, the proportion of Finland (33.1 out of 1000 persons aged 20-29) is the far highest, followed by Sweden (18.9) and Austria (17.1). On the contrary, in Malta only 1.2 out of 1000 persons aged 20-29 followed a doctorate programme.

The distribution of HRST in the EU was balanced among the two youngest age groups (25-34 and 35-44). These two age-groups were overrepresented in the HRST population with around 60 % compared to 40 % belonging to the age-group 45-65.

The highest proportion of scientists and engineers was found in Belgium, where they accounted for almost 8% of the labour force. In Slovakia and Turkey, this proportion fell to under 3 % of the labour force.

In most of the countries under review, scientists and engineers were more likely to be male than female. The gender gap was especially high in Switzerland, where male scientists and engineers accounted for 5.6 % of total labour force and female accounted for 1.2 %. Notable exceptions were Poland and Lithuania, where scientists and engineers were more likely to be female.

5. Innovation

Chapter 5 presents and analyses the results of the 2006 Community Innovation Survey (CIS 2006).

According to CIS 2006, close to two thirds of German enterprises (65 996 in absolute terms) were innovative between 2004 and 2006, which means that these enterprises introduced at least one product (good or service) innovation and/or process innovation during the period under review.

In general, innovative enterprises in the EU more often tend to engage in trade with other Member States than with non-EU countries. This can largely be explained by proximity of other EU countries and the opportunities provided by the Single Market. Custom duties and taxes can also weigh heavily in extra-EU trade.

There appears to be a correlation between innovation activity and enterprise size. The share of innovative enterprises tends to be higher in large and medium-sized enterprises than in small enterprises.

The analysis by NACE (Statistical Classification of Economic Activities in the European Community) highlights in which economic sectors the innovative enterprises are most represented. At EU level, the share of innovative enterprises was slightly higher in the manufacturing sector than in the services sector.

In a majority of countries, innovative enterprises employed more people in 2006 than in 2004. In Greece, the Netherlands, Romania and Slovakia the total number of employees in innovative enterprises decreased slightly between 2004 and 2006. The highest growth rates in employment were observed in Norway (11 %) and Estonia (6 %).

Intramural expenditure plays a fundamental role in R&D funding in most of the countries for which data are available. Cyprus was the only country where innovative enterprises reported higher expenditure levels on extramural R&D than on in-house R&D. In Hungary these two shares were comparable.

In Sweden, the Netherlands and Denmark, more than half of total expenditure on R&D activities was carried out in-house.

With the exception of Cyprus, in all countries for which data are available the percentage of innovative enterprises engaged in intramural R&D was significantly higher than that of those engaged in extramural R&D. Shares of over 60 % were registered in Slovenia, Sweden, the Netherlands and Belgium. In contrast, Bulgaria recorded the lowest share, with less than 15 % of innovative enterprises engaged in intramural R&D. For extramural R&D, the shares ranged from 42 % in Cyprus to 7 % in Malta.

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 the central government. However, there are exceptions. In Belgium and Spain, most 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 Greece, Poland, Romania and Slovakia.

Effects of innovation between 2004 and 2006

In 13 of the countries studied and two candidate countries (Croatia and Turkey), improved quality in goods and services was the main product-oriented effect of innovation for a majority of enterprises.

In terms of process-oriented effect of innovation, increased capacity of production or service provision was the most notable effect of innovation. This was true for 13 out of the countries studied.

Innovative enterprises in the surveyed countries generally consider that the most important side effect of innovation is to meet regulatory requirements.

Factors hampering innovation activities between 2004 and 2006

Innovation activities are subject to external factors that might complicate their implementation. In many innovative enterprises in Europe, innovation activities can be seriously delayed, which is an obstacle for the development of innovation.

In Sweden, 36 % of innovative enterprises declared that many innovation ideas were abandoned at the concept stage. This was also the case for 33 % of enterprises in Slovakia, 29 % of enterprises in Greece and 28 % of enterprises in Estonia, which shows that it is difficult for small enterprises to start in the innovation process.

Intellectual property rights

Between 2004 and 2006, 37 % of innovative enterprises in Turkey applied for at least one patent. They were the most active users of this form of protection. In three European countries under review, more than 15 % of innovative enterprises applied for at least one patent (Austria, Norway and the Netherlands).

Turkey also registered the most trademarks between 2004 and 2006 (43 %), followed by Greece (25 %).

Malta, with 19 % of innovative enterprises, led the way in terms of registration of industrial designs between 2004 and 2006, whereas in Cyprus only 2 % of innovative enterprises resorted to this form of protection.

Among the enterprises surveyed, copyrights were a less widely used method of protection. Nevertheless, more than 12 % of innovative enterprises in Norway claimed at least one copyright in the surveyed period.

Organisational and marketing innovations

Generally, organisational and/or marketing innovations were very popular within innovative enterprises in Europe, as only one Member State (Bulgaria) recorded less than 50 % of innovative enterprise involvement in such activities.

Between 42 % (Hungary) and 8 % (Greece) of innovative enterprises considered 'reduced time to respond to customer or supplier needs' as a highly important effect of organisational innovation.

'Improved quality of goods and services' was considered as a greater effect of organisational innovation by innovative enterprises than 'reduced time to respond to customers and suppliers'.

6. Patents

Patents statistics are widely used to generate indicators that help measure a country's technological output. Chapter 6 takes a closer look at data on triadic patent families, patent applications to the European Patent Office (EPO) and, to a lesser extent, patents granted by the United States Patent and Trademark Office (USPTO). The last part of the chapter focuses on regional patent applications to the EPO.

The data for 2002 show that triadic patent families were highly concentrated, with 35 % of patent families originating from the United States, 31 % from Japan and 25 % from the EU-27.

As regards patent applications to the EPO, in 2005 a total of 55 079 applications were filed by inventors residing in the EU, 34 022 by US-based inventors and 20 913 by inventors in Japan. In 2002, 93 147 patents granted by the USPTO went to inventors residing in the United States, 33 748 to Japanese residents and 21 432 to EU residents. These figures clearly reveal that inventors file more easily their applications at their home office. This fact reduces the comparability of figures across countries. Data on patent families are generally less biased by the 'home office effect' and allow a better comparability.

Germany was the leading European country in terms of patent applications in 2005, not only in absolute numbers, but also as share of GDP and per million inhabitants.

Patent statistics include breakdowns by IPC section, economic activity (NACE) and institutional sector. Indicators on foreign ownership and Patent Cooperation Treaty (PCT) applications are also available.

In 2005, 10 294 high-tech patents were filed at the EPO by EU-27 inventors, whereas 10 204 patents were submitted by inventors residing in the US and 6 447 by inventors in Japan.

Germany was again well ahead considering the number of patent applications filed at the EPO, although in relation to population size, Finland, Sweden and the Netherlands were the best performers in high-tech patenting.

Regarding ICT (information and communication technology) patent applications to the EPO, EU-27 inventors were in the lead in 2005, with 14 692 applications, compared with 12 638 patents applications from US inventors and 9 008 applications from Japan-based inventors.

In terms of biotechnology patent applications, the United States was in the lead, with 2 604 patent applications, followed by the EU-27 (2 397) and Japan (838).

In 2009, Eurostat added nanotechnology to the technological fields under review. Patenting in nanotechnology is currently fairly limited compared to patenting in other fields, but the number of nanotechnology patent applications is growing continuously.

The same year Eurostat also included two sets of new indicators in the patent statistics domain: European and international co-patenting and EU patent citations. The calculated indicators for the first set provide information on the level and growth of co-patenting between EU Member States as compared to international co-patenting with countries outside the EU. However, in 2005, less than 10 % of co-patent applications in the EU involved co-inventors residing in countries other than the declaring country. The indicators on EU patent citations published by Eurostat are based exclusively on patent publications. Unsurprisingly, EU patents far more frequently contain references to EU patent publications than to non-EU patent publications.

In 2005, the five leading EU-27 regions in terms of number of patent applications to the EPO were Île-de-France (FR), Stuttgart (DE), Oberbayern (DE), Noord-Brabant (NL) and Darmstadt (DE). Chapter 6 also provides an overview of regional performance in fields such as high technology, ICT and biotechnology.

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 (e.g. value added and labour productivity), venture capital investment, high-tech trade, employment, and R&D personnel and expenditure.

Enterprises in high-tech industries and knowledge-intensive services

In 2006, Italy counted the most high-tech manufacturers in the EU-27 in absolute terms (over 31 000), followed by Germany (20 060), France (15 982) and Poland (13 811). Together, these four countries accounted for more than 60% of European high-tech manufacturers.

Ireland recorded the highest average production value per person employed, at EUR 129 000, followed by Belgium, with EUR 106 000.

Venture capital investment — VCI

In 2007 the United Kingdom was the leading country in terms of early-stage VCI, with EUR 620.2 million invested in 269 companies, comprising a total of 384 investments.

High-tech trade

Considering the four leading economies in terms of high-tech trade (EU-27, China, Japan and the United States), in 2007 the EU-27 was no longer the top exporter of high-tech products. China was the biggest exporter of high-tech goods in 2007, accounting for 22.7 % of the world share, while the EU-27 made up 19.3 % of the total.

In 2007, ten Member States plus Switzerland each accounted for more than 1 % of high-tech exports at global level. In the EU-27, Germany recorded the highest market share in terms of high-tech exports (9.54 %), followed by a wide margin by the Netherlands (5.60 %), France (4.78 %) and the United Kingdom (3.95 %).

In 2007, 'electronics-telecommunication' accounted for the highest share of high-tech exports (34.1 %), followed by 'computers-office machines' (24.7 %). These two groups accounted for nearly 60 % of high-tech exports worldwide. In contrast, 'chemistry', 'non-electrical machinery', 'electrical machinery' and 'armament' each accounted for less than 4 % of global high-tech exports.

Employment in high-tech industries and knowledge-intensive services

In 2007, 40 million people were employed in the manufacturing sector in the EU-27, representing 18.3 % of total employment in the EU. Germany recorded the largest number of people employed in manufacturing (more than 8 million), followed by Italy and France (more than 4 million respectively), the United Kingdom, Poland and Spain (more than 3 million respectively).

In the EU-27, women accounted for 30.6 % of employment in manufacturing. Bulgaria was the only country where women represented more than half of the workforce employed in manufacturing, although Estonia, Latvia, Lithuania, Portugal and Romania came fairly close to a gender balance (46.1 %, 42.6 %, 48.3 %, 42.2 % and 46.7 % respectively).

The services sector accounted for more than 144 million jobs in the EU-27, almost half of which were in knowledge-intensive services (KIS). Women comprised more than half (54.0 %) of total employment in services in the EU-27. In knowledge-intensive services, the share of female employment (60.4 %) was even higher than in total services.

In 2007, technicians and professionals accounted for 48.3 % of persons employed in high-tech sectors in the EU-27. Technicians and professionals further represented more than 60 % of the workforce in high-tech sectors in Sweden and Norway, and accounted for more than half of the high-tech workforce in a further eight Member States.

Looking at regional statistics, in 2007, employment in high-tech sectors as a percentage of total employment ranged from 0.4 % in Balikesir (TR) to 10.7 % in Berkshire, Buckinghamshire and Oxfordshire (UK). With the exception of Greece, all Member States where regional breakdown was possible had at least one region where the share of employment in high-tech sectors was higher than the EU-27 average (4.4 %).

I

Investing in R&D

1

GBAORD

1.1 Introduction

Data on government budget appropriations or outlays on research and development (GBAORD) are a way of measuring government support for R&D activities. GBAORD data indicate budget provisions, not actual expenditure. They measure how much priority governments give to public funding of R&D. GBAORD include all funds allocated to R&D in central government or federal budgets. Provincial or state governments should also be included when their contribution is significant. Unless stated otherwise, the data include both current and capital expenditure. As shown in the box below, GBAORD cover government-financed R&D performed not only in government establishments but also in the three other sectors at national level (business enterprise, higher education and private non-profit). GBAORD also include government-financed R&D performed abroad (including international institutions).

The advantage of GBAORD data is their timeliness, but there are some drawbacks, such as data sources and harmonisation, which should be taken into account when using them.

Data on actual R&D expenditure are not available in their final form until some time after the end of the budget year and may well differ from the original budget provisions. Further information on methodological differences between GBAORD and R&D expenditure data can be found in the 'Proposed standard practice for surveys on research and experimental development' (*Frascati Manual*, OECD, 2002).

GBAORD data are compiled by national authorities from figures on public budgets. As many countries have their own terminology and methodology for budget items, GBAORD often do not fully match the OECD/Eurostat methodology set out in the *Frascati Manual* and are perceived to be less comparable than data on R&D expenditure, which are collected in a much more harmonised way.

Government budget appropriations or outlays on R&D can be broken down by socio-economic objectives, depending on the purpose of the R&D programme or project, on the basis of the NABS — *the Nomenclature for the analysis and comparison of scientific programmes and budgets*. R&D programmes are allocated to specific socio-economic objectives based on the intentions at the time the funds are committed and not the actual content of the projects concerned.

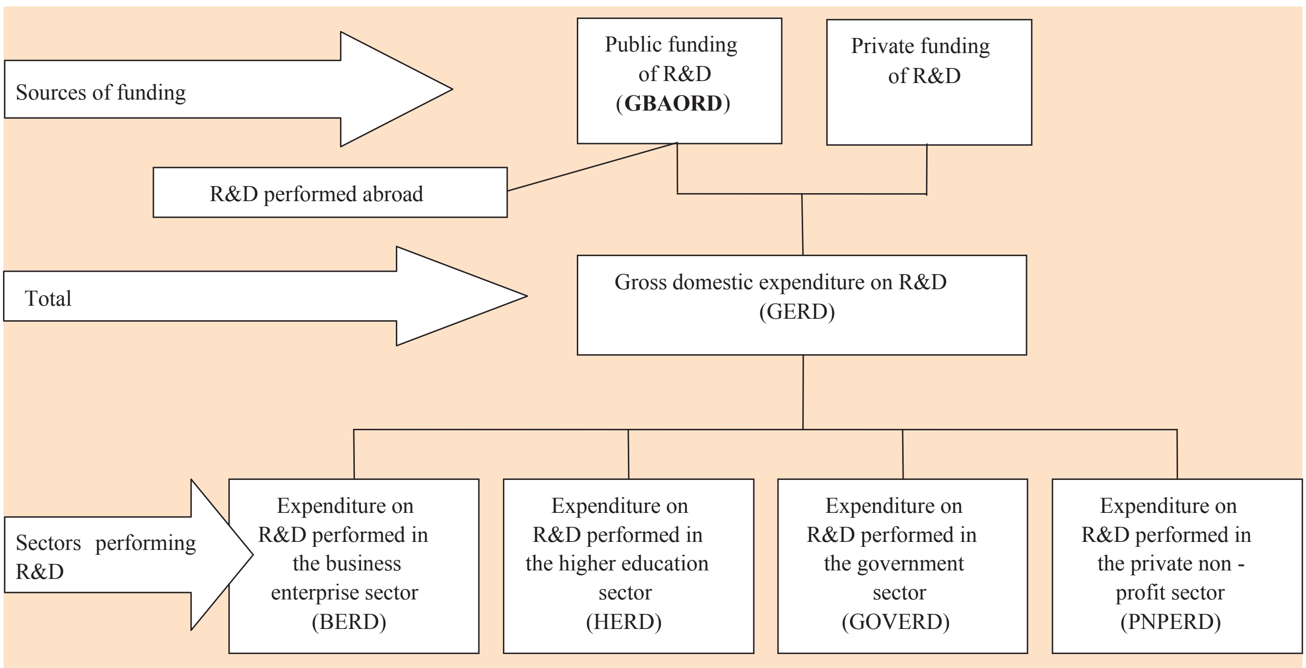
The NABS nomenclature was originally established in 1969 and subsequently revised in 1975, 1983, 1992 and, most recently, in 2007. Data based on the 2007 revision of the NABS are available from 2007 onwards.

The analysis of GBAORD data in this publication covers the period 1997–2007 (with the last year based on the provisional budget for most of the countries). This chapter is subdivided into two main parts:

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

Note that the data presented in this publication reflect the data available in Eurostat's reference database in July 2009.

For further details on the methodologies applied, see the methodological notes.

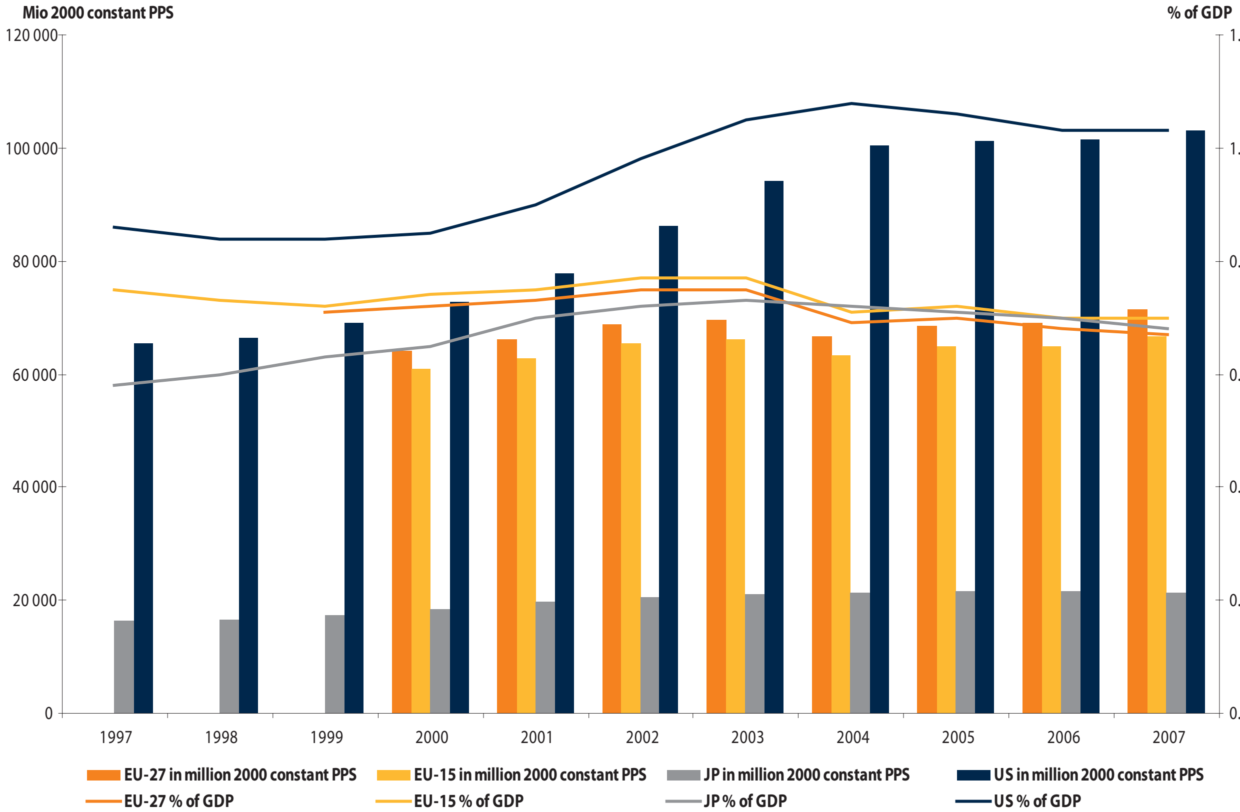


1.2 Total GBAORD

The United States leads the way in terms of GBAORD

Figure 1.1 shows government budget appropriations or outlays on research and development (GBAORD) in million PPS at constant prices and as a percentage of GDP for the European Union, Japan and the United States. These two units were chosen to illustrate, on the one hand, the relative growth compared with GDP and, on the other, the real growth in million PPS.

Figure 1.1: Total GBAORD in million PPS* (at constant 2000 prices) and as a percentage of GDP, EU-27, EU-15, Japan and the United States — 1997–2007



Note:
* PPS = purchasing power standard (an artificial currency unit reflecting different national price levels (EU-27 = 100)).
EU-27, EU-15: Eurostat estimates.
US 2000: break in series.
JP and US: federal or central government only.
US: total excludes data for the R&D content of general payments to the higher education sector for combined education and research (public GUF).

Source: Eurostat (gba_nabsfin92), OECD-MSTI for JP and US.

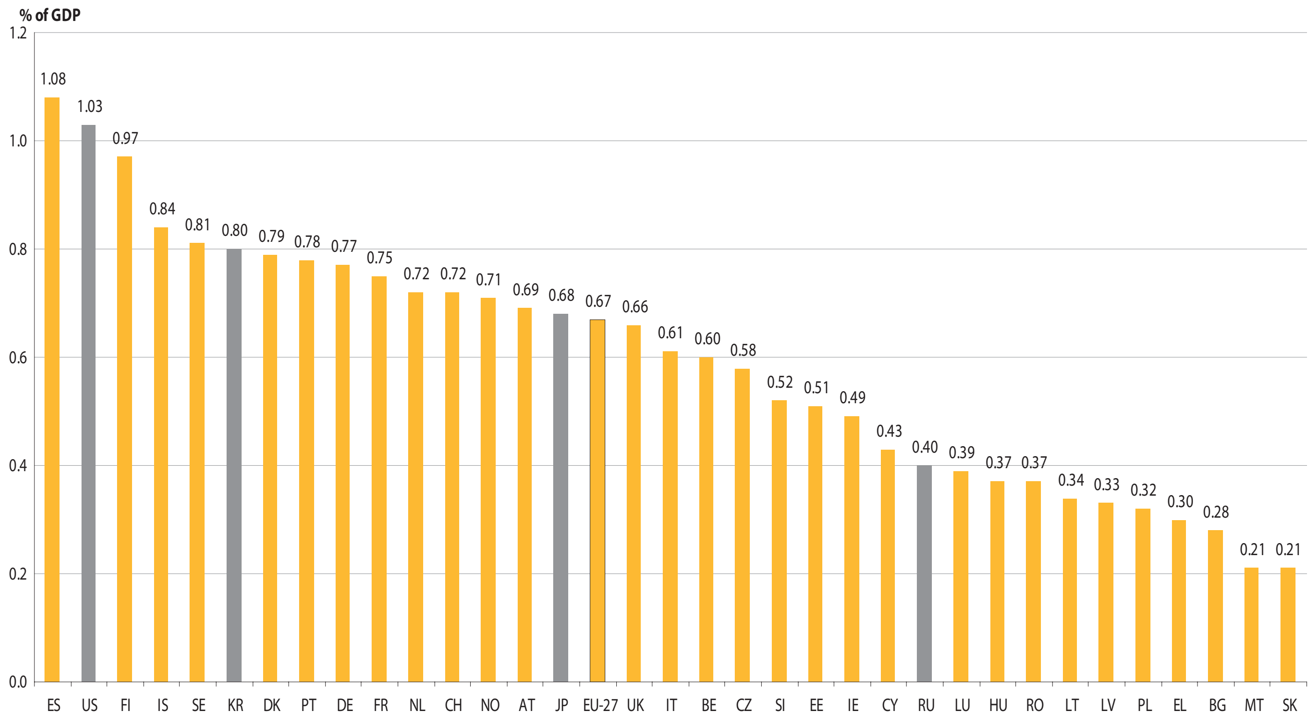
In 2007, as in the previous four years, the US allocated more than 1 % of GDP to GBAORD. However, the amount increased slightly in terms of million 2000 constant PPS. The European Union and Japan allocated 0.67 % and 0.68 % of GDP respectively to GBAORD.

During the period 1997 to 1999, GBAORD as a share of GDP followed similar downward trends in the United States and the EU-15. By contrast, in Japan GBAORD as a share of GDP increased over the same period.

Trends diverged considerably between 1999 and 2004, with GBAORD as a share of GDP remaining relatively stable in the European Union, but increasing slightly in Japan and quite significantly in the United States.

Since 2004, overall fairly positive growth trends have been recorded in terms of GBAORD in million 2000 constant PPS, but as a share of GDP moderate downturns have been observed in every economy, mainly because the GDP growth rate has been higher than the growth rate for GBAORD.

Figure 1.2: Total GBAORD as a percentage of GDP, EU-27 and selected countries — 2007



Note:
Exceptions to the reference year: 2006: IT, CH and KR; 2005: HU.
EU-27: Eurostat estimate.
EL, AT and KR: provisional data.
EE: national estimate.
AT, JP and US: federal or central government only.
US: total excludes data for the R&D content of general payments to the higher education sector for combined education and research (public GUF).

Source: Eurostat (gba_nabsfin92), OECD-MSTI for KR, JP and US.

Figure 1.2 shows, country by country, GBAORD as a share of GDP. The main advantage of this indicator is that it adjusts for differences in the size of the economies, thus making it easier to compare GBAORD levels between countries.

In 2007, GBAORD in the EU-27 stood at 0.67 % of GDP. However, the EU average masks wide variations between the Member States, with GBAORD as a share of GDP ranging from 1.08 % in Spain to 0.21 % in Malta and Slovakia. This share was more than 0.8 % in Spain, the United States, Finland, Iceland and Sweden. Six Member States recorded GBAORD levels between 0.8 % of GDP and the EU-27 average, as did South Korea, Switzerland, Norway and Japan.

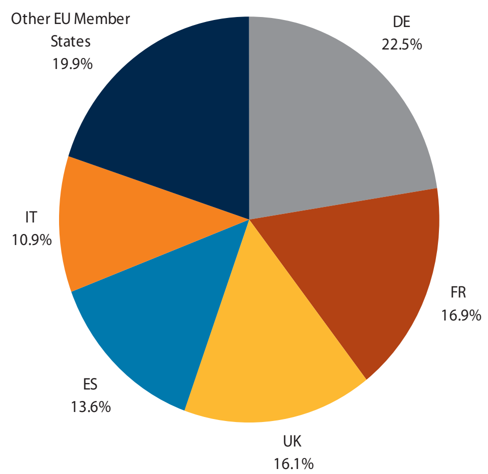
Fifteen Member States plus Russia reported GBAORD levels below the EU average but not lower than 0.3 % of GDP.

At the bottom of the scale, GBAORD levels fell short of 0.3 % of GDP in Bulgaria, Malta and Slovakia.

Figure 1.3 shows the top five Member States in the breakdown of GBAORD in the European Union. In 2007, total GBAORD in the EU-27 added up to more than EUR 83 billion at current prices.

The three leading Member States in terms of GBAORD (Germany, France and the United Kingdom) accounted for more than half of all GBAORD in the EU-27.

Figure 1.3: GBAORD in the top EU countries as a percentage of EU-27 GBAORD — 2007



Note:
Exception to the reference year: 2006: IT.

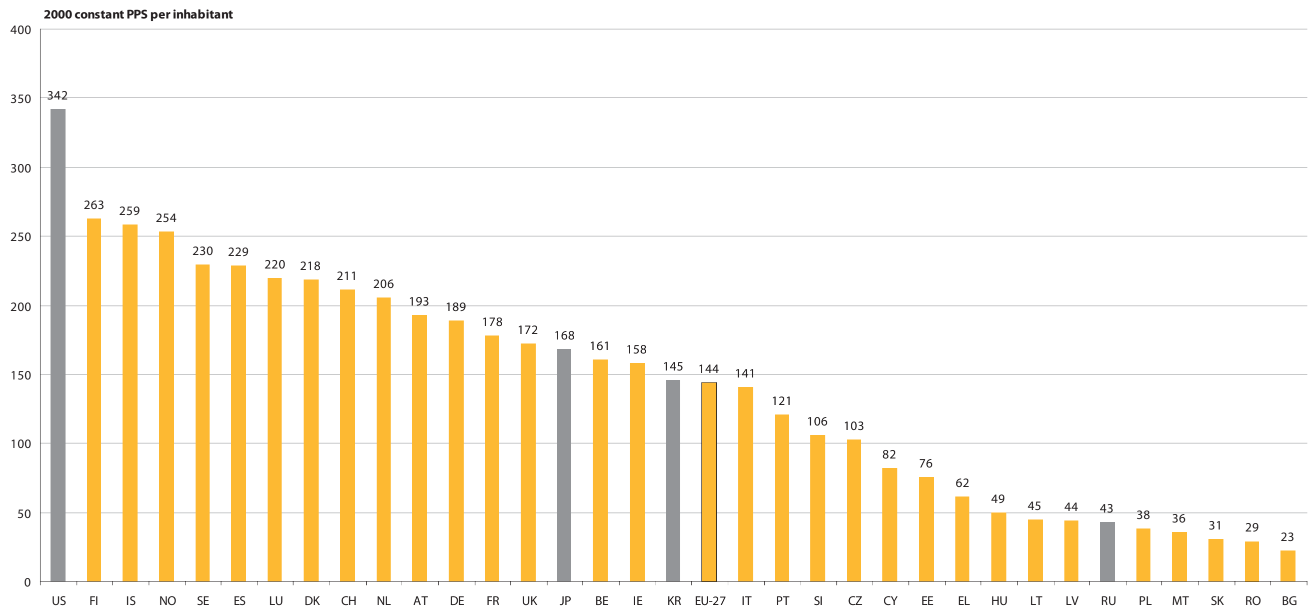
Source: Eurostat (gba_nabsfin92).

The highest GBAORD levels were recorded in Germany, with EUR 18.7 billion, followed by France, with EUR 14.1 billion. The United Kingdom, Spain and Italy (2006 data) allocated EUR 13.4 billion, 11.3 billion and 9.1 billion respectively to GBAORD. These five Member States made up approximately 80 % of total GBAORD in the EU-27.

Figure 1.4 shows the ranking of GBAORD levels in 2000 constant PPS per inhabitant. The United States was far in the lead, followed by four Nordic countries (Finland, Iceland, Norway and Sweden) and Spain. The active promotion of research by the government could play a role in putting these countries in the lead. Furthermore, as shown in section 1.3, the United States does not follow the same objectives at all when it comes to allocation of GBAORD.

GBAORD levels in 2000 constant PPS per inhabitant were higher than the EU average (EUR 144) in nine other Member States, along with Switzerland, Japan and South Korea. The remaining 15 Member States and Russia were below the EU average.

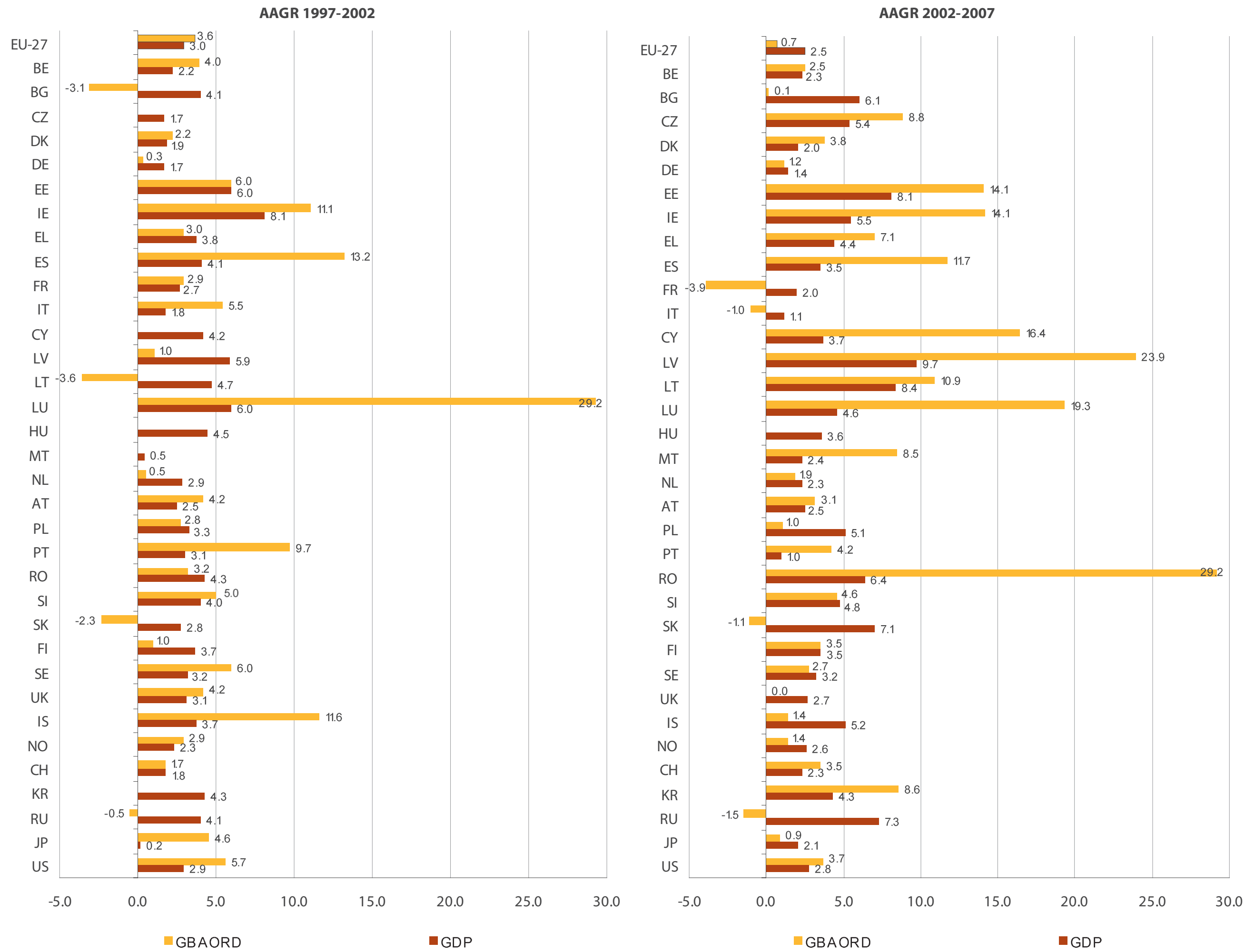
Figure 1.4: Total GBAORD in PPS* per inhabitant (at constant 2000 prices), EU-27 and selected countries — 2007



Note:
* PPS = purchasing power standard (an artificial currency unit reflecting different national price levels (EU-27 = 100)).
EU-27: Eurostat estimate.
Exceptions to the reference year: 2006: IT, CH and KR; 2005: HU.
EL, AT and KR: provisional data.
EE: national estimate.
AT, JP and US: federal or central government only.
US: total excludes data for the R&D content of general payments to the higher education sector for combined education and research (public GUF).

Source: Eurostat (gba_nabsfin92), OECD-MSTI for KR, JP and US.

Figure 1.5: Average annual growth rate (AAGR) of GBAORD and of GDP (expressed in million PPS* at constant 2000 prices), EU-27 and selected countries — 1997–2002 and 2002–2007



Note:

Exceptions to the reference period for GBAORD AAGR 1997-2002:
- 2000-2002: EU-27, BG and LU;
- 1999-2002: EE and RO;
- 1997-2001: IT and PL;
- 1999-2001: LT;
- 1998-2001: SE;
- 1998-2002: CH.

EU-27: Eurostat estimate.
EL, AT and KR: provisional data.
EE: national estimate.
AT, JP and US: federal or central government only.

Exceptions to the reference period for GBAORD AAGR AAGR 2002-2007:
- 2001-2006: IT;
- 2004-2007: CY and MT;
- 2001-2007: LT, PL and SE;
- 2002-2006: CH;
- 2004-2006: KR.

Exceptions to the reference period for GDP: 1999-2002: RO; 2000-2002: MT.

US: total excludes data for the R&D content of general payments to the higher education sector for combined education and research (public GUF).
* PPS = purchasing power standard (an artificial currency unit reflecting different national price levels (EU-27 = 100)).

Source: Eurostat (gba_nabsfin92 and namagdp_c), OECD-MSTI for KR, JP and US.

Figure 1.5 provides a comparative breakdown of the annual average growth rates (AAGR) of total GBAORD and GDP, both expressed in PPS at 2000 prices, for the periods 1997–2002 and 2002–2007.

Between 1997 and 2002, GBAORD in the EU-27 increased by 3.6 % per year on average. This was slightly higher than the increase in GDP, which grew by an average of 3.0 % a year. Twelve Member States recorded a higher AAGR for GBAORD than for GDP; this was also the case in Iceland, Norway, Japan and the United States. The opposite was observed in ten Member States, Switzerland and Russia, where GDP grew faster than GBAORD. The largest discrepancy between the two was reported in Luxembourg, at 23.2 %.

Between 2002 and 2007, the average annual growth rates for GBAORD and GDP in the EU-27 stood at 0.7 % and 2.5 % respectively, which means that government funding for R&D increased at a slower pace than GDP. GBAORD levels increased not only in most Member States, but also in Iceland, Norway, Switzerland, Japan, South Korea and the United States. Italy, France and Slovakia were the only Member States to report a drop in GBAORD levels in PPS at 2000 prices. Fifteen Member States reported stronger growth in GBAORD than in GDP between 2002 and 2007. The average increases in GBAORD were even as high as 29.2 %, 23.9 % and 19.3 % per year in Romania, Latvia and Luxembourg respectively.

On the other hand, the opposite trend was observed in Bulgaria, Germany, France, Italy, the Netherlands, Poland, Slovenia, Slovakia, Sweden and the United Kingdom, which recorded stronger growth rates in GDP than in GBAORD between 2002 and 2007. The same was the case for Iceland, Norway, Japan and Russia.

Over the reference period, GBAORD growth rates were below or close to the EU-27 average (0.7 %) in four of the main European economies: Germany, France, Italy and the United Kingdom. In the rest of the world, GBAORD growth rates in the United States (3.7 %), Japan (0.9 %) and South Korea (8.6 %) were higher than in the EU-27 (0.7 %).

Government funding mechanisms for academic research

"Because US universities generally do not maintain data on departmental research, US 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. GUF is not equivalent to basic research. The US federal government does not provide research support through a GUF equivalent, preferring instead to support specific, separately budgeted R&D projects, usually to address the objectives of the federal agencies that provide the R&D funds. However, some state government funding probably does support departmental research at public universities in the United States.

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 socio-economic 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 support to universities, and in Canada it accounts for roughly 45 % of 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:
http://www.nsf.gov/statistics/seind08/c4/c4s.htm#c4sb1

1.3 GBAORD by socio-economic objective

Table 1.6 shows the breakdown of government budget appropriations or outlays on R&D by NABS 2007 socio-economic objectives and total GBAORD for the EU-27 and selected countries (NABS is the Nomenclature for the analysis and comparison of scientific programmes and budgets).

The latest version of the nomenclature (NABS 2007) has been in use since reference year 2007. Before that its earlier version (NABS 1992) was used. One of the main differences between NABS 2007 and NABS 1992 is the division of the chapter on 'social structures and relationships' into three separate chapters: 'culture, recreation, religion and mass media', 'education' and 'political and social systems, structures and processes'.

The main socio-economic objective within the EU-27 was 'general advancement of knowledge: R&D financed from general university funds (GUF)', which accounted for 32.0 % of total GBAORD, followed by 'general advancement of knowledge: R&D financed from sources other than GUF' (14.5 %), 'industry production and technology' (11.5 %) and 'defence' (11.5 %).

By contrast, government budget appropriations or outlays on R&D were low on 'education' (0.8 %), 'culture, recreation, religion and mass media' (1.0 %) and 'exploration and exploitation of the earth' (1.5 %).

At country level, the two socio-economic objectives linked to 'general advancement of knowledge' took the largest shares of total GBAORD. They cover R&D related to various fields of science — natural sciences, engineering, medical, agricultural and social sciences and humanities.

The socio-economic objective 'general advancement of knowledge: R&D financed from general university funds' accounted for the largest shares in half of the Member States for which data are available and also in Norway and Japan.

In Belgium, Spain, Luxembourg and Finland 'industry production and technology' accounted for more than 20 % of total GBAORD.

'Defence', which took the same share as 'industry production and technology' at EU level, was the leading objective in only France, with 28.8 % of total GBAORD, and in the United States, with 57.8 %.

However, this objective also took large shares in the United Kingdom, Sweden and Spain, with 23.4 %, 16.4 % and 13.1 % respectively. Hence, the substantial share of total GBAORD in the EU-27 (11.5 %) allocated to defence is mainly due to the contribution by these three countries and France.

'Health' also took a sizeable share of GBAORD in the EU-27, on almost 8 %. Spain (10.7 %), Romania (12.9 %) and the United Kingdom (16.0 %) each allocated more than 10 % of GBAORD to this objective.

'Exploration and exploitation of space' made up 5.0 % of total GBAORD at EU level and 10.8 % in Belgium.

'Agriculture' and 'energy' accounted for 3.7 % and 3.4 % of total GBAORD in the EU-27 respectively, followed by 'environment' (2.6 %), 'transport, telecommunication and other infrastructure' (2.4 %) and 'political and social systems, structures and processes' (2.2 %).

Member States like Belgium, Denmark, the Netherlands, Austria, Portugal, Finland and Sweden each allocated more than EUR 1 billion to GBAORD, as did Norway and Russia. At the other end of the scale, Bulgaria, Estonia, Cyprus, Latvia, Lithuania and Malta each allocated less than EUR 100 million to GBAORD.

Public general university funds (GUF)

"To finance their R&D activities, universities usually draw on three types of funds:

- R&D contracts and earmarked grants received from government and other outside sources. These should be credited to their original source.
- Income from endowments, shareholdings and property, plus surplus from the sale of non-R&D services such as fees from individual students, subscriptions to journals and sale of serum or agricultural produce. These are the universities' 'own funds'.
- The general grant they receive from the Ministry of Education or from the corresponding provincial or local authorities in support of their overall research/teaching activities. As government is the original source and intended at least part of the funds concerned to be devoted to R&D, the R&D content of these public general university funds should be credited to government as a source of funds, for the purposes of international comparisons."

Source: http://www.uis.unesco.org/template/pdf/S&T/Workshops/Moscow/13.pdf.

Table 1.6: Breakdown of GBAORD by NABS 2007 socio-economic objectives (as a percentage of total) and total GBAORD (in EUR million), EU-27 and selected countries — 2007

	Exploration and exploitation of the earth	Environment	Exploration and exploitation of space	Transport, telecommunication and other infrastructures	Energy	Industrial production and technology	Health	Agriculture	Education	Culture, recreation, religion and mass media	Political and social systems, structures and processes	General advancement of knowledge: R&D financed from General University Funds (GUF)	General advancement of knowledge: R&D financed from other sources than GUF	Defence	Total GBAORD
EU-27	1.5 s	2.6 s	5.0 s	2.4 s	3.4 s	11.5 s	7.8 s	3.7 s	0.8 s	1.0 s	2.2 s	32.0 s	14.5 s	11.5 s	83 258 s
BE	0.6	2.5	10.8	1.0	1.9	32.1	1.9	1.4	0.2	2.1	3.5	16.8	24.8	0.3	2 025
BG	3.4	4.9	3.2	2.7	3.2	16.5	4.8	16.4	0.3	3.0	3.4	6.3	31.6	0.4	80
CZ	1.9	2.2	2.1	3.5	2.5	12.2	6.6	4.8	0.4	0.7	1.2	25.9	33.8	2.3	737
DK	0.7	1.9	1.7	0.8	3.0	6.4	8.3	5.1	2.5 e	1.5 e	3.5 e	42.3 b	21.7	0.6	1 801
DE	1.7 i	3.2 i	4.8 i	1.8 i	3.5 i	12.1 i	4.7 i	2.6 i	1.0 i	1.1 i	1.7 i	39.8 i	16.4 i	6.0 i	18 701
EE	3.4 e	7.5 e	0.0 e	10.3 e	3.4 e	7.1 e	8.4 e	9.6 e	2.1 e	3.2 e	5.3 e	0.0 e	38.7 e	1.0 e	78 e
IE	1.7	1.2	0.0	1.6	2.3	12.2	5.2	12.3	3.2	0.0	1.9	25.7	32.8	0.0	934
EL	3.2 p	2.6 p	2.1 p	1.6 p	2.0 p	9.0 p	6.9 p	5.6 p	2.2 p	1.0 p	1.0 p	50.7 p	11.4 p	0.5 p	673 p
ES	1.2	4.3	3.2	6.4	3.2	21.1	10.7	7.0	0.6	1.1	1.7	15.8	10.6	13.1	11 320
FR	0.9	1.8	9.0	0.6	5.4	7.9	6.6	1.7	: i	: i	0.8 i	28.4	6.4	28.8	14 108 i
IT	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
CY	1.0	1.0	0.0	0.7	0.1	2.2	7.3	16.4	3.4	2.3	0.8	28.4	36.4	0.0	67
LV	0.2	4.3	1.0	5.2	3.9	5.3	8.2	13.8	3.7	5.1	1.4	0.8	46.8	0.1	69
LT	0.0	5.6	0.0	0.1	0.5	0.4	0.7	0.0	1.6	0.0	0.6	68.0	22.3	0.1	96
LU	0.6	2.9	0.6	2.4	0.8	22.7	7.3	2.7	4.6	1.0	11.8	15.3	27.4	0.0	140
HU	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
MT	0.0	1.1	0.0	0.2	0.0	0.0	0.1	6.0	0.0	3.0	0.4	89.4	0.0	0.0	11
NL	0.3	1.6	2.7	3.5	2.7	12.0	4.7	5.4	0.3	0.4	3.0	45.9	15.5	2.0	4 097
AT	1.5 ip	1.6 ip	0.4 ip	1.5 ip	1.7 ip	15.7 ip	3.2 ip	1.7 ip	0.2 ip	0.4 ip	1.2 ip	58.6 ip	12.2 ip	0.0 ip	1 870 ip
PL	1.6	2.6	0.8	2.2	1.6	16.1	2.8	1.9	0.5	0.5	1.2	4.5	61.5	2.1	980
PT	1.2	3.7	0.5	9.6	1.2	13.3	7.3	6.7	2.5	0.5	2.3	35.4	15.3	0.5	1 272
RO	0.7	1.9	8.4	17.8	7.3	18.0	12.9	6.4	5.5	0.2	0.5	:	18.1	2.3	463
SI	1.0	1.4	0.0	1.6	1.1	16.6	3.8	4.1	0.4	4.0	3.6	3.0	52.5	6.7	180
SK	2.4	4.3	0.6	3.6	2.4	8.9	4.3	8.9	2.3	7.3	3.0	28.3	17.7	6.1	116
FI	1.2	1.6	1.7	1.7	7.8	23.8	6.0	5.8	0.2	0.6	4.6	25.8	16.7	2.4	1 740
SE	0.9	1.4	0.8	4.0	3.4	5.0	0.6	1.5	0.3	0.1	1.9	44.4	19.1	16.4	2 671
UK	2.5	1.9	1.9	1.3	0.6	0.1	16.0	2.7	0.8	1.9	1.7	24.3	21.0	23.4	13 431
IS	:	0.5	:	5.4	1.4	1.0	10.8	16.7	:	:	51.4	12.8	:	:	123
NO	2.2	1.9	2.6	2.5	2.9	7.4	12.5	8.3	0.8	1.0	5.1	34.1	13.3	5.4	2 029
RU	:	0.2	13.4	1.4	1.9	10.1	2.6	1.1	1.5	0.2	0.1	:	:	:	3 790 i
JP	1.8 i	0.9 i	7.0 i	4.2 i	14.7 i	6.6 i	4.0 i	3.7 i	0.3 i	0.1 i	0.3 i	34.7 i	17.2 i	4.5 i	21 775 i
US	0.7 i	0.5 i	7.7 i	1.0 i	1.4 i	0.3 i	21.9 i	1.6 i	0.3 i	0.0 i	0.5 i	0.0 i	6.1 i	57.8 i	103 532 i

Flag 'i':
AT, JP and US: federal or central government only.
DE: unrevised breakdown does not add up to the revised total.
FR: the sum of the breakdown does not add up to the total; 'Education' and 'Culture, recreation, religion and mass media' are included elsewhere; 'Political and social systems, structures and processes' includes other classes.
RU: the sum of the breakdown does not add up to the total.
US: total excludes data for the R&D content of general payments to the higher education sector for combined education and research (public GUF).
JP: defence is underestimated or based on underestimated data.

Source: Eurostat (gba_nabsfin07), OECD-MSTI for JP and US.

Further reading

A more research-intensive and integrated European Research Area, Science, Technology and Competitiveness key figures report 2008/2009, DG Research, European Commission, 2008
http://ec.europa.eu/research/era/pdf/key-figures-report2008-2009_en.pdf

The European Research Area Partnership — 2008 Initiatives, DG Research, European Commission, 2009
http://ec.europa.eu/research/era/pdf/era-partnership-2008-initiatives_en.pdf

A Strategy for ICT R&D and Innovation in Europe: Raising the Game,Commission Staff Working Document SEC(2009) 289, Brussels, 13.3.2009
http://ec.europa.eu/information_society/tl/research/documents/ict-rdi-strategy-staffwd.pdf

Gearing European research towards sustainability — RD4SD Exercise, DG Research, European Commission, 2009
http://ec.europa.eu/research/sd/pdf/rd4sd/rd4sd_final_report.pdf

R&D expenditure

2

2.1 Introduction

R&D is often considered to be a key element in the European Union's bid to be the most dynamic and competitive economy in the world. R&D is defined as 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 EU target for R&D, as set out in the relaunched Lisbon strategy, is to achieve an R&D intensity of 3 % of GDP by 2010, two thirds of which are to be financed by the business sector.

R&D expenditure refers here to 'intramural' or in-house expenditure, comprising all expenditure on R&D within a statistical unit, sector of the economy, region or country during a specific period, normally the calendar year, regardless of the source of funds.

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

- the *Frascati Manual*[1]
- the *Regional Manual*[2].

These manuals provide recommendations with the aim of obtaining statistics that are comparable between the different countries.

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

- Firstly, the main trends at national level are highlighted by analysing the performance of the EU-27 Member States, Iceland, Norway, Switzerland, Croatia and Turkey. International trends are also considered by taking a look at data for China, South Korea, Russia, Japan and the United States.
- Secondly, R&D expenditure at regional level is analysed, focusing on the EU-27 Member States.

Two main indicators are used to present R&D in the various sections of this chapter:

- R&D intensity (measured as R&D expenditure as a percentage of GDP);
- volume of R&D expenditure (in euros or in PPS).

The indicators are provided separately for the four different institutional sectors of performance as well as for the total of all sectors:

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

In addition, further breakdowns are used to present R&D data, such as:

- source of funds;
- type of cost;
- type of R&D activity;
- sector of economic activity (for BES);
- size class;
- field of science.

The regional analysis has been carried out at NUTS 2 level. Footnotes specify when other levels of NUTS are used. Readers should also note that under the NUTS classification, the entire national territories of Estonia, Cyprus, Latvia, Lithuania, Luxembourg, Malta and Iceland are considered to be NUTS 2 regions, which means that these countries may appear in rankings at NUTS 2 level.

The analysis refers to the period 2002-2007, but the length of time series is not identical across all countries. As a rule, if data for 2007 are not available for a particular country, the latest available year is presented.

The complete time series for R&D expenditure are available in Eurostat's dissemination database. Data for China, South Korea, Japan and the United States are based on the OECD's Main Science and Technology Indicators (MSTI).

[1] Proposed Standard Practice for Surveys on Research and Experimental Development — *Frascati Manual*, OECD, 2002.

[2] The Regional Dimension of R&D and Innovation Statistics — *Regional Manual*, Eurostat, 1996.

2.2 R&D at national level

2.2.1 R&D intensity

In 2007, R&D intensity stood at 1.85 % in the EU, which is far below that of Japan, with 3.40 % (2006 figure), South Korea, with 3.00 % (2006 figure), and the United States, with 2.67 %. However the EU's R&D intensity is still slightly higher than China's 1.44 %.

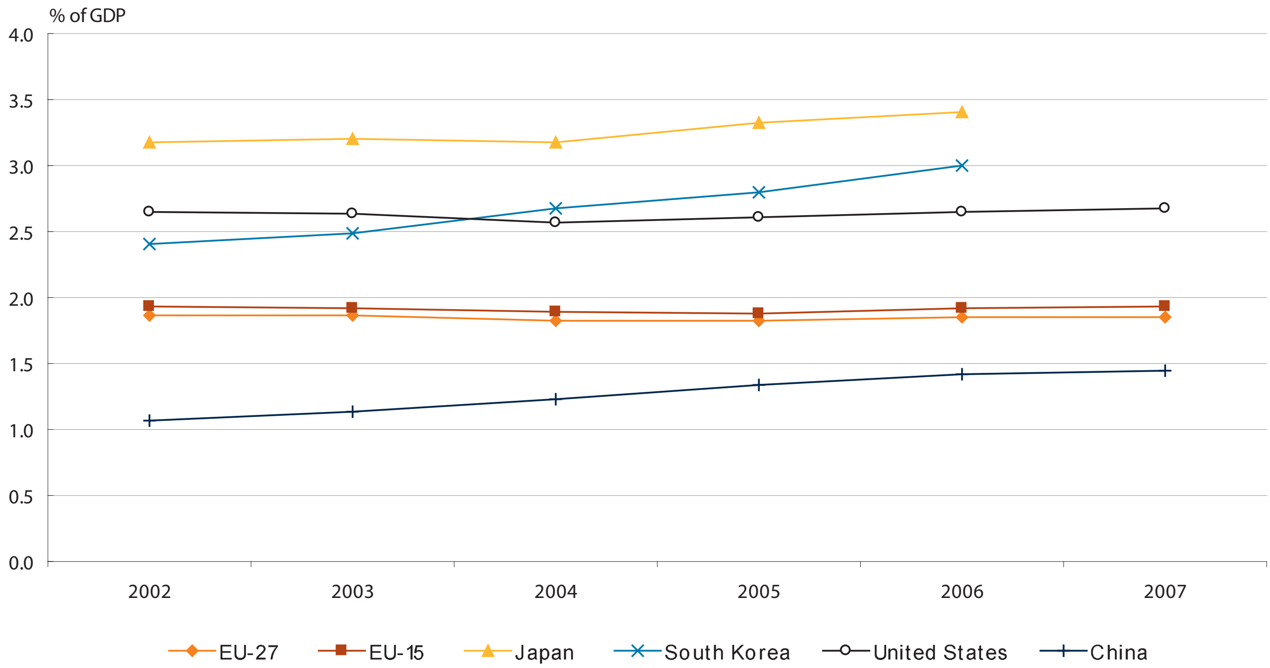
While the share of GDP devoted to R&D remained stable in the 15 old Member States (EU-15), R&D intensity decreased by 0.02 percentage points as a total for the 27 EU Member States between 2002 and 2007. In contrast, the overall trend in R&D intensity for China, South Korea, Japan and the United States was positive, even though a downward trend was observed in Japan and the United States between 2003 and 2004. This downward trend was not followed by South Korea, which since 2004 had an R&D intensity higher than the United States.

Since 2002 R&D intensity has increased by 0.60 percentage points in South Korea, by 0.37 percentage points in China and by 0.23 percentage points in Japan, which is ahead of the United States (0.02 percentage points).

Over the years 2006-2007 R&D expenditure as a share of GDP also increased faster in China and the United States than in the EU-27.

Whereas the difference in R&D intensity between the EU-27 and the United States reached a low of 0.75 percentage points in 2004, the overall gap widened from 0.78 percentage points to 0.82 percentage points between 2002 and 2007. In parallel, the gap between the EU-27 and Japan increased steadily from 1.30 percentage points in 2002 to 1.35 percentage points in 2004 and 1.55 percentage points in 2006.

Figure 2.1: R&D expenditure as a percentage of GDP (R&D intensity), all sectors, EU-27, EU-15, Japan, the United States, China and South Korea — 2002–2007



Note:
EU-27 and EU-15: Eurostat estimations.
US: provisional data for 2007; excludes most or all capital expenditure.
KR: excludes R&D in social sciences and humanities.

Source: Eurostat (rd_e_gerdtot), OECD-MSTI for CN, KR, JP and US.

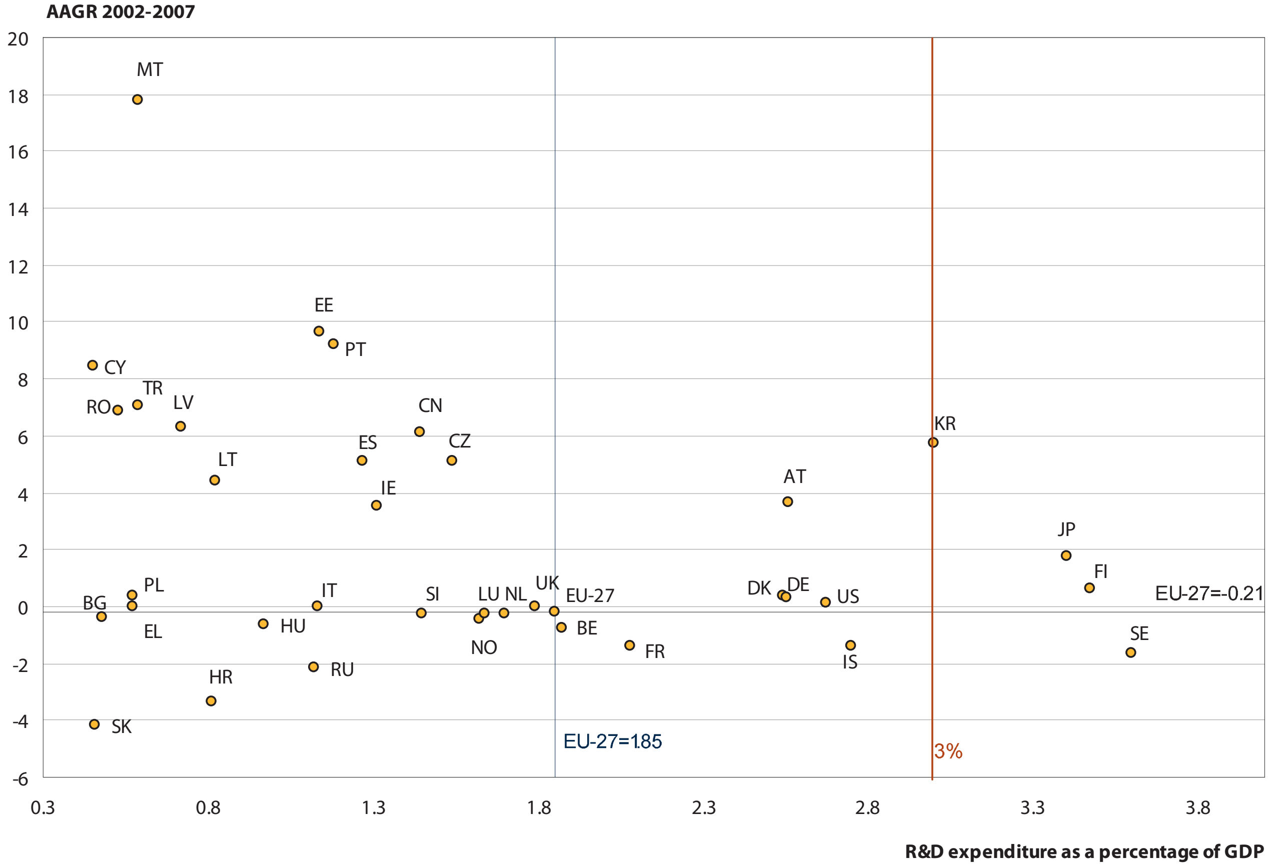
R&D investment in South Korea increased by a factor of 26 000 in 40 years

"Korea's research and development investment increased about 26 000 times between 1963 and 2007, from KRW 1.2 billion to KRW 31.3 trillion. R&D investment had increased every year except 1998, in the immediate aftermath of the Asian crisis.

Key achievements were the 64k DRAM in 1983, the Alpha engine for automobiles in 1991, the world's first commercialisation of CDMA in 1994, construction of the Pohang Light Source (PLS) in 1994, of a nuclear power plant with home-grown technology in 1998, and of the FINEX process replacing the blast furnace method in 2007."

Source: http://english.chosun.com/w21data/html/news/200903/200903200002.html

Figure 2.2: R&D expenditure as a percentage of GDP in 2007 and average annual growth rate (AAGR)(1) all sectors, EU-27 and selected countries — 2002–2007



Note:
(1) Calculated on R&D expenditure expressed as a percentage of GDP.
Exceptions to the reference year: 2006: IT, KR and JP.
Exceptions to the reference period: 2003 -2007: EL, LU and SE; 2002-2006: IT, KR and JP.

EU-27: Eurostat estimation.
BE, IE, FR, CY, LU, MT, NL, PT, SE, UK and US: provisional data.
DK, DE, EL and AT: national estimates.
US: excludes most or all capital expenditure.
KR: excludes R&D in social sciences and humanities.

Source: Eurostat (rd_e_gerdtot), OECD-MST for CN, KR, JP and US.

Figure 2.2 is a scatter chart presenting R&D intensity (x-axis) and the related average annual growth rate 2002-2007 (y-axis) for the EU-27 and selected countries.

In 2007, R&D intensity stood at 1.85 % in the EU-27 and recorded an average annual decrease of 0.21 % between 2002 and 2007.

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

In the *group of leaders*, R&D intensity and the related AAGR were above the EU-27 average. This group includes four EU Member States — Finland, Denmark, Austria and Germany — plus Japan, South Korea and the United States. These countries are increasing their lead on the others.

Finland and Sweden were the only EU Member States to have already exceeded the 3 % objective set by the Lisbon strategy. Considering the positive growth rates observed in Austria, Denmark and Germany, reaching this target seems to be quite a realistic possibility. Sweden, France, Belgium and Iceland registered R&D intensity higher than the EU-27 average, but recorded below-average AAGR. In the *group of followers*, R&D intensity was below the EU-27 average, but AAGR was above it. This group includes fourteen EU Member States, such as the United Kingdom, the Czech Republic, Spain, Italy, Portugal and Romania. China and Turkey also belong to this group.

Although these countries have been lagging behind, they are gradually closing the gap with the EU-27 average. Nevertheless, considerable efforts will 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 six EU Member States: the Netherlands, Luxembourg, Slovenia, Hungary, Bulgaria and Slovakia. Norway, Croatia and Russia are also included in this group. If no major changes take place, these countries will not reach the 3 % target by 2010.

Investing in European Research

"The progress of science and technology is crucial:

- to help European companies innovate and stay competitive
- to create more and better jobs in Europe
- to keep improving the European way of life.

This is why the European Union decided that investment in research should increase in Europe. At present, less than 2 % of Europe's wealth (GDP) is devoted to research, which compares poorly with 2.5 % in the USA and more than 3 % in Japan.

Our goal is to approach 3 % of GDP for research. This is an important part of the 'Lisbon strategy', which consists of a partnership between the European Union and Member States to transform Europe into a vibrant knowledge economy, in order to boost economic growth, create more and better jobs and ensure lasting prosperity in Europe.

However, since the 3 % goal was set in 2002, **progress has remained too slow**. Yet many concrete measures have been taken by the European Union, as well as by countries and regions, to increase investment in research, which make the '3 % objective' a very much alive and exciting venture.

Our initiatives for investing in research are closely linked with actions to promote innovation in Europe. On 12 October 2005, the European Commission proposed a **'Common Approach' to promote both research investment and innovation**.

On the 3 % Website, you will find the following information:

- latest news and events
- EU proposals and initiatives to promote investment in research
- EU funding schemes
- national and regional policies
- coordination of policies
- monitoring and analysis."

Source: European Commission, http://ec.europa.eu/invest-in-research/index_en.htm

The 1.85 % of GDP that the EU devoted to research in 2007 is still more than 1 percentage point below the 3 % target set for 2010 by the Lisbon strategy. The business enterprise sector (BES) accounted for the highest R&D expenditure at EU-27 level, 64 % of total expenditure, followed by the higher education sector (22 %) and the government sector (13 %), as shown in Figure 2.3.

However, R&D intensity varied widely between countries and sectors.

While the BES accounted for the bulk of R&D expenditure in most of the countries, there were some exceptions. R&D was mainly performed by the government sector in Bulgaria (58 %) and Poland (35 %). In Slovakia, Romania, Cyprus, Russia and Croatia, government sector expenditure in R&D exceeded 25 %, being the second main sector of performance (except in Croatia).

The higher education sector accounted for the highest share of R&D expenditure in Lithuania (51 %), Greece (50 %), Turkey (48 %), Latvia (43 %) and Cyprus (43 %). As a general trend, the higher education sector exceeded 20 % in 25 out of 37 countries studied.

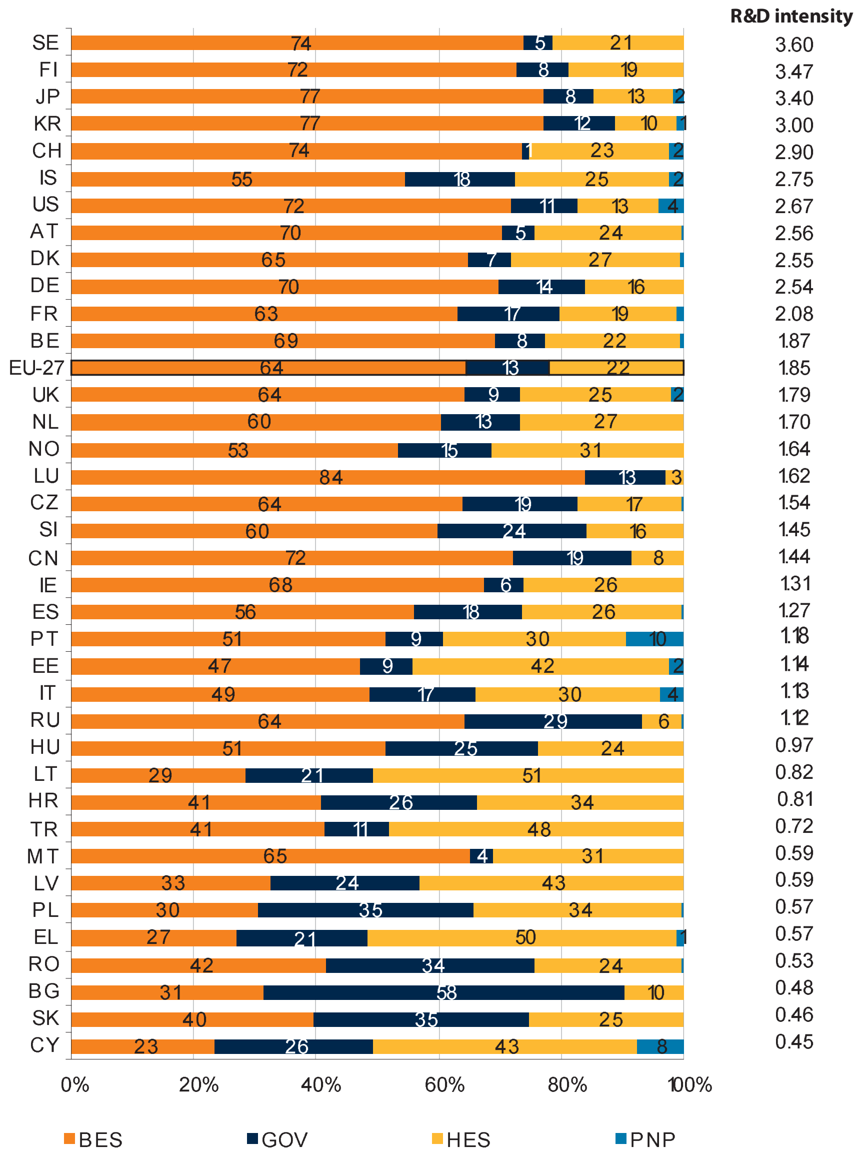
Private non-profit (PNP) expenditure in R&D was remarkably high in Portugal (10 %), followed by Cyprus (8 %). In the rest of the countries the percentage was lower than 5 % and some EU Member States (e.g. Germany and the Netherlands) include R&D expenditure made in the PNP sector in the government sector.

In Luxembourg, the business enterprise sector accounted for 84 % of the country's R&D expenditure.

The BES also accounted for more than 70 % of R&D expenditure in Sweden, Finland, Switzerland, China, South Korea, Japan and the United States. All these countries (except China) together with Austria, Denmark, Germany, France and Iceland, also recorded an R&D intensity above 2 %.

Conversely, the business enterprise sector accounted for less than 30 % of total R&D expenditure in Lithuania, Greece and Cyprus.

Figure 2.3: R&D expenditure by sector of performance as a percentage of total, EU-27 and selected countries ranked in terms of R&D intensity (R&D expenditure as a percentage of GDP) — 2007



Note:

Exceptions to the reference year for R&D expenditure: 2006: IE, IT, KR and JP; 2004: CH.

Exceptions to the reference year for R&D intensity: 2006: IT, KR and JP; 2004: CH.

EU-27: Eurostat estimation.
BE, IE, FR, CY, LU, MT, NL, PT, SE, UK and US: provisional data.
DK, DE, EL and AT: national estimates.
HU: incomplete breakdown of R&D expenditure by sector of performance.
US: excludes most or all capital expenditure. US and CH: GOV sector includes federal or central government only.
KR: excludes R&D in social sciences and humanities.
DE and NL: GOV sector includes PNP sector.

Source: Eurostat (rd_e_gerdtot), OECD-MSTI for CN, KR, JP and US.

2.2.2 R&D expenditure in volume

Table 2.4 shows R&D expenditure both in million euros and in million PPS. In 2007, the EU-27 dedicated EUR 228 billion to R&D, compared to EUR 269 billion spent by the United States and EUR 118 billion by Japan. Within the EU-27, four Member States — Germany, France, Italy and the United Kingdom — accounted for more than half of total EU-27 R&D expenditure. Germany alone, with EUR 61.5 billion, made up more than one quarter of the total. France, the United Kingdom and Italy followed, with EUR 39.3 billion, EUR 36.7 billion and EUR 16.8 billion respectively.

Spain and Sweden allocated more than EUR 10 billion to R&D, followed closely by the Netherlands (EUR 9.6 billion). As mentioned above, Sweden was the leading Member State in terms of R&D intensity.

The table shows R&D expenditure in million PPS (purchasing power standards) in order to give a more comparable measure of real financial resources devoted to R&D as this measure is adjusted for the exchange rates and price levels in different countries.

For the eleven Member States contributing most to EU-27 total R&D expenditure in million euros the described trend is quite similar in million PPS. They keep the same positions in the ranking in million PPS. With the exception of Spain, for all these countries the values in million PPS are lower than in million euros.

For seven countries out of the 16 remaining EU Member States the ranking in million PPS is not the same as in million euros. With the exception of Luxembourg the values in million PPS are higher than in million euros. Whereas Ireland, Luxembourg and Estonia lost one or more places, the Czech Republic, Poland, Slovenia and Bulgaria moved up at least one place.

Table 2.4: R&D expenditure in million EUR and in million PPS, by sector of performance, EU-27 and selected countries — 2007

	Millions of euro					Millions of PPS				
	Total	Business enterprise sector	Government sector	Higher education sector	Private non-profit sector	Total	Business enterprise sector	Government sector	Higher education sector	Private non-profit sector
EU-27	228 682 s	146 241 s	30 238 s	49 964 s	2 237 s	218 887 s	138 582 s	30 078 s	48 098 s	2 129 s
BE	6 263 p	4 337 p	520 p	1 367	39 p	5 840 p	4 044 p	485 p	1 275	36 p
BG	140	43	82	13	1	345	108	202	33	2
CZ	1 955	1 248	370	330	7	3 169	2 023	600	535	12
DK	5 779 e	3 752 e	402	1 589	37	4 162 e	2 702 e	290	1 144	26
DE	61 543 e	43 003 p	8 540 i	10 000 e	: i	59 716 e	41 726 p	8 287 i	9 703 e	: i
EE	174	82	15	73	4	258	122	22	108	6
IE	2 311 p	1 560 p	150	601 p	:	1 930 p	1 303 p	125	502	:
EL	1 311 e	353 e	281 e	661 e	17 e	1 519 e	409 e	325 e	765 e	20 e
ES	13 342	7 454	2 349	3 519	21	14 958	8 356	2 633	3 945	24
FR	39 369 p	24 872 p	6 500 p	7 545 p	452 p	35 927 p	22 697 p	5 932 p	6 885 p	412 p
IT	16 831	8 210	2 897	5 094	630	16 394	7 997	2 822	4 961	614
CY	70 p	16 p	18 p	30 p	5 p	79 p	18 p	20 p	34 p	6 p
LV	126	41	30	54	:	195	64	47	84	:
LT	233	66	48	118	:	409	117	85	207	:
LU	591 p	495 p	78 p	18 p	0 p	519 p	434 p	69 p	15 p	0 p
HU	977	492 i	236 i	228 i	:	1 515	762 i	366 i	354 i	:
MT	32 p	21 p	1 p	10 p	0	47 p	31 p	2 p	15 p	0
NL	9 666 p	5 840 p	1 260 ip	2 566 ep	: i	9 099 p	5 498 p	1 186 ip	2 416 ep	: i
AT	6 946 e	4 891 e	363 e	1 674 e	18 e	6 578 e	4 632 e	344 e	1 586 e	17 e
PL	1 764	535	625	598	5	2 894	878	1 025	981	9
PT	1 921 p	988 p	176 p	574 p	183 p	2 368 p	1 219 p	217 p	707 p	226 p
RO	653	272	222	157	2	1 192	496	405	287	4
SI	501	299	122	78	1	651	390	159	101	1
SK	252	100	89	63	0	422	167	149	105	0
FI	6 243	4 513	528	1 165	36	5 299	3 831	448	989	31
SE	11 936 p	8 805	574	2 543	15 p	10 035 p	7 403	482	2 138	12 p
UK	36 728 p	23 544 p	3 388 ep	9 012 p	784 p	32 322 p	20 719 p	2 982 ep	7 930 p	690 p
HR	348	141	89	117	:	548	223	140	185	:
TR	3 410	1 407	360	1 643	:	5 676	2 342	599	2 735	:
IS	401	219	71	101	10	254	138	45	64	6
NO	4 665	2 488	715 b	1 462 b	:	3 434	1 832	526 b	1 077 b	:
CH	8 486	6 257	91 i	1 943	194	6 294	4 641	67 i	1 441	144
CN	35 614	25 744	6 850	3 021	:	85 148	61 549	16 377	7 222	:
KR	22 777 i	17 604 i	2 636 i	2 269 i	280 ip	29 800 i	23 032 i	3 449 i	2 969 i	367 i
RU	10 597	6 807	3 084	670	35	19 514	12 536	5 679	1 234	65
JP	118 295	91 271	9 796	15 017	2 211	115 740	89 299	9 585	14 692	2 163
US	269 098 ip	193 501 ip	28 710 ip	35 690 ip	11 197 ip	306 464 ip	220 370 ip	32 697 ip	40 646 ip	12 752 ip

Note:
Exceptions to the reference year: 2006: IE, IT, KR and JP; 2004: CH.

Flag i:
US: excludes most or all capital expenditure.
US and CH: GOV sector includes federal or central government only.
KR: excludes R&D in social sciences and humanities.
DE and NL: GOV sector includes PNP sector.
HU: incomplete breakdown of R&D expenditure by sector of performance.

Source: Eurostat (rd_e_gerdtot), OECD-MSTI for CN, KR, JP and US.

Table 2.5: R&D expenditure in million PPS at 2000 prices and average annual growth rate (AAGR)[(1)], by sector of performance, EU-27 and selected countries — 2002 – 2007

	All sectors			Busines enterprise sector			Government sector			Higher education sector		
	2002	2007	AAGR 2002-2007	2002	2007	AAGR 2002-2007	2002	2007	AAGR 2002-2007	2002	2007	AAGR 2002-2007
EU-27	168 212 s	191 705 s	2.6 s	106 349 s	121 413 s	2.7 s	22 981 s	26 216 s	2.7 s	37 412 s	42 194 s	2.4 s
BE	4 886	5 271 p	1.5	3 441	3 650 p	1.2	350	438 p	4.6	1 034	1 151	2.2
BG	229	305	5.8	42	95	17.4	164	178	1.7	23	29	5.0
CZ	1 678	2 801	10.8	1 025	1 788	11.8	385	530	6.6	262	473	12.5
DK	3 395	3 816 e	2.4	2 343	2 477 e	1.1	250 b	266	1.2 b	782 b	1 049	6.0 b
DE	46 786	51 212 e	1.8	32 395	35 784 p	2.0	6 429 i	7 106 i	2.0	7 961	8 321 e	0.9
EE	97	227	18.5	30	107	29.2	16	20	3.6	47	95	15.3
IE	1 177	1 713 p	9.8	810	1 156 p	9.3	103	111	2.0	264	445	13.9
EL	1 135	1 342 e	4.3	364	361 e	-0.2	230	287 e	5.7	530	676 e	6.2
ES	7 841	11 994	8.9	4 280 b	6 701	9.4 b	1 208	2 112	11.8	2 335	3 163	6.3
FR	30 631	31 488 p	0.6	19 374	19 893 p	0.5	5 064	5 199 p	0.5	5 777	6 035 p	0.9
IT	14 619	15 325	1.2	7 066	7 476	1.4	2 568	2 638	0.7	4 798	4 638	-0.8
CY	38	67 p	12.1	8	16 p	15.3	15	17 p	2.3	11	29 p	20.9
LV	80	181	17.7	33	59	12.5	15	44	23.6	32	78	19.5
LT	198	367	13.1	33	105	25.7	66	76	3.0	99	186	13.5
LU	364	441 p	4.9	324	369 p	3.3	38	59 p	11.1	1 e	13 p	78.9
HU	1 183 i	1 366	2.9	419 i	688 i	10.4	388 i	330 i	-3.2	297 i	319 i	1.4
MT	17	42 p	20.4	4	27 p	46.1	3	2 p	-10.5	10	13 p	6.0
NL	7 162	7 929 p	2.1	4 058	4 790 p	3.4	988	1 034 ip	0.9	2 065	2 105 ep	0.4
AT	4 385	5 954 e	6.3	2 931	4 192 e	7.4	249	311 e	4.5	1 185	1 435 e	3.9
PL	2 019	2 634	5.5	411	799	14.2	918	933	0.3	685	893	5.5
PT	1 187 e	1 930 p	10.2	385 e	993 p	20.8	223 e	176 p	-4.6	445 e	576 p	5.3
RO	467	889	13.7	282	370	5.6	113	302	21.7	73	214	24.1
SI	475	594	4.6	284	355	4.6	110	145	5.8	74	92	4.6
SK	319	361	2.5	205	143	-7.0	85 i	128	8.5	29	90	25.5
FI	4 049	4 970	4.2	2 829	3 593	4.9	420	421	0.1	776	927	3.6
SE	8 692 i	9 361 p	1.9	6 463 i	6 906	1.7	304 i	450	10.3	1 892	1 994	1.3
UK	24 973	28 644 p	2.8	16 195	18 362 p	2.5	2 295	2 642 ep	2.9	5 998	7 028 p	3.2
HR	440	467	1.2	188	190	0.2	98	119	4.0	154	158	0.4
TR	2 699	5 166	13.9	774	2 132	22.4	189	545	23.6	1 735	2 489	7.5
IS	217 e	259	3.6	124 e	141	2.7	53 e	46	-2.8	35 e	65	13.3
NO	2 426	2 728	2.4	1 393	1 455	0.9	383	418 b	1.7 b	649	855 b	5.7 b
CN	33 108	75 247	17.8	20 256	54 392	21.8	9 496	14 473	8.8	3 356	6 382	13.7
KR	18 020 i	26 515 i	10.1	13 541 i	20 493 i	10.9	2 417 i	3 069 i	6.2	1 875 i	2 642 i	9.0
RU	13 401	17 147	5.1	9 364	11 015	3.3	3 278	4 990	8.8	727	1 085	8.3
JP	89 930	104 849	3.9	66 945	80 897	4.8	8 577	8 683	0.3	12 484	13 310	1.6
US	231 578 i	268 111 ip	3.0	162 039 i	192 791 ip	3.5	28 123 i	28 605 ip	0.3	31 094 i	35 559 ip	2.7

Note:
(1) Calculated on R&D expenditure in PPS at 2000 prices.
Exceptions to the reference year 2002: EL, LU and SE: 2003.
Exceptions to the reference year 2007: IT, IE, KR and JP: 2006.
Exceptions to the reference period 2002-2007: EL, LU and SE: 2003-2007; IT, IE, KR and JP: 2002-2006.

Flag i:
HU: incomplete breakdown of R&D expenditure by sector of performance.
HU (all sectors for 2002) and SK (GOV sector for 2002): defence excluded (all or mostly).
US: excludes most or all capital expenditure.
SE and US: GOV sector includes federal or central government only.
KR: excludes R&D in social sciences and humanities.
DE and NL: GOV sector includes PNP sector.
SE: underestimated or based on underestimated data.

Source: Eurostat (rd_e_gerdtot), OECD-MSTI for CN, KR, JP and US.

Between 2002 and 2007 R&D expenditure (expressed in PPS at 2000 prices) in the EU-27 increased at an average annual growth rate of 2.6 %.

Malta recorded the highest average growth rate (20.4 %), followed by Estonia (18.5 %) and Latvia (17.7 %). R&D expenditure also increased by more than 10 % in Cyprus, Lithuania, the Czech Republic, Portugal and Romania. This suggests that these countries are making considerable efforts to reach the Lisbon strategy target.

Between 2002 and 2007, the EU-27 recorded a lower AAGR (expressed in PPS at 2000 prices) in terms of R&D expenditure than its international competitors. R&D expenditure in China and South Korea increased by more than 10 %, followed by Russia (5.1 %), Japan (3.9 %) and the United States (3.0 %).

At EU-27 level, both the business enterprise sector (BES) and the government sector (GOV) registered the same average annual growth rate between 2002 and 2007 (2.7 %). This equilibrium was not followed by its international competitors, whose R&D investment growth rates for the same period were much higher in the BES than in the GOV sector (except in Russia).

The higher education sector (HES) was the second most important R&D-performing sector after the BES at EU-27 level in absolute terms; however, this trend does not apply to China, South Korea and Russia. China recorded the highest annual average growth rate in this sector (13.7 %), followed by South Korea (9.0 %) and Russia (8.3 %); however, in absolute terms, their R&D investment in the HES (expressed in PPS at 2000 prices) was far below the amount invested by the EU-27 (EUR 42 billion).

Looking at EU Member States, the BES experienced the greatest increase between 2002 and 2007 in Malta (46.1 %), followed by Estonia (29.2 %), Lithuania (25.7 %) and Portugal (20.8 %). Belgium, Denmark, Germany, France, Italy, Sweden and the United Kingdom presented lower AAGRs than the EU-27 average. But in absolute terms these countries, except Denmark, were among the top 10 EU Member States contributing most to EU-27 business R&D expenditure.

On the other side of the spectrum, Greece and Slovakia were the only two countries that experienced a decrease in R&D investment by the BES in the reference period.

If, as stated above, Malta recorded the highest AAGR for the BES, it recorded the steepest decrease for the GOV sector (-10.5 %). Hungary, Portugal and Iceland followed this negative trend. In contrast, Latvia, Romania and Turkey registered growth rates higher than 20 %.

Between 2003 and 2007 the AAGR of R&D investment in the HES by Luxembourg reached 78.9 %. This can be explained by the fact that it created a university during that period. Slovakia, Romania and Cyprus also posted high growth rates (more than 20 %). Only Italy experienced a decrease in the AAGR of R&D expenditure in the HES sector (-0.8 %).

Table 2.6: R&D expenditure by sector of performance and by source of funds in EUR million and as a percentage of total, EU-27 — 2006

Source of funds	Sector of performance									
	Millions of euro					Percentage of total R&D expenditure				
	Total	Business enterprise sector	Government sector	Higher education sector	Private non-profit sector	Total	Business enterprise sector	Government sector	Higher education sector	Private non-profit sector
Total	215 553	137 431	28 414	47 478	2 230	100.0	63.8	13.2	22.0	1.0
Business enterprise sector	119 327	113 618	2 478	3 005	225	55.4	52.7	1.1	1.4	0.1
Government sector	72 245	9 765	23 445	38 314	721	33.5	4.5	10.9	17.8	0.3
Higher education sector	1 825	22	83	1 695	25	0.8	0.0	0.0	0.8	0.0
Private non-profit sector	3 524	128	508	1 861	1 027	1.6	0.1	0.2	0.9	0.5
Abroad	18 633	13 898	1 899	2 604	232	8.6	6.4	0.9	1.2	0.1

Note:
EU-27: Eurostat estimation.

Source: Eurostat (rd_e_gerdfund)

Table 2.6 shows the source of funds devoted to R&D in each sector of performance.

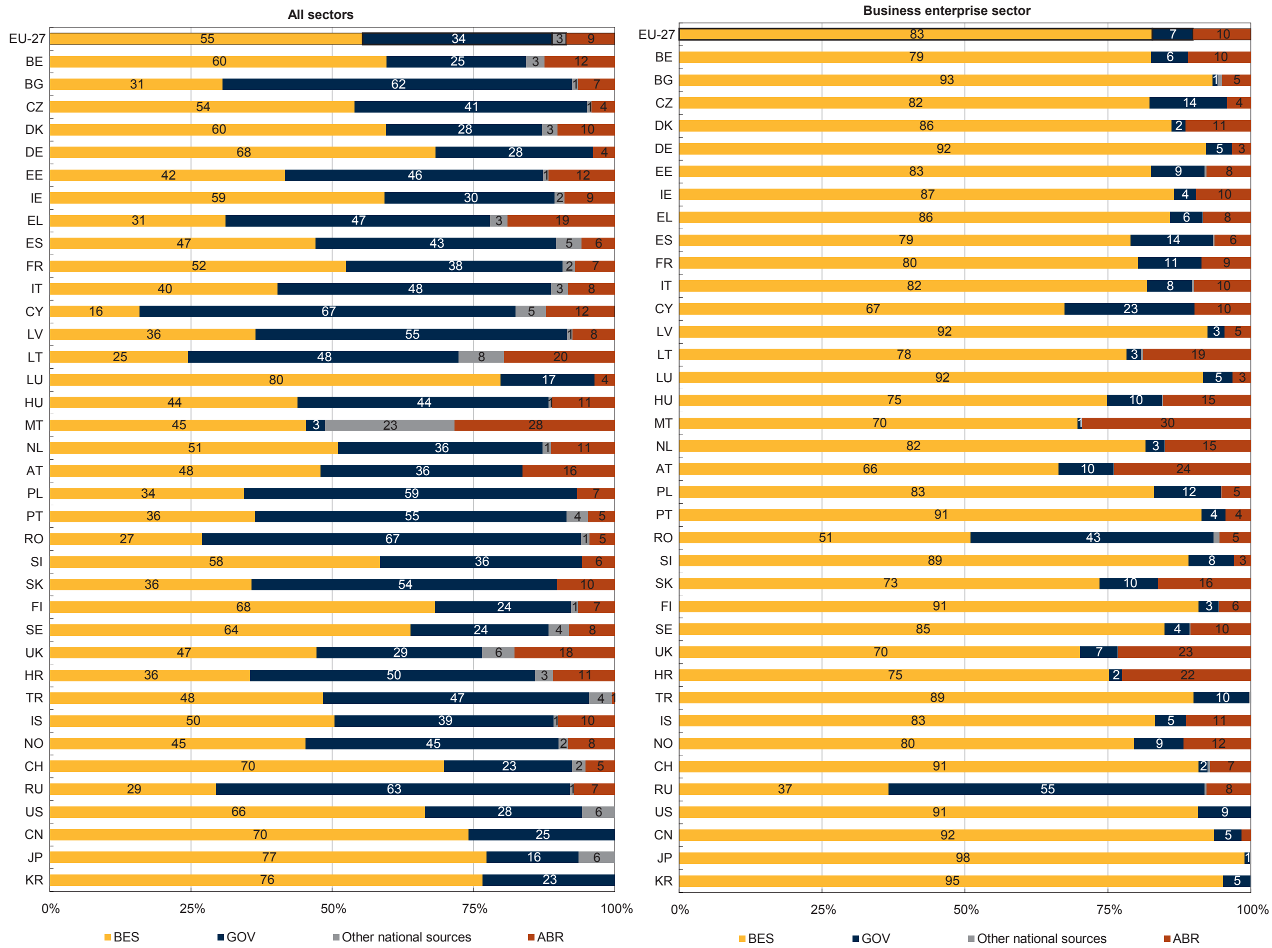
In 2006, the business enterprise sector (BES), the government sector (GOV) and the private non-profit sector (PNP) tended to self-finance R&D activities. However, this was not the case in the higher education sector, where R&D was mostly financed by the government sector.

In the EU-27, 55.4 % of R&D was financed by the BES and most of it was also allocated to the BES (52.7 %). R&D funding received by the BES from abroad accounted for 6.4 % of total BES expenditure and from the government sector for 4.5 %. The higher education sector and the private non-profit sector invested at minimum levels in the BES.

The government sector was the second ranking sector in terms of R&D funding (33.5 %) out of the total invested in R&D in the EU-27. However, more than half of these funds (17.8 %) were directed to the higher education sector while the other sources of funding of this sector did not reach 5 % of total R&D investment.

The business enterprise sector generally received more financing from abroad than the other sectors, mainly as a result of the financial flows of multinational business firms.

Figure 2.7: Total and business enterprise R&D expenditure by source of funds as a percentage of total, EU-27 and selected countries — 2007



Note:
EU-27: Eurostat estimation.
Exceptions to the reference year:
2006: EU-27, BE (BES), BG, DE, IE, ES, FR, IT (All sectors), CY, AT (BES), JP and KR;
2005: BE (All sectors), DK, EL, LU, PT and SE (All sectors);
2004: CH;
2003: NL.
IE, IT (BES), MT, UK and US: provisional data.
AT: national estimates.
BE (BES): underestimated breakdown not adding up to the revised total.
SE (All sectors): break in series.
US: excludes most or all capital expenditure.
KR: excludes R&D in social sciences and humanities.
CN: the sum of the breakdown does not add up to the total.

Source: Eurostat (rd_e_fundgerd and rd_e_gerdfund), OECD-MSTI for CN, KR, JP and US.

Figure 2.7 (all sectors) indicates that business enterprises were in 2007 the primary source of financing for R&D expenditure in 15 of the EU Member States, while the government sector is the main source of finance for the rest of the EU countries. In the EU-27 R&D financed by the BES accounted for 55 %, which is below the Lisbon strategy target for two thirds of EU research to be funded by business enterprises by 2010.

The BES finances more than 75 % of R&D activities only in Luxembourg (80 %). The share of the BES is, however, remarkable in Finland (68 %), Germany (68 %), Sweden (64 %), Denmark (60 %), Belgium (60 %) and Switzerland (70 %). The Czech Republic, Ireland, France, Slovenia, the Netherlands and Iceland posted shares of over 50 %.

The sources of funding were more balanced in the Member States that joined the EU recently (2004 and 2007 enlargements), the candidate countries and Russia. With the exception of the Czech Republic, Hungary, Malta, Slovenia and Turkey, 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 strong there and that the business sector still requires time to develop, to be in a position to increase its R&D investments.

The remaining sources — 'abroad' and 'other national sources' — were of minor importance in most countries, except in Greece, Lithuania, Malta, Austria and the United Kingdom, where more than 15 % of R&D expenditure was financed from 'abroad'.

The breakdown by source of funds shows that R&D expenditure in the BES has one main source of funding (self-financing), whereas R&D expenditure in all sectors has at least two main sources. 83 % of business R&D expenditure in the EU-27 was self-financed.

In the BES the lowest shares of self-financing were found in Romania (51 %), Austria (66 %), Cyprus (67 %), Malta (70 %) and the United Kingdom (70 %). In Austria, Malta and the United Kingdom, this is explained by the fact that business R&D was to a large extent financed from abroad, while in Romania and Cyprus the government sector contributed significantly to BES R&D expenditure.

Table 2.8: R&D expenditure in million EUR, by type of cost, all sectors and business enterprise sector, EU-27 and selected countries — 2006

	All sectors			Bussines enterprise sector		
	Total	Current expenditure	Capital expenditure	Total	Current expenditure	Capital expenditure
EU-27	215 553 s	193 783 s	21 771 s	137 431 s	125 337 s	12 094 s
BE	5 552	5 063	488	3 776	3 439	336
BG	121	108	13	31	23	8
CZ	1 761	1 436	325	1 165	913	252
DK	5 420	5 090	330	3 628	3 354	274
DE	55 739	50 630 i	5 059 i	38 651	35 503	3 148
EE	151	120	31	67	55	13
IE	2 311 p	2 028 p	283 p	1 560 p	1 340 p	220 p
EL	1 154	1 018	136	357	300	57
ES	11 815	9 605	2 210	6 558	5 353	1 205
FR	37 909 p	34 065	3 844	23 915 p	21 635	2 280
IT	16 831	15 058	1 774	8 210	7 565	646
CY	62	57	5	14	13	2
LV	112	88	24	57	46	11
LT	191	158	32	53	42	11
LU	472	410	62	408	350	58
HU	900 i	724	158	435	321	114
MT	31	30	2	21	20	1
NL	8 842 p	7 955 p	887 p	5 169	4 652	517
AT	6 319	5 743	576	4 449	4 055	393
PL	1 513	1 229	283	477	387	90
PT	1 201	1 001	200	462	328	134
RO	444	374	70	215	184	31
SI	484	438	46	291	262	29
SK	217	194	22	93	84	10
FI	5 761	5 465 i	296 i	4 108	3 859 i	249 i
SE	10 619 b	10 026 b	593 b	7 725 b	7 243 b	482 b
UK	34 037	:	:	20 985	19 835	1 150
HR	298	254	43	109	87	22
TR	2 432	2 109	323	901	790	111
IS	398	370	29	212	196	16
NO	4 071	3 769	302	2 204	2 056	148
CH	8 486	7 809	677	6 257	5 691	567
RU	8 466	8 143	323	5 643	5 446	197

Note:
Exceptions to the reference year: 2005: BE, DE, EL, LU, NL, PT and SE; 2004: CH.

Flag i:
DE: nobreakdown is available for the additional funds from the German Research Association.
HU: incomplete breakdown of R&D expenditure by type of costs.
FI: current expenditure includes other classes, capital expenditure included elsewhere.

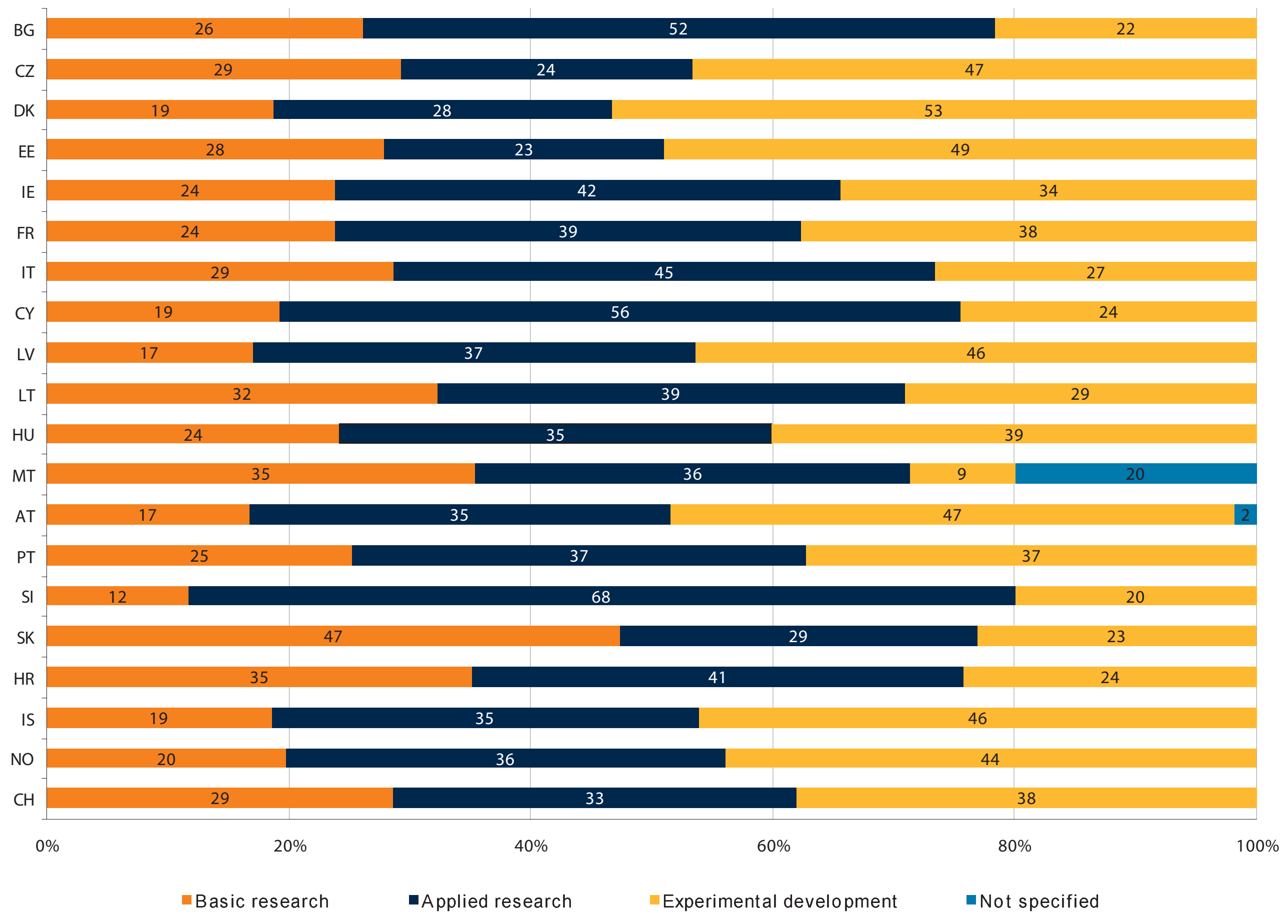
Source: Eurostat (rd_e_gerdcost)

Table 2.8 presents R&D expenditure by type of cost in all sectors and, more specifically, in the business enterprise sector. Current expenditure is composed of labour costs and other costs of consumable goods that last for only a limited period of time. Capital expenditure refers to expenditure on fixed assets used in R&D.

Most of the R&D expenditure in all sectors in 2006 comprised current expenditure. In nine EU Member States together with Iceland, Norway, Switzerland and Russia, current expenditure accounted for more than 90 % of total R&D expenditure. With the exception of Estonia and Latvia, all countries in the EU registered current expenditure shares above 80 %.

A similar pattern was observed in the business enterprise sector, where the share of current expenditure ranged from 94.5 % in the United Kingdom to 73.7 % in Bulgaria. Capital expenditure shares in the business enterprise sector were very high in Bulgaria, Hungary and Portugal, with 26.3 %, 26.2 % and 29.1 % respectively.

Figure 2.9: R&D expenditure by type of R&D activity as a percentage of total, available countries — 2006



Note:
Exceptions to the reference year: 2005: DK, PT and NO; 2004: CH.
IE: provisional data.
DK and SK: national estimates.
BE, DE, EL, ES, LU, NL, PL, RO, FI, SE and UK: data not available.

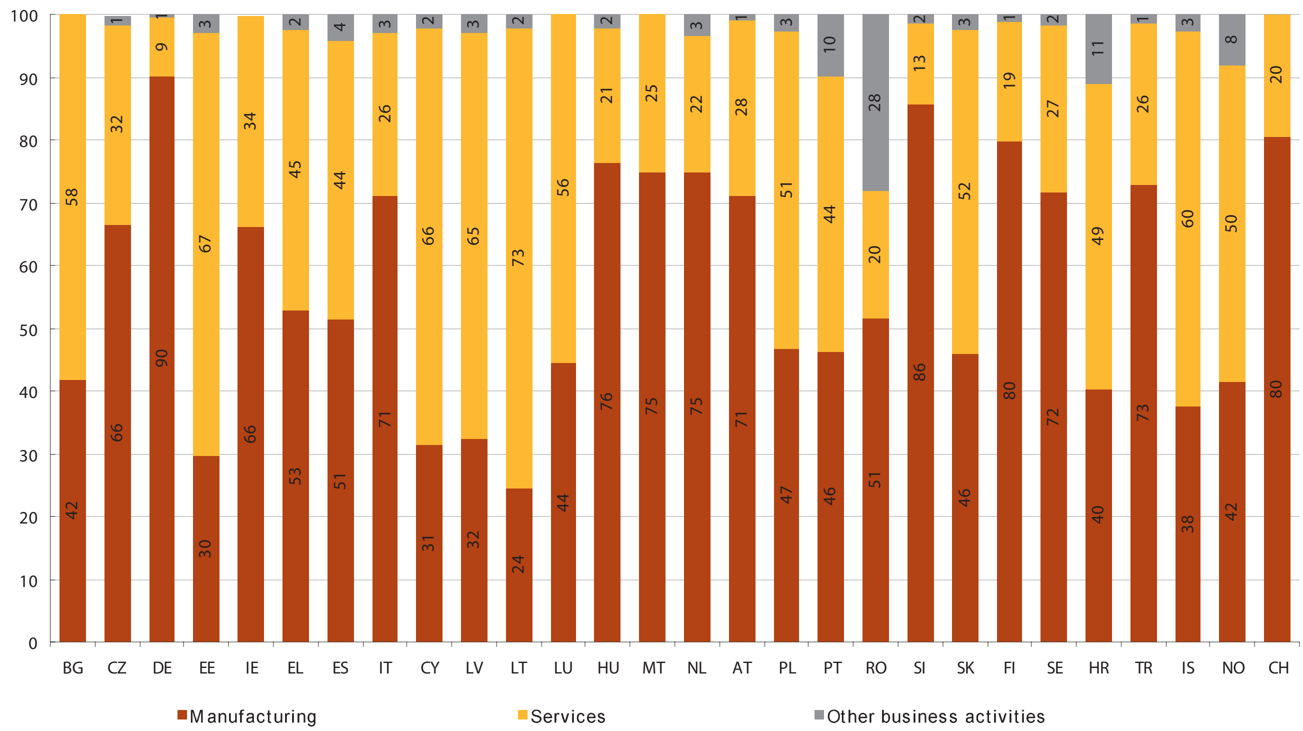
Source: Eurostat (rd_e_gerdact)

Figure 2.9 provides information on the distribution of R&D expenditure by type of research. R&D expenditure in most of the EU Member States studied was mostly directed to applied research, followed by experimental development and basic research. This trend indicates that the EU places far more emphasis on practical innovation and the development of new products and processes than on fundamental research, though this distribution varied considerably at national level. In the Czech Republic, Denmark, Estonia, Latvia, Hungary and Austria more focus was placed on experimental development. This also holds true for Iceland, Norway and Switzerland, which devoted between 38 % and 46 % of R&D investment to experimental development. In Portugal there was a balanced distribution of R&D expenditure between applied research and experimental development — 37 % to each.

A notable exception was Slovakia, where 47 % of R&D expenditure was earmarked for basic research. Lithuania, Malta and Croatia also spent more than 30 % on basic research.

In all cases it should be remembered that these figures are expressed as a share of national R&D expenditure, which in absolute terms varies considerably from one country to the next.

Figure 2.10: Business enterprise R&D expenditure by sector of activity (NACE Rev. 1.1) as a percentage of total, EU-27 and selected countries — 2006



Note:
Exceptions to the reference year: 2005: IE, EL, LU, PT, SE and IS; 2004: CH.

BE, DK, FR, UK: breakdown according to the principle activity of the enterprises is not available.
EL: provisional data.
SE: break in series.
HU: the sum of the breakdown does not add up to the total.

Source: Eurostat (rd_e_berdind)

Figure 2.10 provides a breakdown of R&D expenditure in the business enterprise sector by sector of economic activity according to NACE Rev 1.1 (see methodological notes).

'Manufacturing' was the largest sector of activity in many of the countries under review, especially Germany, where 90 % of R&D expenditure in the BES was devoted to the manufacturing sector. This was followed by Slovenia, with 86 % of R&D expenditure in the BES invested in manufacturing activities, Finland (80 %) and Switzerland (80 %).

On the other hand, in Bulgaria, Estonia, Cyprus, Latvia, Lithuania, Luxembourg, Poland, Portugal, Slovakia, Iceland, Norway and Croatia, less than 50 % of R&D expenditure from the BES sector was devoted to manufacturing. In the above countries, the bulk of R&D expenditure in the BES was invested in services, except in Portugal.

ICT companies make over 25 % of European R&D investments

"The Information and Communication Technology (ICT) sector accounts for 26 % of all industrial Research and Development (R&D) expenditure in the EU and employs 32 % of business sector researchers, according to 'the 2009 report on R&D in ICT in the European Union' (PREDICT) published by the JRC's Institute for Prospective Technological Studies. Although the European ICT sector only represents about 3 % of total employment in the EU and 4.9 % of GDP, it is by far the largest R&D investing sector of the economy. Furthermore, the JRC report shows that the ICT sector in the EU's main competitors (such as the US, Japan, or South Korea) also has the lead in their respective economies in terms of R&D expenditure. The research, which provides for the first time a comprehensive overview of ICT R&D investment in the EU (2001-2005) by combining national statistics, company data and technology indicators, also reveals that additional ICT R&D is carried out in Europe within non-ICT designated sectors such as the automotive industry. The report contains a host of information on economic trends in the ICT sector, examining the input-output relationship of ICT R&D and offering an analysis of EU ICT patents."

Source: European Commission, JRC, IPTS.

Table 2.11 shows the distribution of business R&D expenditure by enterprise size in 2006. In most EU Member States, the level of R&D expenditure in the business enterprise sector was related to the size of the enterprise.

As a general trend, enterprises with 50 to 249 employees and enterprises with 500 or more employees tend to invest more in R&D than enterprises in the other size classes. However, wide discrepancies were found in this trend.

In the Czech Republic, Denmark, Germany, France, Italy, Luxembourg, Hungary, Austria, Slovenia, Finland, Sweden and the United Kingdom, enterprises with more than 500 employees accounted for more than 50 % of total R&D expenditure.

Small countries registered higher levels of business R&D expenditure in smaller companies. For instance, enterprises with 0 to 49 employees were responsible for 49.9 % of total R&D expenditure in Cyprus and 25.2 % in Malta, while companies with 50 to 249 employees accounted for 50.8 % of total R&D spending in Latvia and 53.6 % in Lithuania.

Table 2.11: Business enterprise R&D expenditure in million EUR and by size class as a percentage of total, EU-27 and selected countries — 2006

	Total in mio EUR	By size class as a percentage			
		0 to 49 employees	50 to 249 employees	250 to 499 employees	500 and more employees
EU-27	137 431 s	:	:	:	:
BE	4 129 p	16.0 p	22.7 p	8.2 p	48.4 p
BG	31	29.6	26.7	11.2	32.4
CZ	1 165	9.1	20.2	9.8	61.0
DK	3 477	15.0	14.0	8.7	62.2
DE	38 651	2.4	7.5	5.4	84.8
EE	67	34.7 i	23.2	16.4	25.7
IE	1 560 p	20.4	25.8	18.3	35.6
EL	357	33.8	26.0	5.9	34.4
ES	6 558	21.2	27.7	12.7	38.4
FR	23 915 p	6.7	11.2	8.1	74.1
IT	6 979	5.1	11.9	10.2	72.7
CY	14	49.9	10.8	7.7	31.6
LV	57	22.7	50.8	1.7	24.8
LT	53	13.1	53.6	16.8	16.5
LU	408	10.3	17.9	10.8	61.0
HU	435	15.4	12.3	4.2	68.1
MT	21	25.2	11.7	36.0	27.1
NL	5 480	:	:	:	:
AT	4 449	9.3 i	18.9	9.4	62.4
PL	477	4.2	30.7	24.0	41.0
PT	462	12.9	22.3	14.7	50.0
RO	215	14.7	33.0	12.1	40.3
SI	291	9.1	17.6	6.8	66.5
SK	93	9.3	47.0	10.9	32.7
FI	4 108	9.0 i	12.0	8.9	70.1 i
SE	7 725 b	8.9 b	12.5 b	6.7 b	66.8 b
UK	19 464	5.9 i	12.9	9.8	72.2
HR	109	7.3	20.5	72.2 i	:
NO	1 987	21.5	30.3	8.7	:
CH	6 257	8.0	12.4	11.3	68.2

Note:
Exceptions to the reference year: 2005: DK, DE, EL, LU, PT, SE, UK and NO; 2004: CH; 2003: IT.

Flag i:
EE, AT, FI, UK and HR: includes other classes.

Source: Eurostat (rd_e_berdsize)

Table 2.12: R&D expenditure in million EUR and by field of science as a percentage of total, government and higher education sector, EU-27 and selected countries — 2006

	Government sector							Higher education sector						
	Total EUR million	Natural sciences	Engineering and technology	Medical and health sciences	Agricultural sciences	Social sciences	Huma-nities	Total EUR million	Natural sciences	Engineering and technology	Medical and health sciences	Agricultural sciences	Social sciences	Huma-nities
EU-27	28 414 s	:	:	:	:	:	:	47 478 s	:	:	:	:	:	:
BE	464	9.2	70.9	1.4	10.4	2.3	5.8	1 239	21.0	16.6	27.3	10.4	17.0	7.6
BG	78	40.7	17.2	4.6	25.7	2.7	9.0	12	29.3	39.1	8.1	1.7	15.3	6.5
CZ	309	55.5	13.0	5.8	10.0	7.5	8.2	279	25.5	33.5	19.5	5.8	10.1	5.7
DK	356	20.8	16.2	21.8	20.3	15.1 b	5.9 b	1 404	23.5	15.0	29.0	4.7	17.9 b	9.8 b
DE	8 156 i	46.8	28.0	6.4	5.5	4.8	8.6	9 568	28.5	19.4	27.5	3.5	9.2	12.0
EE	20	29.9	14.2	18.5	9.6	2.9	24.9	61	45.3	23.8	8.9	6.0	9.5	6.5
IE	150	20.0	1.3	20.8	43.0	14.7	0.3	601 i	27.0	22.1	18.1	2.6	15.3	6.6
EL	254 e	:	:	:	:	:	:	585 e	:	:	:	:	:	:
ES	1 971	12.6	27.4	35.5	15.4	5.4	3.8	3 266	23.1	23.4	14.1	2.5	22.3	14.6
FR	6 254 p	:	:	:	:	:	:	7 279 p	:	:	:	:	:	:
IT	2 897	46.0	14.9	19.0	5.1	12.1	2.9	5 094 i	31.5	14.6	15.6	4.1	18.6	15.2
CY	18	20.1	1.8	2.4	55.4	9.3	11.0	26	41.6	18.1	1.1	:	28.6	10.6
LV	17	52.5	5.1	:	35.6	6.8	:	39	40.7	19.6	10.0	5.9	14.1	9.6
LT	44	43.4	17.1	1.0	14.2	8.9	15.4	94	20.9	26.7	18.6	4.8	18.4	10.7
LU	57	22.0	36.7	16.2	6.2	17.4	1.6	7	36.6	25.4	:	0.0	25.4	12.7
HU	228	40.6	8.5	9.5	16.3	12.6	12.5	219	27.1	17.9	16.2	9.3	17.5	12.0
MT	1 i	5.7	5.2	1.5	49.6	32.4	3.7	9 i	16.1	17.0	19.1	1.0	31.7	13.5
NL	1 260 i	:	:	:	:	:	:	2516 ep	:	:	:	:	:	:
AT	330	11.6	6.7	36.8	11.1	13.5	20.3	1 523	31.3	14.3	26.1	4.6	13.7	10.0
PL	560	64.8	:	:	:	:	:	469	:	:	:	:	:	:
PT	176	15.1	25.6	15.2	30.9	9.8	3.4	425	29.2	24.9	8.2	7.4	18.4	11.9
RO	144	36.2	42.1	4.2	7.1	5.4	5.0	79	18.6	31.6	11.5	10.7	26.8	0.7
SI	119	53.7	13.5	3.4	3.5	13.2	12.7	73	10.2	39.7	15.4	16.1	13.2	5.5
SK	71 i	35.8 i	17.8 i	12.3 i	20.0 i	6.9	7.2	52	40.6	22.7	9.7	7.4	16.5	3.2
FI	539	16.2 i	42.9 i	13.2 i	18.8 i	13.8 i	1.7 i	1 079	25.6	19.0	24.2	2.4	21.1	7.7
SE	525	:	:	:	:	:	:	2 418 i	19.8 e	23.6 e	32.1 e	5.1 e	12.1 e	6.3 e
UK	3 401	:	:	:	:	:	:	8 892	:	:	:	:	:	:
HR	79	44.4	8.0	8.2	9.0	18.0	12.4	109	8.8	31.6	11.5	18.6	6.3	23.2
TR	284	:	:	:	:	:	:	1 248	8.2	13.4	44.5	5.7	18.1	10.1
IS	86 i	15.8	9.8	10.0	35.0	12.4	0.9	80 i	1.8	3.0	13.6	6.7	18.8	7.6
NO	577	22.4	16.4	11.2	22.5	23.6	3.8	1 136	20.5	11.1	33.0	4.8	20.4	10.1
CH	76 i	:	:	:	:	:	:	1 943	23.0	9.3	15.7	2.3	:	:
RU	2 285	39.7	42.5	6.8	5.2	3.0	2.9	517	31.7	46.4	3.2	1.8	13.9	2.9

Note:
Exceptions to the reference year: 2005: BE, LU, PT, IS and NO; 2004: CH (HES).

Flag i:
DE, FI and NL: includes other classes.
SK: defence excluded (all or mostly).
CH (GOV): federal or central government only.
IE, IT, MT, SE and IS: includes unspecified data.

Source: Eurostat (rd_e_gersc)

In 2006, 'natural sciences' accounted for the largest share of R&D expenditure in the government sector in most EU Member States for which data are available. The government sector gave the highest priority to natural sciences in Poland (64.8 %), followed by the Czech Republic (55.5 %). Latvia and Slovenia also exceed 50 %.

'Engineering and technology' was the most important field of science in terms of government R&D expenditure in Belgium, Luxembourg, Romania, Finland and Russia, while 'medical and health sciences' was the leading field of science in Denmark, Spain and Austria.

'Agricultural sciences' accounted for the highest shares of government R&D expenditure in Ireland, Cyprus, Malta, Portugal and Iceland.

None of the countries allocated the largest part of government R&D expenditure to 'social sciences' or 'humanities'. However, 'social sciences' accounted for 32.4 % of government R&D expenditure in Malta, and 'humanities' accounted for 24.9 % of government R&D expenditure in Estonia.

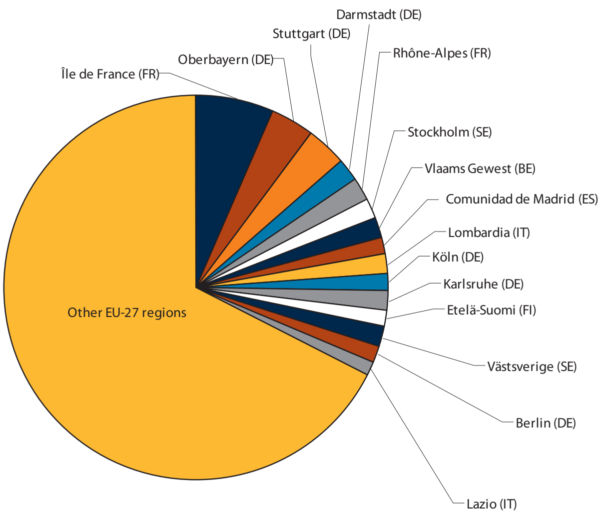
The above trends differ when considering R&D expenditure in the higher education sector. Although 'natural sciences' accounted for the highest shares in many of the countries studied (12 EU Member States and Switzerland), 'engineering and technology' and 'medical and health sciences' accounted for considerably higher shares in other countries.

The higher education sector in Bulgaria, the Czech Republic, Spain, Lithuania, Romania, Slovenia, Croatia and Russia gave high priority to 'engineering and technology'. In contrast, in Belgium, Denmark, Sweden, Turkey and Norway, more emphasis was placed on 'medical and health sciences'.

The higher education sector did not devote much R&D expenditure to 'agricultural sciences' but it allocated high shares of R&D investment to 'social sciences' in Cyprus (28.6 %) and Malta (31.7 %).

2.3 R&D at regional level

Figure 2.13: R&D expenditure in the top 15 EU regions, as a percentage of all EU-27 regions, all sectors — 2006



Note:
Exceptions to the reference year: 2005: regions from DE, IT and SE; 2004: regions from FR.
BE: by NUTS 1 regions.
SE: in some cases R&D expenditure is allocated to the head office.

Source: Eurostat (rd_e_gerdreg)

Table 2.14: Top 15 EU regions in terms of R&D expenditure as a percentage of GDP, all sectors — 2006

Regions	% of GDP	EUR million	% of EU-27
EU-27	1.85 s	215 553 s	100
Braunschweig (DE)	5.83	2 477	1.15
Västsverige (SE)	5.40 i	3 055 i	1.42
Stuttgart (DE)	5.37	6 896	3.20
Pohjois-Suomi (FI)	4.75	832	0.39
Oberbayern (DE)	4.71	7 854	3.64
Sydsverige (SE)	4.45 i	1 697 i	0.79
Stockholm (SE)	4.29 i	3 668 i	1.70
Midi-Pyrénées (FR)	4.15	2 680	1.24
Östra Mellansverige (SE)	3.99 i	1 686 i	0.78
Tübingen (DE)	3.94	2 040	0.95
Karlsruhe (DE)	3.92	3 303	1.53
Berlin (DE)	3.82	3 017	1.40
Länsi-Suomi (FI)	3.70	1 387	0.64
Dresden (DE)	3.55	1 231	0.57
Wien (AT)	3.54	2 430	1.13

Note:
Exceptions to the reference year: 2005: regions from DE, IT and SE; 2004: regions from FR.

Flag i:
SE: in some cases R&D expenditure is allocated to the head office.

Source: Eurostat (rd_e_gerdreg)

Figure 2.13 presents the top 15 EU regions in terms of R&D expenditure (expressed as a percentage of the EU-27 total), whereas Table 2.14 shows the leading 15 regions in terms of R&D intensity.

In absolute terms, six German regions (Oberbayern, Stuttgart, Darmstadt, Köln, Karlsruhe and Berlin) featured among the top 15 in terms of R&D expenditure, together with two French regions, Île de France and Rhône-Alpes, the Belgian region of Vlaams Gewest, the Stockholm region and Västsverige in Sweden, Lombardia and Lazio in Italy, Etelä-Suomi in Finland and Comunidad de Madrid in Spain.

In 2006, Île de France (FR) was ranked first in terms of total R&D expenditure, accounting for 6.73 % of the EU-27 total. It was followed by 14 other regions, together accounting for more than 30 % of total R&D expenditure in the EU 27.

All the 15 leading regions in terms of R&D expenditure as a share of GDP were above the 3 % target set by the Lisbon strategy as shown in Table 2.14; however, only three of them were above 5 %. With an R&D intensity of 5.83 % of GDP, Braunschweig (DE) led the way, followed by Västsverige (SE) with 5.40 % and Stuttgart with 5.37 %.

In absolute terms, Oberbayern (DE), with EUR 7.9 billion, accounted for the highest R&D expenditure in the EU-27.

Pohjois-Suomi (FI), Sydsverige (SE), Östra Mellansverige (SE), Tübingen (DE), Länsi-Suomi (FI) and Dresden (DE) were comparatively small in terms of volume of R&D expenditure (less than 1 % of the EU-27 total).

Many of the top 15 regions belong to northern European countries. Seven regions were located in Germany, four in Sweden, two in Finland and one in France and Austria respectively.

Map 2.15 shows that of the 19 EU regions that achieved R&D intensities above the 3 % Lisbon strategy target, seven were German, four Swedish, three Finnish, two Austrian, two French and one Dutch.

As shown on Map 2.15, not many countries had one or more regions with R&D expenditure higher than 2 % of GDP. In addition to the countries listed above, the Czech Republic, Belgium, Slovenia and Iceland also registered regions with shares of over 2 %.

Map 2.15: R&D expenditure as a percentage of GDP, all sectors, NUTS 2 — 2006

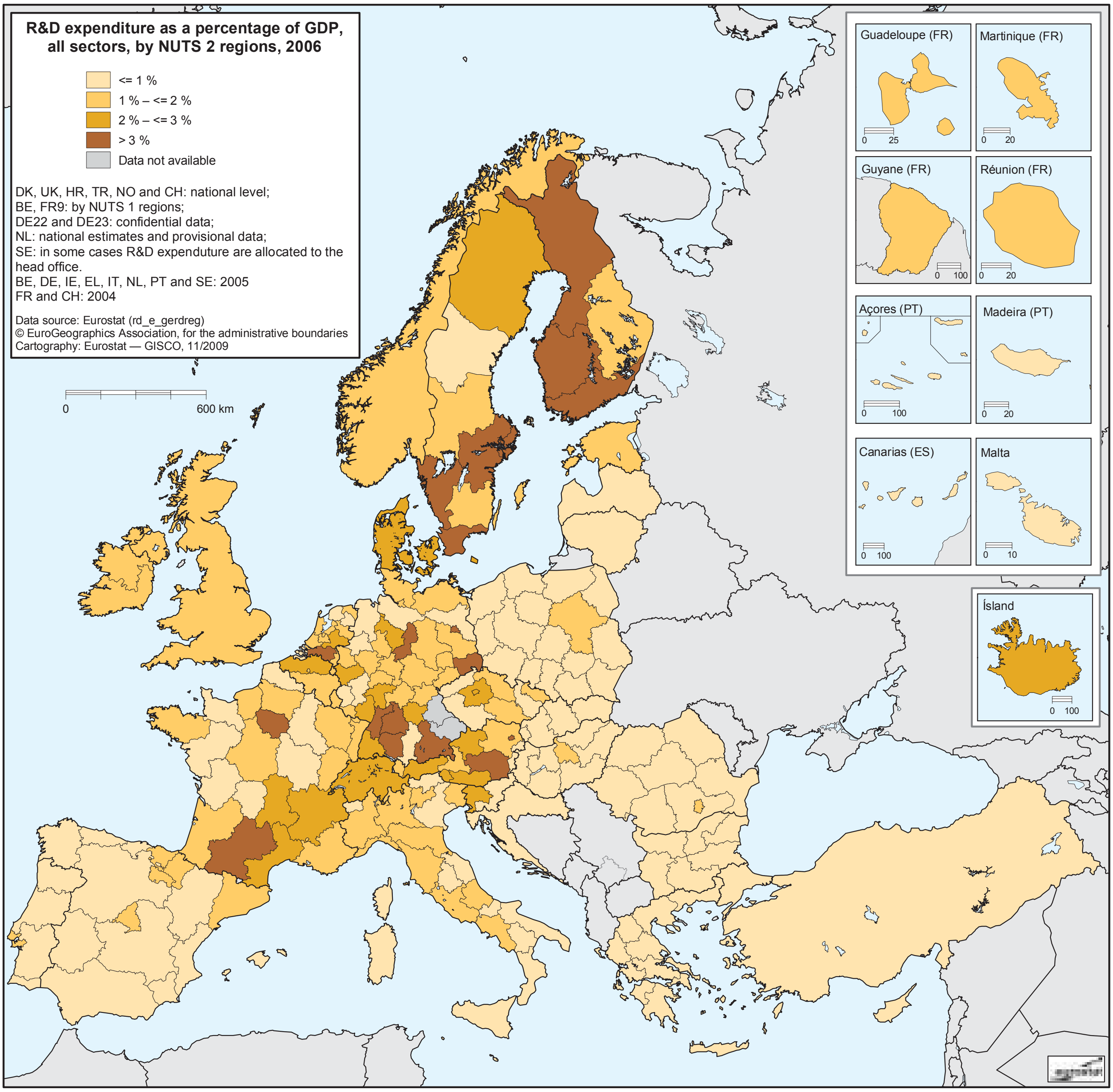
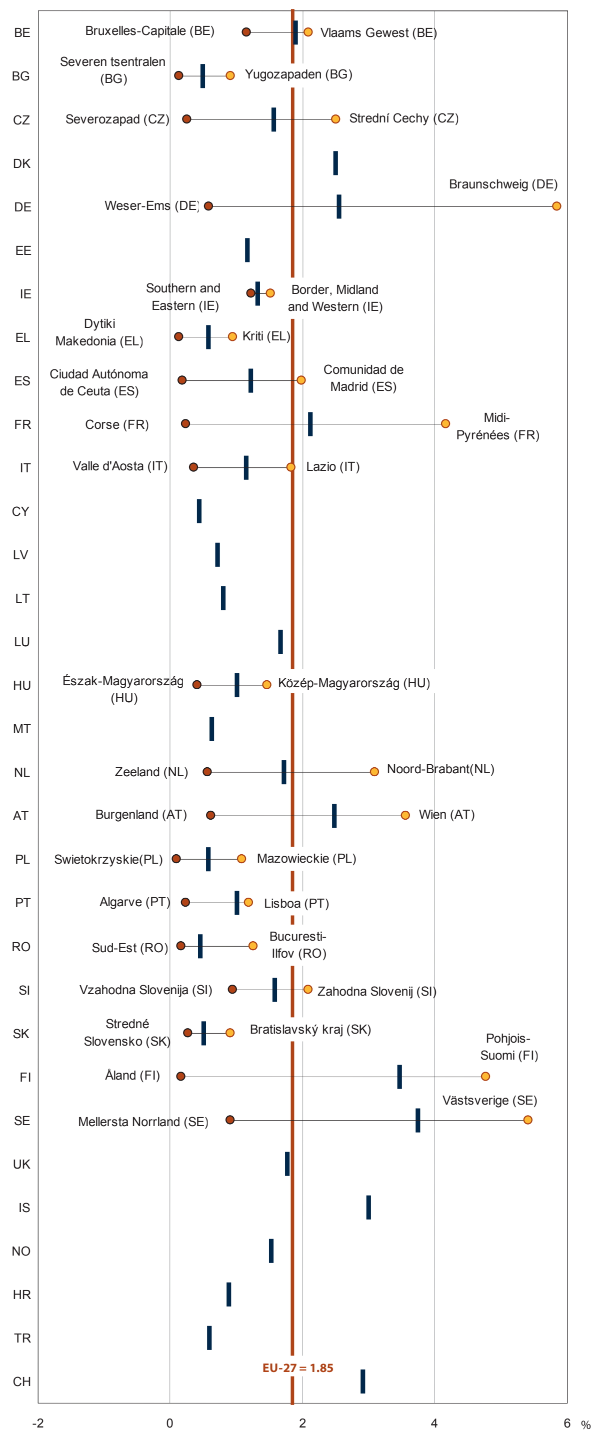


Figure 2.16: Regional disparities (at NUTS 2 level) in R&D expenditure as a percentage of GDP, all sectors, EU-27 and selected countries — 2006



Note:
Exceptions to the reference year: 2005: BE, DE, IE, EL, IT, NL, PT and SE; 2004: FR and CH.
DK, UK, HR, TR and CH: national level.
BE: by NUTS 1 regions.
NL: national estimates and provisional data.
SE: in some cases R&D expenditure is allocated to the head office.

Source: Eurostat (rd_e_gerdreg)

Figure 2.16 shows the regional disparities in R&D expenditure as a share of GDP for the EU-27 and selected countries. At national level, the R&D intensity of the leading regions varied significantly from one country to another. Three main groups of countries emerge from the ranking.

The foremost group includes Germany, France, Finland and Sweden, with an R&D intensity of above 4.00 % in their leading region.

The second group consists of countries with an R&D intensity in the leading region between the EU-27 average (1.85 %) and 4.00 %. This group includes Belgium, the Czech Republic, the Netherlands, Slovenia, Spain and Austria.

The final group comprises countries where R&D intensity in the leading region is below the EU-27 average. This group comprises Bulgaria, Estonia, Greece, Italy, Ireland, Cyprus, Latvia, Lithuania, Luxembourg, Malta, Hungary, Poland, Portugal, Slovakia and Romania.

Disparities were found not only between countries, but also between regions of the same country. The largest discrepancy between the highest- and lowest-ranking regions within a given country was found in Germany, reaching 5.27 percentage points; conversely, the smallest gap was registered in Ireland, at 0.3 percentage points. Except for Bruxelles-Capitale (BE) and Southern and Eastern (IE), with an R&D expenditure of 1.14 % and 1.2 % of GDP respectively, the R&D intensity in the other lowest-ranked regions did not reach 1 %.

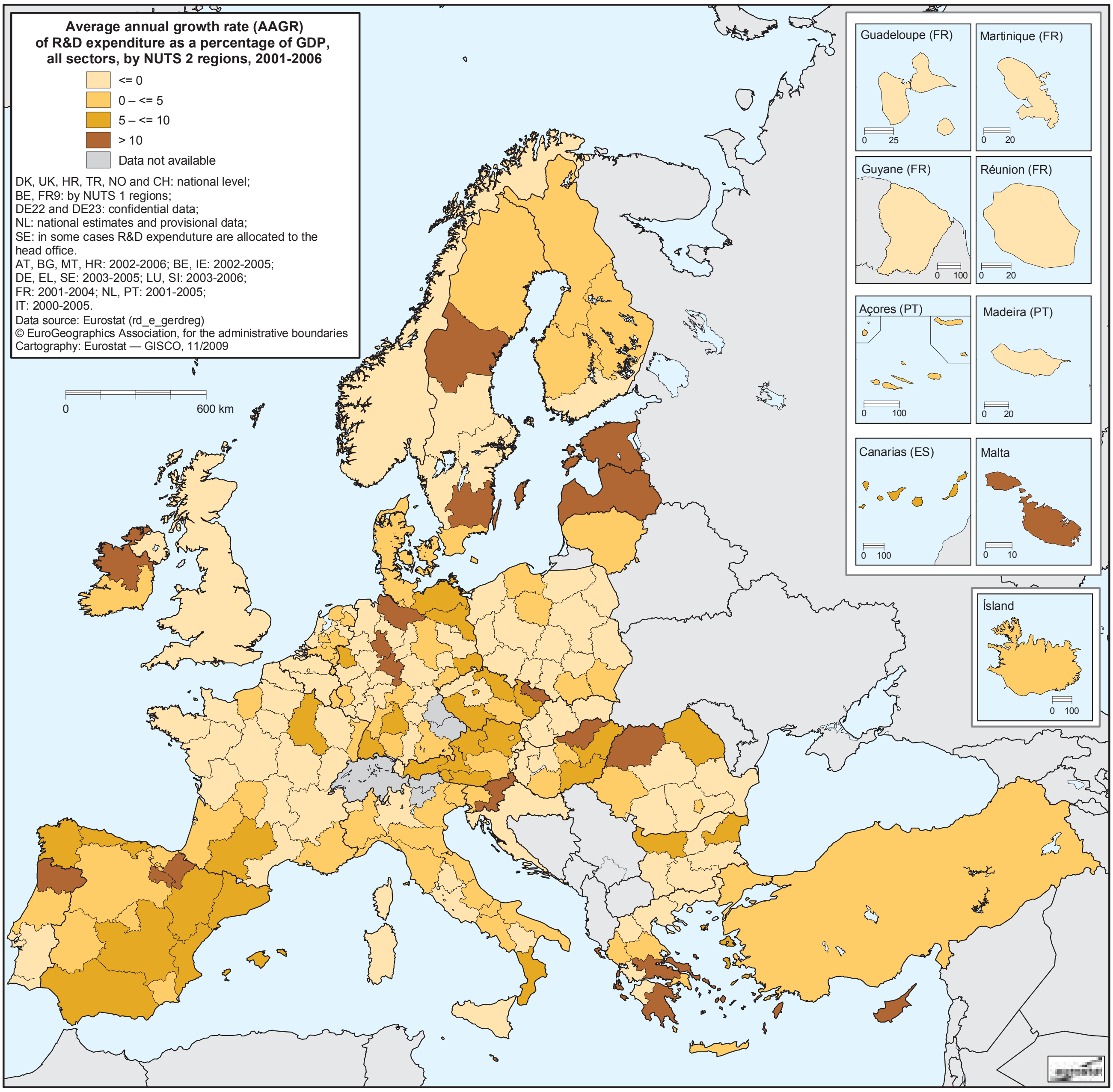
Stuttgart

"Unlike many other European economic regions, the Stuttgart Region has met and exceeded most of the key Lisbon targets. In a benchmark comparison, the region's primary strength is its high level of innovative power, measurable in investment in research and development (R&D) and the number of patent applications filed. The share of R&D expenditure in gross domestic product is approximately 6 per cent in the Stuttgart Region.

More than 90 per cent of this R&D expenditure is incurred by companies located in the region. State-funded research and innovation financing schemes tend to take a back seat, and economic development chiefly translates into promoting communication and cooperation — in other words, creating the best possible network for existing resources."

Source: Based on http://cordis.europa.eu/stuttgart/rd_en.html

Map 2.17: Average annual growth rate (AAGR) of R&D expenditure as a percentage of GDP, all sectors, by NUTS 2 regions — 2001–2006



Map 2.17 shows the average annual growth rate of R&D expenditure as a percentage of GDP in the European regions for the period 2001-2006.

21 European regions presented an AAGR higher than 10 %, the Greek region of Esterea Ellada being the one showing the highest AAGR (55.8 %), followed by Peloponnisos (EL), with 49.4 %, and Lüneburg (DE), with 36.4 %.

The great majority of European regions presented an AAGR between 0 % and 5 %, although many of them, especially in Belgium, Germany, France, the Netherlands, Portugal and Slovakia, showed negative growth rates.

II

Monitoring the knowledge workers

3

R&D personnel

3.1 Introduction

Research and 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 use of this stock of knowledge to devise new applications. As such, R&D is often considered an essential driver of economic growth.

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

As R&D personnel are a key factor in knowledge, S&T dissemination and development, data on them have become a valuable instrument for policy-makers. They measure the human resources allocated directly to R&D activities. R&D personnel include all employed directly in R&D or 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. 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, Switzerland and the candidate countries. This part also looks at the rest of the world by drawing comparisons with China, South Korea, Japan, Russia and the United States.
- Second, R&D personnel are analysed at regional level by focusing on the individual regions of the EU-27 Member States, Iceland and Norway.

Two populations are measured in both sections of this chapter:

- Total R&D personnel, and
- Researchers — possibly the most important sub-population in terms of R&D activities.

Researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and in management of the projects concerned (*Frascati Manual*, paragraph 301).

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

- One FTE equals one year's work by one person employed full time.
- The HC equals the number of individuals 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 on R&D personnel and researchers are provided separately for each sector in which the R&D activities are performed:

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

Besides the total for each sector, the data are further broken down by:

- sex,
- age group,
- occupation,
- field of science,
- formal qualifications,
- country of citizenship,
- sector of economic activity (for the BES).

The regional analysis is carried out at NUTS 2 level. Other levels of NUTS are used in certain instances for certain countries (see footnotes). Readers should also note that, in the NUTS classification, the entire country is considered a NUTS 2 region in the cases of Estonia, Cyprus, Latvia, Lithuania, Luxembourg, Malta and Iceland.

The analysis refers to the period 2002-2007 (or 2001-2006 as different time series were available, depending whether the data were expressed in head count or in full-time equivalent). In general, when data for the reference year are not available for a particular country, the figures for the latest previous year available are given.

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

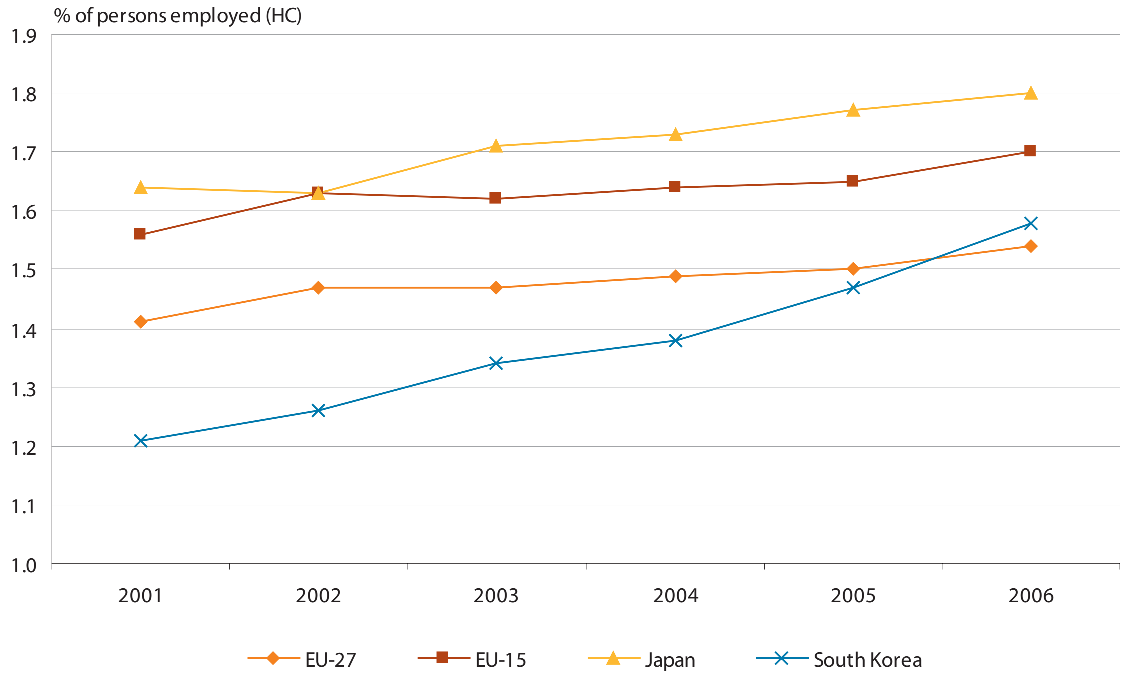
3.2 R&D personnel at national level

3.2.1 R&D personnel in head count as a percentage of total employment

In the EU, the R&D personnel head count (HC) as a percentage of total employment gradually increased over the period 2001-2006. This was also the case in Japan and South Korea. The R&D personnel intensity (proportion of R&D personnel in total employment) in 2006 was, however, lower in the EU-27 (1.54 %) than in Japan (1.80 %) or South Korea (1.58 %). Nevertheless, the level of employment in R&D in the EU-15 was almost on a par with Japan, with 1.70 % of total employment.

Between 2001 and 2006, R&D personnel (HC) as a percentage of total employment increased by 0.13 percentage points in the EU-27. Over the same period, this share rose by 0.16 percentage points in Japan and 0.37 points in South Korea.

Figure 3.1: R&D personnel (HC) as a percentage of total employment, all sectors, EU-27, EU-15, Japan and South Korea — 2001–2006



Note:
EU-27 and EU-15: Eurostat estimates.
KR: excludes R&D in social sciences and humanities.

Source: Eurostat (rd_p_perslf), OECD-MSTI for JP and KR.

Korean R&D Human Resource Development Programme

"The R&D Human Resource Development Programme was recently introduced by the Ministry of Commerce, Industry and Energy to cultivate R&D talents nationwide by providing financial support to R&D centres (or host companies). Newly established R&D centres or existing R&D centres in South Korea can take advantage of the programme specifically for newly-employed R&D personnel and training personnel dispatched from abroad.

R&D personnel

- **New employment**: R&D centres (or host companies) can receive matching grants for newly-employed R&D personnel.

- **Renewed employment**: R&D centres (or host companies) can hire persons described above as long-term employees and receive matching grants.

Training personnel

-**Temporary stationing**: R&D centres (or host companies) can transfer training personnel from abroad."

Source: Korea Trade Investment Promotion Agency, www.kotra.or.kr

Between 2001 and 2006, R&D personnel intensity, measured by head count as a share of total employment, in the EU-27 increased at an average rate of 1.78 % per year (see Figure 3.2).

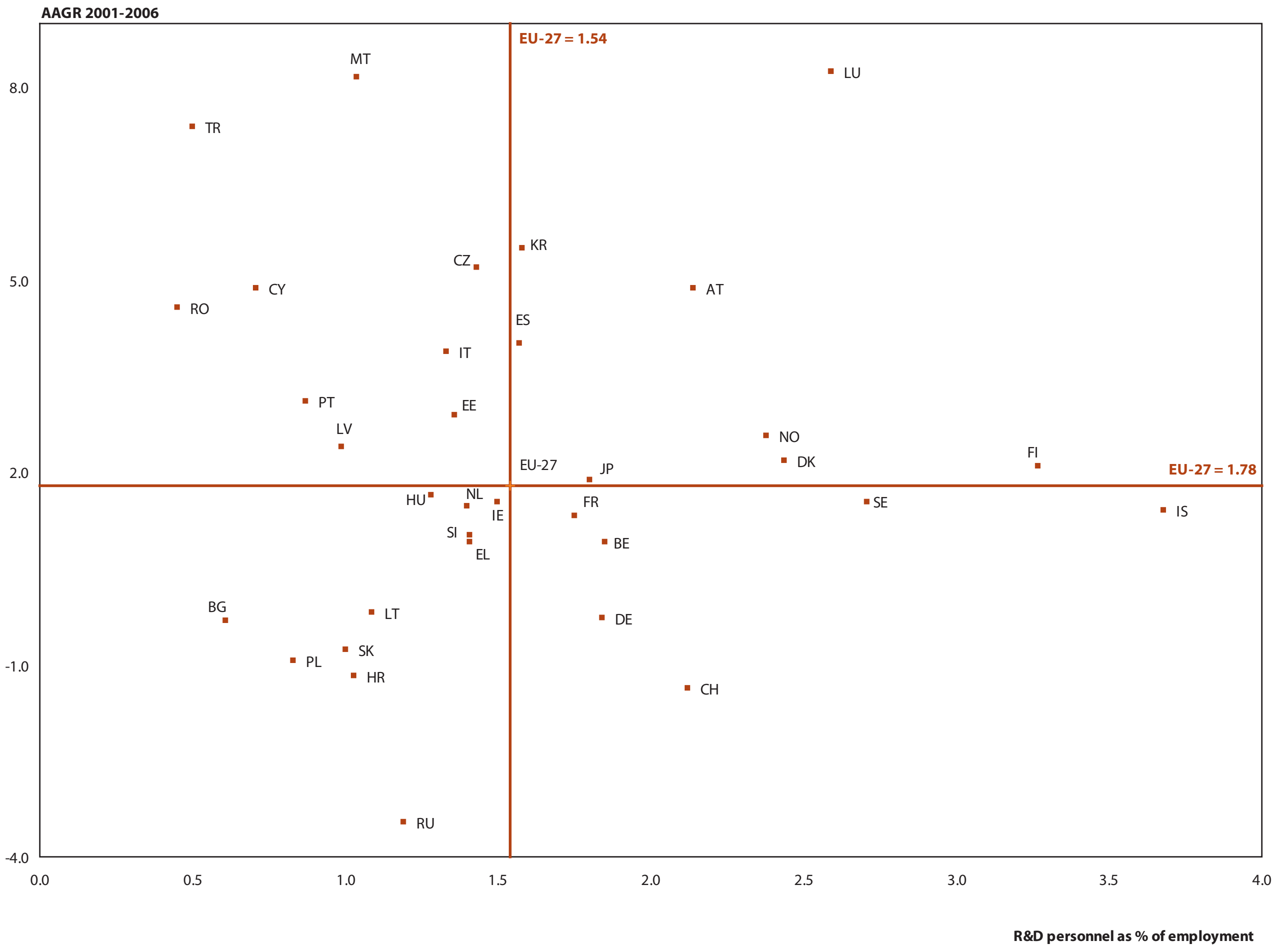
Four groups of countries can be distinguished in this graph. First, there are countries with R&D personnel intensity and AAGR above the EU-27 average: Luxembourg, Austria, Norway, Denmark, Finland, Spain, South Korea and Japan.

The second group comprises countries with R&D personnel intensity above the EU-27 average, but AAGR below it: France, Belgium, Germany, Switzerland, Sweden and Iceland.

Third, in Malta, Cyprus, Romania, the Czech Republic, Estonia, Italy, Portugal and Latvia, together with Turkey, the AAGR for R&D personnel was high, but R&D personnel intensity low.

The last group comprises countries where both R&D personnel intensity and AAGR were below the EU-27 average: Hungary, the Netherlands, Ireland, Slovenia, Greece, Lithuania, Slovakia, Poland, Bulgaria, Croatia and Russia.

Figure 3.2: R&D personnel intensity in 2006 and AAGR(1) thereof 2001-2006, EU-27 and selected countries

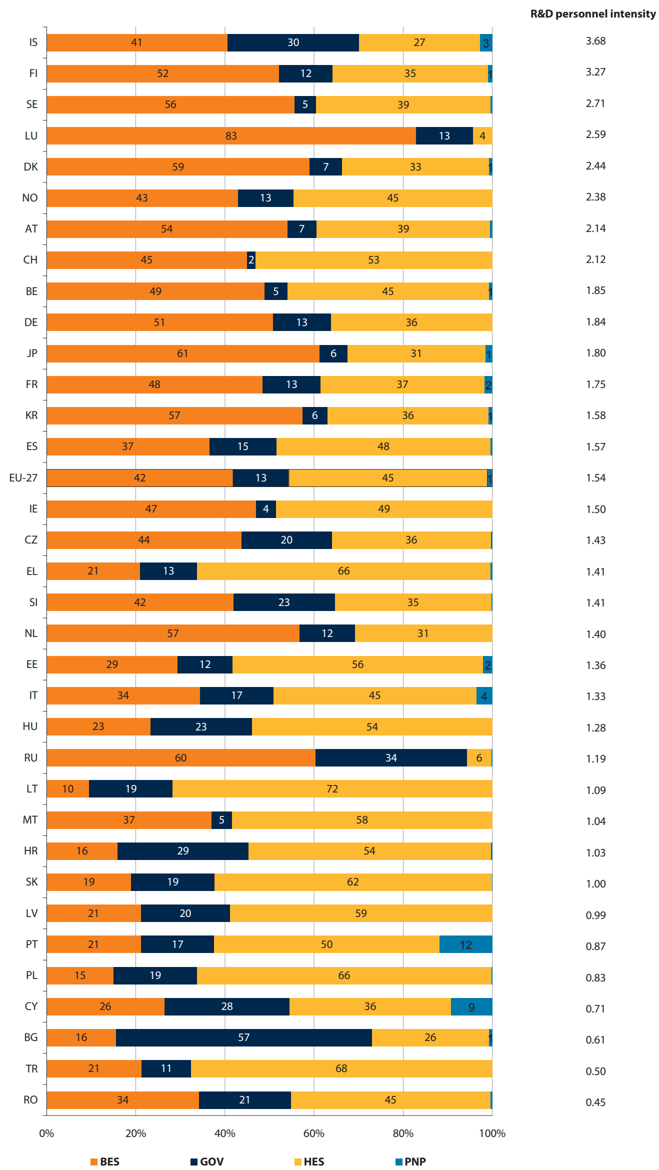


Note:
(1) Calculated as R&D personnel expressed as a percentage of total employment.
Exceptions to the reference year: 2005: BE, DE, EL, LU, NL, PT, IS, NO and RU.
Exceptions to the reference period: 2000-2004: CH; 2001-2005: EL, PT, SE, NO and RU; 2002-2005: BE and NL; 2002-2006: MT, AT and HR; 2003-2005: DE and LU; 2003-2006: IS.

EU-27: Eurostat estimate.
IE and NL: provisional data.
SE: break in series.
UK: data not available.
TR and RU: underestimated or based on underestimated data.
HU (2001) and FR: defence excluded (all or most).
KR: excludes R&D in social sciences and humanities.

Source: Eurostat (rd_p_perslf), OECD-MSTI for JP and KR.

Figure 3.3: R&D personnel (HC) by sector of performance as a percentage of total, EU-27 and selected countries — 2006



Note:

Exceptions to the reference year:	2005: BE, DE, EL, LU, NL, PT, SE, NO and RU (for R&D personnel intensity). 2004: CH.

EU-27: Eurostat estimate.
NL (HES): national estimate.
UK: data for all sectors and for HES are not available.
IE and NL: provisional data.
SK (GOV) and FR: defence excluded (all or most).
SE: break in series.
TR and RU: underestimated or based on underestimated data.
NL: GOV includes other classes.
KR: excludes R&D in social sciences and humanities.
CH: federal or central government only.

Source: Eurostat (rd_p_persocc), OECD-MSTI for JP and KR.

Figure 3.3 shows the distribution of R&D personnel in head count (HC) by sector in which the R&D activities are performed. The business enterprise and higher education sectors accounted for the majority of R&D employment in all countries, except in Bulgaria where the government sector employed the most R&D personnel.

In the EU-27, higher education employed 45 % of all R&D personnel, followed by the business enterprise (42 %), government (13 %) and private non-profit sectors (1 %).

In Luxembourg more than 80 % of R&D personnel were employed in the business enterprise sector. The same sector also employed more than 60 % of all R&D personnel in Japan and Russia. At the other end of the scale, the business enterprise sector in Lithuania employed only 10 % of all persons working on R&D.

The government sector was not a significant employer in most countries (except in Bulgaria), with very low shares of total employment in R&D, especially in Switzerland, Ireland, Belgium, Malta and Sweden.

The higher education sector was the foremost R&D employer in 14 EU Member States plus Norway, Switzerland, Croatia and Turkey.

In Lithuania, Turkey, Poland, Greece and Slovakia more than 60 % of R&D personnel were employed in higher education. However, this sector's share was much lower in Luxembourg and Russia, with less than 6 % of total R&D employment.

3.2.2 R&D personnel in head count by qualifications

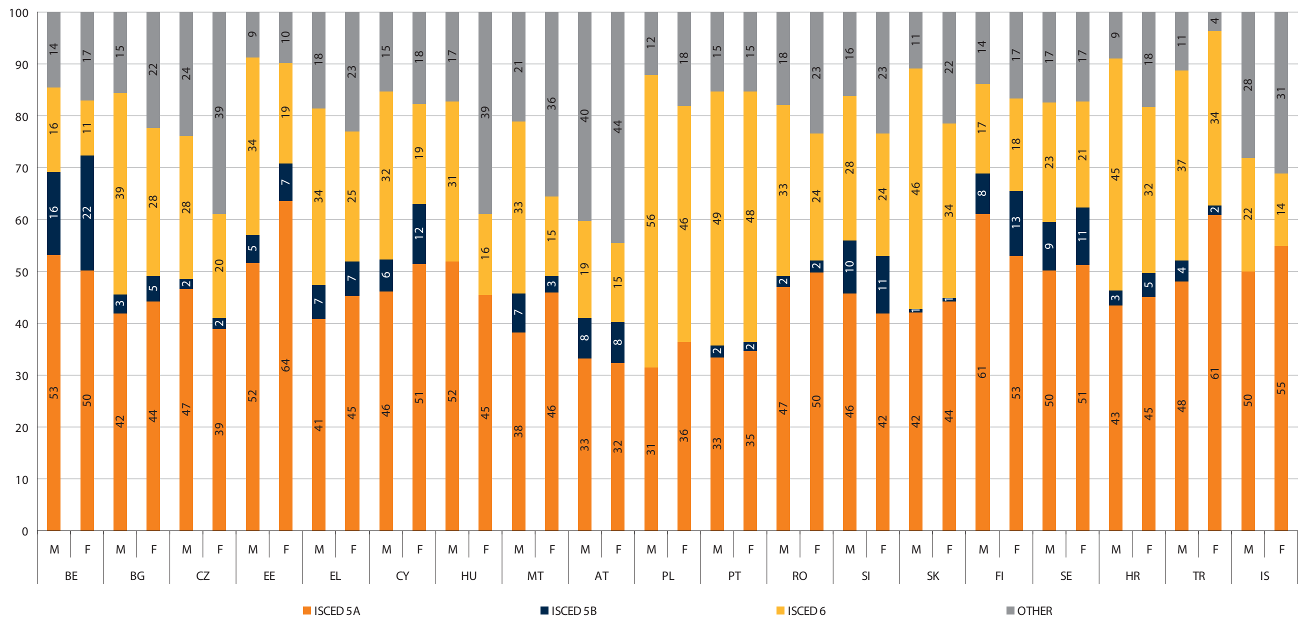
Figure 3.4 shows R&D personnel in head count (HC) by level of formal qualifications and sex as a percentage of the total. A majority of R&D personnel in many of the countries surveyed hold basic university degrees at ISCED 5A level. This was the case in all the countries included below except Poland and Portugal, where most R&D personnel had doctorate level (ISCED 6) qualifications. At ISCED 5A level of education, no great discrepancies were observed between male and female R&D personnel. In Belgium, the Czech Republic, Hungary, Austria, Slovenia and Finland the proportion of male R&D personnel with ISCED 5A education was higher than that of women. In this context, the widest gender gap in ISCED 5A qualifications (8 percentage points) was recorded in the Czech Republic and in Finland. Conversely, in Bulgaria, Estonia, Greece, Cyprus, Malta, Poland, Portugal, Romania, Slovakia, Sweden, Croatia, Turkey and Iceland the proportion of women in R&D with ISCED 5A education was higher than that of men, especially in Estonia and Turkey.

ISCED 5B programmes are typically shorter than ISCED 5A studies and focus on practical, technical or occupational skills for direct entry into the labour market. The shares of male and female R&D personnel with ISCED 5B level education were equal in the Czech Republic, Greece, Austria, Portugal, Romania and Slovakia. Belgium recorded the highest proportion of female R&D personnel with ISCED 5B education (22 %), followed by Finland (13 %), Cyprus (12 %), Slovenia and Sweden (11 % in both cases).

A wider gender gap emerged when looking at R&D personnel with ISCED 6 level education. In all the countries surveyed, except Finland, the share of male R&D personnel with ISCED 6 education was higher than that of women. In Hungary and Malta the proportion was twice as high among men as among women.

The proportion of R&D personnel with other qualifications was fairly high in Austria (40 % for men and 44 % for women). Hungary was also noteworthy, as the gender discrepancies for R&D personnel with other qualifications ranged from 17 % for men to 39 % for women. This was also the case in the Czech Republic, where 24 % of male R&D personnel and 39 % of female R&D personnel had other qualifications.

Figure 3.4: R&D personnel (HC) by qualifications as a percentage of total and by sex, available countries — 2006



Note:
Exceptions to the reference year: 2005: BE, EL, PT and SE; 2003: IS.
SE: break in series.
HU, PL and IS: data on ISCED 5B not available.
HU and PL: ISCED 5A includes ISCED 5B.

Source: Eurostat (rd_p_persqual)

3.2.3 R&D personnel in full-time equivalents

Counted as full-time equivalents (FTE), more than 2.3 million person years were recorded for R&D activities in 2007. More than half of them (1.2 million FTE) were worked in the business enterprise sector (BES). Higher education (HES) and government (GOV) employed 736 053 FTE and 342 788 FTE respectively in R&D. The remainder, 30 365 FTE, were in the private non-profit sector.

Germany alone, with 493 858, employed more than 20 % of all R&D personnel measured as FTE in the EU-27. This phenomenon was even more marked in the business enterprise sector, where Germany accounted for 26 % of all BES R&D personnel in the EU-27.

Table 3.5: R&D personnel in FTE and percentage of women in 2007 and average annual growth rate (AAGR)[1] 2002-2007, 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 2002-2007	R&D PSL in FTE	% of women	AAGR 2002-2007	R&D PSL in FTE	% of women	AAGR 2002-2007	R&D PSL in FTE	% of women	AAGR 2002-2007
EU-27	2 314 627 s	33.5 s	2.2 s	1 205 421 s	22.7 s	2.2 s	342 788 s	43.9 s	2.0 s	736 053 s	45.7 s	2.1 s
BE	56 244 p	:	1.6	32 515 p	:	0.5	3 911 p	:	1.2	19 442 p	:	3.8
BG	16 940	:	2.4	2 422	:	7.7	10 124	:	-0.7	4 269	:	8.4
CZ	49 192	31.8	13.6	25 650	22.0	15.2	10 908	47.2	8.2	12 465	38.3	16.3
DK	46 029 e	:	1.7	29 976 e	:	1.0	3 361 e	:	-0.1	12 400 e	:	3.8
DE	493 858 e	:	0.6	315 214 p	18.3 e	0.8	80 644	37.7	2.1	98 000 e	:	-1.3
EE	5 002	43.3	3.9	1 689	31.7	19.2	782	62.1	-0.3	2 406	44.7	-1.3
IE	17 660	:	6.8	10 800	:	4.1	1 248	38.3	1.0	5 612	42.1	15.3
EL	35 629 e	:	2.8	11 660 e	:	0.1	4 584 e	:	-2.6	19 172 e	:	6.4
ES	201 108	:	8.4	87 543	:	9.2	37 919	:	10.3	75 148	:	6.7
FR	363 867 p	:	1.4	202 157 p	:	1.1	54 506 p	:	2.7	101 073 p	:	1.4
IT	192 002	34.8	4.0	80 082	19.0	3.3	36 165	43.7	4.0	67 688	46.1	2.9
CY	1 285 p	:	9.3	335 p	:	12.4	350 p	:	-1.4	495 p	:	19.2
LV	6 378	52.1	3.8	1 128	49.2	-2.3	1 371	57.6	4.1	3 879	50.9	5.9
LT	12 656	53.3	5.8	2 160	37.0	39.3	2 992	57.1	-2.6	7 504	56.5	5.6
LU	4 585 p	:	3.4	3 671 p	31.8 p	1.2	722 p	:	11.0	193 i	:	54.4
HU	25 954	40.5	1.8	10 342	31.9	7.5	7 834	47.3	-0.4	7 778	45.0	-1.8
MT	845 p	:	12.2	503 p	:	46.3	33 p	30.3 p	-24.6	310 p	32.9 p	3.2
NL	91 090 p	:	0.8	49 238 p	:	0.9	12 114 ip	:	-1.1	29 738 ep	:	2.2
AT	53 019 e	:	6.4	36 643 e	:	6.5	2 601 e	:	4.8	13 603 e	:	6.6
PL	75 309	:	-0.2	15 032	:	12.1	17 467	:	-6.0	42 595	:	-0.5
PT	34 593 p	:	7.4	12 444 p	:	20.0	4 467 p	:	-3.9	14 002 p	:	5.6
RO	28 977	45.8	-2.4	13 107	40.7	-6.6	8 786	52.2	-0.3	6 931	47.3	4.8
SI	10 369	:	3.8	5 299	:	3.3	3 096	:	6.4	1 950	:	3.4
SK	15 421	44.7	2.5	2 699	30.8	-9.6	4 214	52.6	2.0	8 493	45.2	9.7
FI	56 243	:	0.4	31 940	:	1.0	7 325	:	-0.2	16 503	:	-0.5
SE	76 815 bip	28.9 bip	1.3 b	55 948 b	24.9 b	3.8 b	3 253 i	36.0 i	2.0	17 525	40.8	-5.0
UK	333 671 e	:	0.7	162 828 p	:	0.6	18 380 p	:	-2.9	:	:	:
HR	10 124	50.6	-4.8	2 382	44.6	-0.9	3 344	54.0	2.0	4 384	51.2	-10.0
TR	63 377	30.8	17.0	24 261	22.3	32.6	9 572	23.1	11.7	29 543	40.2	11.0
IS	2 982	37.6	1.3	1 417	30.5	3.7	701	40.5	-1.3	773	45.0	0.2
NO	34 086	:	4.5	17 392	:	3.5	5 683 b	:	2.9 b	11 011 b	:	7.2 b
CH	52 250	:	0.0	33 085	:	-2.2	810 i	:	-2.5	18 355 e	:	4.8
CN	1 736 155 i	:	10.9	1 186 751 i	:	14.6	295 503 i	:	3.2	253 901 i	:	6.9
KR	237 599 i	:	8.4	171 643 i	:	9.2	19 026 i	:	8.0	44 150 i	:	5.6
RU	912 291	:	-1.6	507 415	:	-3.5	295 851	:	1.2	105 643	:	1.5
JP	935 182	:	2.2	619 184	:	2.7	63 196	:	-0.3	238 813	:	2.0

Note:
[1] Calculated as R&D personnel expressed in FTE.
Exceptions to the reference year: 2006: IE, IT, JP and KR; 2004: CH.
Exceptions to the reference period: 2002-2006: IT, JP and KR; 2003-2007: EL, LU and SE; 2000-2004: CH.

Flag i:
LU: national estimate.
NL: includes other classes.
SE: underestimated or based on underestimated data.
CH: federal or central government only.
CN: data do not comply with *Frascati Manual* recommendations.
KR: excludes R&D in social sciences and humanities

Source: Eurostat (rd_p_persocc), OECD-MSTI for CN, JP and KR.

In the business enterprise and government sectors Germany led in absolute terms, followed by France. This ranking was reversed in the higher education sector. The United Kingdom, Spain and Italy followed in the top five with 31.4 % of the total EU-27 R&D personnel in FTE.

On average, women made up only 33.5 % of R&D personnel in the EU in 2007. Nevertheless, in Latvia and Lithuania women were in the majority.

In general, the share of female R&D personnel was lower in the BES than in the other sectors.

Overall, R&D personnel measured as FTE increased at an annual rate of 2.2 % in the EU-27 between 2002 and 2007 and the number of R&D personnel in the individual sectors rose by 2 % or more per year. Among the EU Member States the highest overall increase was recorded in the Czech Republic (13.6 %), followed by Malta (12.2 %). Malta reported the highest increase in AAGR in the BES (46.3 %), albeit at the expense of the government sector, which posted a decrease of 24.6 %.

Among the countries surveyed, only Latvia, Romania and Slovakia along with Switzerland, Croatia and Russia reported a decrease in R&D personnel in the BES between 2002 and 2007. The number of R&D personnel in the government sector fell in 14 EU Member States and also in Iceland, Switzerland and Japan.

In the higher education sector in Luxembourg the number of person-years spent on R&D increased by an average of 54.4 % per year between 2003 and 2007. This can mainly be explained by the opening of the University of Luxembourg in 2003. In the same sector average annual growth rates of more than 10 % were also observed in the Czech Republic, Ireland, Cyprus and Turkey.

DIVERSITY: Improving gender diversity management in materials research institutions

"DIVERSITY is a support action-type project funded by the European Commission within the *7th Framework Programme* for research and technological development and comes under the *Capacities programme*, part 5 *Science in Society*, activity 5.2.1. *Gender and Research*, thematic area 5.2.1.1 **Strengthening the role of women in scientific research**.

This consortium aims to tackle the problem of under-representation of women in decision-making by fostering a change in institutional culture and attitudes to gender diversity in materials research organisations. In this way a more stimulating research environment in the spirit of the *European Charter for Researchers* and the *Code of Conduct for their Recruitment* will be achieved.

The central goal of the project is to identify effective methods, policies and mechanisms to support women scientists in gaining access to decision-making positions in the sphere of materials research, which traditionally is a male-dominated field of science. Commitment to promotion of women to the highest level of research is anchored at the topmost political and institutional level in the DIVERSITY project.

Project objectives: improvement of gender diversity management in materials research organisations by:

- strengthening the role of women scientists in decision-making,

- supporting the materials research institutions to create their individual profile on the basis provided by the principles of the European Charter for Researchers and the Code of Conduct for their Recruitment,

- enhancing the solidarity and involvement of male decision-makers in promoting gender equality in scientific decision-making,

- raising awareness within the scientific community, in the general public and among policy-makers about gender and research.

Project activities: the activities planned are logically organised into six work packages (WP), which can be grouped into three stages:

Stage 1

focuses on benchmarking and monitoring the gender equality and diversity measures in the participating research institutions in order to identify examples of best practice along with the reasons behind the low participation of women in the decision-making process.

Stage 2

aims to support the materials research institutions to create their individual profile on the basis provided by the principles of the Charter and Code and to provide guidelines and recommendations for improving transparency in recruitment, promotion and appointment in order to increase the proportion of women at the highest levels of research.

Stage 3

is dedicated to awareness-raising and dissemination activities."

Source: Based on http://www.diversity-fp7.eu/project.html

3.3 Researchers at national level

3.3.1 Researchers in head count by gender

Table 3.6 shows the number of researchers in head count (HC) broken down by sector of performance and sex in the EU-27 and selected countries.

Female researchers are still largely under-represented in most EU-27 countries, especially in the business enterprise sector, which employed more than four times as many male researchers as female. This proportion was even higher in the Netherlands, where male researchers outnumbered female by a factor of 9.0. Proportions higher than the EU-27 average were also recorded in Germany (7.6), Austria (6.4), Luxembourg (6.0), the Czech Republic (5.5), Finland (4.5), Japan (13.7) and South Korea (8.7).

Bulgaria, Estonia, Lithuania and Portugal were the only countries where more than half of the researchers in the government sector were women. In higher education, male researchers outnumbered female by a factor of 1.7 in the EU-27. This proportion was fairly stable across the EU Member States, ranging from an almost even gender balance in Latvia and Lithuania to 2.8 male researchers per female in Luxembourg.

Table 3.6: Researchers (HC) by sector of performance and sex, EU-27 and selected countries — 2006

	All sectors		Business enterprise sector		Government sector		Higher education sector	
	Male	Female	Male	Female	Male	Female	Male	Female
EU-27	1 365 803 s	596 962 s	608 230 s	137 300 s	137 500 s	86 133 s	607 028 s	363 742 s
BE	34 344	14 413	15 847	4 080	1 722	789	16 622	9 437
BG	6 666	5 367	949	551	3 185	3 308	2 463	1 446
CZ	28 381	11 295	11 348	2 064	5 729	3 252	11 222	5 949
DK	30 552	12 908	18 216	6 048	1 973	1 131	10 091	5 591
DE	319 520	86 733	165 066	21 666	32 103	12 795	122 351	52 272
EE	3 585	2 636	1 042	358	293	443	2 183	1 763
IE	12 304	5 349	6 139	1 557	295	162	5 870	3 630
EL	21 249	12 147	4 577	1 780	1 726	1 190	14 878	9 106
ES	122 194	70 830	37 083	14 190	14 938	13 019	69 757	43 318
FR	189 765 i	72 656 i	97 692	24 159	18 347 i	9 094 i	71 225	37 538
IT	91 434	45 729	28 446	6 904	12 964	10 207	46 683	25 721
CY	1 015	482	269	76	135	99	554	276
LV	3 782	3 418	676	316	693	569	2 412	2 533
LT	6 087	5 926	658	360	825	934	4 604	4 632
LU	1 998	445	1 548	259	299	132	151	54
HU	21 813	10 973	5 963	1 678	3 850	2 367	12 000	6 928
MT	774	274	225	62	26	21	523	191
NL	40 999 p	8 980 p	26 294	2 934	5 508 i	2 299 i	9 197 ep	3 747 ep
AT	37 056	12 541	19 806	3 109	1 694	1 095	15 419	8 190
PL	58 309	38 065	8 578	2 830	8 509	6 002	41 160	29 171
PT	21 012	16 757	4 550	1 636	2 434	3 168	11 359	10 025
RO	17 087	13 035	4 767	3 269	2 941	2 923	9 293	6 789
SI	5 352	2 918	1 980	680	1 115	858	2 235	1 374
SK	10 960	7 856	1 723	759	1 677 i	1 262 i	7 547	5 832
FI	36 465	16 808	21 817	4 849	3 260	2 443	11 141	9 226
SE	53 002 bi	29 494 bi	31 775 bi	10 701 bi	2 996 bi	1 775 bi	18 060 bi	16 882 bi
UK	:	:	77 453 e	18 336 e	6 598	3 149	:	:
HR	5 833	4 595	605	311	1 499	1 426	3 727	2 857
TR	57 432	32 686	10 321	3 310	3 862	1 606	43 249 i	27 770 i
IS	2 636	1 654	1 166	492	637	502	775	606
NO	25 258	11 740	11 449 i	2 920 i	2 843 i	1 699 i	10 966	7 121
CH	31 665	11 555	11 025	2 940	715 i	245 i	19 925 e	8 370 e
KR	222 916 i	33 682 i	155 915 i	17 989 i	12 615 i	1 975 i	52 879 i	13 044 i
RU	224 967 i	163 972 i	129 757 i	88 945 i	75 761 i	62 967 i	18 955 i	11 838 i
JP	766 143	108 547	491 124	35 976	31 477	4 791	234 609	66 584

Note:
Exceptions to the reference year: 2005: BE, DK, DE, IE, EL, LU, NL, PT, SE and NO; 2004: CH.

Source: Eurostat (rd_p_persocc), OECD-MSTI for JP and KR.

Flag i:
SE, NO and TR: university graduates instead of researchers.
NL: includes other classes.
SK and FR: defence excluded (all or most).
CH: federal or central government only.
KR: excludes R&D in social sciences and humanities.
RU: underestimated or based on underestimated data.

Table 3.7: Researchers (HC) in the government sector by field of science and sex, EU-27 and selected countries — 2006

	Government sector											
	Natural sciences		Engineering and technology		Medical and health sciences		Agricultural sciences		Social sciences		Humanities	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
EU-27	:	:	:	:	:	:	:	:	:	:	:	:
BE	266	79	881	350	43	27	267	150	97	55	168	128
BG	1 309	1 519	853	428	224	252	375	423	124	174	300	512
CZ	2 755	1 321	1 157	254	382	413	334	301	375	377	726	586
DK	552	204	388	95	358	397	237	186	253	219	238 b	155 b
DE	15 987	6 183	10 226	2 630	1 687	1 343	1 762	999	1 790	1 255	2 108	1 814
EE	119	61	33	18	28	85	17	35	5	43	91	201
IE	120	54	34	27	5	18	139	75	39	30	4	:
EL	:	:	:	:	:	:	:	:	:	:	:	:
ES	1 713	1 238	3 000	1 955	7 648	7 507	1 240	1 177	765	629	571	514
FR	:	:	:	:	:	:	:	:	:	:	:	:
IT	5 291	2 671	1 826	847	3 825	4 753	652	461	985	1 061	385	414
CY	32	43	11	3	14	5	41	8	26	25	11	15
LV	215	227	141	20	64	52	134	111	86	106	53	53
LT	409	391	195	106	3	7	59	111	55	107	104	212
LU	105	61	133	51	13	17	17	7	41	27	6	4
HU	1 569	653	505	125	249	381	403	258	522	297	602	653
MT	9	5	2	1	0	1	3	2	4	8	3	2
NL	:	:	:	:	:	:	:	:	:	:	:	:
AT	359	122	220	108	97	69	261	89	397	355	360	352
PL	:	:	:	:	:	:	:	:	:	:	:	:
PT	343 i	558 i	342 i	246 i	1 156	1 530	342	457	189	254	62	123
RO	901	1 041	1 009	764	121	337	266	92	269	405	375	284
SI	527	312	129	46	160	163	66	46	114	149	119	142
SK	682 i	425 i	331 i	131 i	126 i	218 i	246 i	148 i	124	157	168	183
FI	:	:	:	:	:	:	:	:	:	:	:	:
SE	260	148	822	470	151	87	22	12	649	371	151	87
UK	:	:	:	:	:	:	:	:	:	:	:	:
HR	404	383	59	20	459	487	98	62	311	292	168	182
TR	708	288	1 329	462	84	64	1 220	515	37	26	1	0
NO	647 i	263 i	494 i	104 i	223 i	266 i	563 i	331 i	669 i	504 i	247 i	231 i
RU	31 532 i	22 693 i	29 200 i	19 251 i	5 217 i	7 731 i	4 780 i	5 798 i	2 385 i	3 720 i	2 647 i	3 774 i

Note:
Exceptions to the reference year: 2005: BE, PT, and NO
2004: TR;
2003: SE.

Flag i:
PT: the sum of the breakdowns does not add up to the total.
SK: defence excluded (all or most).
NO: university graduates instead of researchers.
RU: underestimated or based on underestimated data.

Source: Eurostat (rd_p_perssci)

Major disparities were observed between countries in the distribution of government-sector researchers by field of science. In 13 of the countries surveyed the majority of researchers in the government sector were working in the field of 'natural sciences'. In Belgium, Luxembourg, Sweden and Turkey most government-sector researchers were employed in 'engineering and technology'. The majority of researchers in Spain, Italy, Portugal and Croatia were employed in 'medical and health sciences', whereas 'social sciences' and 'humanities' were the main fields of work for government researchers in Estonia, Austria and Norway (see Table 3.7).

Looking at the gender distribution of researchers in the government sector, 'engineering and technology' primarily employed male researchers in all the countries studied. Wide gender disparities in this field were found in Latvia, where there were seven times more male researchers than female.

Female researchers were also in the minority in 'agricultural sciences' and 'natural sciences' in every country surveyed except Bulgaria, Estonia, Lithuania, Portugal and Russia for 'agricultural sciences' and Bulgaria, Cyprus, Latvia, Portugal and Romania in the case of 'natural sciences'. By contrast, the proportion of female researchers in the government sector tended to be higher in 'medical and health sciences'. This share was remarkably high in Estonia, Ireland and Romania.

The male/female distribution of researchers in the fields of 'social sciences' and 'humanities' was balanced across EU countries. However, significant gender differences were found at country level. In 'social sciences', the balance between male and female researchers was almost even in the Czech Republic, Denmark, Spain, Italy, Cyprus, Latvia, Austria and Croatia, whereas in Estonia female researchers in the field of 'humanities' outnumbered male by a factor of 2.2.

A fairly similar pattern emerges for researchers in the higher education sector (see Table 3.8), where male researchers were in the majority in the field of 'engineering and technology'. Except in Spain and Romania, there were more than twice as many male researchers in 'engineering and technology' as female.

'Natural sciences' and 'agricultural sciences' also employed more male researchers than female. Bulgaria was the only country which reported a majority of female researchers in 'natural sciences' and Latvia, Slovenia and Sweden were the only countries where female researchers outnumbered male in 'agricultural sciences'.

The proportion of female researchers in the field of 'medical and health sciences' was higher than that of male researchers in ten of the countries surveyed.

Table 3.8: Researchers (HC) in the higher education sector by field of science and sex, EU-27 and selected countries — 2006

	Higher education sector											
	Natural sciences		Engineering and technology		Medical and health sciences		Agricultural sciences		Social sciences		Humanities	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
EU-27	:	:	:	:	:	:	:	:	:	:	:	:
BE	:	:	:	:	:	:	:	:	:	:	:	:
BG	153	188	1 256	347	175	199	166	114	612	459	101	139
CZ	1 793	664	3 450	948	2 073	1 853	984	499	2 021	1 431	901	554
DK	2 151	714	1 740	436	2 875	2 506	341	276	1 932 b	1 299 b	1 112 b	688 b
DE	34 100	10 827	25 178	4 620	26 995	18 698	3 482	2 498	17 993	7 576	18 647	13 759
EE	821	506	533	206	122	166	109	77	327	426	271	382
IE	1 826 b	687 b	1 737 b	505 b	670	891	96	69	1 170	1 022	695	670
EL	:	:	:	:	:	:	:	:	:	:	:	:
ES	15 400	9 757	16 123	8 498	10 272	6 792	1 681	1 066	15 852	10 340	10 429	6 865
FR	:	:	:	:	:	:	:	:	:	:	:	:
IT	11 782	6 833	8 054	2 562	9 808	4 631	1 832	923	9 312	5 524	5 701	5 081
CY	214	96	100	21	8	0	0	0	175	103	57	56
LV	714	506	637	275	132	201	158	185	501	755	270	611
LT	978	752	1 285	493	549	655	162	139	828	1 333	802	1 260
LU	29	10	67	15	0	0	0	0	35	18	20	11
HU	2 403	775	1 893	444	1 907	1 487	641	311	3 261	2 446	1 895	1 465
MT	65	10	77	7	165	83	5	0	130	68	79	23
NL	:	:	:	:	:	:	:	:	:	:	:	:
AT	4 713	1 658	2 769	600	3 464	2 267	342	335	2 462	1 901	1 669	1 429
PL	:	:	:	:	:	:	:	:	:	:	:	:
PT	3 182 i	2 976 i	3 080 i	1 483 i	809	943	549	546	2 175	2 423	1 564	1 654
RO	839	712	3 765	2 373	963	1 004	1 588	695	2 028	1 951	110	54
SI	227	89	857	237	395	396	204	230	294	197	258	225
SK	1 742	1 160	2 286	1 032	856	1 127	430	341	1 730	1 796	503	376
FI	:	:	:	:	:	:	:	:	:	:	:	:
SE	3 248 b	1 722 b	5 968 b	1 703 b	2 865 b	4 437 b	674 b	852 b	:	:	:	:
UK	:	:	:	:	:	:	:	:	:	:	:	:
HR	286	209	1 272	582	665	723	428	311	657	554	419	478
TR	3 979	2 834	8 334	3 695	12 857	10 403	2 856	1 050	10 052	6 053	5 171	3 735
NO	2 143	748	1 592	384	2 562	2 496	269	207	2 611	1 925	1 744	1 296
RU	7 787 i	5 266 i	8 005 i	2 621 i	654 i	944 i	336 i	271 i	1 483 i	1 775 i	690 i	961 i

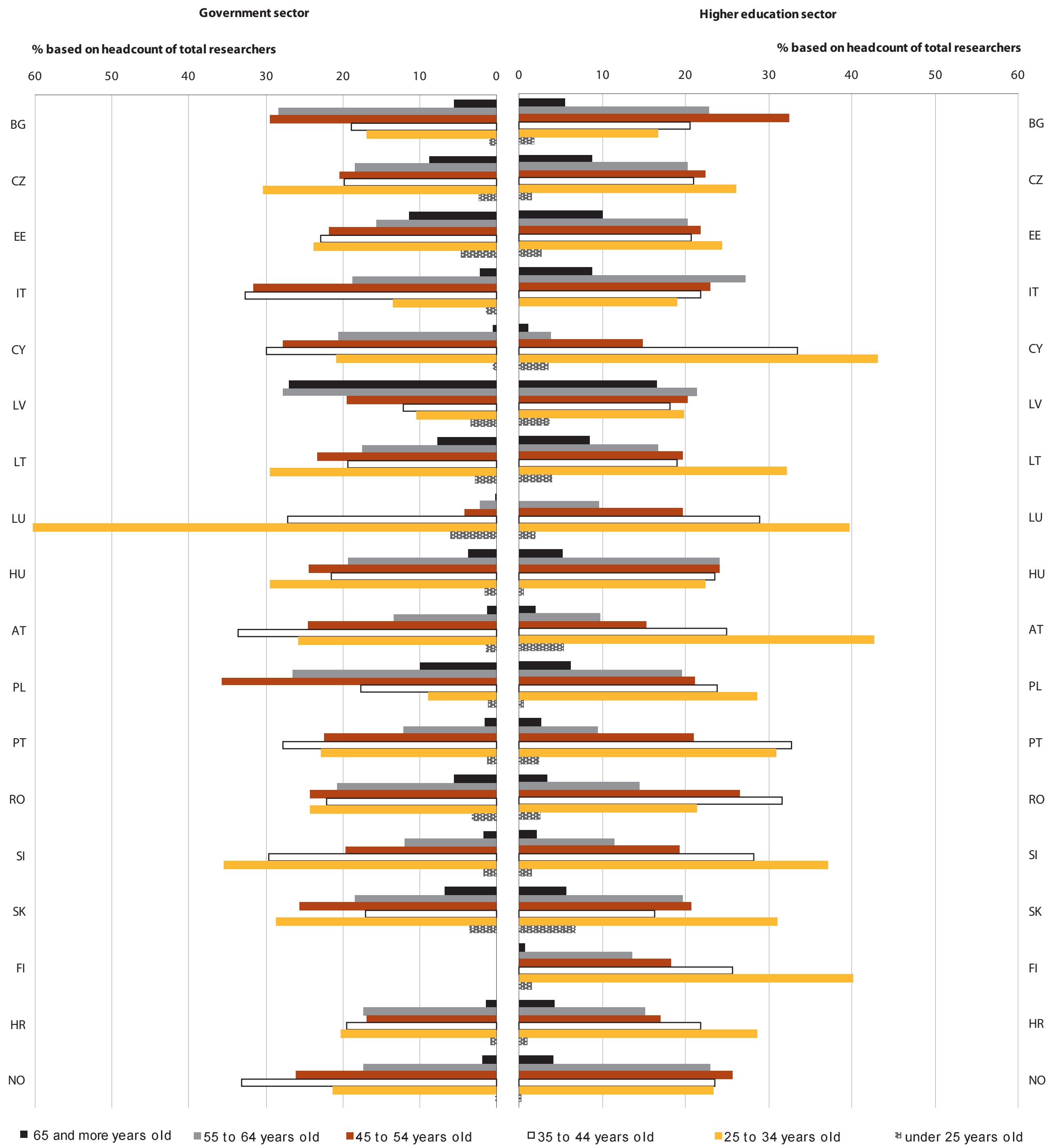
Note:
Exceptions to the reference year: 2005: LU, PT, SE and NO.

Flag i:
PT: the sum of the breakdowns does not add up to the total.
RU: underestimated or based on underestimated data.

Source: Eurostat (rd_p_perssci)

3.3.2 Researchers in head count by age group

Figure 3.9: Researchers (HC) in the government and higher education sectors by age group, as a percentage, available countries — 2006



Note:
Exceptions to the reference year: 2005: IT, PL, PT and NO.

PT: the sum of the breakdowns does not add up to the total.
SK (GOV): defence excluded (all or most).
HR: unrevised breakdown not adding up to the revised total.
NO (GOV): university graduates instead of researchers.

Source: Eurostat (rd_p_persage)

Statistics on researchers in the government sector by age group are available for only 15 EU Member States plus Croatia and Norway. However, this limited number nonetheless provides interesting insights into the age structure of the researcher population at national level.

The results for Luxembourg are the most eye-catching, as two thirds of researchers in the government sector are younger than 35.

Conversely, the opposite trend was observed in Latvia, where the increasing age of researchers is especially visible in the government sector. More than 50 % of all Latvian researchers in the government sector are over 55 and more than a quarter are over 65. However, R&D expenditure in the government sector in Latvia increased by 23.6 % per year between 2002 and 2007 (measured at 2000 constant prices, see Table 2.5). If this trend continues, it will probably encourage more young Latvian researchers to start a career and remain in this sector. The current imbalances in the age structure are therefore expected to improve.

The data on researchers in the higher education sector cover all 15 countries reported on for the government sector plus Finland.

At first glance, the age pyramid of the researcher population in higher education is fairly similar to that for the government sector, but some differences were noted. As in the government sector, researchers in Luxembourg were also very young in higher education, as 42 % were under 35. However, researchers in the government sector were younger than in higher education.

The higher education sector employed many young researchers in Austria, Cyprus and Finland, where more than 40 % of researchers were aged under 35. Austria and Finland are already performing well in research and benefit from comprehensive higher education systems that promote direct transition from graduation into research careers. By contrast, most Cypriot students have to study abroad because the existing educational facilities are too small to cater for all the students who wish to enrol in tertiary education.

As was the case in the government sector, Latvia had the highest share of older researchers in the higher education sector, where 38 % were over 55. In Italy too 36 % of researchers in higher education were over 55 years old.

Young researchers in Europe

"Young researchers, doctoral candidates, play a key role in establishment of a knowledge society in Europe. In order to achieve the ambitious Lisbon objectives, Europe needs to increase the number of researchers. Doctoral training as research training thus is a cornerstone for achieving these goals.

Moreover, young researchers not only pursue a career in research, teaching or science communication but also increasingly aim for positions in innovation, development, consultancy and progressive industry. In this context, there is a need for fostering and being aware of complementary skills, acquired mostly from research practice itself, in a team-oriented approach.

Many doctoral candidates in Europe are not properly integrated in the scientific community. In particular scholarship-holders and persons who have to finance their research project from their own funds or work on a part-time basis are often not treated as valued members of the research institution.

It has to be broadly recognised that doctoral candidates contribute a considerable amount to the scientific output of their research institution. Universities have to discern this potential and aim to raise the awareness of doctoral candidates as professionals, early-stage researchers with commensurate rights.

Throughout Europe, many doctoral candidates work on their dissertation in relative isolation or in a closed research group. Both doctoral candidates themselves and, consequently, their research institution would benefit from increased scientific communication and exchanges between young researchers. In this way, the research institution should seek to overcome obsolete traditional apprenticeship-like relations."

Source: Based on http://doktorat.at/others/Young_Researchers_in_Europe.html

3.3.3 Researchers in head count by citizenship

Table 3.10: Researchers (HC) in the government and higher education sectors by citizenship, total number and as percentages, available countries — 2006

	Government sector				Higher education sector			
	Total number in head count	% of total			Total number in head count	% of total		
		National	European Union	Other citizenship		National	European Union	Other citizenship
BG	6 493	99.8	:	0.1	3 909	98.8	0.4	0.8
CZ	8 981	94.9	3.3	1.8	17 171	96.3	2.8	0.9
DK	3 104	92.2	: i	7.8 i	15 682	88.8	: i	11.2 i
EE	736	98.9	0.0	1.1	3 946	97.6	1.4	1.0
CY	234	96.2	3.8	0.0	830	77.1	20.6	2.3
LV	773	100.0	0.0	0.0	4 368	100.0	0.0	0.0
LT	1 759	99.6	0.2	0.2	9 236	99.4	0.4	0.2
LU	482	20.1	75.7	4.1	259	37.1	59.5	3.5
HU	6 217	98.6	0.5	1.0	18 928	98.3	1.0	0.7
MT	47	95.7	2.1	2.1	714	100.0	0.0	0.0
PL	14 094	99.5	0.0	0.5	72 261	98.9	0.0	1.1
PT	5 602	92.7	1.5	5.8	21 384	93.3	2.9	3.7
RO	5 864	99.9	0.0	0.1	16 082	99.9	0.1	0.0
SI	1 973	98.5	1.0	0.6	3 609	99.1	0.6	0.2
SK	2 939 i	99.4	:	:	13 379	98.8	:	0.2
HR	2 925	76.0	0.1	:	6 584	87.9	0.0	12.1
NO	4 330 i	89.8	6.8	2.7	16 216	87.8	6.7	4.3
CH	980 i	91.3 i	: i	8.7 i	29 640 e	56.3	: i	43.7 i

Note:
Exceptions to the reference year: 2005: DK, LV, PL and PT; 2003: NO.

Flag i:
DK and CH: includes all foreign citizenships under 'Other'.
SK: defence excluded (all or most).
CH (GOV): federal or central government only.
NO: university graduates instead of researchers.

Source: Eurostat (rd_p_perscitz)

The European Union needs more researchers and is endeavouring to meet the targets set by the Barcelona European Council in March 2002. To this end, better working conditions can encourage European researchers to remain in Europe or to return from abroad. The aim is to turn the current perceived 'brain drain' in research into a 'brain gain'. Another way of achieving the Barcelona targets is to make it easier to integrate researchers from outside the EU.

No precise data are available on EU researchers working abroad. Currently 15 EU Member States along with Croatia, Norway and Switzerland provide data on the citizenship of researchers in their government and higher education sectors. In most countries for which data are available, fewer than 5 % of researchers are not citizens of their country of employment. Luxembourg is an exception in this respect, as more than three quarters of government researchers in this country are from other EU Member States.

In Denmark, non-EU researchers made up more than 7 % of all researchers in the government sector.

In Luxembourg, over a third of researchers employed in higher education were Luxembourg citizens; the remaining two thirds were mostly from other EU Member States.

In Switzerland, foreign citizens accounted for 43.7 % of researchers working in the higher education sector. This can be partly attributed to the country's multilingual background and geopolitical situation. Denmark also reported a substantial share of foreign researchers in higher education (11.2 %).

In Cyprus, 20.6 % of researchers in the higher education sector were from another EU Member State and in Croatia 12.1 % of foreign researchers in this sector were from countries outside the EU.

3.3.4 Researchers in full-time equivalents

Table 3.11: Researchers in FTE, by sector of performance, EU-27 and selected countries — 2005 to 2007

	All sectors			Business enterprise sector			Government sector			Higher education sector		
	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
EU-27	1 286 552 s	1 331 213 s	1 355 680 s	624 657 s	653 980 s	661 879 s	179 875 s	182 695 s	186 748 s	466 598 s	477 837 s	489 345 s
BE	33 146	34 921 p	35 937 p	16 769	17 951 p	18 427 p	2 274	2 363 p	2 537 p	13 853	14 417 p	14 771 p
BG	10 053	10 336	11 203	1 157	1 304	1 318	6 076	6 148	6 178	2 607	2 756	3 605
CZ	24 169 b	26 267	27 878	10 353 b	11 290	12 497	6 113 b	6 564	6 648	7 575 b	8 352	8 664
DK	28 179	28 846	29 572 e	17 624	17 718	18 149 e	2 105	2 173	2 231 e	8 242	8 763	8 995 e
DE	272 148	279 452	284 305 e	166 874	171 063 e	172 744 e	39 911	41 486	43 561	65 363	66 903 b	68 000 e
EE	3 331	3 513	3 690	883	876	961	474	513	545	1 905	2 042	2 084
IE	11 587	12 169 p	:	6 768	7 000 p	:	419	497	497 p	4 400	4 672	:
EL	19 593	19 907 e	20 817 e	6 033	5 397 e	6 090 e	2 076	2 259 e	2 201 e	11 356	12 110 e	12 382 e
ES	109 720	115 798	122 624	35 034	39 936	42 101	20 446	20 063	21 412	54 028	55 443	58 813
FR	204 484 i	211 129 i	211 129 p	106 837	114 059	114 059 p	25 889 i	25 641 i	25 641 p	66 290	67 935	67 935 p
IT	82 489	88 430	:	27 939	30 006	36 733 p	14 454	16 590	17 836 p	37 073 b	37 636	:
CY	682	748	795 p	130	161	180 p	107	111	110 p	414	435	460 p
LV	3 282	4 024	4 223	468	777	463	589	598	744	2 224	2 648	3 016
LT	7 637	8 036	8 489	716	877	1 305	1 805	1 707	1 675	5 116	5 452	5 509
LU	2 227	2 054	2 174 p	1 696	1 460	1 522 p	374	435	493 p	157	159	159 i
HU	15 878	17 547	17 391	5 008	6 248	6 986	4 959	5 226	4 572	5 911	6 073	5 833
MT	479	521	515 p	236	256	262 p	18	27	17 p	225	238	236 p
NL	40 589 p	47 314 p	44 116 p	22 898	29 252	26 106 p	7 030 i	7 131 i	6 850 ip	10 661 ep	10 931 ep	11 160 ep
AT	28 148 e	29 199	31 352 e	17 835 e	18 471	19 833 e	1 245 e	1 349	1 448 e	8 944 e	9 261	9 944 e
PL	62 162	59 573	61 395	9 412	9 344	9 848	12 175	12 438	12 813	40 449	37 653	38 562
PT	21 126	24 556 e	27 986 p	4 014	6 326 e	8 639 p	3 338	3 223 e	3 107 p	10 956	12 026 e	13 096 p
RO	22 958	20 506	18 808	10 319	7 708	7 754	7 082	5 585	5 818	5 386	7 137	5 104
SI	5 253	5 857	6 250	1 936	2 262	2 571	1 591	1 804	1 998	1 695	1 763	1 657
SK	10 921	11 776	12 354	1 947	1 901	1 599	2 503 i	2 494 i	2 890	6 458	7 370	7 854
FI	39 582	40 411	39 000	21 967	22 721	22 005	4 374	4 470	4 482	12 879	12 849	12 153
SE	55 090 b	55 729	47 762 bip	36 697 bi	37 700 i	30 928 b	3 018 bi	3 041 i	1 941 bi	15 125 bi	14 740	14 840
UK	174 557 e	176 213 e	175 476 e	93 717	93 844	91 548 p	9 311	8 945	8 504 p	67 719 e	69 499 e	71 500 e
HR	5 727	5 778	6 129	707	736	881	1 899	1 912	1 863	3 118	3 128	3 385
TR	39 139	42 663	49 668	9 456	11 242	15 293	4 249	4 709	4 832	25 434 i	26 713 i	29 543
IS	2 155	2 400	2 208	1 012	1 144	1 069	501	528	459	585	663	621
NO	21 653	23 054	24 769	10 692 i	11 654 i	12 417 i	3 449 i	3 530 i	3 878 bi	7 512	7 870	8 474 b
CH	:	:	:	:	:	:	:	435 i	:	:	12 710 e	:
CN	1 118 698 i	1 223 756 i	1 423 381 i	696 413 i	777 029 i	944 440 i	200 377 i	210 149 i	230 662 i	221 908 i	236 578 i	248 279 i
KR	179 812 i	199 990 i	:	137 706 i	155 506 i	:	12 791 i	14 054 i	:	27 416 i	28 386 i	:
RU	464 577	464 357	469 076	237 959	236 792	237 408	154 827	153 629	153 059	70 494	72 310	76 298
JP	704 949	709 691	:	481 496	483 339	:	34 035	33 593	:	180 494	184 319	:
US	1 387 882 e	:	:	1 097 700	1 135 500	:	:	:	:	:	:	:

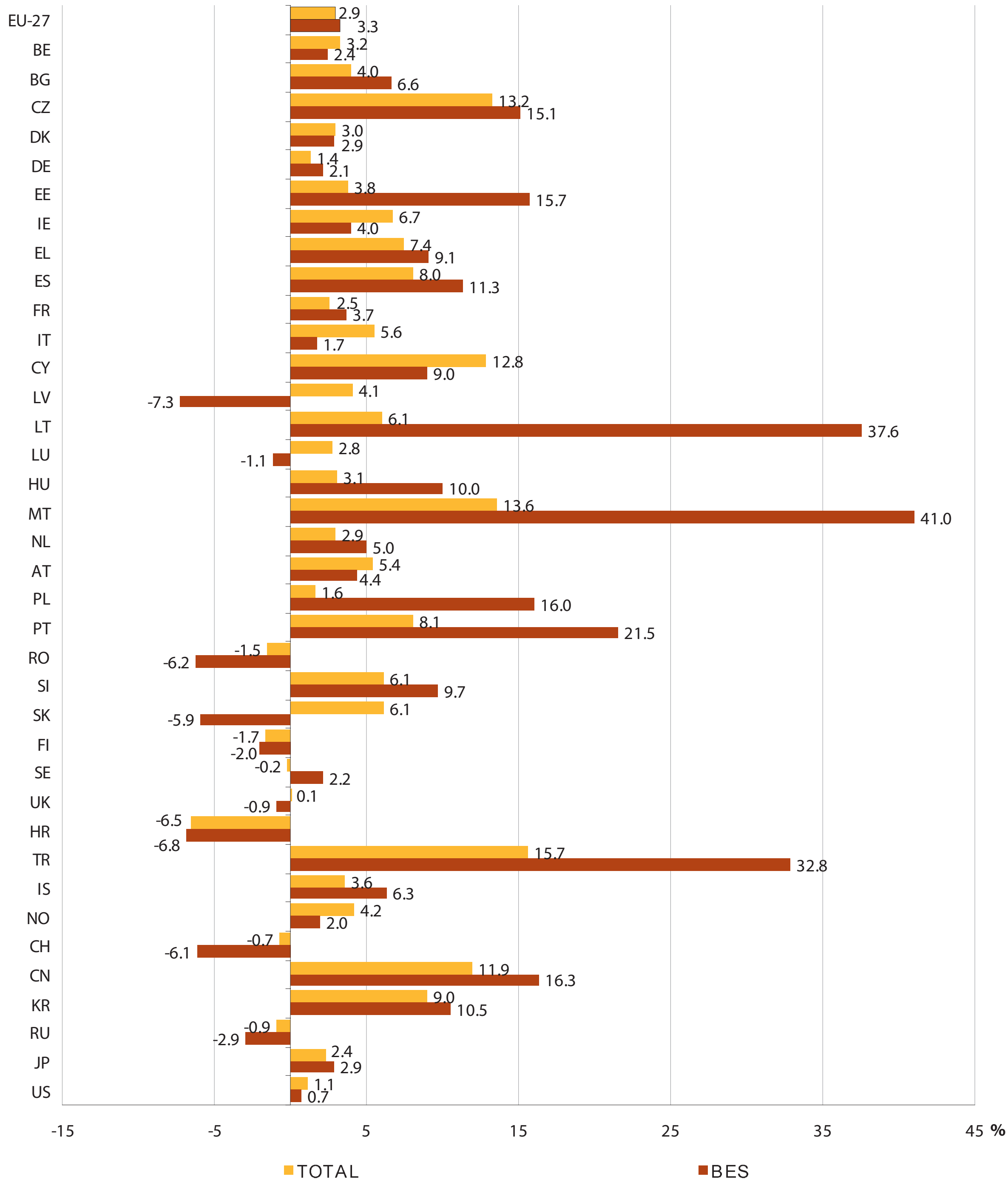
Flag i:
LU: national estimate.
NL: includes other classes.
SK and FR: defence excluded (all or most).
SE (2007): underestimated or based on underestimated data.
CH: federal or central government only.
SE (2005, 2006), NO and TR: university graduates instead of researchers.
CN: data do not comply with Frascati Manual recommendations.
KR: excludes R&D in social sciences and humanities.

Source: Eurostat (rd_p_persocc), OECD-MSTI for CN, KR, JP and US.

In 2007, the EU-27 had a total of 1.3 million researchers in terms of full-time equivalents. This number has increased by 69 128 since 2005. An upward trend was also generally observed at country level, with the exception of Luxembourg, Poland, Romania, Finland and Sweden, where the number of researchers in FTE decreased over the same period. The majority of researchers in the EU-27 were employed in the business enterprise sector, followed by higher education. The government sector accounted for 14 % of researchers at EU level.

At country level, 70 % of researchers in Luxembourg were employed in the business enterprise sector. This sector's share was also very high (more than 60 %) in Denmark, Germany, Austria, Sweden and China.

Figure 3.12: Average annual growth rate (AAGR) for researchers in FTE, all sectors and business enterprise sector, EU-27 and selected countries — 2002-2007



Note:
Exceptions to the reference period: 2002-2006: IE, IT, KR and JP;
2002-2005: US;
2000-2004: CH;
2003-2007: EL, LU, SE, IS and NO;
2004-2007: FI.

EU-27: Eurostat estimate.
BE, IE, FR, CY, LU, MT, NL, PT and SE: provisional data.
DK, DE, EL, AT, UK and US: national estimates.
NO (BES): university graduates instead of researchers.
SE: underestimated or based on underestimated data.
CN: data do not comply with Frascati Manual recommendations.
KR: excludes R&D in social sciences and humanities.

Source: Eurostat (rd_p_persocc), OECD-MSTI for CN, KR, JP and US.

In the EU-27, the number of researchers (in FTE) in all sectors and in the business enterprise sector increased by 2.9 % and 3.3 % per year respectively between 2002 and 2007.

In the rest of the world, between 2002 and 2007 the number of researchers in FTE also increased in China, Japan, South Korea and the United States. Average annual growth rates in China (11.9 %) and South Korea (9.0 %) were higher than the EU-27 average. By contrast, growth rates in Japan (2.4 %) and the United States (1.1 %) fell short of the EU average. Over the same period, the number of researchers in Russia fell by 0.9 % per year.

In all sectors, the highest increases in AAGR were observed in Malta (13.6 %), the Czech Republic (13.2 %), Cyprus (12.8 %) and Turkey (15.7 %). Five EU Member States recorded growth rates lower than the EU27 average. Romania, Finland and Sweden posted an overall decrease, as did Croatia and Switzerland.

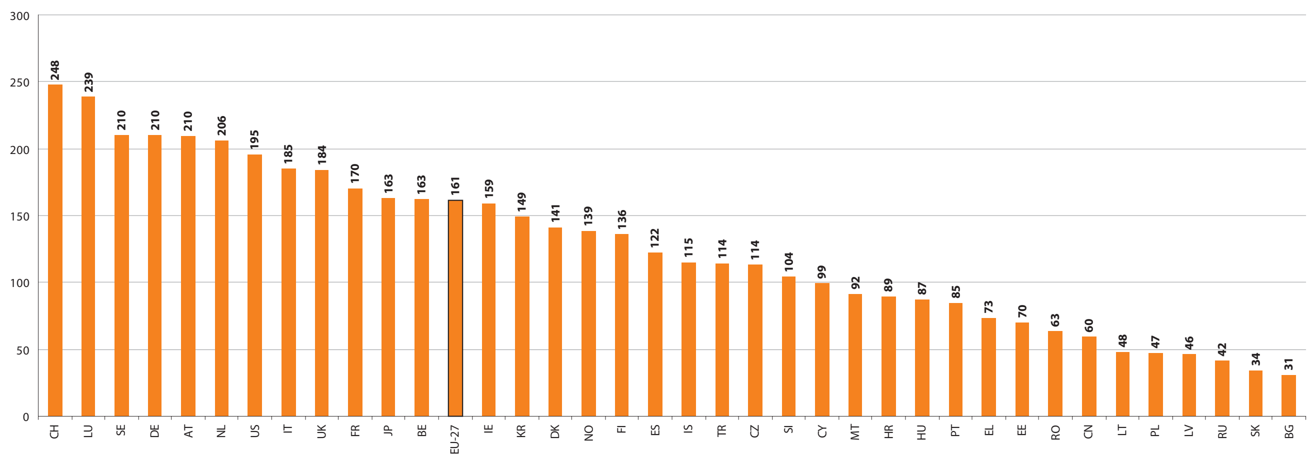
The number of researchers (in FTE) in the business enterprise sector in the EU27 grew by an average of 3.3 % a year between 2002 and 2007. The highest growth rates were recorded by Malta (41.0 %), Lithuania (37.6 %) and Portugal (21.5 %). In Turkey the number of researchers in the business enterprise sector grew by 32.8 % a year.

Five EU Member States achieved positive growth rates for researchers in the BES but lower than the EU-27 average. The largest falls in AAGR were recorded in Latvia (down by 7.3 %), Romania (6.2 %) and Slovakia (5.9 %). The number of researchers in the BES also decreased in Luxembourg, Finland and the United Kingdom.

In comparison with the rest of the world, growth in the number of researchers employed in the BES was stronger in the EU-27 than in Japan (2.9 %) and the United States (0.7 %), while average annual growth rates remained very strong in China (16.3 %) and South Korea (10.5 %).

3.3.5 R&D expenditure per researcher

Figure 3.13: R&D expenditure in thousand PPS per resarcher (FTE), EU-27 and selected countries — 2007



Note:
Exceptions to the reference year: 2006: IE, IT, KR and JP; 2005: US; 2004: CH.

EU-27: Eurostat estimate.
.BE, IE, FR, CY, LU, MT, NL, PT and SE: provisional data.
DK, DE, EL, AT, UK and US: national estimates.
SE: underestimated or based on underestimated data.
KR: excludes R&D in social sciences and humanities.
CN: data do not comply with Frascati Manual recommendations.
US: excludes most or all capital expenditure.

Source: Eurostat (rd_e_gerdtot and rd_p_persocc), OECD-MSTI for CN, KR, JP and US

In 2007, the EU-27 spent 161 000 purchasing power standards (PPS) on R&D per researcher full-time equivalent (FTE). Belgium, France, the United Kingdom, Italy, the Netherlands, Austria, Germany, Sweden and Luxembourg were above the EU-27 average, as were Switzerland, the United States and Japan. In the EU, Luxembourg had the highest R&D expenditure per researcher, with PPS 239 000.

Ireland, South Korea, Denmark, Norway, Finland, Spain, Iceland, Turkey, the Czech Republic and Slovenia each spent more than PPS 100 000 for each researcher.

At the other end of the scale, Slovakia and Bulgaria fell short of PPS 40 000 per researcher.

By international standards, the EU-27 and Japan spent similar amounts on R&D per researcher, but more than PPS 20 000 less than the United States. However, Switzerland spent the largest amount per researcher, with PPS 248 000.

3.3.6 Researchers in full-time equivalents by economic activity

In 2007, 661 879 researchers, measured in FTE, were employed in the business enterprise sector (BES) in the EU-27, as shown in Table 3.14. Germany recorded the highest number of BES researchers in Europe (172 744), followed by France (114 059). The proportion of business enterprise researcher years worked in the manufacturing sector stood at 86.6 % in Germany, 79.9 % in France, 75.6 % in Slovenia, 75.4 % in Malta, 75.2 % in Finland and 74.1 % in Switzerland.

In 13 other EU Member States and Turkey more than 50 % of researchers in the BES were employed in manufacturing.

Nevertheless, seven EU Member States together with Iceland and Norway recorded a larger proportion of BES researchers working in services than in manufacturing. The highest proportion of BES researchers working in the services sector was recorded in Estonia (63.5 %), followed by Slovakia (61.3 %).

Table 3.14: Business enterprise researchers in FTE, by economic activity (NACE Rev 1.1), EU-27 and selected countries — 2007

	Total	Manufacturing	Services	Other business activities
EU-27	661 879 s	:	:	:
BE	17 951 p	13 050 p	3 600 p	489 p
BG	1 304	673	629	2
CZ	12 497	6 531	5 839	127
DK	17 718	9 818	7 764	136
DE	172 744 e	149 577 e	22 367 e	800 e
EE	961	306	610	45
IE	6 768	3 653	3 097	18
EL	6 033	2 837	3 050	145
ES	39 936	17 477	20 964	1 494
FR	114 059	91 119	18 674	4 267
IT	30 006	18 508	10 998	500
CY	161	61	94	7
LV	463	190	273	0
LT	1 305	635	657	13
LU	1 522 p	775 p	747 p	0 p
HU	6 986	4 299	2 431	256
MT	256	193	63	1
NL	29 252	16 783	11 032	1 437
AT	18 471	12 480	5 853	138
PL	9 848	4 940	4 826	82
PT	4 014	2 042	1 887	85
RO	7 754	3 879	1 834	2 041
SI	2 262	1 709	526	27
SK	1 599	566	980	53
FI	22 005	16 551	5 210	244
SE	30 928 b	21 119	9 504	305
UK	93 844	: c	: c	1 370
HR	881	385	366	130
TR	15 293	8 405	6 702	185
IS	1 012	348	635	29
NO	12 417 i	4 396	7 185	835
CH	12 640	9 365	3 275	0
CN	944 440 i	:	:	:
JP	483 339	:	:	:
KR	155 506 i	:	:	:
RU	237 408	:	:	:
US	1 135 500	:	:	:

Note:
Exceptions to the reference year: 2006: BE, BG, DK, ES, FR, IT, CY, MT, NL, AT, SI, UK, US, JP and KR; 2005: IE, EL, PT and IS; 2004: CH.
BE: breakdown does not equal to the total.

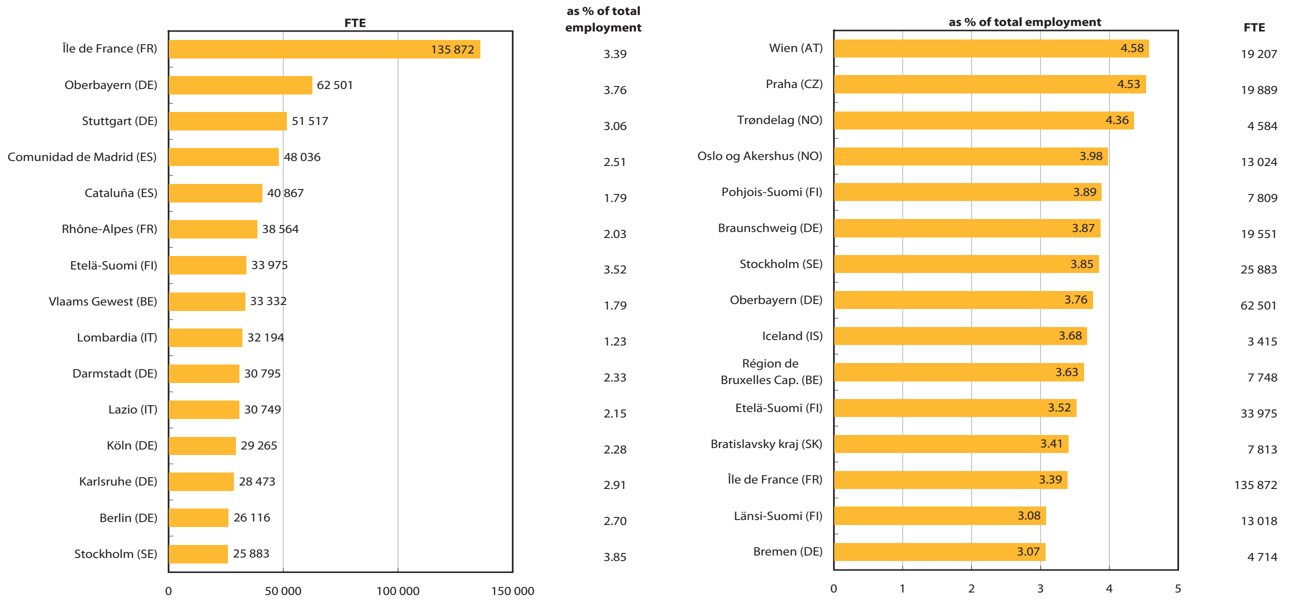
Flag i:
NO: university graduates instead of researchers.
CN: data do not comply with *Frascati Manual* recommendations.
KR: excludes R&D in social sciences and humanities.

Source: Eurostat (rd_p_bempocc), OECD-MSTI for CN, KR, JP and US.

3.4 R&D personnel and researchers at regional level

3.4.1 Total R&D personnel

Figure 3.15: Top 15 regions in terms of R&D personnel in FTE and as a percentage of total employment (HC), all sectors — 2006



Note:
Exceptions to the reference year: BE, DE, IT, SE and NO: 2005; FR: 2001 (as a % of total employment); FR: 2004 (in FTE).
BE: by NUTS 1 regions.
SE: in some cases R&D personnel are allocated to the head office.

Source: Eurostat (rd_p_persreg)

In 2006, the leading EU region for R&D personnel in terms of full-time equivalents (see Figure 3.15) was Île-de-France (FR), with 135 872 persons employed.

Oberbayern (DE) and Stuttgart (DE) ranked second and third, with 62 501 and 51 517 FTE respectively, followed by Comunidad de Madrid (ES), with 48 036.

With six regions in the top 15, Germany was the leading country in terms of R&D personnel in FTE. Spain, Italy and France each had two regions in the top 15, while Belgium, Finland and Sweden had one each.

A number of discrepancies emerge when comparing the total number of persons employed in R&D in FTE with R&D personnel as a share of total employment, which is based on head counts. Four regions were amongst the leaders in both rankings, i.e. both in relative size and in intensity: Île-de-France (FR), Oberbayern (DE), Etelä-Suomi (FI) and Stockholm (SE). The leading French region in terms of R&D personnel in FTE (Île-de-France) came thirteenth as a share of total employment (with 3.39 %).

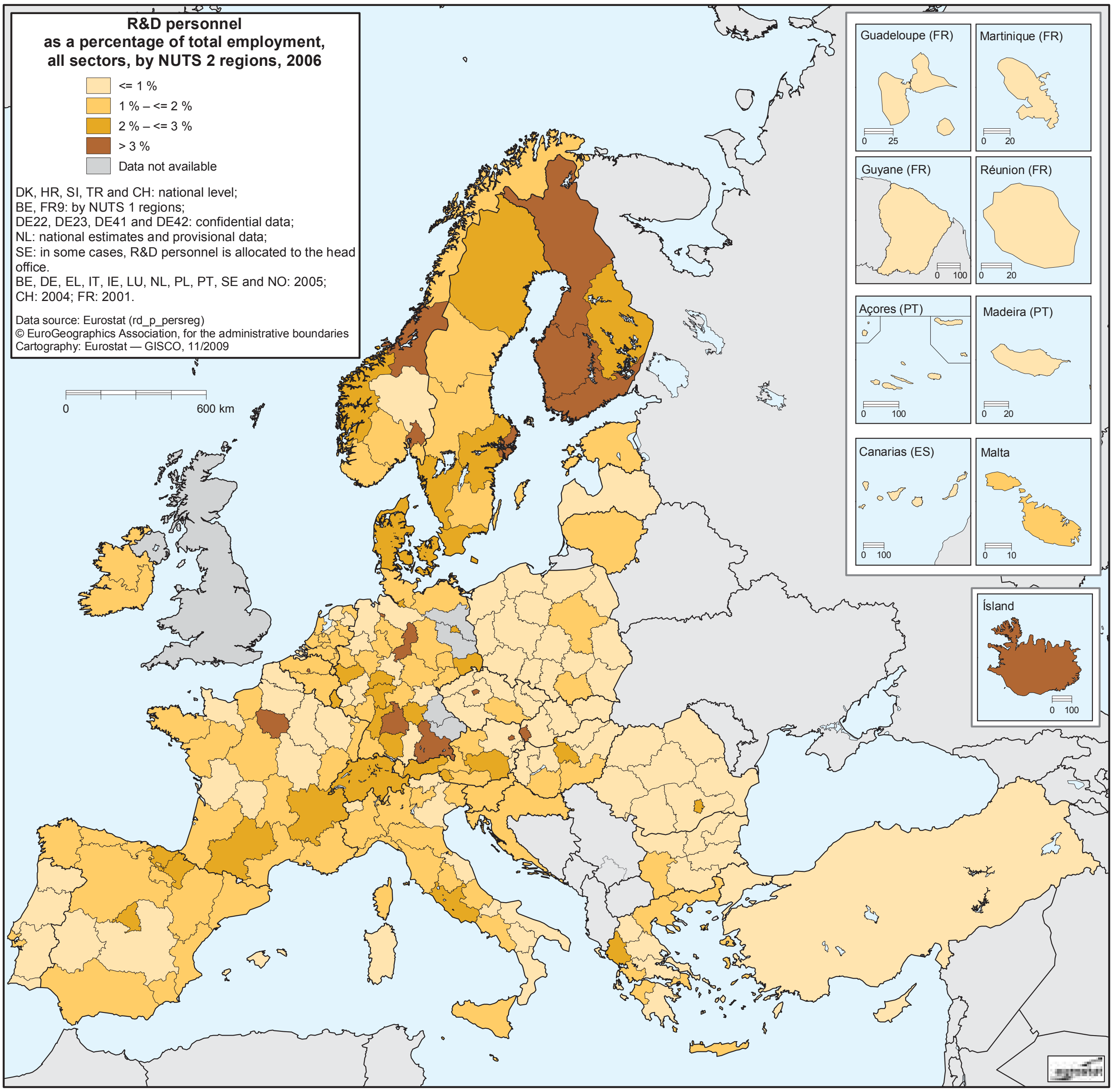
Wien (AT) was the leading region in terms of share of R&D personnel in total employment, with 4.58 %. In absolute terms, this was equal to 19 207 workers in R&D in FTE.

It was followed by the regions of Praha (CZ) (4.53 %) and Trøndelag (NO) (4.36 %).

Again, Germany and Finland were the countries with the most representatives in the top 15 (with three regions each), followed by Norway (with two). Belgium, Slovakia and Sweden each had only one region in the top 15 and Iceland, which is classified as a region at NUTS 2 level, ranked ninth.

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

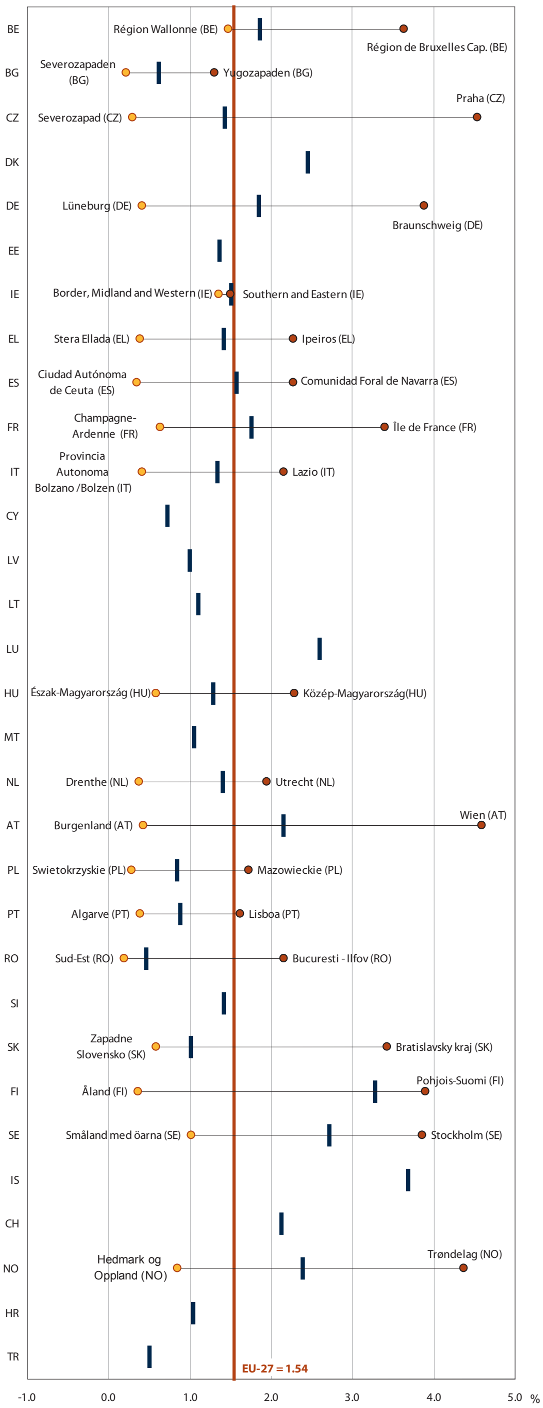
Map 3.16: R&D personnel (HC) as a percentage of total employment, all sectors, NUTS 2 — 2006



Map 3.16 shows R&D personnel in head counts as a percentage of total employment in 2006 by NUTS 2 region. The greatest concentrations of R&D personnel (more than 3 %) were found in 16 regions in Austria, Belgium, the Czech Republic, Finland, Iceland, Norway, Sweden and Slovakia.

Shares of between 2 % and 3 % were recorded in 29 European regions. In the vast majority of European regions, the concentration of R&D personnel fluctuated between 1 % and 2 %.

Figure 3.17: Regional disparities (NUTS 2) in R&D personnel as a percentage of total employment, all sectors, EU-27 and selected countries — 2006



Note:

Exceptions to the reference year: BE, DE, EL, IT, IE, LU, NL, PL, PT, SE and NO: 2005 ; CH: 2004; FR: 2001.

BE: by NUTS 1 regions.
NL: national estimate and provisional data.
SE: in some cases R&D personnel are allocated to the head office.
UK: data not available.

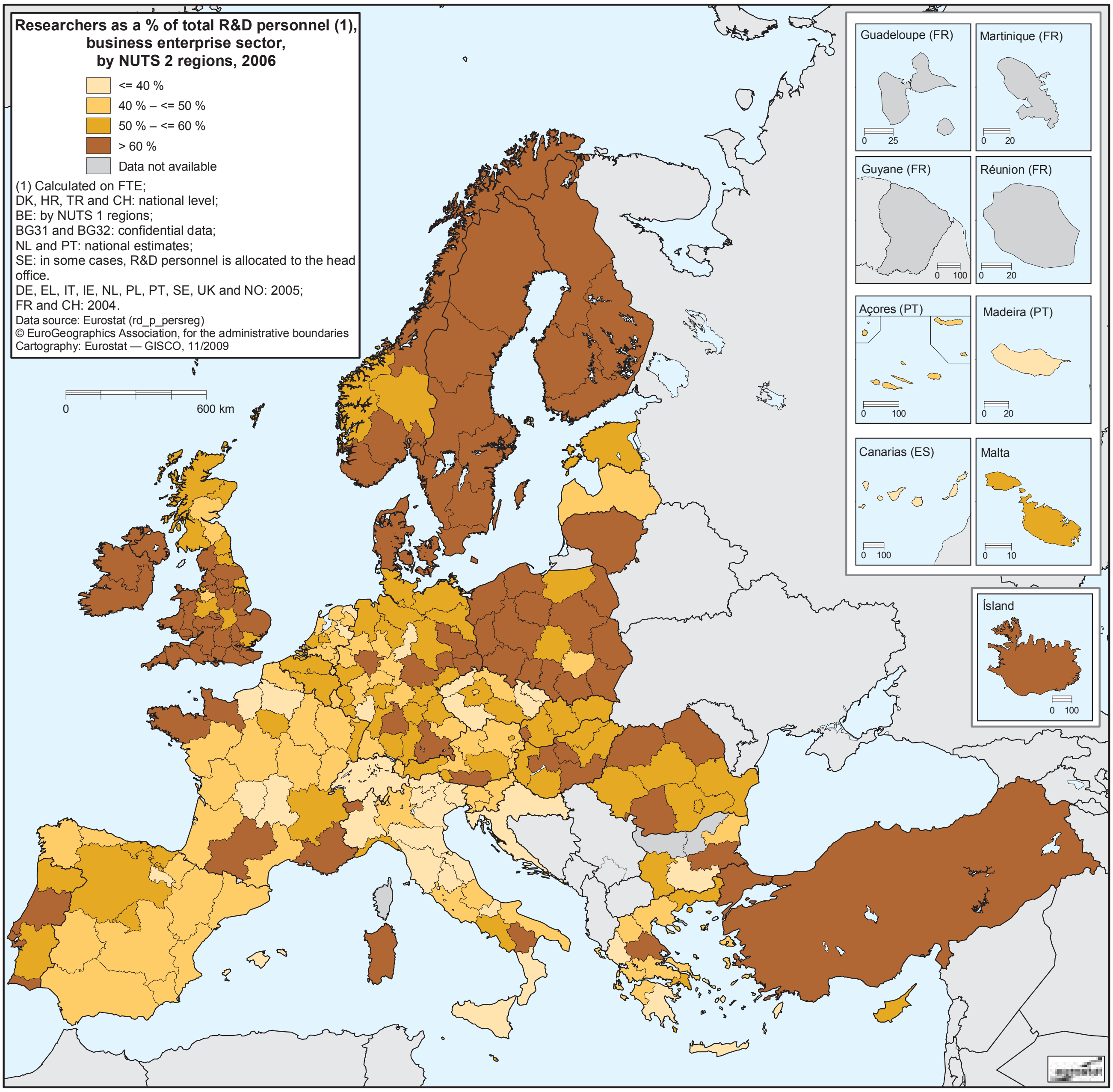
Source: Eurostat (rd_p_persreg)

Figure 3.17 shows the regional disparities in R&D personnel as a share of total employment.

More than 3.29 percentage points separate the top region in Austria (Wien) from the top region in Bulgaria (Yugozapaden). R&D personnel accounted for more than 3 % of total employment in the top regions in Belgium, the Czech Republic, Germany, France, Austria, Slovakia, Finland, Sweden and Norway. The sharpest contrasts between regions in a given country were found in the Czech Republic and Austria, while the smallest discrepancies were observed in Ireland (0.15 percentage points) and Bulgaria (1.09).

3.4.2 Researchers

Map 3.18: Researchers as a percentage of total R&D personnel[(1)], business enterprise sector, by NUTS 2 region — 2006



Map 3.18 shows the share of researchers in total R&D personnel employed in the business enterprise sector (BES) in 2006. In 88 European regions, more than 60 % of R&D personnel in the BES were researchers. Ten EU Member States (Bulgaria, the Czech Republic, Germany, Greece, Spain, France, Italy, the Netherlands, Portugal and Finland) each had at least one region where this share stood below 40 %.

4

Human resources in science and technology

4.1 Introduction

Growth and employment were defined as central objectives by the relaunched Lisbon strategy of 2005. Education plays a key role in this context and requires particular attention from all policy makers.

Economic growth and the development of a knowledge-based economy can only be achieved by investing in human capital.

Statistics on human resources in science and technology (HRST) are a key indicator for measuring the knowledge-based economy and how it is evolving. They show the supply of, and demand for, people highly qualified in science and technology. This chapter aims to examine three aspects in detail: education inflows, HRST stocks and HRST mobility.

To facilitate the analysis of HRST, a number of sub-categories, listed in Figure 4.1, have been defined in line with the recommendations made 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), reflecting the level of formal education achievement;

- The International Standard Classification of Occupations (ISCO), reflecting the type of occupation.

Human resources in science and technology 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 — 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 or technicians — ISCO-88, COM codes 2 or 3.

Based on the *Canberra Manual* (section 71), seven broad fields of S&T study are used: natural sciences, engineering and technology, medical sciences, agricultural sciences, social sciences, humanities, and other fields. In other words, 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).

One HRST sub-population of particular interest is 'Scientists and engineers' (SE). The categories most 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 compiling data on stocks and mobility for HRST.

The education inflows described in Chapter 4.2 are a useful measure of the current and future supply of HRST, as individuals who have completed tertiary-level education are included in HRST stocks. Inflows can be 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).

The information on participation in higher education also includes data on foreign students. These data give an idea of the proportion of internationally mobile students in Europe. Lastly, the analysis will focus more closely on doctoral students and graduates, the most highly educated section of the population.

Meanwhile, the data on HRST stocks in Chapter 4.3 provide an indication of the number of HRST at a particular point in time. These can then be broken down to provide information on socioeconomic 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, the analysis of HRST mobility casts light on two different aspects: the job-to-job mobility of employed HRST (Chapter 4.4) and the international mobility of HRSTC in and outside the EU (Chapter 4.5). Job-to-job mobility illustrates the ability of HRST to move between different jobs and is based on the length of time spent with the same employer. The indicator shows the number of employed HRST who have changed jobs in the last 12 months. A high level of HRST job-to-job mobility is considered as a good stimulus for the economy of a country. The international mobility of HRSTC is based on whether or not the persons concerned were born in their country of residence.

(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; Proposed Standard Practice for Surveys on Research and Experimental Development — *Frascati Manual*, OECD, 2002, paragraph 302.

Figure 4.1: Categories of human resources in science and technology (HRST)

			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

Opening doors for young researchers: the Marie Curie Initial Training Networks (ITNs)

"Thousands of students all over Europe are graduating and struggling with an important decision: choosing the first step in their career. With the financial and economic crisis the picture looks grim and the job market is as competitive as it has ever been. However, political leaders in industrialised countries are taking steps to adapt their countries to new economic realities. Most realise that investing in research to create a knowledge-based economy will lead to recovery from the crisis by creating new jobs, services and technology beneficial for everyone.

Research — a smart choice

Personally fulfilling, socially committed and economically essential, research careers are, without a doubt, the jobs of the future. The Marie Curie Actions help recent graduates interested in an international career in research to take their first step.

Marie Curie Initial Training Networks (ITNs) offer researchers in the first five years of their careers the opportunity to join established research teams, improve their research skills and enhance their career prospects. The networks offer research positions in all fields and, in addition to the research work itself, provide specialised training modules in science and transferable skills such as management and financing of research projects and programmes, intellectual property rights, means of exploiting research results, entrepreneurship, ethical aspects, communication and societal outreach.

By joining a Training Network researchers will be employed in one group but will benefit from the resources, capacities and knowledge of the whole network. They will be able to start their research in a dynamic environment and will be given opportunities to collaborate, and receive excellent career guidance. In addition, Marie Curie Actions consider researchers as professionals and therefore offer employment contracts with social security coverage.

The benefits of European support

Marie Curie fellows enjoy excellent working conditions; they are entitled to receive a salary with social benefits such as pension rights and health insurance. Social benefits are also provided for in case of pregnancy or parental leave. In addition to the salary, fellows will benefit from mobility and travel allowances and will also receive a career exploratory allowance to help with the next career step after their ITN fellowship.

ITNs mainly recruit researchers from European Union Member States and associated countries, but the scheme is also open to researchers from third countries. Researchers supported by an ITN are normally required to undertake transnational mobility (i.e. move from one country to another) when taking up an appointment."

Source: http://ec.europa.eu/research/mariecurieactions/

4.2 Education inflows

The Lisbon strategy has made it clear that education and training are crucial in the development of a knowledge-based economy.

As science and technology have been recognised as key fields for European development, policy makers need to be able to assess the potential supply of human resources in science and technology (HRST). The tertiary education inflows described in this chapter provide a useful measure of the current and future supply of HRST in the labour market.

4.2.1 Participation in tertiary education

In 2007, when dividing the number of tertiary students of all ages by the population aged 20-29 in the EU, more than a quarter was in tertiary education. At national level, Malta recorded the lowest participation level in tertiary education (16.4 %), while Finland recorded the highest (46.7 %).

Female participation in tertiary education is high in the European Union, as in 2007 more than half of all students in the EU were women. Germany and Cyprus were the only EU Member States where women accounted for less than 50 % of all students (49.7 % in both countries). Looking further afield, female participation in tertiary education did not reach 50 % in Turkey, Liechtenstein, Switzerland and Japan.

Looking at the distribution of students in the two main S&T fields of study, the field of 'engineering, manufacturing and construction' had more students than 'science, mathematics and computing', representing 14.0 % and 10.5 % of the total student population respectively. Female participation was higher in 'science, mathematics and computing' (37.5 %) than in 'engineering, manufacturing and construction' (24.7 %).

European standards for internal quality assurance within higher education institutions

"1. *Policy and procedures for quality assurance*: Institutions should have a policy and associated procedures for the assurance of the quality and standards of their programmes and awards.

They should also commit themselves explicitly to the development of a culture which recognises the importance of quality, and quality assurance, in their work. To achieve this, institutions should develop and implement a strategy for the continuous enhancement of quality. The strategy, policy and procedures should have a formal status and be publicly available. They should also include a role for students and other stakeholders.

2. *Approval, monitoring and periodic review of programmes and awards*: Institutions should have formal mechanisms for the approval, periodic review and monitoring of their programmes and awards.

3. *Assessment of students*: Students should be assessed using published criteria, regulations and procedures which are applied consistently.

4. *Quality assurance of teaching staff*: Institutions should have ways of satisfying themselves that staff involved in the teaching of students are qualified and competent with regard to teaching. The methods and procedures for ensuring that this is the case should be available to those undertaking external reviews, and commented upon in reports.

5. *Learning resources and student support*: Institutions should ensure that the resources available for the support of student learning are adequate and appropriate for each programme offered.

6. *Information systems*: Institutions should ensure that they collect, analyse and use relevant information for the effective management of their programmes of study and other activities.

7. *Public information*: Institutions should regularly publish up-to-date, impartial and objective information, both quantitative and qualitative, about the programmes and awards they are offering."

Source: http://www.lu.se/upload/LUPDF/Bologna/LU_Bologna/sammanf_EQAStandards.pdf

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 — 2007

	Students participating in tertiary education								
	All fields			Science, mathematics and computing			Engineering, manufacturing and construction		
	Total	% of population aged 20-29	% women	Total	% of all tertiary students	% women	Total	% of all tertiary students	% women
EU-27	18 876 681 i	28.6 i	55.2 i	1 991 064 i	10.5 i	37.5 i	2 646 687 i	14.0 i	24.7 i
BE	393 687	29.8	54.9	25 677	6.5	29.9	37 215	9.5	20.1
BG	258 692	23.7	53.7	13 222	5.1	46.8	51 058	19.7	31.1
CZ	362 630	23.9	54.7	31 577	8.7	32.9	51 609	14.2	24.7
DK	232 194	37.3	57.6	20 174	8.7	35.4	23 452	10.1	33.3
DE	2 278 897	23.3	49.7	348 781	15.3	35.0	352 379	15.5	18.2
EE	68 767	34.0	61.1	6 829	9.9	37.6	9 018	13.1	26.1
IE	190 349	25.4	55.2	21 000	11.0	42.6	19 553	10.3	17.1
EL	602 858	39.8	50.4	82 247	13.6	37.2	102 224	17.0	25.9
ES	1 777 498	27.5	54.0	186 479	10.5	33.8	313 313	17.6	28.1
FR	2 179 505	26.8	55.3	269 885	12.4	35.9	279 493	12.8	24.1
IT	2 033 642	30.1	57.2	160 713	7.9	50.3	316 849	15.6	28.8
CY	22 227	16.9	49.7	2 642	11.9	35.2	1 512	6.8	18.6
LV	129 497	37.4	63.9	6 627	5.1	30.3	13 531	10.4	21.0
LT	199 855	40.1	60.0	11 744	5.9	32.0	36 383	18.2	24.1
LU	:	:	:	:	:	:	:	:	:
HU	431 572	30.2	58.3	29 676	6.9	28.2	49 476	11.5	18.6
MT	9 811	16.4	57.4	1 009	10.3	34.8	773	7.9	29.2
NL	582 613	29.7	51.6	37 964	6.5	16.2	47 211	8.1	15.2
AT	260 975	24.6	53.7	31 266	12.0	34.4	33 164	12.7	22.9
PL	2 146 926	33.6	57.4	203 200	9.5	36.3	269 906	12.6	27.1
PT	366 729	25.3	54.0	26 720	7.3	48.3	81 801	22.3	25.1
RO	928 175	27.4	56.1	57 823	6.2	56.8	159 184	17.2	30.4
SI	115 944	40.1	58.3	6 446	5.6	33.6	19 374	16.7	24.7
SK	217 952	24.1	58.9	19 500	8.9	36.6	34 139	15.7	29.2
FI	309 163	46.7	54.0	34 636	11.2	39.7	78 663	25.4	18.9
SE	413 710	37.6	59.9	38 879	9.4	43.2	66 565	16.1	28.1
UK	2 362 813	29.0	57.2	316 348	13.4	37.2	198 842	8.4	20.4
HR	139 996	22.9	54.1	10 849	7.7	41.8	22 019	15.7	26.5
MK	58 199	17.9	54.5	5 489	9.4	40.6	8 625	14.8	32.4
TR	2 453 664	:	42.6	184 422	7.5	39.2	321 834	13.1	19.4
IS	15 821	34.4	64.1	1 255	7.9	38.1	1 213	7.7	32.0
LI	673	15.3	31.8	0	:	:	154	22.9	39.0
NO	215 237	37.5	60.2	18 968	8.8	35.5	15 097	7.0	24.9
CH	213 112	23.0	47.6	22 476	10.5	29.3	28 205	13.2	14.5
JP	4 032 625	:	45.6	117 663	2.9	24.8	636 299	15.8	11.6
US	17 758 870	:	57.3	1 579 386	8.9	38.6	1 185 273	6.7	16.2

Note:
EU-27 excluding data for LU.
Students of all ages participating in tertiary education are divided by the population aged 20-29 years.

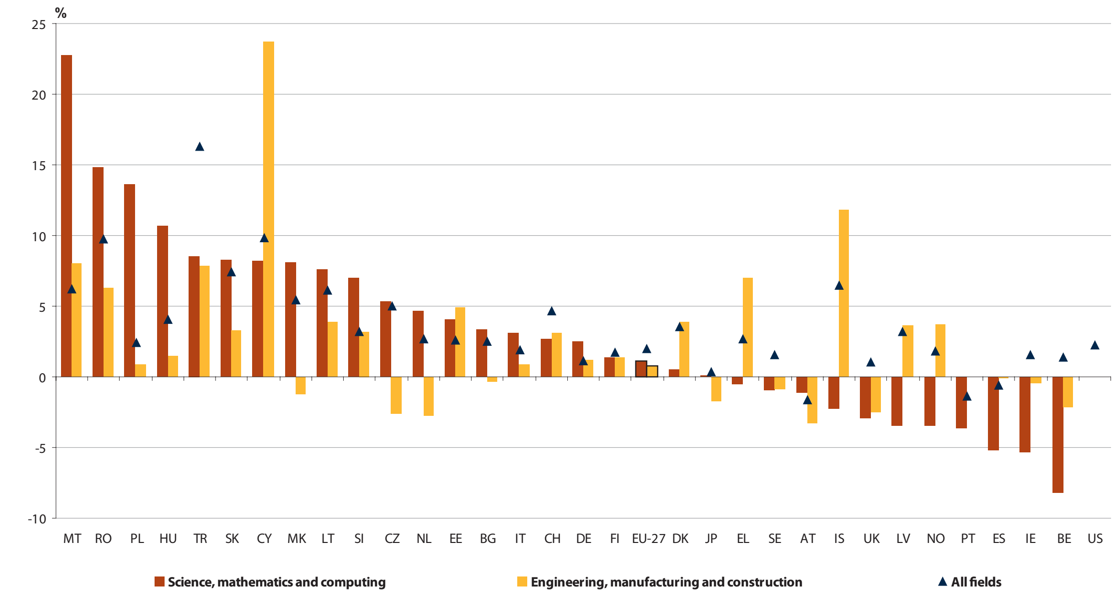
Source: Eurostat (educ_enrl5).

More than 10 % of the population aged 20-29 in Germany, Ireland, Greece, Spain, France, Cyprus, Malta, Finland, the United Kingdom and Switzerland chose 'science, mathematics and computing' as their field of study. In Bulgaria and Latvia the percentage was just above 5 % while the lowest share was found in Japan, with 2.9 %.

Female participation in 'science, mathematics and computing' was especially high in Romania (56.8 %) and Italy (50.3 %), while in the Netherlands only 16.2 % of the students were women.

'Engineering, manufacturing and construction' attracted more students than 'science, mathematics and computing' in most of the countries presented, except in Ireland, Cyprus, Malta, the United Kingdom, Iceland, Norway and the US. However, in all the countries, women were less represented than men in this field of study than in 'science, mathematics and computing'.

Figure 4.3: Average annual growth rate (AAGR) of the number of tertiary education students, total and in selected fields of study, EU-27 and selected countries — 2002-2007



Note:
EU-27 aggregate excluding FR and LU.
Exception to the reference period: 2002-2006: CH.

Source: Eurostat (educ_enrl5)

As shown in Figure 4.3, in the EU-27 the overall number of tertiary education students grew by an average of 2.0 % per year between 2002 and 2007. The number of students in 'engineering, manufacturing and construction' increased by an average of 0.8 % a year, compared with 1.1 % in 'science, mathematics and computing'.

Over the same period, Malta recorded the highest average increase in the number of science students in the EU-27 (22.8 %). Cyprus reported the largest increase in the number of engineering students (23.7 %), and Turkey recorded the highest increase in the number of students in all fields of study (16.3 %).

At the other end of the scale, the number of 'science, mathematics and computing' students fell in Greece, Sweden, Austria, Iceland, the United Kingdom, Latvia, Norway, Portugal, Spain, Ireland and Belgium. In parallel, the number of 'engineering, manufacturing and construction' students decreased in the former Yugoslav Republic of Macedonia, the Czech Republic, the Netherlands, Bulgaria, Japan, Sweden, Austria, the United Kingdom, Ireland and Belgium. The most significant decrease was noted in Austria, at -3.3 %.

Bologna process: national qualifications

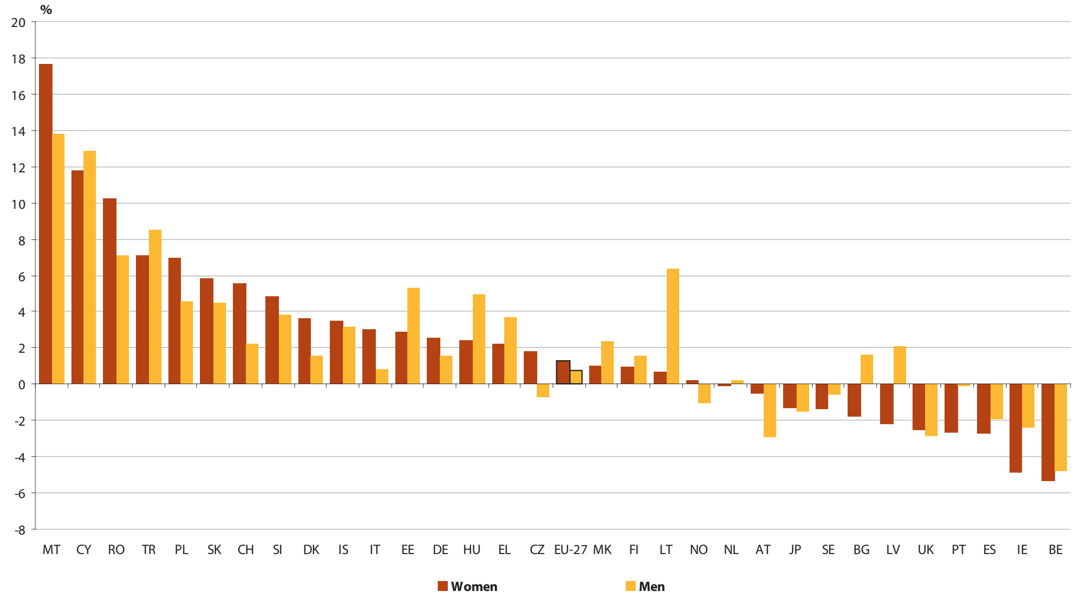
"All countries of the European Higher Education Area have committed to developing national qualifications frameworks compatible with the overarching framework of the European Higher Education Area by 2010. This commitment was undertaken in 2005, and the 2007 stocktaking report reasonably showed that this is an area where considerable work remains to be done.

National qualifications frameworks encompass all education qualifications — or all higher education qualifications, depending on the policy of the country concerned — in an education system. They show what learners may be expected to know, understand and be able to do on the basis of a given qualification (learning outcomes) as well as how qualifications within a system articulate, that is how learners may move between qualifications in an education system.

National qualifications frameworks are developed by the competent public authorities in the country concerned. While this is ultimately the competence and responsibility of the public authorities responsible for the country's higher education system, the participation of a broad range of stakeholders — including higher education institutions, students, staff and employers — is necessary for the framework to be successful. The development of national qualifications frameworks should therefore include broad consultations."

Source: http://www.ond.vlaanderen.be/

Figure 4.4: Average annual growth rate of tertiary education graduates in the fields of science and engineering by sex, EU-27 and selected countries — 2002-2007



Note:
EU-27 excluding and FR and LU.

Source: Eurostat (educ_enrl5)

In the EU-27, the number of female tertiary education graduates in 'science, mathematics and computing', and 'engineering, manufacturing and construction' together increased faster on average than that of their male counterparts between 2002 and 2007.

Over the same period, half of the countries under review recorded higher average annual growth rates among male tertiary education graduates than among their female counterparts.

The highest growth rate among female tertiary education graduates was recorded in Malta (17.6 %), followed by Cyprus (11.8 %). In contrast, the largest decreases were recorded in Ireland and Belgium, with -4.9 % and 5.3 % respectively.

The highest growth rates for male tertiary education graduates were recorded in Malta and Lithuania, with 13.8 % and 12.8 % respectively. The largest differences between female and male growth rates were noted in Lithuania, Latvia and Bulgaria.

EURYDICE NETWORK

"The Eurydice Network provides information on and analyses of European education systems and policies.

It consists of 35 national units based in all 31 countries participating in the EU's Lifelong Learning programme (EU Member States, EEA countries and Turkey) and is coordinated and managed by the EU Education, Audiovisual and Culture Executive Agency in Brussels, which drafts its publications and databases.

Eurydice is committed to providing those responsible for education systems and policies in Europe with European-level analyses and information which will assist them in their decision making.

The Eurydice network focuses primarily on the way education in Europe is structured and organised at all levels. It provides a vast source of information, including

- Detailed descriptions and overviews of national education systems (Eurybase)
- Comparative thematic studies devoted to specific topics of Community interest, such as early childhood education and care, school autonomy and higher education governance (Thematic studies)
- Indicators and statistics (Key Data Series)
- A series of reference material and tools related to education, such as the European glossary, school calendars and education thesaurus (Eurydice Tools)"

Source: http://www.euridyce.org

4.2.1.1 Student mobility

Reforms are currently under way in Europe to establish a European Higher Education Area by 2010. This will be done not only by introducing a system of convergent curricula and degrees, but also by means of various other reforms to extend student mobility. Promoting student mobility is generally viewed as a key objective in the development of higher education and is considered as a good way of acquiring specialised skills, taking a multicultural approach[(1)].

Figure 4.5 shows the share of tertiary education graduates who are not citizens of the reporting country in all fields of study and in the field of science and engineering (S&E). In 2007, the proportion of foreign students in comparison with the total student population in all fields of study varied considerably from one EU Member State to another. Cyprus, with a share of 26.9 %, recorded the highest proportion of foreign students among the student population, followed by the United Kingdom and Austria, with a share of 17.9 % and 16.7 % respectively. This proportion fell to 0.6 % in Poland and 0.9 % in Slovakia.

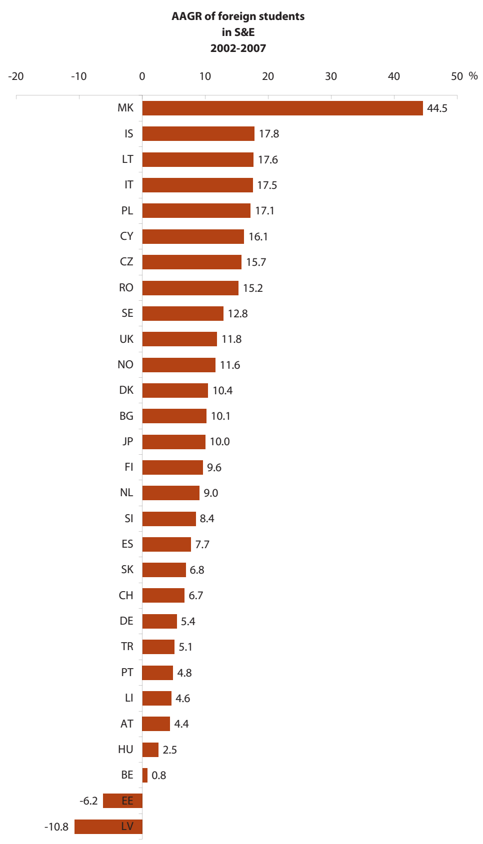
A closer look at the S&E fields in Denmark, Germany, France, Cyprus, Austria and Sweden shows that 10 % or more of all students studying S&E in 2007 were not citizens of the reporting country.

The average number of foreign S&E students grew in all the EU Member States between 2002 and 2007, except in Latvia and Estonia. Among the EU Member States, Lithuania, Italy and Poland recorded the highest average annual increase in the number of foreign S&E students (above 17 %), followed by Cyprus, the Czech Republic and Romania (above 15 %). The lowest growth was registered in Belgium (0.8 %) and Hungary (2.5 %), while Latvia and Estonia experienced a decrease in the number of foreign students (respectively -10.8 % and -6.2 %).

[(1)] See: www.bologna-bergen2005.no/Docs/00-Main_doc/050520_Bergen_Communique.pdf

Figure 4.5: Students, non-citizens of the reporting country in tertiary education, all fields and S&E, total and as a proportion of student population — 2007 and AAGR 2002-2007, EU-27 and selected countries

	Students non-citizens of reporting country			
	All fields		In S&E	
	Total	As % of the respective student population	Total	As % of the respective student population
BE	41 351	10.5	6 230	9.9
BG	9 351	3.6	2 150	3.3
CZ	24 483	6.8	5 295	6.4
DK	20 851	9.0	6 155	14.1
DE	258 513	11.3	90 638	12.9
EE	2 200	3.2	334	2.1
IE	10 201	5.6	:	:
EL	14 361	2.4	:	:
ES	59 814	3.4	7 120	1.4
FR	246 612	11.3	69 943	12.7
IT	57 271	2.8	12 049	2.5
CY	5 973	26.9	709	17.1
LV	1 433	1.1	78	0.4
LT	1 920	1.0	245	0.5
LU	:	:	:	:
HU	15 110	3.5	2 457	3.1
MT	607	6.2	33	1.9
NL	37 607	6.5	5 241	6.2
AT	43 572	16.7	10 395	16.1
PL	13 021	0.6	1 325	0.3
PT	17 950	4.9	4 596	4.2
RO	12 188	1.3	1 994	0.9
SI	1 511	1.3	379	1.5
SK	2 010	0.9	376	0.7
FI	10 066	3.3	4 132	3.6
SE	42 769	10.3	16 370	15.5
UK	418 353	17.9	418 371	21.8
IS	783	4.9	188	7.6
LI	594	88.3	146	94.8
NO	15 618	7.3	3 418	10.0
CH	41 058	19.3	12 164	24.0
HR	940	0.7	:	:
MK	884	1.5	189	1.3
TR	19 257	0.8	4 511	0.9
JP	125 877	3.1	19 818	2.6



Note:
Data not available for LU and for IE, EL and HR in the S&E fields.
Exceptions to the reference year: 2004: EL, 2003: IE, 2006: UK
Exceptions to the reference period: 2002-2006: UK; 2004-2007: ES, 2003-2006: LI, 2006-2007: EE
AAGR not published for MT due to the small size of the population, leading to extreme values for AAGR.

Source: Eurostat (educ_enrl6, educ_enrl1tl)

EURODOC

"EEURODOC is the European Council of doctoral candidates and young researchers. It takes the form of a federation of national associations of Ph.D. candidates and young researchers.

Eurodoc's objectives are:

- To represent doctoral candidates and junior researchers at the European level in matters of education, research, and professional development of their careers.
- To advance the quality of doctoral programmes and the standards of research activity in Europe.
- To promote the circulation of information on issues regarding young researchers; organise events, take part in debates and assist in the elaboration of policies about Higher Education and Research in Europe.
- To establish and promote cooperation between national associations representing doctoral candidates and junior researchers within Europe."

Source: http://www.eurodoc.net/index.html

4.2.1.2 Doctoral students

Doctoral students are at the second stage of higher education (ISCED level 6), which should lead to an advanced research qualification such as a doctorate in biology, geography or physics. These programmes focus on advanced study and original research and are not based exclusively on course work.

Table 4.6 shows the number of doctoral students by field of study. These indicators paint an interesting picture of the potential stock of researchers in each country. In the EU, with the exceptions of Germany and Luxembourg, for which no data were available, 9.6 out of every 1 000 persons aged 20-29 were following a doctoral programme in 2007.

Looking at individual Member States, the proportion of Finland (33.1 out of 1 000 persons aged 20-29) is by far the highest, followed by Sweden (18.9) and Austria (17.1). By contrast, in Malta only 1.2 out of 1 000 persons aged 20-29 followed a doctorate programme.

In absolute numbers there were 518 301 doctoral students in the EU, remembering that the values for Germany and Luxembourg are missing. Spain, France and the United Kingdom accounted for more than a third of them.

Considering the distribution by sex, gender balance was almost achieved in the EU-27, with women accounting for close to half of all doctoral students (47.9 %). Female doctoral students outnumbered their male counterparts in Latvia (61.0 %), Lithuania (57.8 %), Portugal (55.8 %), Estonia (54.9 %), Italy (52.2 %), Finland (52.1 %), Spain (51.8 %), Iceland (57.2 %) and the US (52.1 %).

Contrary to what was observed in the tertiary student population as a whole (see Table 4.2), doctoral students tended to choose 'science, mathematics and computing' studies more often than 'engineering, manufacturing and construction' studies. In the EU, Cyprus and Ireland recorded the highest proportion of doctoral students in 'science, mathematics and computing', with 37.9 % and 35.3 % respectively. By contrast, almost 30 % of doctoral students in Romania chose engineering, compared with only 8.0 % in Spain and France.

Among doctoral students, female participation was higher in 'science, mathematics and computing' (42.8 %) than in 'engineering, manufacturing and construction' (28.3 %). In the field of 'science, mathematics and computing', the percentage of female doctoral students was higher than the male percentage in Italy, Lithuania, Poland, Portugal and Croatia.

Table 4.6: Doctoral students (ISCED level 6), in all fields and in selected fields of study, in total and in relation to the population aged 20-29, in relation to all doctoral students and proportion of female doctoral students, EU-27 and selected countries — 2007

	Doctoral students (ISCED level 6)								
	All fields			Science, mathematics and computing			Engineering, manufacturing and construction		
	Total	per 1000 population aged 20-29	% of women	Total	% of all doctoral students	% of women	Total	% of all doctoral students	% of women
EU-27	518 301 i	9.6	47.9	109 980 i	21.2	42.8	81 654 i	15.8	28.3
BE	7 389	5.6	42.7	2 287	31.0	41.8	1 035	14.0	21.8
BG	4 816	4.4	49.6	836	17.4	49.6	1 175	24.4	35.6
CZ	23 654	15.6	39.1	4 676	19.8	41.8	6 244	26.4	22.2
DK	4 831	7.8	46.4	522	10.8	40.4	1 155	23.9	25.4
DE	:	:	:	:	:	:	:	:	:
EE	2 142	10.6	54.9	594	27.7	47.0	320	14.9	40.6
IE	5 590	7.5	47.0	1 972	35.3	42.1	674	12.1	20.2
EL	21 698	14.3	42.5	2 730	12.6	39.6	4 712	21.7	24.3
ES	72 741	11.2	51.8	9 698	13.3	48.9	5 807	8.0	30.9
FR	71 621	8.8	46.5	24 191	33.8	39.3	5 706	8.0	28.7
IT	40 119	5.9	52.2	9 527	23.7	51.8	7 509	18.7	34.8
CY	351	2.7	47.6	133	37.9	45.1	49	14.0	32.7
LV	1 797	5.2	61.0	222	12.4	48.6	284	15.8	35.6
LT	2 898	5.8	57.8	563	19.4	55.8	590	20.4	36.9
LU	:	:	:	:	:	:	:	:	:
HU	7 784	5.4	48.6	1 626	20.9	38.3	655	8.4	27.9
MT	72	1.2	34.7	15	20.8	46.7	9	12.5	0.0
NL	7 508	3.8	42.0	:	:	:	:	:	:
AT	18 151	17.1	45.8	3 113	17.2	35.2	2 529	13.9	24.2
PL	31 831	5.0	50.0	4 890	15.4	52.8	5 618	17.6	29.9
PT	18 678	12.9	55.8	3 237	17.3	54.4	2 622	14.0	36.7
RO	27 712	8.2	45.6	3 918	14.1	45.6	8 001	28.9	33.2
SI	1 250	4.3	47.8	267	21.4	46.1	348	27.8	29.0
SK	11 066	12.2	44.9	1 531	13.8	46.4	2 574	23.3	27.0
FI	21 899	33.1	52.1	3 112	14.2	46.0	5 599	25.6	27.9
SE	20 795	18.9	49.5	4 169	20.0	40.9	4 485	21.6	30.7
UK	99 416	12.2	45.2	26 151	26.3	37.8	13 954	14.0	22.7
HR	1 766	2.9	45.4	376	21.3	51.1	597	33.8	26.5
MK	119	0.4	49.6	9	7.6	33.3	23	19.3	34.8
TR	33 834		41.0	5 198	15.4	45.3	6 296	18.6	32.2
IS	201	4.4	57.2	54	26.9	48.1	10	5.0	30.0
LI	18	4.1	27.8	0	:	:	0	:	:
NO	5 650	9.8	46.7	1 845	32.7	36.9	524	9.3	26.7
CH	17 555	18.9	41.3	4 855	27.7	35.1	2 011	11.5	22.0
JP	75 504	:	30.1	10 677	14.1	22.4	13 971	18.5	12.1
US	396 231	:	52.1	80 847	20.4	40.9	38 832	9.8	23.5

Note:
EU-27 aggregate excluding DE and LU in all fields and NL in selected fields of study.
Doctoral students of all ages are divided by the population aged 20-29 years.

Source: Eurostat (educ_enrl5)

FFigure 4.7 presents the average annual growth rates of male and female doctoral students. Between 2002 and 2007, the number of female doctoral students grew faster than that of their male counterparts in all the countries under review except Estonia and Romania.

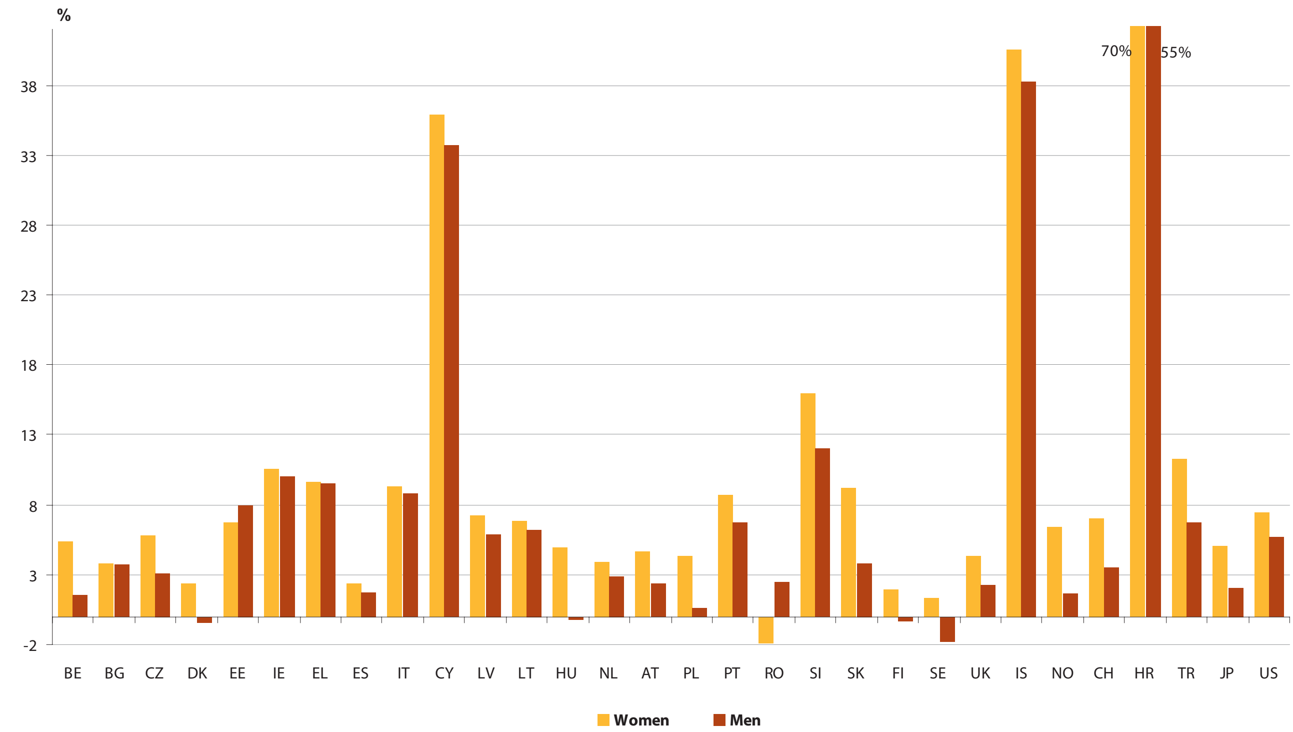
Spectacular average annual growth of both male and female doctoral students was registered in Croatia (respectively 70 % and 55 %), where the doctoral student population was multiplied by 6 in 5 years.

Iceland and Cyprus also recorded high average growth of more than 30 % per year. It should be noted than even if the figures for students in Iceland and in Cyprus quadrupled in 5 years, in absolute terms the doctoral student population is still comparably small and proportionally lower relative to most other countries.

In the remaining countries presented in Figure 4.7, relatively high growth rates were also observed in Slovenia, Turkey, Ireland, Greece, Italy, Estonia and Portugal.

An interesting pattern observed is that the number of women enrolled in doctoral studies continued to increase at a faster pace than that of men and was more than twice as high as that of men in several countries (Japan, Switzerland, Norway, Slovakia, Poland, and Belgium). Four EU countries, Denmark, Hungary, Finland and Sweden, registered a decrease in the number of male doctoral students.

Figure 4.7: Average annual growth rate of doctoral students in all fields by sex, EU-27 and selected countries — 2002-2007



Note:
Data not available: DE, FR, LU.
AAGR for EU-27 not calculated due to missing data for too many countries.
Exception to the reference period: 2003-2007: NL, RO, HR, US;
2005-2007: SI.
AAGR not published for MT due to the small size of the population, leading to extreme values for AAGR.

Source: Eurostat (educ_enrl5)

4.2.2 Graduation from tertiary education

Table 4.8 provides data on tertiary education graduates in all fields of study, in 'science, mathematics and computing' and in 'engineering, manufacturing and construction'. As mentioned above, even though student participation is a useful proxy for estimating future national HRST stocks, this can be supplemented with data on higher education graduates. This indicator gives a more precise idea of the number of people effectively entering the pool of HRST.

In 2007, the EU-27 had almost 4 million graduates from tertiary education, representing 6.0 % if this number of graduates of all ages is related to the population aged 20-29. This ratio was highest in Lithuania, with 8.7 %.

Taken together, France, Poland, the United Kingdom and Germany accounted for more than half of all tertiary education graduates in the EU. All the countries under review except Bulgaria and Spain recorded an increase in the number of tertiary education graduates between 2002 and 2007. The highest increases were observed in Liechtenstein (24.4 %), the former Yugoslav Republic of Macedonia (18.3 %) and Romania (17.1 %).

The EU-27 had more tertiary education graduates in the field of 'engineering, manufacturing and construction' than in 'science, mathematics and computing'. This was also the case in all the countries under review except Ireland, Cyprus, Malta, the United Kingdom, Iceland, Norway and the United States. Ireland and the United Kingdom reported the highest shares of tertiary education graduates in the field of 'science, mathematics and computing', 15.1 % and 13.2 % respectively. In contrast, this proportion did not reach 5 % in Bulgaria, Latvia, Slovenia or Japan. In Liechtenstein 'engineering, manufacturing and construction' comprised the highest proportion of graduates (more than 30 %). This field also accounted for almost 20 % of the graduates in Finland, Portugal and Austria.

In the European Union, the share of female graduates was much higher in 'science, mathematics and computing' (40.2 %) than in 'engineering, manufacturing and construction' (25.5 %). This reflects the rate of female participation in tertiary education shown in Table 4.2. In Bulgaria, Greece, Italy, Romania and the former Yugoslav Republic of Macedonia the share of female graduates in 'science, mathematics and computing' exceeded 50 %. However, in all the countries under review, women accounted for less than half of all tertiary education graduates in the field of 'engineering, manufacturing and construction'.

Euraxess — the European services network

"**EURAXESS Services** is a network of more than 200 centres located in 35 European countries. If you are a mobile researcher, **Euraxess Services** can assist you and your family in every step of your move, starting in your home country and continuing until you have settled in a new one. This free personalised service is here to remove red tape and make your life easier. You will receive comprehensive, up-to-date information, as well as customised assistance on all matters relating to your professional and daily life. A team of well informed staff is at your disposal across Europe. Ask for information and customised assistance on the following topics:

- accommodation
- day care and schooling
- intellectual property rights
- language courses and recognition of qualifications
- salaries and taxation
- social and cultural aspects
- social security, pension rights and healthcare
- visas and work permits."

Source: http://www.euraxess.eu

Table 4.8: Tertiary education graduates, total and in selected fields of study, proportion of the population aged 20-29, AAGR 2002-2007 and proportion of female graduates, EU-27 and selected countries — 2007

	Graduates from tertiary education											
	All fields				Science, mathematics and computing				Engineering, manufacturing and construction			
	Total	% of population aged 20-29	AAGR	% women	Total	% of all tertiary graduates	AAGR	% women	Total	% of all tertiary graduates	AAGR	% women
EU-27	3 955 204 i	6.0	4.4 i	59.1	384 685 i	9.7	4.8 i	40.2	497 615 i	12.6	3.2 i	25.5
BE	103 970	7.9	7.3	58.1	7 612	7.3	4.7	32.9	10 840	10.4	7.1	23.2
BG	49 165	4.5	-0.6	59.9	1 993	4.1	-6.4	58.9	7 259	14.8	-7.4	33.9
CZ	77 580	5.1	12.2	57.1	5 896	7.6	3.7	38.9	12 445	16.0	19.1	24.8
DK	50 849	8.2	3.6	57.4	3 723	7.3	-2.0	35.7	6 423	12.6	10.2	36.2
DE	438 891	4.5	8.3	56.6	53 772	12.3	14.7	42.5	58 034	13.2	3.2	17.9
EE	12 612	6.2	7.0	68.9	1 323	10.5	16.7	43.2	1 343	10.6	8.1	34.2
IE	59 011	7.9	5.6	56.6	8 936	15.1	1.5	39.7	5 021	8.5	1.1	16.2
EL	60 475	4.0	7.9	59.5	5 647	9.3	-12.0	50.4	7 400	12.2	15.0	39.5
ES	279 412	4.3	-0.8	58.4	26 223	9.4	-3.3	35.9	46 906	16.8	-0.5	26.6
FR	622 937	7.7	1.6	55.1	68 951	11.1	-2.4	36.1	97 282	15.6	0.5	22.5
IT	256 445	3.8	0.6	58.6	16 840	6.6	-2.1	52.5	39 128	15.3	0.7	30.4
CY	4 445	3.4	7.4	58.9	383	8.6	12.8	37.1	166	3.7	-2.5	18.7
LV	26 752	7.7	7.2	71.9	1 249	4.7	1.4	38.8	1 898	7.1	5.4	28.7
LT	43 153	8.7	7.7	66.7	2 495	5.8	13.2	38.4	6 453	15.0	3.0	30.2
LU	:	:	:	:	:	:	:	:	:	:	:	:
HU	67 224	4.7	1.5	66.5	4 299	6.4	17.3	29.3	5 015	7.5	-2.9	24.7
MT	2 729	4.6	5.9	57.3	219	8.0	21.1	46.1	202	7.4	15.6	28.7
NL	123 321	6.3	7.5	56.5	8 013	6.5	11.7	20.2	9 476	7.7	1.1	17.8
AT	36 429	3.4	6.2	52.5	4 403	12.1	18.4	32.5	7 198	19.8	3.4	18.5
PL	532 827	8.3	3.0	65.2	42 931	8.1	20.8	45.4	46 328	8.7	7.0	33.4
PT	83 276	5.7	5.4	61.4	10 350	12.4	24.5	43.5	16 290	19.6	14.6	29.2
RO	205 970	6.1	17.1	59.7	10 665	5.2	16.2	61.9	29 728	14.4	14.1	32.2
SI	16 680	5.8	3.2	61.8	731	4.4	5.7	36.4	2 105	12.6	-1.7	21.1
SK	46 379	5.1	10.5	61.7	4 045	8.7	10.8	40.5	6 820	14.7	7.8	32.4
FI	43 370	6.5	2.3	63.2	3 806	8.8	6.0	44.5	8 638	19.9	0.9	22.1
SE	60 243	5.5	5.8	63.7	4 488	7.4	-0.3	42.9	10 334	17.2	0.7	28.9
UK	651 059	8.0	3.0	58.1	85 692	13.2	-2.0	37.5	54 883	8.4	-0.5	21.1
HR	22 228	3.6	7.1	57.7	1 545	7.0	5.8	47.3	2 599	11.7	4.7	27.6
MK	8 719	2.7	18.3	61.4	568	6.5	10.5	54.4	918	10.5	7.2	30.7
TR	416 329	:	12.3	45.5	33 322	8.0	8.6	45.2	56 454	13.6	5.2	22.8
IS	3 541	7.7	10.0	67.5	244	6.9	-4.1	35.7	212	6.0	16.7	32.5
LI	146	3.3	24.4	32.2	0	:	:	:	46	31.5	: i	30.4
NO	35 410	6.2	3.6	61.8	2 666	7.5	2.1	32.9	2 622	7.4	4.0	24.3
CH	75 650	8.2	5.6	47.7	6 437	8.5	1.1	27.3	9 991	13.2	6.3	11.8
JP	1 062 444	:	0.3	48.8	31 711	3.0	1.3	25.8	189 417	17.8	-1.4	12.4
US	2 704 070	:	3.9	58.5	234 312	8.7	2.2	41.0	189 247	7.0	1.1	18.6

Note:
EU-27 excluding LU.
AAGR for EU-27 excluding EL, FR and LU due to missing data in 2002.
Exceptions to the reference period: 2003-2007: FR, LI, HR;
2004-2007: EL.
AAGR not published for LI in the field of 'engineering, manufacturing and construction' due to the small size of the population, leading to extreme values for AAGR.
Graduates of tertiary education of all ages are divided by the population aged 20-29 years.

Source: Eurostat (educ_grad5)

4.2.3 Doctoral graduates

In 2007, out of the 3.9 million new graduates in the EU, approximately 109 000 obtained a doctorate (see Table 4.9). Germany, the United Kingdom, France and Italy were the leading EU Member States in absolute numbers and together accounted for more than 60 % of EU doctoral graduates in 2007. Related to the population aged 20-29, Portugal recorded the highest share of new doctoral graduates, with 4.2 ‰. This share was 3.0 ‰ or more in Finland, Sweden and Switzerland.

Table 4.9: Doctoral graduates (ISCED level 6), total and in selected fields of study, proportion of the population aged 20-29 (all fields), in relation to all doctoral graduates (S&E fields) and proportion of female doctoral graduates, EU-27 and selected countries — 2007

	Doctoral graduates (ISCED 6 level) 2007								
	All fields			Science, mathematics and computing			Engineering, manufacturing and construction		
	Total	per 1000 population aged 20-29	% women	Total	% of all doctoral graduates	% women	Total	% of all doctoral graduates	% women
EU-27	108 789 i	1.6 i	45.8 i	29 779 i	27.4	41.8	15 438 i	14.2	25.4
BE	1 716	1.3	39.1	551	32.1	39.0	277	16.1	18.1
BG	621	0.6	54.8	110	17.7	64.5	115	18.5	35.7
CZ	2 272	1.5	37.1	490	21.6	41.0	576	25.4	22.0
DK	973	1.6	40.8	150	15.4	32.7	241	24.8	23.2
DE	24 439	2.5	42.5	6 531	26.7	36.1	2 237	9.2	12.7
EE	153	0.8	51.6	55	35.9	34.5	18	11.8	44.4
IE	1 035	1.4	46.0	407	39.3	47.2	151	14.6	21.2
EL	2 436	1.6	39.9	287	11.8	36.9	232	9.5	27.6
ES	7 150	1.1	47.6	2 174	30.4	50.2	653	9.1	27.9
FR	10 650	1.3	41.8	5 132	48.2	37.2	1 172	11.0	28.4
IT	10 188	1.5	51.3	2 680	26.3	51.9	1 959	19.2	34.7
CY	16	0.1	68.8	7	43.8	85.7	0	:	:
LV	146	0.4	59.6	32	21.9	46.9	25	17.1	44.0
LT	367	0.7	59.9	87	23.7	57.5	72	19.6	27.8
LU	:	:	:	:	:	:	:	:	:
HU	1 059	0.7	42.1	246	23.2	35.4	93	8.8	25.8
MT	9	0.2	33.3	1	11.1	0.0	2	22.2	0.0
NL	3 160	1.6	41.8	501	15.9	31.5	549	17.4	23.9
AT	2 085	2.0	42.4	429	20.6	38.5	434	20.8	23.5
PL	6 072	1.0	49.4	997	16.4	55.3	1 045	17.2	24.2
PT	6 038	4.2	61.2	1 509	25.0	57.9	709	11.7	39.2
RO	2 983	0.9	49.9	284	9.5	47.5	494	16.6	33.2
SI	415	1.4	45.8	118	28.4	37.3	73	17.6	24.7
SK	1 371	1.5	46.4	269	19.6	49.1	252	18.4	34.1
FI	1 986	3.0	51.6	481	24.2	42.8	405	20.4	27.9
SE	3 904	3.5	46.4	922	23.6	39.8	1 012	25.9	28.2
UK	17 545	2.2	44.1	5 329	30.4	38.4	2 642	15.1	22.0
HR	466	0.8	52.1	118	25.3	61.0	75	16.1	36.0
MK	82	0.3	52.4	8	9.8	50.0	13	15.9	46.2
TR	3 357	:	41.4	500	14.9	44.0	506	15.1	34.2
IS	10	0.2	60.0	3	30.0	33.3	0	:	:
LI	4	0.9	50.0	0	:	:	0	:	:
NO	980	1.7	42.2	392	40.0	29.3	45	4.6	22.2
CH	3 428	3.7	37.6	1 065	31.1	33.8	417	12.2	17.5
JP	16 810	:	26.6	2 752	16.4	20.7	3 719	22.1	10.9
US	60 616	:	50.1	14 146	23.3	38.1	8 301	13.7	21.4

Note:
EU-27 aggregate including 2006 data for IT and excluding LU.
Exception to the reference year: 2006: IT.
Doctoral graduates of all ages are divided by the population 20-29.

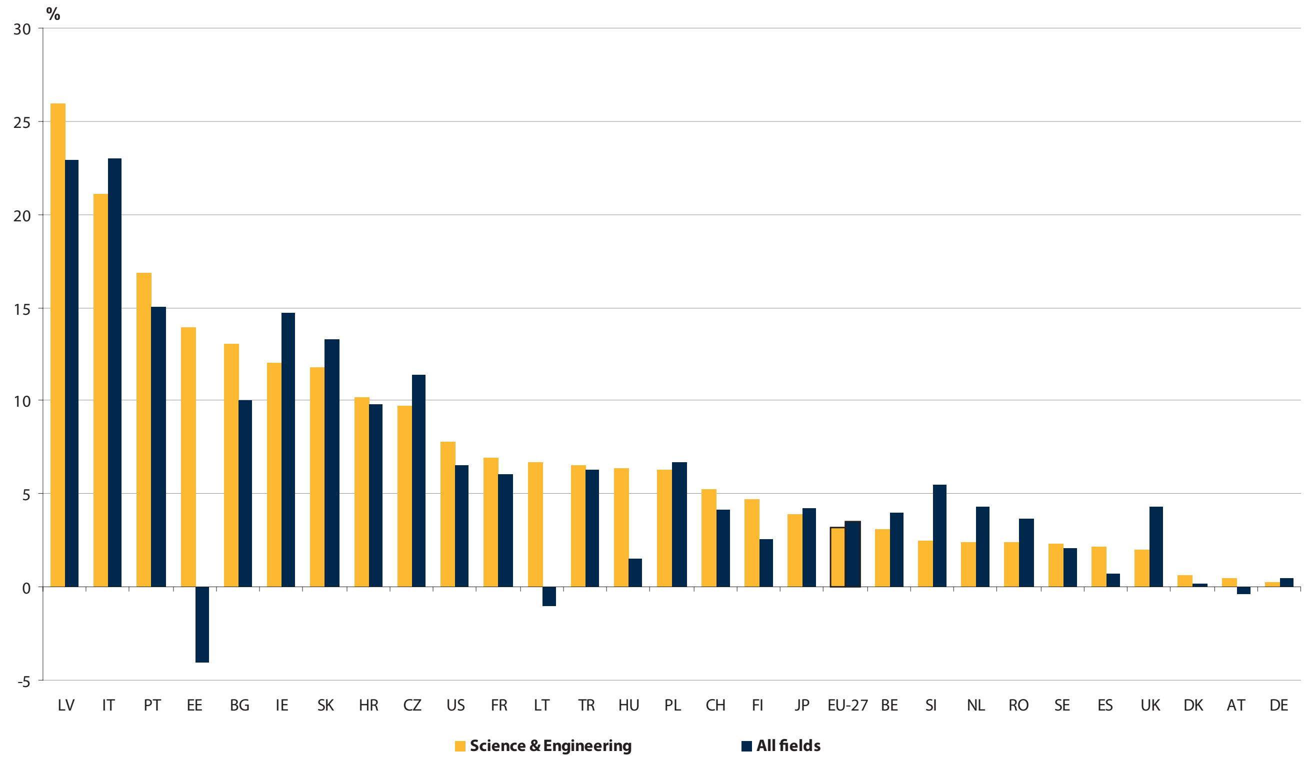
Source: Eurostat (educ_grad5)

In 2007, more than 45 000 students in the EU graduated with a doctorate in 'science, mathematics and computing' or 'engineering, manufacturing and construction'. In absolute terms, Germany accounted for the most doctoral graduates in these two fields of study (8 768). In the EU-27, doctoral graduates were better represented in the field of 'science, mathematics and computing' (27.4 %) than in 'engineering, manufacturing and construction' (14.2 %). However, the opposite was observed in Bulgaria, the Czech Republic, Denmark, Malta, the Netherlands, Austria, Poland, Romania, Sweden, the former Yugoslav Republic of Macedonia, Turkey and Japan.

France had the highest share of doctoral graduates in the field of 'science, mathematics and computing' (48.2 %), followed by Cyprus (43.8 %), while in Romania and the former Yugoslav Republic of Macedonia this share did not reach 10 %. The highest share of doctoral graduates in 'engineering, manufacturing and construction' was noted in Sweden (25.9 %), followed by the Czech Republic (25.4 %) and Denmark (24.8 %).

In 2007, 45.8 % of EU doctoral graduates were women. This proportion was 60 % or more in Cyprus (68.8 %), Portugal (61.2 %) and Iceland (60.0 %). In the field of 'science, mathematics and computing', seven EU Member States reported more female doctoral graduates than male doctoral graduates. In the field of 'engineering, manufacturing and construction' men outnumbered women in all EU countries, but in Estonia and Latvia, the proportion of female doctoral graduates was higher than 40 %.

Figure 4.10: Average annual growth rates of doctoral graduates in all fields and in science & engineering, EU-27 and selected countries — 2002-2007



Note:
Data not available: LU, IS, LI.
EU-27 excluding LU, EL, FR, IT and RO.
Exception to the reference period: 2003-2007: FR, RO, HR;
2002-2006: IT.
EL and NO figures not published due to breaks in series that strongly affect AAGR.
CY, MT, MK figures not published due to small populations, leading to extreme values for AAGR.
Science and engineering = science, mathematics and computing + engineering, manufacturing and construction.

Source: Eurostat (educ_grad5)

FFigure 4.10 shows the average annual growth rate of doctoral graduates in all fields and in 'science, mathematics and computing' and 'engineering, manufacturing and construction' together ('science & engineering') for the EU Member States and other selected countries.

In the EU 27, the average growth in the number of new doctorate holders was 3.2 % in 'science & engineering' and 3.5 % in all fields of study. This increase was uneven across the various countries considered.

Between 2002 and 2007, Italy and Latvia recorded the highest growth rates of doctoral graduates in all fields of study, with 23 %. Over the same period the number of 'science & engineering' graduates in Italy also grew strongly (21.1 %), surpassed only by Latvia, which showed the highest growth rate of all countries, with 25.9 %.

The number of doctoral students in 'science & engineering' grew faster than the total for all fields in Latvia, Portugal, Estonia, Bulgaria, Croatia, the United States, France, Lithuania, Turkey, Hungary, Switzerland, Finland, Sweden, Spain, Denmark and Austria.

Estonia (-4.0 %), Lithuania (-1.1 %) and Austria (-0.4 %) were the only countries to record an average decrease in the number of doctoral graduates in all fields of study.

4.3 Stocks of human resources in science and technology

Human resources, especially in science and technology, are a key ingredient of competitiveness and economic development. Building on the analysis of the supply of human resources in science and technology (HRST), in the form of inflows from tertiary education, this section takes a closer look at characteristics of the stock of HRST.

The HRST stock includes all persons who have either successfully completed third-level education or who are working as professionals or technicians. The stock can then be narrowed down to various sub-categories of HRST, for example persons only fulfilling the education criteria (HRSTE) or persons only fulfilling the occupation criteria (HRSTO). Persons fulfilling both criteria, in other words persons who have both successfully completed third-level education and who are working as professionals or technicians, are referred to as the core group of HRST (HRSTC).

4.3.1 HRST stocks at national level

Table 4.11: Human resources in science and technology stocks, 25-64 years old, by HRST category, proportion of women and average annual growth rate of HRST by gender, 2002 to 2007, EU-27 and selected countries — 2007

	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		HRST Average annual growth rate 2002-2007	
	1000 s	% of women	1000 s	% of women	1000 s	% of women	1000 s	% of women	women	men
EU-27	87 028 i	50.5 i	35 243 i	52.0 i	27 140 i	49.1 i	24 646 i	50.0 i	4.5	3.0
BE	2 212	50.0	967	52.5	867	52.2	378	38.7	4.2	3.2
BG	1 093	58.8	513	67.1	423	53.6	158	46.0	-0.1	-0.2
CZ	1 802	51.5	540	46.5	285	44.7	977	56.2	4.5	3.3
DK	1 253 b	51.1 b	592 b	55.7 b	315 b	48.3 b	346 b	45.7 b	1.5	1.2
DE	16 915	47.8	6 610	44.9	4 334	38.6	5 971	57.8	2.8	0.9
EE	266	62.9	103	73.0	116	54.7	47	61.1	2.1	4.6
IE	827	52.8	338	54.4	390	52.7	99	47.3	8.2	7.2
EL	1 546	48.1	778	48.9	547	47.2	221	47.7	5.9	5.1
ES	8 621	48.7	3 592	51.4	4 011	49.1	1 019	38.1	7.5	6.2
FR	11 084	51.3	4 534	53.4	3 711	55.6	2 839	42.2	4.7	2.8
IT	8 723	49.6	2 797	51.6	1 669	58.8	4 256	44.6	6.1	3.6
CY	160	50.3	75	48.6	66	55.1	19	40.9	7.3	4.5
LV	395	63.6	156	69.3	118	54.0	121	65.4	8.0	6.6
LT	625	61.8	268	70.9	249	47.7	109	71.8	3.7	4.9
LU	94	48.6	52	48.0	17	47.2	25	50.8	9.0	4.4
HU	1 409	58.3	576	56.8	426	54.5	407	64.3	3.9	3.3
MT	43	40.3	17	48.4	9	42.4	17	31.4	6.1	4.5
NL	3 872	48.1	1 725	47.3	1 028	44.3	1 119	52.9	4.2	2.5
AT	1 423	44.9	446	46.9	356	36.4	621	48.3	3.1	3.8
PL	5 269	58.8	2 318	60.3	1 544	54.7	1 407	60.7	5.5	5.4
PT	1 118	53.5	527	60.7	280	60.0	311	35.4	8.0	7.3
RO	2 112	53.2	973	51.6	450	42.2	690	62.6	1.8	1.7
SI	374	55.2	169	61.0	88	49.9	117	50.8	5.4	4.8
SK	804	56.3	272	54.0	164	47.7	367	61.9	3.2	5.2
FI	1 257	54.7	562	59.9	457	53.8	237	43.9	2.6	1.5
SE	2 105	51.5	1 032	59.1	442	51.6	630	39.0	2.9	2.0
UK	11 626	48.6	4 713	51.9	4 778	48.1	2 135	42.5	5.0	3.1
HR	499	50.7	223	56.6	136	49.7	140	42.4	1.6	1.7
TR	4 125	33.9	1 470	36.9	1 806	37.8	848	20.6	:	:
IS	61	56.2	22	55.7	11	53.3	28	57.6	5.3	1.7
NO	1 103	51.5	599	54.7	259	52.5	245	42.7	2.8	0.3
CH	1 946	43.2	805	38.0	515	35.5	626	56.2	4.3	2.7

Note:
Exceptions to the reference year: 2006: HR, IS.
Exceptions to the reference period: 2002-2006: HR and IS.

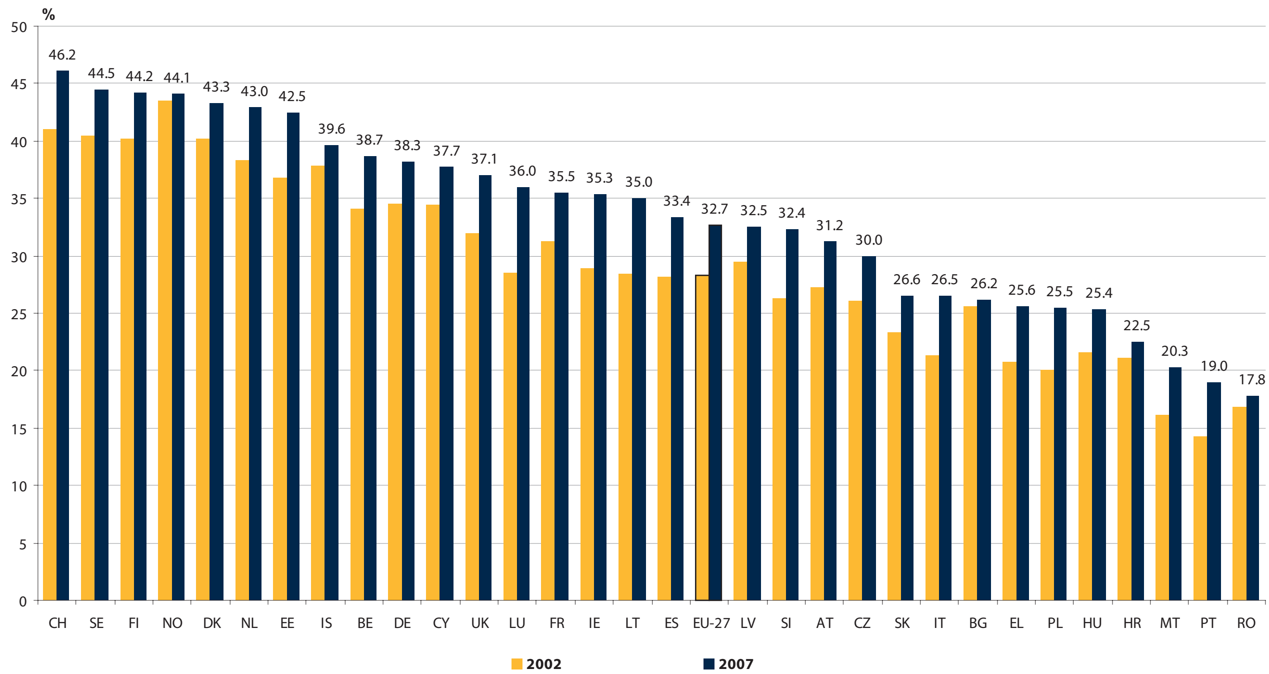
Source: Eurostat (hrst_st_ncat)

As shown in Table 4.11, in almost all the EU Member States (except Bulgaria), the number of persons employed in S&T (HRST) increased between 2002 and 2007. The highest growth rates in the number of men working in S&T occupations were recorded in Portugal, Spain and Latvia, with 7.3 %, 7.2 % and 6.6 % respectively. In parallel, the highest growth rates for women employed in S&T were reported in Ireland, Latvia, Luxembourg and Portugal, ranging between 8 % and 9 %.

Except for Estonia, Lithuania, Austria and Slovakia, female HRST stocks grew faster than male HRST stocks. The EU-27 average increased by 4.5 % for women, compared with 3.0 % for men.

At EU level, women accounted for more than half of the HRST population (50.5 %). Near gender balance was achieved in all HRST categories. The only instance where women were in the minority (49.1 %) was at HRSTE level. The highest percentage of women in HRSTC was found in Estonia (73.0 %), followed by Lithuania (70.9 %). Portugal and Italy recorded the highest female participation levels in HRSTE, while the Baltic States, together with Hungary, Romania and Slovakia, reported the highest proportions of women in HRSTO.

Figure 4.12: HRST as a percentage of total population aged 25-64, EU-27 and selected countries — 2002 and 2007



Note:
Exceptions to the reference year: 2006: HR and IS.

Source: Eurostat (hrst_st_ncat)

IIn the EU-27 the proportion of HRST in the total population aged 25-64 increased by an average of 4.3 percentage points between 2002 and 2007.

The biggest increase was noted in Luxembourg (7.5 percentage points), followed by Lithuania (6.6 percentage points) and Ireland (6.4 percentage points).

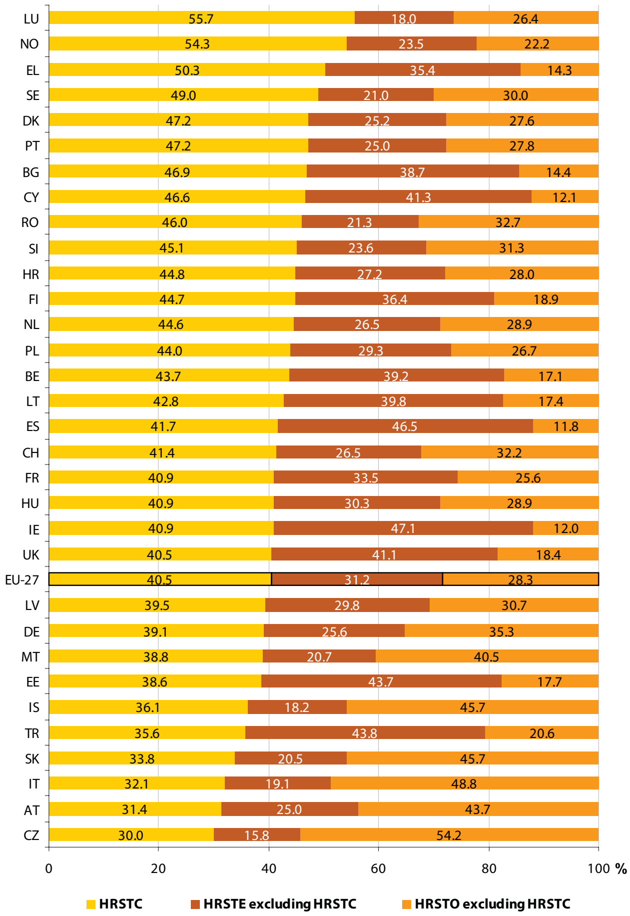
In absolute terms in 2007, Switzerland recorded the highest percentage of HRST among the population aged 25-64 (46.2 %), followed closely by Sweden, Finland, Norway and Denmark.

Despite an increase of more than 4 percentage points between 2002 and 2007, Portugal recorded the second lowest proportion of HRST in the population aged 25-64 (19.0 %) after Romania (17.8 %).

"The Inspire project aims to develop and experiment new teaching methods in the field of math, science and technology (MST). The purpose is to challenge the lack of interest of students to start scientific studies and more widely to extend the supply of scientific specialists and to develop a scientific culture in European countries. The project has been proposed in the context of the Lisbon agenda to address the strategic objective of quality and effectiveness of education and training systems. The purpose is to improve the education and training of teachers and trainers, to develop key competences for the knowledge society and to ensure access to information and communication technology. Inspire proposes to set up a limited validation observatory where 60 schools in Europe will be invited to use, test, and analyse new didactical tools in the field of MST. Special attention will be given to the impact of these new teaching methods at the level of pupils and their motivation and analysis of the pre-requisites to be defined for enabling the teachers to integrate these new techniques in their pedagogy."

Source: http://www.xplora.org/ww/en/pub/xplora/inspire.htm

Figure 4.13: Distribution of HRST by category, EU-27 and selected countries — 2007



Note:
Exceptions to the reference year: 2006: HR and IS.

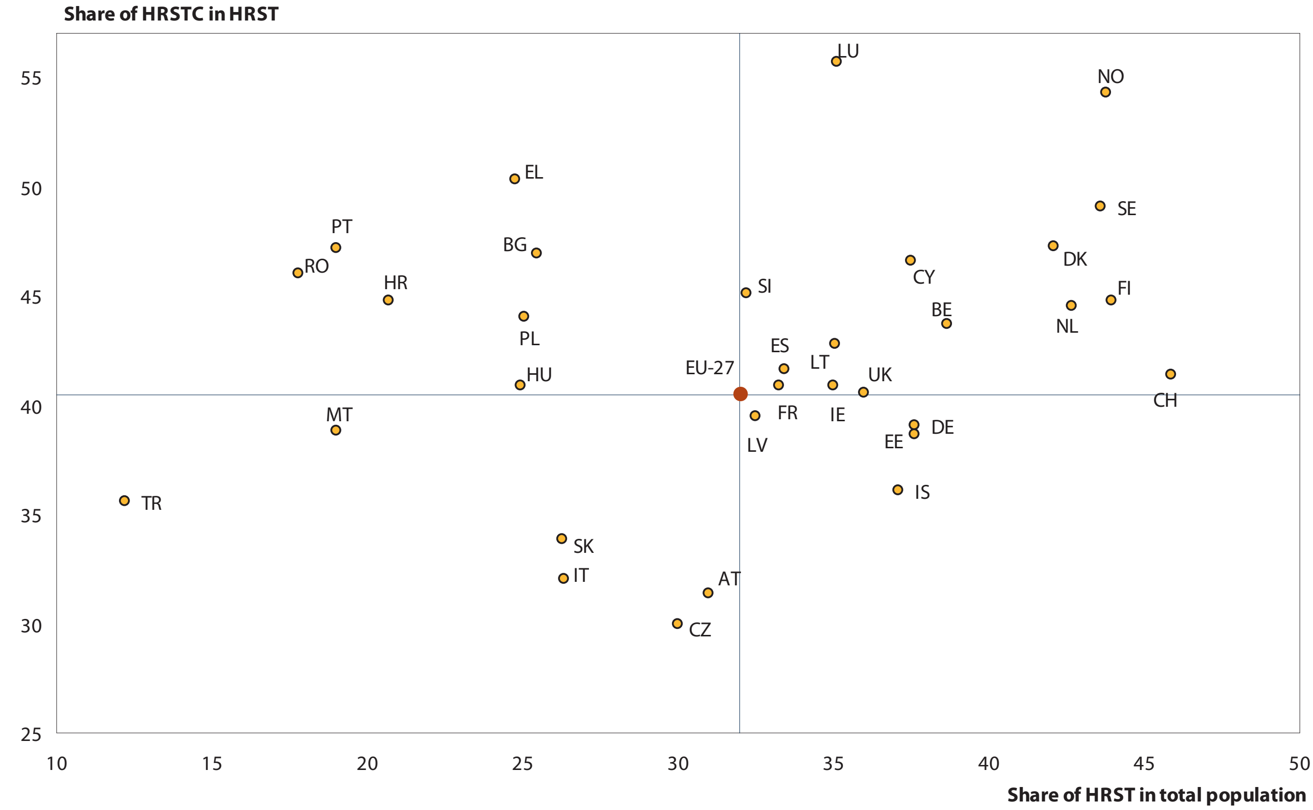
Source: Eurostat (hrst_st_ncat)

HHRST can be divided into core HRST (HRSTC), HRST in terms of education (HRSTE) (but excluding HRSTC) and HRST in terms of occupation (HRSTO) (but excluding HRSTC). In 21 of the countries studied, HRSTC accounted for the highest share. Out of these countries, Luxembourg, Norway and Greece recorded shares higher than 50 %.

Ireland, Spain, Turkey, Estonia and the United Kingdom recorded higher shares of HRSTE than other countries, albeit remaining below 50 %.

The Czech Republic recorded a very high share of HRSTO (54.2 %), followed by Italy (48.8 %), Slovakia (45.7 %) and Iceland (45.7 %). Austria and Malta also reported higher shares (more than 40 %) of HRSTO than the other countries under review.

Figure 4.14: Share of HRSTC among the HRST population and percentage of HRST in the total population, EU-27 and selected countries -— 2007



Note:
Exceptions to the reference year: 2006: HR and IS.

Source: Eurostat (hrst_st_ncat)

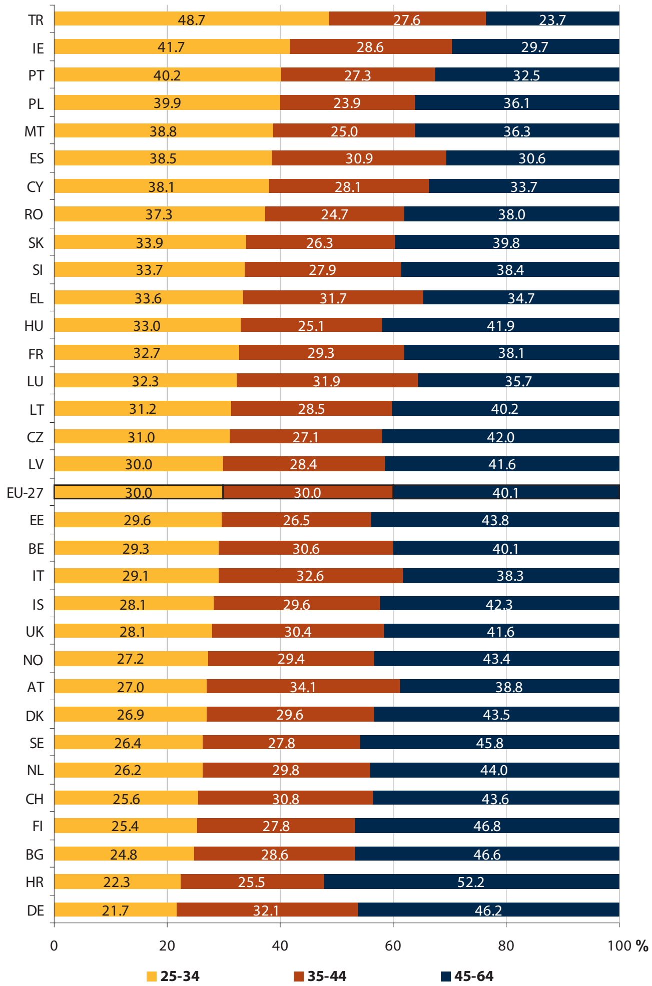
The core HRST population (HRSTC) can be said to contribute significantly to the knowledge-based economy. It includes persons who are both highly skilled (professionals and technicians) and highly educated (tertiary level) and HRSTC are often seen as people who can initiate development, change and innovation, thus setting trends in the new economy. This is why high shares of HRSTC in the total or active population remain essential for growth and development in the context of the Lisbon strategy. Figure 4.14 combines the share of HRSTC in the HRST population with the share of HRST in the total population.

The analysis of Figure 4.14 reveals interesting patterns among the countries reviewed. The EU-27 constitutes the reference point, with a cluster of countries including Spain, France, Ireland, Slovenia, Latvia, Estonia, Germany, Lithuania, the United Kingdom and Iceland surrounding the EU average. Four Nordic countries, Luxembourg, the Netherlands, Switzerland, Belgium and Cyprus together with the above-mentioned countries surrounding the EU-27 average belong to a group comprising the highest shares of HRST in the total population. In Switzerland almost half of the population are HRST and in Luxembourg HRSTC constitutes more than 55 % of HRST.

At the other end of the scale, Turkey, Malta, Slovakia and Italy recorded less than 30 % of HRST in the population combined with shares of core HRST in the HRST population below the EU average. Austria and the Czech Republic were the two countries with the lowest shares of HRSTC but had shares of HRST close to the EU average.

Another group is composed of countries with relatively low shares of HRST, but high shares of HRSTC among HRST. These are Romania, Portugal, Croatia, Bulgaria, Poland, Hungary and Greece. It is interesting to add that in many of these countries the growth of the HRSTC population was fairly strong (above the EU average).

Figure 4.15: HRST by age group, EU-27 and selected countries — 2007



Note:
Exceptions to the reference year: 2006: HR and IS.

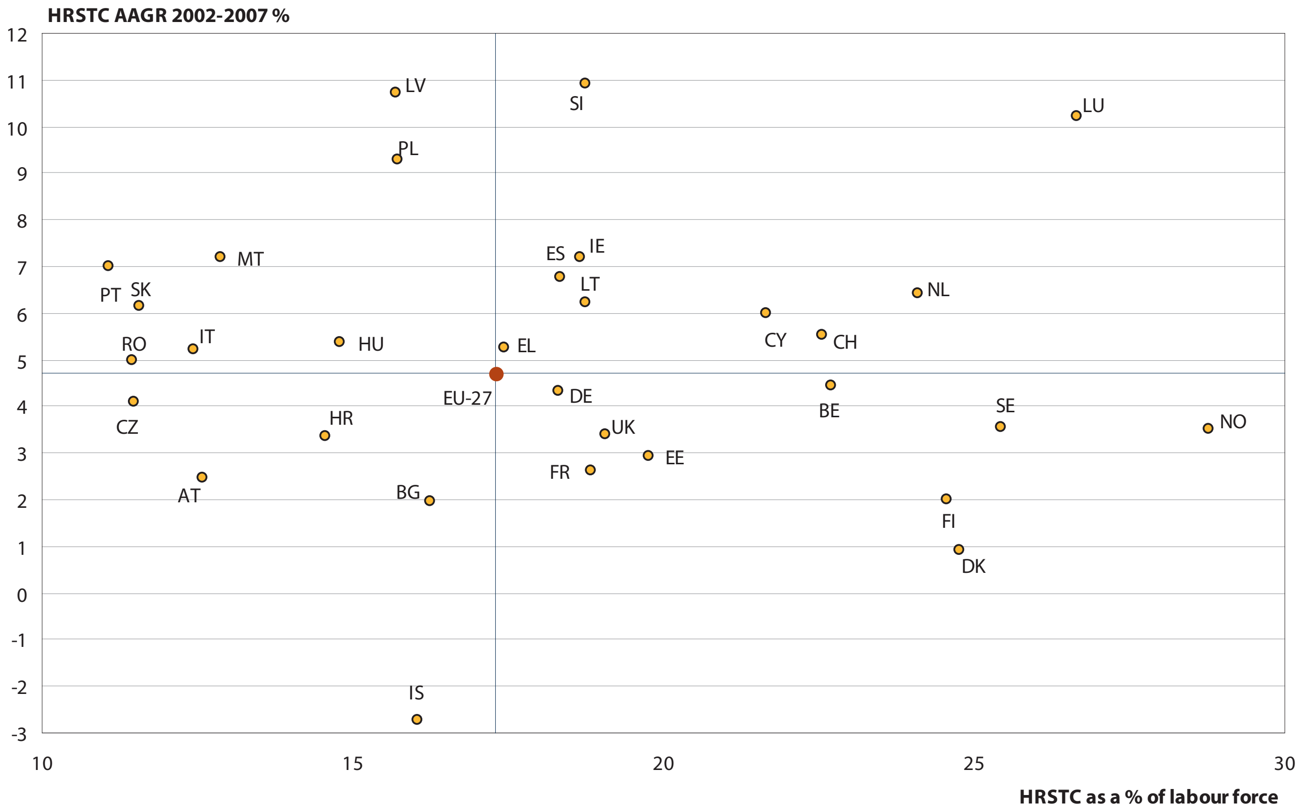
Source: Eurostat (hrst_st_ncat)

Figure 4.15 shows the distribution of human resources in science and technology (HRST) by age group. The distribution of HRST in the EU-27 was balanced among the two youngest age groups (25-34 and 35-44), with a slightly higher percentage among the population aged 45-65. The 45-64 age group is under-represented compared to the other two age groups taken together.

In 2007 Turkey recorded the lowest share of HRST in the total population (12.2 %) (see Figure 4.14), but the highest share of the youngest age group and one of the highest shares of HRSTE (see Figure 4.13). This could potentially mean that there is a continuously growing group of young HRST that will allow Turkey to catch up with the others in terms of the share of HRST in the population.

Ireland followed close behind, with 41.7 % of HRST aged 25-34, while Germany recorded the lowest share of young HRST, as only 21.7 % of HRST were between 24 and 34 years old.

Figure 4.16: Average annual growth rates of HRSTC, 2002-2007, and their proportion of the labour force, EU-27 and selected countries — 2007



Note:
Exceptions to the reference year: 2006: HR and IS.
Exceptions to the reference period: 2002-2006: HR, IS.

Source: Eurostat (hrst_st_ncat)

Figure 4.16 presents the growth of core HRST (HRSTC) between 2002 and 2007 along with their shares in the total labour force.

At EU level, HRSTC stocks accounted for 17.3 % of the total labour force in 2007. Although HRSTC stocks grew on average by 4.7 % per year between 2002 and 2007, big differences persist between Member States.

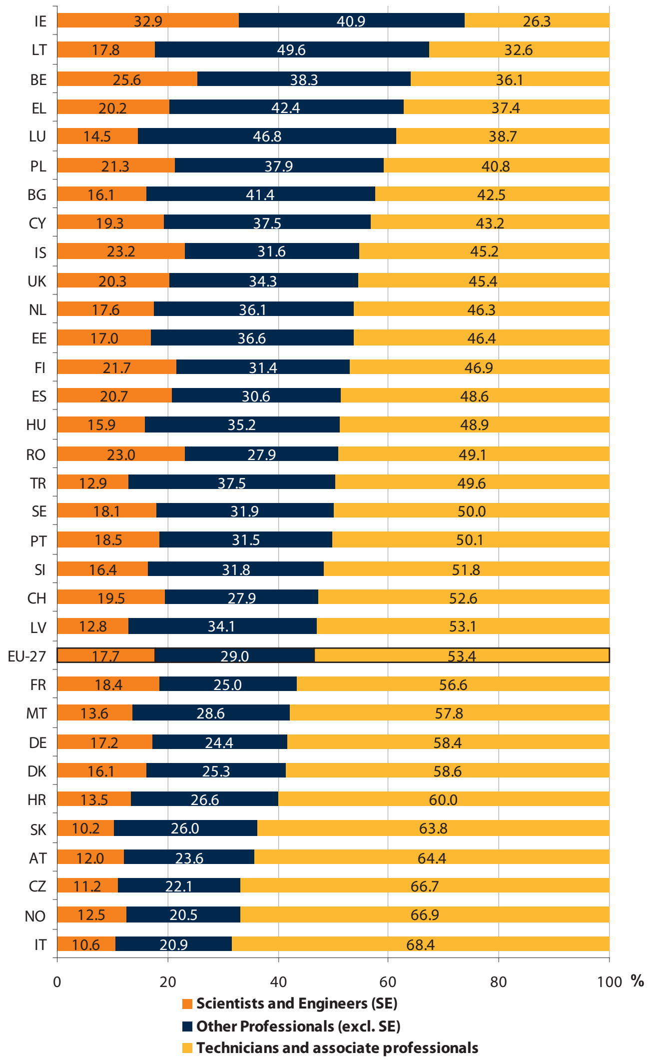
In relation to the European average, Member States of the EU-15 generally recorded high shares of HRSTC in their labour force. The highest shares of HRSTC, which were around a quarter of the labour force, were found in four Nordic countries, Luxembourg and the Netherlands. In Luxembourg and the Netherlands the HRSTC population grew at a rapid pace while the four Nordic countries reported moderate growth below the EU average.

Along with Luxembourg a substantial increase of over 9 % per year was also observed in Slovenia, Latvia and Poland. A number of other new Member States also reported rapid growth, which could be explained by the catching-up effect, but their share of HRSTC in the total labour force was still below the EU average. In contrast, the increase in most of the EU-15 Member States has stabilised over time, as their share of HRSTC in the labour force was already high.

But the combination of high growth in HRSTC and low shares in the total labour force is not a general rule. In Austria, Bulgaria, the Czech Republic, Croatia and Iceland the shares of HRSTC in the labour force were relatively low and growth rates in the HRSTC population were below the EU average. In Iceland, the number of HRSTC even decreased by 2.7 % per year between 2002 and 2007.

To summarise the figure, the trends for HRSTC stocks vary substantially across the countries. As a proportion of the total workforce, the HRSTC population accounted for shares ranging from around 11 % in Portugal, Romania, Slovakia and the Czech Republic to over 25 % in Norway and Sweden. In spite of these disparities, the overall tendency (excepting Iceland) points towards an increase in the core HRST population.

Figure 4.17: Distribution of HRSTO aged 25-64 by occupation, EU-27 and selected countries — 2007



Note:
Exceptions to the reference year: 2006: HR and IS.

Source: Eurostat (hrst_st_nocc)

Figure 4.17 presents the distribution of HRST in terms of occupation (HRSTO) by dividing HRSTO into three groups, 'Scientists and engineers (S&E)', 'Other professionals' and 'Technicians and associate professionals'. By definition, S&E include people working in 'physical, mathematical and engineering' occupations (ISCO-88 COM code 21), such as mathematicians or civil engineers, and in 'life science and health' occupations (ISCO-88 COM code 22), such as biologists or medical doctors (see the methodological notes for more detail).

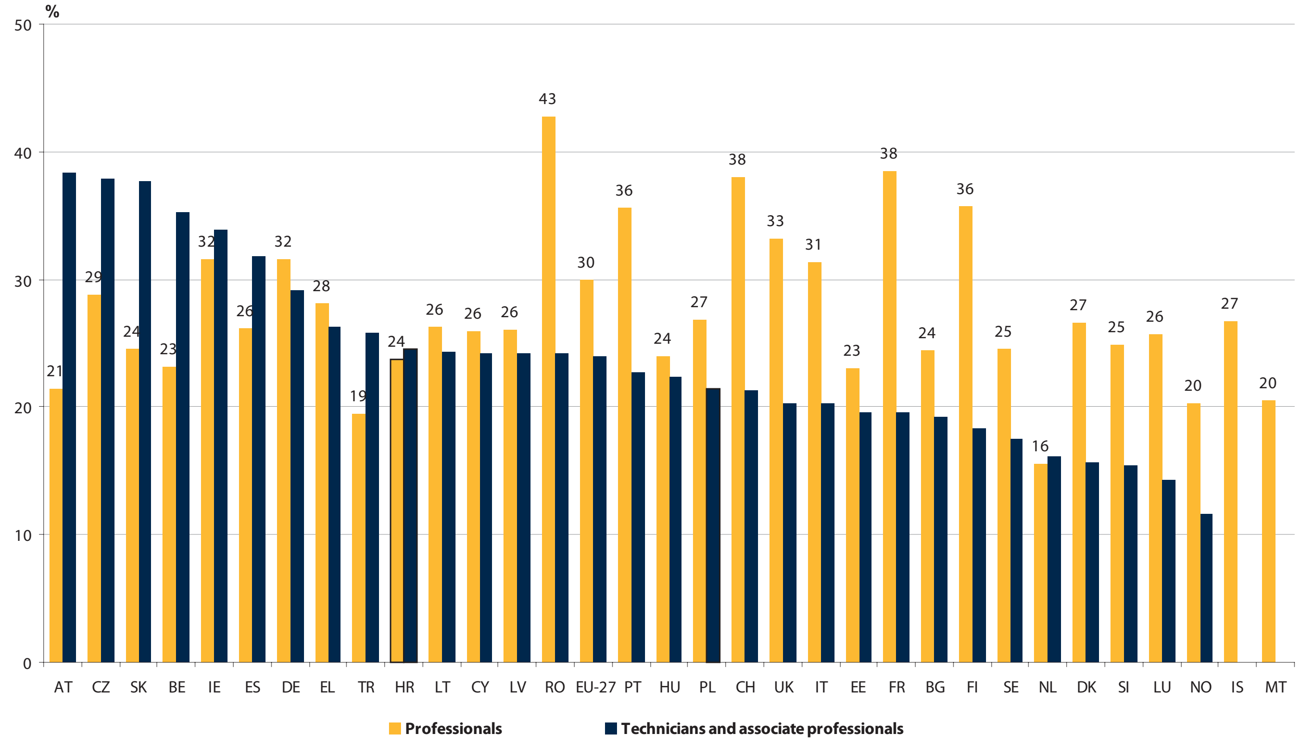
Persons employed in an S&T occupation are allocated to one of two groups: either 'professionals' or 'technicians and associate professionals'. By definition, the first group conducts research, improves or develops concepts, theories and operational methods or applies knowledge relating to different areas of science. Technicians and associate professionals perform mostly technical and related tasks connected with research and the application of scientific and artistic concepts, operational methods and government or business regulations and teach at certain levels.

On average in the EU-27, professionals (including scientists and engineers) accounted for 46.6 % of HRSTO. Ireland, Lithuania, Belgium, Greece and Luxembourg recorded shares of more than 60 % of professionals in their HRSTO populations.

Ireland, Belgium, Iceland, Romania, Finland, Poland, Spain, the United Kingdom and Greece registered shares of more than 20 % of scientists and engineers.

At the other end of the scale, Slovakia, Italy, Norway, the Czech Republic and Austria registered less than 40 % of professionals in their HRSTO populations. The shares of the particular population of scientists and engineers are likewise the lowest among the countries under review.

Figure 4.18: Share of employed HRST that have a tertiary education in "science and engineering" fields, by occupation, as a percentage of labour force, EU-27 and selected countries — 2007



Note:
Exceptions to the reference year: 2005: IE, HR;
2006: IS.
Data for technicians are not publishable for MT and IS because of lack of reliability due to reduced sample size.
Data lack reliability due to reduced sample size but are publishable: EE and MT for professionals, EE, LT and LU for technicians.

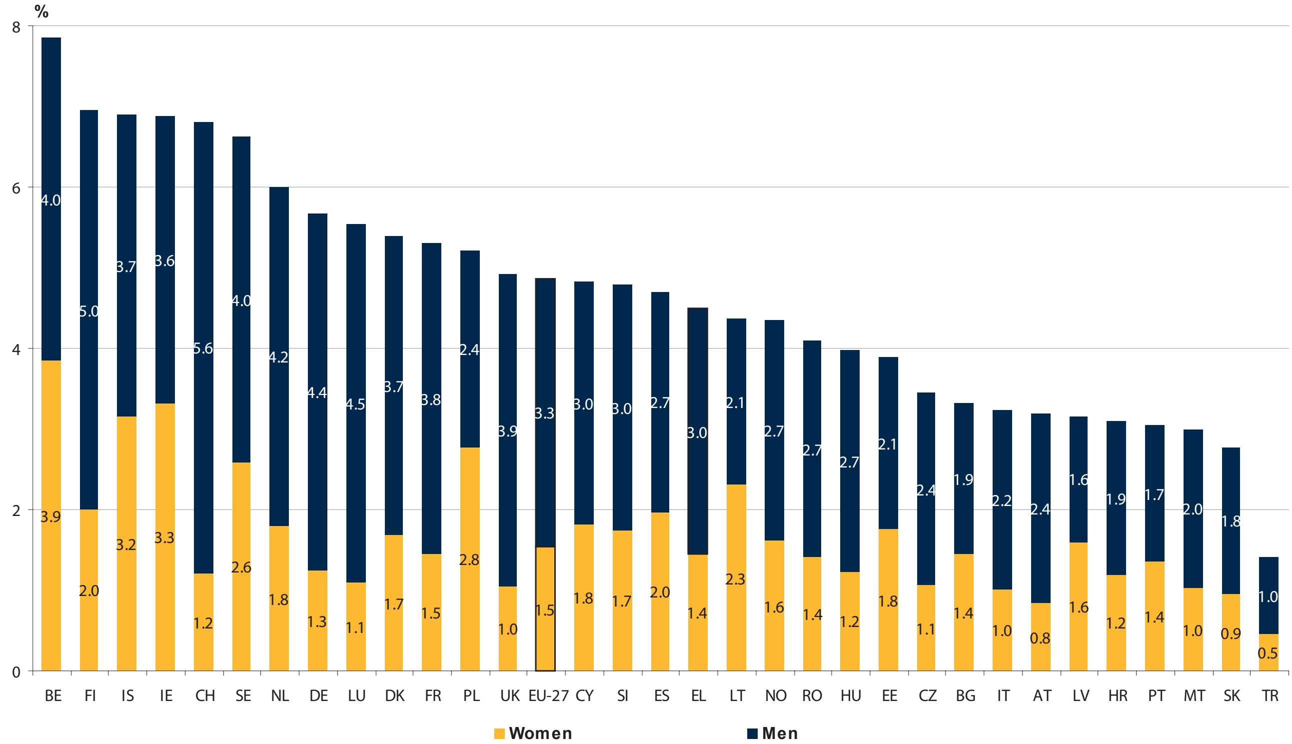
Source: Eurostat (hrst_st_nfieocc)

Figure 4.18 looks at the percentage of persons with tertiary education in science and engineering fields in the two S&T occupations ('professionals' and 'technicians and associate professionals'). Science and engineering fields of education are made up by: 'science, mathematics and computing' and 'engineering, manufacturing and construction'.

30 % of 'professionals' in the EU had a tertiary education in a 'science and engineering' field compared to 24 % of persons working as 'technicians and associate professionals'. In most countries studied, the percentage with a tertiary education in 'science and engineering' was higher among 'professionals' than among 'technicians and associate professionals'. Romania recorded the highest share among its professionals (43 %), followed by France (38 %) and Switzerland (38 %).

Despite this, nine countries had a larger share of tertiary educated graduates in 'science and engineering' among 'technicians and associate professionals' than among 'professionals'. This was especially the case in Austria, the Czech Republic, Slovakia and Belgium, where at least 35 % of all 'technicians and associate professionals' had tertiary education in 'science and engineering'. The other countries with a higher share among 'technicians and associate professionals' were Ireland, Spain, Croatia, Turkey and the Netherlands.

Figure 4.19: Breakdown of scientists and engineers (S&E) aged 25-64 years by sex, as a percentage of the total labour force, EU-27 and selected countries — 2007



Note:
Data lack reliability due to reduced sample size but are publishable: EE and MT.
Exceptions to the reference year: 2006: IS and HR.

Source: Eurostat (hrst_st_ncat)

Scientists and engineers (S&E) are an HRST subset of particular interest.

Figure 4.19 presents the percentage of scientists and engineers in the labour force and also adds their gender distribution.

The highest proportion of scientists and engineers was found in Belgium, where they accounted for almost 8 % of the labour force. In Slovakia and Turkey, this proportion fell to under 3 % of the labour force.

In most of the countries under review, scientists and engineers were more likely to be male than female. The gender gap was especially wide in Switzerland, where male scientists and engineers accounted for 5.6 % of the total labour force and women accounted for 1.2 %. Notable exceptions were Poland and Lithuania, where scientists and engineers were more likely to be female.

EUROPEAN PLATFORM OF WOMEN SCIENTISTS - EPWS

"Women working in science are still significantly under-represented, despite the fact that the number of European women graduates has risen to slightly more than 50 %, which corresponds to their overall share in the population. With this in mind, achieving equal and full participation of women in science is a priority of the European Commission in order to safeguard European excellence in science. Networking has been identified as an essential empowerment tool for women scientists to participate in the policy debate and to enhance their professional and career advancement.

The purpose of having the EPWS is to build a structural link between women scientists and research policy makers. The aim is to introduce a new key strategic actor into the research policy debate by making the voice of women scientists heard.

EPWS activities are supported by the European Commission under the 7th Framework Programme of Research and Technological Development (FP7)."

Source: http://www.epws.org/

Table 4.20: Persons employed as professionals or technicians with tertiary level education (HRSTC), as a percentage of total employment, aged 25-64 years, in selected sectors of economic activity, EU-27 and selected countries — 2007

		Manufacturing			Services	
	All sectors	High-tech manufacturing	Medium high-tech manufacturing	Low and medium low-tech manufacturing	Knowledge-Intensive Services (KIS)	Less knowledge intensive services
EU-27	16.3 i	20.0 i	14.4 i	5.9 i	28.8 i	8.6 i
BE	22.2	27.6	17.1	9.6	32.6	8.6
BG	15.8	:u	9.4	4.3	31.8	9.7
CZ	11.0	9.6	5.8	3.4	28.4	6.0
DK	21.5 b	25.2 b	18.8 b	9.0 b	30.0 b	10.5 b
DE	17.4	22.6	19.1	5.7	28.4	10.3
EE	17.4	:u	:u	:u	:u	14.3
IE	16.2	19.6	19.8	7.0	24.9	4.4
EL	17.3	20.7 u	15.6	5.9	30.8	7.5
ES	17.7	25.6	16.6	7.1	39.6	8.4
FR	18.1	30.0	18.8	8.0	34.9	9.5
IT	12.1	11.5	6.7	2.9	21.0	4.6
CY	19.8	:u	:u	6.0	43.5	9.8
LV	13.9	:u	:u	7.4	18.2 u	12.0
LT	17.5	:u	:u	6.7 u	28.5 u	13.6
LU	25.9	:u	:u	13.6	44.1	18.2
HU	14.7	8.0	6.7	4.0	28.9	8.1
MT	10.9	:u	:u	:u	:u	3.6 u
NL	20.7	23.5	16.7	8.7	28.3	10.0
AT	11.1	15.0	9.7	4.0	15.3	5.8
PL	15.3	9.8 u	11.8	5.3	30.5	11.2
PT	10.4	: u	7.0	2.6	23.6	5.1
RO	10.4	21.1 u	12.2	5.9	31.2	10.7
SI	17.4	14.1 u	11.0	6.4	26.3	14.8
SK	11.5	6.9	5.8	3.9	27.6	7.2
FI	22.7	37.4	19.9	10.7	31.7	14.0
SE	23.2	24.0	13.9	6.5	38.0	13.7
UK	16.8	18.4	13.2	8.1	22.8	6.8
TR	7.0	9.9	5.8	1.9	16.4	4.6
NO	24.8	47.1	17.2	8.3	42.8	12.2
CH	19.7	18.1	23.0	7.1	30.9	11.1

Source: Eurostat (hrst_st_nsec)

HRSTC 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 and work in S&T occupations (share of HRSTC). In turn, this can be used as a proxy for knowledge intensity in each sector of economic activity.

Table 4.20 shows the HRSTC intensity in specific sectors of economic activity classified according to NACE Rev. 1.1.

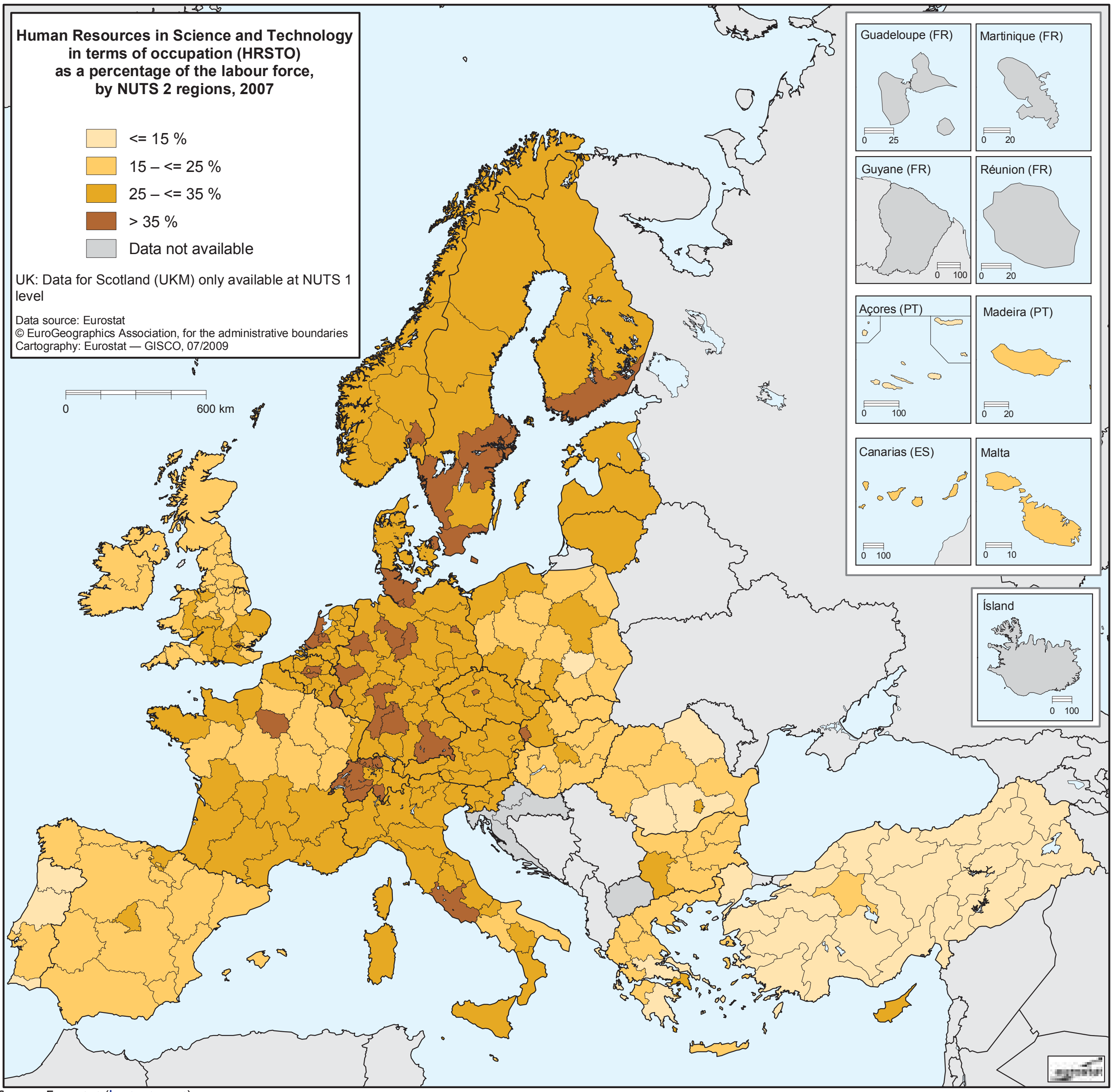
Among the persons in the EU that were employed in Knowledge-Intensive Services (KIS) — which cover activities related for example to post and telecommunications, computer and related activities and research and development (see methodological notes) — 28.8 % had tertiary education and worked in an S&T occupation. In this context, Luxembourg recorded the highest share (44.1 %), followed by Cyprus (43.5 %) and Norway (42.8 %), while Austria recorded the lowest (15.3 %).

'High-tech manufacturing' was the second sector in terms of high HRSTC intensity, with an average EU rate of 20 %. In Norway 47.1 % of the persons employed in this sector had completed tertiary education and were working in an S&T occupation. Finland, France and Belgium followed, with somewhat lower proportions (37.4 %, 30.0 % and 27.6 % respectively). In contrast, Slovakia scored the lowest HRSTC intensity in 'High-tech manufacturing', with 6.9 %. In addition, this country recorded the lowest proportion in all manufacturing sectors except in 'Low and medium low-tech manufacturing', where Italy, Poland, Portugal, the Czech Republic and Turkey recorded lower shares.

Of the aggregates listed, 'Medium high-tech manufacturing' is the third highest in terms of HRSTC intensity, with 14.4 % of HRST in total employment, followed by 'Less knowledge intensive services' and 'Low and medium low-tech manufacturing'.

4.3.2 HRST stocks at regional level

Map 4.21: Human Resources in Science and Technology in terms of occupation (HRSTO) as a percentage of the labour force, by NUTS 2 regions — 2007



Source: Eurostat (hrst_st_rcat)

Map 4.21 illustrates the regional distribution of human resources employed in S&T (HRSTO), as a percentage of the total labour force, at NUTS 2 level in 2007.

The map reveals marked differences, with certain regions concentrating larger shares of HRSTO among the workforce, especially in Scandinavia and in central Europe.

The Prague region in the Czech Republic recorded the highest proportion of HRSTO among the labour force, with 51.6 %. A few other regions recorded HRSTO shares of more than 40 %, including Stockholm (SE), Oslo og Akershus (NO), Hovedstaden (DK), Zürich (CH), Bratislavsky kraj (SK), Utrecht (NL), Berlin (DE) and Oberbayern (DE).

At the other end of the scale there are regions with relatively low shares of HRSTO in total employment, not exceeding 15 %. In Turkey this percentage was below 15 % in all regions except for the capital region. Romania, Portugal, Greece and Poland also reported regions with shares of HRSTO below 15 %. In Romania, the regional shares ranged from 13.5 % to 18.1 %, except in the capital region, where it rose to 34.8 %.

Portugal and Greece also had similar results, with HRSTO shares of under 20 %, except in the capital regions, where the figure rose to 24.9 % and 27.2 % respectively.

Table 4.22: The top 30 regions in the EU and selected countries ranked according to the proportion of employed HRSTC, in thousands and as a share of total employment in manufacturing and in services, NUTS 1 levels — 2007

		Regions - NUTS 1	Total manufacturing				Regions - NUTS 1	Total services	
			1000s	% of total employment in manufacturing				1000s	% of total employment in services
	EU-27		3 696	9.3		EU-27		30 065	20.9
1	FR	Île de France	177	31.3	1	ES	Noreste	404	31.4
2	DE	Berlin	40	25.6	2	DE	Berlin	384	31.1
3	UK	London	62	22.7	3	NO	Norway	567	31.0
4	BE	Région de Bruxelles-capitale	5	21.7	4	SE	Östra Sverige	426	31.0
5	ES	Comunidad de Madrid	66	19.8	5	LU	Luxembourg	50	30.5
6	FI	Manner-Suomi	74	16.4	6	BE	Région Wallonne	292	29.8
7	BE	Région Wallonne	29	16.2	7	PL	Region Centralny	614	29.8
8	SE	Östra Sverige	30	16.2	8	BE	Région de Bruxelles-Capitale	96	29.1
9	UK	South East (England)	74	15.7	9	SE	Södra Sverige	406	28.6
10	DE	Schleswig-Holstein	28	15.6	10	ES	Comunidad de Madrid	658	28.1
11	FR	Sud-Ouest	60	15.3	11	FI	Manner-Suomi	474	27.9
12	DE	Baden-Württemberg	259	15.2	12	NL	West-Nederland	846	27.8
13	ES	Noreste	66	14.9	13	LT	Lithuania	250	27.7
14	FR	Est	77	14.8	14	BG	Yugozapadna i Yuzhna Tsentralna Bulgaria	273	27.5
15	DE	Sachsen	54	14.5	15	FR	Île de France	1 099	27.5
16	LU	Luxembourg	2	14.4	16	EE	Estonia	98	27.0
17	CH	Switzerland	89	14.4	17	BE	Vlaams Gewest	514	26.9
18	FR	Centre-Est	86	14.2	18	HU	Kozep-Magyarorszag	250	26.8
19	NL	West-Nederland	50	13.6	19	UK	London	773	26.8
20	DK	Denmark	58 b	13.6 b	20	DE	Sachsen	345	26.8
21	NO	Norway	37	13.4	21	CY	Cyprus	73	26.6
22	DE	Bayern	221	13.3	22	EL	Voreia Ellada	220	26.5
23	IE	Ireland	35	13.2	23	SI	Slovenia	141	26.4
24	EL	Attiki	31	13.0	24	DK	Denmark	534 b	26.4 b
25	DE	Hessen	75	13.0	25	EL	Attiki	335	26.1
26	DE	Rheinland-Pfalz	57	12.8	26	DE	Brandenburg	218	25.9
27	ES	Noroeste	40	12.8	27	SE	Norra Sverige	148	25.3
28	UK	Scotland	33	12.6	28	ES	Noroeste	294	25.1
29	BE	Vlaams Gewest	66	12.5	29	PL	Region Wschodni	326	25.0
30	UK	North East (England)	19	12.0	30	ES	Centro	347	24.6

Note:
At NUTS 1 level the following countries are classified as regions: CY, CZ, DK, EE, IE, LT, LU, LV, MT, SI, SK, CH and NO.
Data not available: HR, LI, IS and MK.
Due to the small sample size data cannot be published for the following regions: DE4, DE5, DE6, DE8, DEC, DEE, DEG, FI2, GR4, MT0, PT2, PT3, TR9, TRA, TRB, TRC, UKN.

Source: Eurostat (hrst_st_rsect)

Table 4.22 provides a ranking of the top 30 regions in the EU, Norway, Switzerland and Turkey according to the proportion of persons with tertiary education and employed as professionals or technicians (HRSTC) among total employment in the manufacturing and service sectors. Results are given at NUTS 1 regional level for 2007.

The share of HRSTC working in the service sector was much higher than in manufacturing (20.9 % in services and 9.3 % in manufacturing). Noreste (ES) recorded the highest proportion of HRSTC employed in the service sector (31.4 %). Île de France (FR) recorded the highest proportion of HRSTC employed in manufacturing industry, with 31.3 %.

Five of the top 10 regions with the highest proportion of HRSTC working in manufacturing were also among the top 10 regions in services: Berlin (DE), Région de Bruxelles-Capitale (BE), Comunidad de Madrid (ES), Région Wallonne (BE) and Östra Sverige (SE).

The top 30 regions employing HRSTC in the manufacturing sector include seven regions in Germany, four in France and four in the United Kingdom. Spain was the most represented country in services, with four regions, followed by Belgium, Sweden and Germany, with three regions each.

4.4 Mobility

4.4.1 Job-to-job mobility

Table 4.23: Job-to-job mobility of employed HRST, by age group, by gender, and by sector of economical activity (manufacturing and services) as a percentage of respective employed HRST population, EU-27 and selected countries — 2007

	Job-to-job mobility						
	Female	Male	25 to 34 years old	35 to 44 years old	45 to 64 years old	Total manufacturing	Total services
BE	6.5	7.0	12.4	6.0	2.7	1.1	5.2
BG	:	:	:	:	:	:	:
CZ	4.4	4.9	7.3	3.8	3.2	0.8	3.4
DK	13.9	14.5	19.1	16.1	9.6	1.7	11.7
DE	5.5	5.6	11.0	5.9	2.5	0.8	4.4
EE	7.4 u	:u	10.5 u	:u	:u	:u	5.2 u
IE	:	:	:	:	:	:	:
EL	3.8	2.9	5.7	3.0	1.3	0.2 u	3.0
ES	9.5	9.5	15.9	7.7	3.3	1.1	7.1
FR	5.8	7.2	11.3	6.3	2.4	1.1	5.0
IT	5.8	4.5	9.6	5.1	2.1	0.7	4.1
CY	9.7	8.5	14.1	7.2	4.8	:u	8.1
LV	6.7	8.9	9.8	9.0	4.7 u	:u	5.8
LT	5.6	6.9 u	9.5 u	6.5 u	3.1 u	:u	4.6
LU	5.3	5.3	8.8	5.2 u	2.1 u	:u	5.0
HU	3.8	4.2	6.8	3.2	2.1	0.7	3.0
MT	:u	6.5 u	:u	:u	:u	:u	4.7 u
NL	8.1	9.0	15.0	8.6	4.2	0.7	6.9
AT	6.0	6.7	11.7	6.0	2.8	1.0	4.9
PL	5.6	7.8	10.8	4.4	2.9	1.0	5.0
PT	5.7	5.7	9.6	4.7	:u	:u	4.9
RO	3.5	3.9	5.5	3.1	2.1	0.6 u	2.7
SI	6.9	7.1	12.7	4.8	3.5	1.2	5.5
SK	3.6	4.5	6.1	3.8	2.4	0.8	2.8
FI	9.7	8.3	14.4	10.0	5.4	1.3	7.1
SE	4.6	5.7	8.6	5.6	2.9	0.5	4.4
UK	8.6	9.2	13.5	8.7	5.8	0.9	7.3
NO	11.3	14.2	20.2	13.6	7.0	1.1	10.8
TR	7.2	6.8	9.5	4.8	3.3	1.2	5.2

Source: Eurostat (hrst_fl_mobsex, hrst_fl_mobage, hrst_fl_mobsect)

Table 4.23 presents employed HRST aged 25-64 years that changed jobs in 2007, broken down by age group.

Women tend to be more mobile than men in a few countries, namely Greece, Italy, Cyprus, Finland and Turkey. The greatest discrepancy in job mobility was found in Norway, Poland and Latvia (in favour of men).

Denmark registered the highest proportion of job-to-job mobility in the EU-27 among the population aged 25-34 years (19.1 %). This number is the highest number for all age groups at EU level, but in Norway mobility in this age group was even higher (20.2 %). In Spain and the Netherlands, the proportion of people aged 25-34 changing jobs was also at least 15 %.

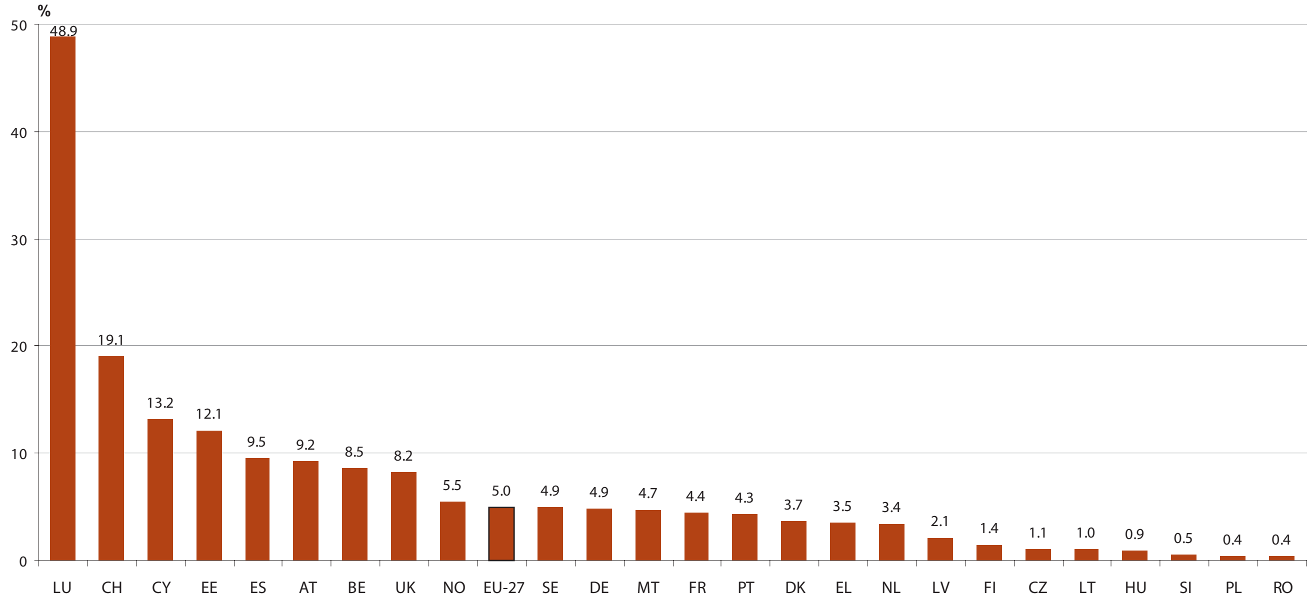
In contrast, Greece and Romania recorded comparably low percentages (only 5.7 % and 5.5 % respectively).

Job-to-job mobility tends to decrease with age and in the data displayed this is the case for all countries without exception. Looking at the oldest age group, mobility did not reach 10 % in any country, even if Denmark again showed a high share (9.6 %).

HRST working in services are more mobile than HRST working in manufacturing. This is the case for all countries studied and the difference is especially large in Denmark and Norway.

4.4.2 International mobility

Figure 4.24: Share of non-nationals in HRST, aged 25-64 years, EU-27 and selected countries — 2007



Note:
Data lack reliability due to reduced sample size but are publishable: LT, MT, PL, RO and SI.
Data are not published for BG because of lack of reliability due to reduced sample size.
Data for IE, SK and TR are not available.

Source: Eurostat (hrst_st_nnat)

Figure 4.24 reveals the percentage of HRST having different citizenship than that of the country of residence. Big disparities among the countries can be observed in the share of non-nationals among HRST.

In 2007, non-nationals accounted for an average of 5 % of the HRST population in the EU. This share was below 10 % in all but four of the countries under review. In Luxembourg, almost half of all HRST were of different nationality than the country of residence. A high proportion of foreign HRST was also recorded in Switzerland, with a share of 19.1 %.

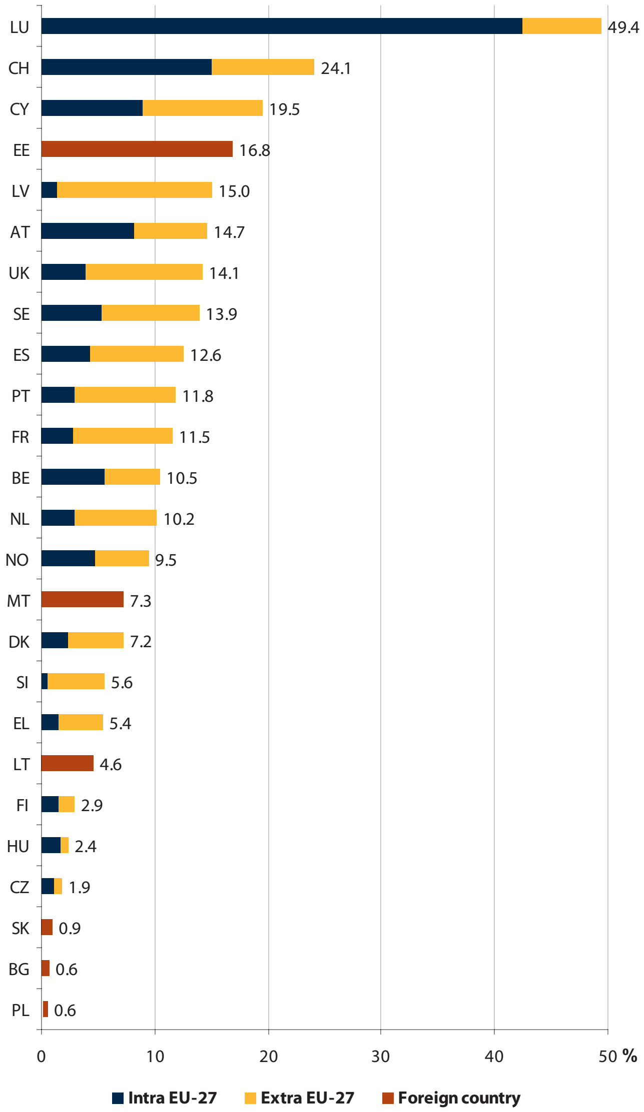
In Hungary, Slovenia, Poland and Romania, non-nationals comprised less than 1 % of the HRST population.

Determinants of migration of human capital and high skill individuals

"The factors influencing international migration (such as relative income differentials, immigration policies in the country of destination, state of the business cycle, network effects, others), in principle, are applicable to individuals of different skills. However, some factors (costs of migrating, importance of network effects, cultural barriers, etc.) are probably more relevant for the unskilled migrant than for the emigration of individuals with a high stock of human capital. The decision to emigrate for students, scientists and professionals has some specific traits that need to be mentioned, besides the standard determinants of migration that we listed before. These people leave their home countries for a variety of reasons: the possibility of acquiring knowledge and first rate education in the best centres of the world (for students), the lure of interacting with peers of international recognition, the aim of pursuing a successful career abroad (for scientists, researchers and professionals). Individual researchers benefit from interacting with a critical mass of other researchers and scientists working in the same field. Intellectual creation is rarely a purely individual endeavour. Therefore, the productivity of human capital depends, positively, on the availability of human capital. In other words, there are increasing returns in knowledge creation. Matching complementarities and increasing returns are thus an essential part of the story of emigration of human capital."

Source: International Mobility of the Highly Skilled: The case between Europe and Latin America
http://www.andressolimano.com/articles/migration/International%20mobility,%20BID%202004.pdf

Figure 4.25: HRST by country of birth, EU-27 and selected countries — 2007



Note:
Data not available: DE, IE, RO and TR.
Owing to many missing or unreliable data the EU aggregate was not calculated.
Breakdown by country of birth (EU and non-EU born) not available for EE, MT, LT, SK, BG and PL.
Data lack reliability due to reduced sample size but are publishable: LV, PL, SI for intra EU-27 born, MT for extra EU-27 born, BG for foreign born.

Source: Eurostat (hrst_st_ncob)

IIn Figure 4.25, Luxembourg stands out as nearly half of its HRST population was born in another country (49.4 %). By comparison, Poland and Bulgaria are at the other end of the scale, with shares of foreign-born HRST of only 0.6 %. In the Member States that joined the EU in 2004 (with the exception of Cyprus, Estonia, Latvia and Malta), the shares of foreign-born HRST are comparatively low (below 6 %).

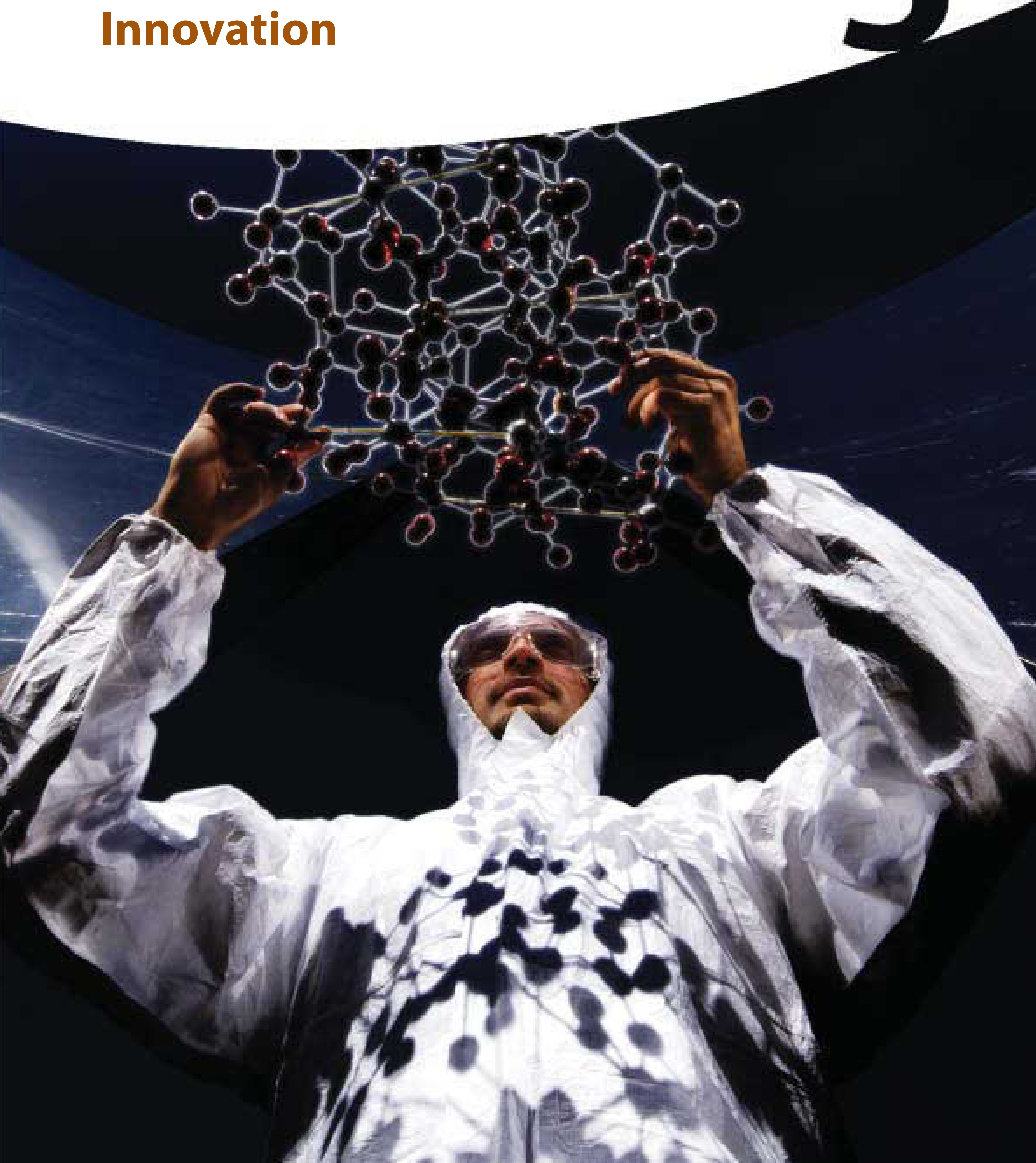
In Luxembourg, the large majority (around 80 %) of the foreign-born HRST were born in another EU Member State. In Latvia, nine out of ten foreign-born HRST were born in a country outside the EU. The majority of the foreign-born HRST in Latvia, Estonia and Lithuania are of Russian origin.

III

Productivity and competitiveness

5

Innovation



5.1 Introduction

Innovation is a continuous and dynamic process which is difficult to measure easily and accurately. The Community innovation survey (CIS) was created to complement 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 gain a better understanding of innovation and how it relates to economic growth.

This chapter begins by providing general information on the Community innovation surveys (methodology, history and other innovation surveys).

Following this, detailed results of the most recent survey (CIS 2006) will be presented.

The last part of the chapter provides a brief comparison of CIS 2006 and CIS 4.

5.2 Community innovation survey

5.2.1 CIS 2006

The Community innovation survey (CIS) is a survey designed to monitor the progress of innovation activity in Europe.

The innovation policies in the Member States and the European Union must be founded on 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 (including competitiveness, employment, economic growth, trade patterns, etc.). Data collections and analyses are supported by various Community RTD Framework Programmes. Since 2000, the CIS has also become a major data source for the "European Innovation Scoreboard". To ensure the timely updating of the scoreboard, the Commission has asked Member States to carry out the CIS more frequently.

Since 2004 the frequency of Community innovation surveys has increased, with a full survey conducted every four years and a reduced survey two years after each full survey. Reduced surveys do not require countries to provide data for all indicators, as some of them are voluntary. For this reason, and also due to derogations granted by the Commission, geographical coverage for the CIS varies across indicators, and for many of them it is not possible to calculate an EU-27 aggregate value.

CIS 2006 was a reduced survey carried out in 2007 the 27 EU Member States, two candidate countries (Croatia and Turkey) and Norway, based on the reference year 2006.

In order to ensure comparability across countries, Eurostat, in close cooperation with the EU Member States and other countries, developed standard core questionnaires for CIS 2006, with an accompanying set of definitions and methodological recommendations.

The basis for CIS 2006 is the second edition of the *Oslo Manual* (1997) which provides methodological guidelines and defines the concept of innovation, and Commission Regulation (EC) No 1450/2004.

On 22 July 2005, the European Commission granted a derogation to France in respect of CIS 2006 data. As a result, CIS 2006 data for France cover only the manufacturing sector (NACE D) for enterprises with more than 50 employees.

Data collections are carried out by the statistical offices or competent research institutes in the Member States. The results of these surveys are handled at national level using a common methodology and are further processed by Eurostat to increase cross-country comparability. In order to ensure strict confidentiality of data relating to enterprises, the micro-level database is restricted and is only accessible to Eurostat staff.

It should be noted that CIS 2006:

- uses the same main characteristics as CIS 4 (such as the survey questionnaire and the survey methodology);
- is widely implemented at national level, often on a voluntary basis;
- adds pilot modules on organisational and marketing innovations, as well as on knowledge flows — with a view to preparing CIS 2008.

The CIS 2006 was launched at national level in 2007. The deadline for data transmission as stated in the annex to the Commission Regulation on innovation statistics was 30 June 2008. Data for all participating countries have been officially available since October 2008.

The *Oslo Manual* has been revised in order to take account of new orientations of European innovation policy. Among other aspects, the next CIS should contribute to a better understanding of the "non-technical" aspects of innovation, such as management techniques and organisational change, as well as design and marketing issues. The third edition of the Oslo Manual (2005) will be used for CIS 2008.

In addition to CIS 2006, Eurostat — in close cooperation with the Member States — has launched CIS 2008, which will include the following points:

- CIS 2008 will be based on the new edition of the *Oslo Manual* (2005).
- Eco-innovation will be included as a pilot module in the CIS 2008 data collection.

CIS 2008, which is currently being launched, is a full survey covering data for the observation period 2006–2008 and the reference year 2008. The deadline for data transmission set out in the annex to the Commission Regulation on innovation statistics is 30 June 2010.

5.2.2 A history of Community innovation surveys

Since the beginning of the 1990s, there have been five Community Innovation Surveys, all of which were based on the most recent available version of the *Oslo Manual*. With each round, the scope of the surveys was expanded, and the number of participating countries increased.

The first Community innovation survey (CIS) covered 40 817 enterprises in 13 European countries (Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Norway, Portugal, Spain, the Netherlands and the United Kingdom). It was conducted in 1993 and covered innovative activities during the three-year period from 1990 to 1992. CIS 1 was limited to the manufacturing sector.

The second round, CIS 2, which was conducted in 1997 and completed in 1999, included 11 667 services firms and 27 102 manufacturing firms. More countries participated than in the first survey (Austria, Iceland, Finland and Sweden were added). The survey covered activities from 1994 to 1996. CIS 2 was based on the 1997 revision of the *Oslo Manual*, and its scope was extended to include selected service sector industries. Different surveys were used for manufacturing and services industries. Wide variations in the share of innovative firms were noted in CIS 2 data across EU countries, industries and sectors. Just over half (51 %) of EU manufacturing enterprises were innovative in 1994-96, compared to 40 % of services enterprises. The share of innovators in manufacturing ranged from 26 % to 73 % in Portugal and Ireland respectively, and in services from 13 % to 58 % in Belgium and Ireland respectively.

The third round, CIS 3, was launched in 2001 and the results were delivered in 2002. It covered innovation activities from 1998 to 2000 for the same countries as CIS 2. Compared to its predecessor, a larger number of firms (64 000 enterprises) were sampled. The scope of CIS 3 was expanded to include manufacturing and all services sectors.

CIS 2 and CIS 3 were substantially different in a number of ways. Because countries were not required to implement CIS 3, no common questionnaire or collection methodology was used. Owing to conceptual and methodological differences, therefore, it is difficult to compare results between countries for CIS 3 and between CIS 3 and CIS 1 or CIS 2 within the same country.

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

Roughly 40 % of enterprises in 16 countries had innovating activities, ranging from 28 % in Greece to 51 % in Germany. As with CIS 2, substantial discrepancies were found between countries in all CIS innovation indicators. Strategic and organisational changes, measured for the first time in CIS 3, are found more often in businesses with innovative activities than in businesses without such activities.

Definitional and methodological issues may contribute to the wide variations in reported shares of innovative firms, over and above actual differences in innovative behaviours. Non-technological innovations, such as organisational changes, are widespread and are probably linked to technological innovations, particularly in services; however, these were not measured in CIS 2. The definition of the term "technological" presented some difficulties, as its interpretations may vary slightly when translated into different languages, and some countries did not use the word in their questionnaires. Response rates for CIS 3 ranged from 20 % – 30 % in Belgium, Denmark, and Germany to more than 80 % in France and Norway. Some of the differences in response rates may be due to discrepancies in collection methodologies. For example, CIS 3 was mandatory in five countries (Norway, Spain, France, Italy and Sweden), two of which reported the highest response rates (France and Norway), but elsewhere it was voluntary. The analysis of non-response for CIS 3 reveals differences between responders and non-responders for some countries, but no bias in aggregate data.

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

The following full survey, CIS 4, was conducted in 2005 covering the EU Member States, candidate countries, Iceland and Norway. The observation period covered by the survey was 2002-2004, i.e. the three years from the beginning of 2002 to the end of 2004. The reference year for CIS 4 was 2004.

The CIS 4 survey was 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 sole legal basis for the previous surveys was a gentlemen's agreement.

The methodological basis of the CIS was provided by the *Oslo Manual*, a joint publication produced by Eurostat and the OECD. CIS 4 goes beyond the scope of the 1997 *Oslo Manual* (second edition) to include innovative activities such as organisational innovation, which is included in the 2005 revision, but in general it remains largely based on the second edition of the *Oslo Manual*.

The survey asked for information about product & process innovation and organisational & marketing innovation. CIS 4 collected information on a number of dimensions of innovation, including the number of enterprises that had introduced new or improved products or processes within the company, and the number of enterprises that had introduced at least one innovation. The CIS distinguished between innovations that are new to the enterprise and those that are new to the market.

For the purposes of the survey, enterprises were classified as follows:

All enterprises
- Enterprises with innovation activity
  - Product and/or process innovator
    - Product innovator only
    - Process innovator only
    - Product and process innovator
  - Enterprises with only ongoing and/or abandoned innovation activities
- Non-innovative enterprises

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

The CIS 4 questionnaire not only focused on product and process innovation, but also looked at the effects of innovation, the sources of information for innovation activities, such as cooperation, as well as the factors hampering innovation. It was shorter than the CIS 3 questionnaire and the participating countries found it less difficult to reply to.

In 2006, Eurostat — in close cooperation with the Member States — prepared the next CIS based on the reference year 2006 ("CIS 2006"). It was decided that CIS 2006 should adopt a fairly conservative approach by using the same harmonised survey questionnaire and methodology as for CIS 4 (2004).

As the questionnaire and methodology have been left unchanged from CIS 4 (2004) to CIS 2006, it will be possible to compare data and analyse trends by looking at the results from CIS 3, CIS 4 and CIS 2006.

The pilot modules on marketing and organisational innovations include questions on whether these new types are integrated or linked with product or process innovations. This type of data can potentially provide a number of insights on how innovation activities (and thus also knowledge transfers) are linked between firms and to what extent innovation projects span more than one 'area'.

5.2.3 Innovation surveys in other countries

In the last twenty years a number of countries have launched innovation surveys; they include:

- Canada, United States
- Switzerland
- Australia, New Zealand
- Argentina, Brazil, Chile, Colombia, Mexico, Peru, Uruguay, Venezuela
- China, Japan, Malaysia, Russia, Singapore, South Korea, Taiwan, Thailand
- South Africa

In many of these countries the survey was only a one-off exercise, which was not intended to be repeated at regular intervals. Moreover, some countries preferred to include the data collection on innovation in other surveys, such as R&D or general economic surveys.

For these reasons, a limited number of examples are provided below.

Australia

Australia conducted several innovation surveys between 1993 and 2008.

The 2003 survey covered more industries, excluded businesses with fewer than 5 employees, and was rolled out to a stratified random sample of businesses. The 2003 survey was based on the 1997 *Oslo Manual*, and was therefore comparable with the CIS surveys. Australia expanded the scope of its 2003 survey by including questions on non-technological innovation.

The *Oslo Manual*, updated in 2005, forms the basis of the concepts and definitions used to measure the incidence of innovation in Australian business using the Business Characteristics Survey (BCS). The BCS collects information about the broad types and status of innovation undertaken by Australian business in the 12-month reference period.

According to figures released by the Australian Bureau of Statistics (ABS), in 2006/07 over one third (37 %) of Australian businesses reported some form of innovation.

Over 25 % of businesses claimed that a lack of skilled staff significantly hampered their ability to innovate. Other findings include the following:

- The Information Media and Telecommunications industry had the highest proportion of innovation activity (52 %).
- Information technology skills (35 %) were the most commonly used for innovation purposes.
- Introduction of goods or services that were new-to-the-world was reported by 9 % of innovative businesses.
- More than three quarters (76 %) of innovative businesses claimed that the most common driver of innovation was profit-related.

Source: ABS ITU Bulletin 14, August 2006 and http://www.abs.gov.au/

Canada

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

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

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

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

Source: Canada Statistics, http://www.statcan.gc.ca/

New Zealand

'Innovation in New Zealand: 2007' gives a statistical picture of business innovation and performance in New Zealand. Innovation is defined as the introduction of any new or significantly improved good, service, process or marketing method.

Economic growth and development depends on the generation, exploitation and dissemination of new knowledge, methods, processes and products. Policymakers need quantitative and qualitative data to understand the nature of innovation and the way it changes over time, the mechanisms that foster or hinder the innovation process, and the effect of innovation on business performance.

The Business Operations Survey 2007 was conducted in August 2007. The survey had a modular design and included an innovation module (sponsored by the Ministry of Research, Science and Technology) and a business performance module. The modular design makes it possible to analyse the effect of businesses' practices on their performance.

Source: http://www.stats.govt.nz

South Africa

The Centre for Science, Technology and Innovation Indicators (CeSTII) conducted the first official South African Innovation Survey.

The broader objectives of the South African innovation survey 2005 are to:

- produce a set of internationally comparable data and indicators for 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,
- gain 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 has worked closely with the OECD and Eurostat in this respect.

Nearly 52 % of South African enterprises had technological innovation activities, comprising both product (goods and services) and process innovations. A further 11 % of enterprises recorded 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 for 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

United States

The new Business R&D and Innovation Survey (BRDIS) covers a variety of data on the R&D activities of companies operating in the United States. The five main topic areas are financial measures of R&D activity; company R&D activity funded by others; R&D employment; R&D management and strategy; and intellectual property, technology transfer and innovation.

Source: http://www.nsf.gov

European Institute of Innovation and Technology

"The European Institute of Innovation and Technology (EIT) is to be a key driver of sustainable European growth and competitiveness through the stimulation of world-leading innovations with a positive impact on economy and society.

The mission of the EIT is to grow and capitalise on the innovation capacity and capability of actors from higher education, research, business and entrepreneurship from the EU and beyond through the creation of highly integrated Knowledge and Innovation Communities (KICs).

Innovation: key for our future

Innovation is the key to growth, competitiveness and thus social well-being in the 21st century. The capacity of a society to innovate will be crucial in an ever more knowledge-intensive economy. Innovation is also necessary in order to find new and lasting solutions to major global challenges, such as energy, climate change, or the future of information and communication. The European Institute of Innovation and Technology (EIT) is a new initiative which aims to become a flagship for excellence in European innovation in order to face these common challenges.

Boosting European innovation

Europe could still do much better in innovation. Although there are excellent European education and research institutions, they are often rather isolated from the business world and do not achieve the "critical mass" necessary for innovation. The EIT is set to overcome these shortcomings through a novel approach: it is the first European initiative to integrate fully the three sides of the "Knowledge Triangle" (Higher Education, Research, Business-Innovation). Concretely, this means the EIT will allow Europe's excellent universities, research centres, businesses and other innovation actors to grow and capitalise on their innovation capacity and capability. In doing so, the EIT seeks to stand out as a world-class innovation-orientated reference model, inspiring and driving change in existing education and research institutions.

Tangible economic outcomes

By boosting the EU's capacity to transform education and research results into tangible commercial innovation opportunities, the EIT will further bridge the innovation gap between the EU and its major international competitors. The EIT will favour sustainable economic growth and job creation throughout the Union by generating new products, services and markets responding both to public demand and to the needs of the knowledge economy.

Based on "Knowledge and Innovation Communities" (KICs) — highly integrated public-private partnerships of universities, research organisations and businesses — the EIT's activities will be coordinated by a Governing Board ensuring its strategic management. Direct involvement of business stakeholders, including SMEs, in all strategic, operational and financial aspects of the Institute is the cornerstone of the initiative."

Source: http://eit.europa.eu/home.html

5.3 Results of CIS 2006

The presentation of the CIS 2006 results by country follows the structure of the underlying questionnaire quite closely.

5.3.1 General information about the enterprises

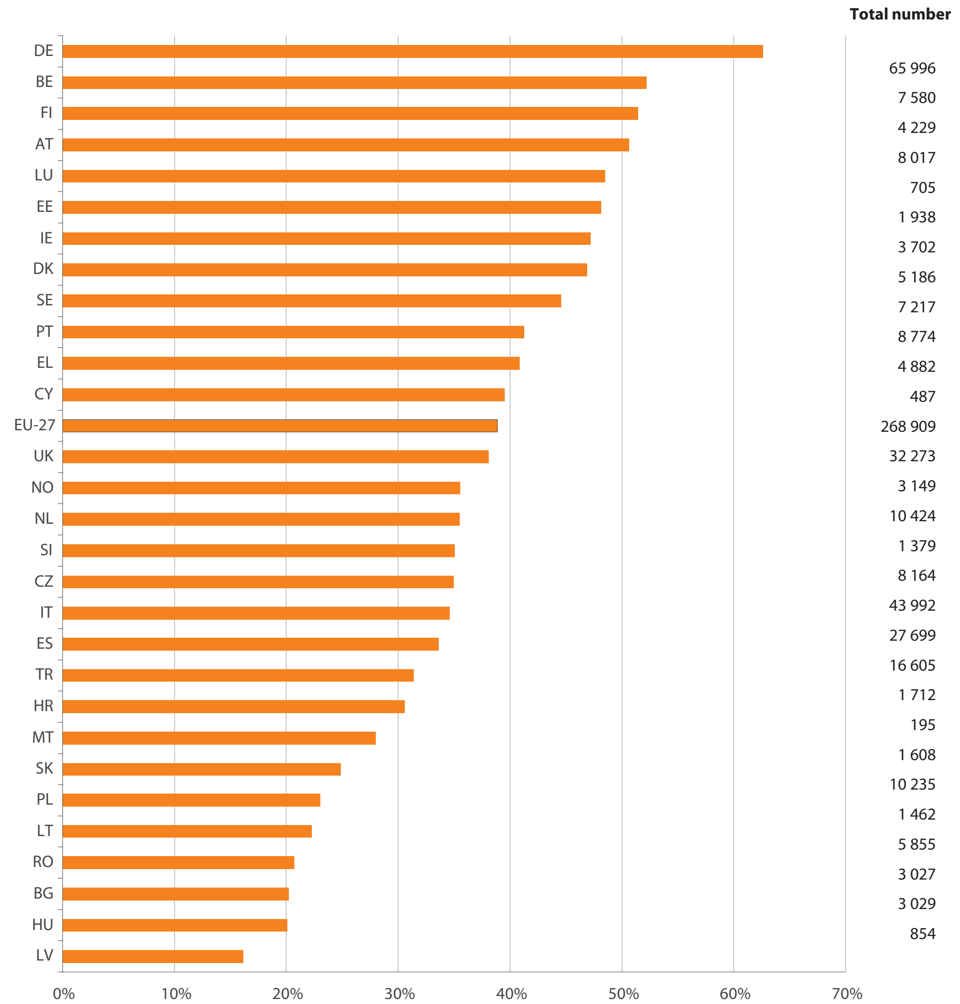
According to CIS 2006, close to two thirds of German enterprises (65 996) were innovative during the period under review, which means that these enterprises introduced at least one product (goods or services) innovation and/or process innovation during the 2004-2006 reference period.

"Innovation activities include the acquisition of machinery, equipment, software and licences; engineering and development work, training, marketing and R&D when they are specifically undertaken in order to develop and/or implement a product or process innovation." (CIS 2006 questionnaire)

After Germany came three other countries in which at least half of all enterprises are innovative. These countries are Belgium, Finland and Austria. At the other end of the scale, Latvia had less than 20 % of innovative enterprises.

The ranking was substantially different when considering innovation figures in absolute terms: this can essentially be explained by the varying size of the national economies. Germany still had the most innovative enterprises, but in this case it was followed by Italy, the United Kingdom, Spain and Turkey.

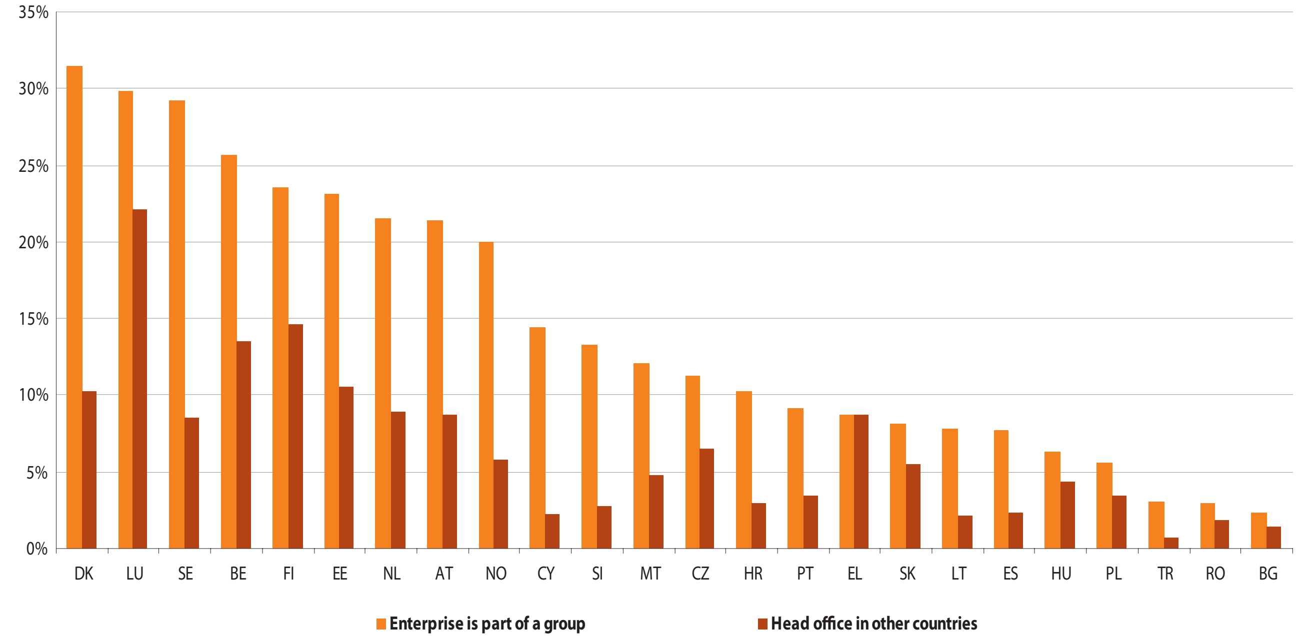
Figure 5.1: Innovative enterprises — 2006
(total number and as a percentage of all enterprises)



Note:
Data missing for FR. EU-27 does not include FR.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_prod)

Figure 5.2: Breakdown of innovative enterprises as part of a group and as part of a group with a foreign head office — 2006
(as a percentage of innovative enterprises)



Note:
Data missing for DE, IE, FR, IT, LV and UK.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_gen)

To better understand the structure of the enterprises surveyed in CIS 2006, they were requested to state whether they were part of an enterprise group and in which country the head office was located.

"An enterprise group has two or more legally defined enterprises. These can be 'sister' enterprises, such as other legally defined product divisions, 'daughter' enterprises such as subsidiaries, or parent enterprises, such as a regional or international head office. Each can be located in the same country as the respondent or in a different country." (CIS 2008 methodological notes for the questionnaire)

The share of innovative enterprises which are part of an enterprise group ranged from 31 % in Denmark to 2 % in Bulgaria.

The structure of enterprises engaged in innovative activities with a head office in other countries also varies across EU Member States: in countries such as Luxembourg (22 %) and Finland (14 %), many more enterprises are part of enterprise groups than in other countries, especially the most recent EU Member States - Bulgaria and Romania. In Turkey, less than 1 % of innovative enterprises had their head office in another country.

A second part of this question inquired about the geographic markets of enterprises. Figure 5.3 shows the geographic markets of innovative enterprises. Four markets are distinguished:

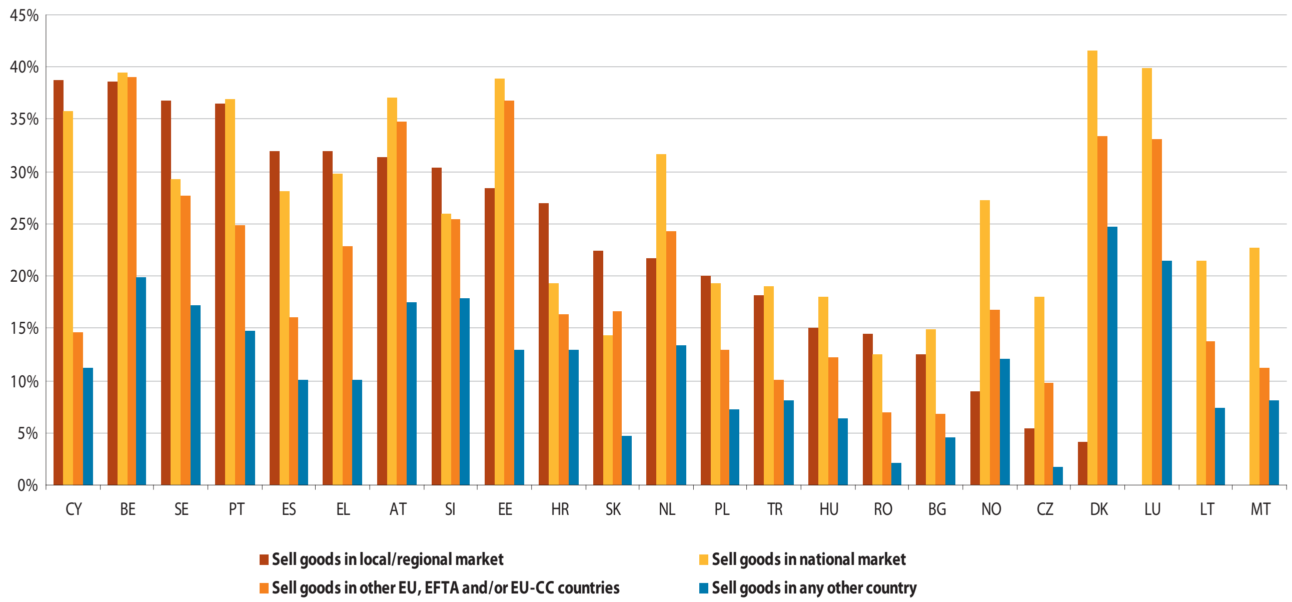
- Local/regional market within the country
- National market
- Other EU, EFTA and/or EU candidate countries
- Any other country

The enterprises surveyed were not limited to providing a single answer, but could choose between up to four replies.

The results for the geographic markets do not provide a clear common pattern. In many countries the domestic market (regional/local + national) is the most important. However, in Belgium, Austria, Estonia, Denmark and Luxembourg more than 30 % of innovative enterprises sell goods in other EU, EFTA and/or EU candidate countries.

In general, intra-European trade plays a more important role for innovative enterprises than does trade with non-EU countries. This can be explained by the fact that the geographical distance to other EU countries is often shorter than to other countries in the world. Custom duties and taxes can also weigh heavily in extra-EU trade.

Figure 5.3: Geographic markets of innovative enterprises — 2006
(as a percentage of innovative enterprises)



Note:
Data missing for DE, IE, FR, IT, LV, FI and UK.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_gen)

Table 5.4: Innovative enterprises by size-class — 2006
(as a percentage of all enterprises)

	Total	10 to 49 employees	50 to 249 employees	More than 250 employees
EU-27	38.9	34.4	52.3	70.1
BE	52.2	48.6	62.3	81.5
BG	20.2	17.0	26.4	52.7
CZ	35.0	28.9	48.6	70.4
DK	46.9	42.3	59.7	81.2
DE	62.6	57.3	71.9	87.4
EE	48.2	43.0	64.4	85.2
IE	47.2	42.7	62.5	74.9
EL	40.9	37.3	55.7	73.6
ES	33.6	30.0	48.6	72.0
FR	:	:	:	:
IT	34.6	31.3	54.2	69.2
CY	39.5	35.0	56.6	82.1
LV	16.2	13.1	23.7	48.4
LT	22.3	18.3	39.1	58.8
LU	48.5	43.6	56.1	83.3
HU	20.1	15.6	31.6	55.5
MT	28.0	22.3	45.7	77.8
NL	35.5	31.3	49.2	65.5
AT	50.6	44.0	71.1	82.8
PL	23.0	15.5	37.7	64.1
PT	41.3	37.3	56.7	78.5
RO	20.7	17.2	26.6	41.6
SI	35.1	27.7	51.3	76.9
SK	24.9	19.1	33.7	56.2
FI	51.4	46.9	61.2	83.0
SE	44.6	40.5	56.9	74.2
UK	38.1	36.0	45.0	52.3
HR	30.6	25.4	42.6	58.3
TR	31.4	29.7	37.2	43.6
NO	35.5	31.9	48.1	57.3

Note:
Data missing for FR. EU-27 does not include FR.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_prod)

As shown in Table 5.4, there appears to be a strong correlation between innovation activity and enterprise size: in large and medium-sized enterprises the share of innovative enterprises is generally higher than in small ones. However, this relationship is not as straightforward as it seems at first glance.

Although larger enterprises appear to be more innovative, it should be noted that, in the EU, large enterprises account for only 4 % of enterprises engaged in innovation activity, whereas small enterprises make up 79 % of all innovative enterprises. Therefore, although a lower share of small enterprises are engaged in innovation activity, small enterprises outnumber their larger counterparts by a wide margin. The impact of small enterprises on innovation is therefore far more substantial than the table suggests.

Nevertheless, an enterprise needs to be large enough to have its own R&D department. Small enterprises do indeed innovate, but they do not always have sufficient resources (financial, human, etc.) to benefit from their innovations.

Table 5.5: Innovative enterprises by NACE — 2006
(as a percentage of all enterprises)

	All NACE - Core NACE	Total industry (excluding construction)	Manu-facturing	Core G_to_K Services	Wholesale trade and commission trade, except of motor vehicles and motorcycles	Transport, storage and communication	Financial inter-mediation	K: Core coverage	74 Core: Other business services
EU-27	38.9	41.2	42.0	36.0	33.3	27.2	44.9	:	:
BE	52.2	59.6	59.6	46.1	49.3	31.0	50.2	69.5	69.5
BG	20.2	23.8	24.0	14.5	12.3	9.6	26.6	35.5	23.5
CZ	35.0	36.6	36.9	32.7	33.0	20.8	42.1	45.5	35.7
DK	46.9	56.4	57.0	39.9	44.4	19.0	50.8	55.7	41.3
DE	62.6	69.7	71.2	56.6	58.2	43.8	69.7	72.9	64.9
EE	48.2	55.1	56.3	39.9	42.9	27.5	70.8	54.9	48.5
IE	47.2	56.7	57.8	41.3	36.4	31.0	45.4	:	45.6
EL	40.9	37.8	37.9	44.5	40.5	52.1	67.8	47.9	20.5
ES	33.6	37.0	37.2	29.1	28.4	18.5	46.9	49.9	42.7
FR	:	:	59.2	:	:	:	:	:	:
IT	34.6	37.3	37.5	28.3	30.2	20.4	31.0	38.0	36.8
CY	39.5	46.3	45.5	33.4	29.3	30.1	48.0	42.6	19.4
LV	16.2	14.6	15.0	17.7	15.9	10.2	47.0	40.3	30.2
LT	22.3	26.8	26.7	17.2	13.8	16.6	50.0	28.1	18.9
LU	48.5	50.8	51.6	47.8	38.3	27.6	68.2	60.0	:
HU	20.1	21.2	21.2	18.4	15.2	10.3	39.5	33.3	12.3
MT	28.0	37.9	39.3	21.2	16.4	17.0	45.0	36.8	15.8
NL	35.5	42.2	42.1	31.5	30.8	20.6	29.3	48.0	40.3
AT	50.6	53.0	53.5	48.6	49.9	32.6	62.8	64.3	51.3
PL	23.0	23.9	23.7	21.5	16.4	17.8	53.4	33.3	24.5
PT	41.3	40.7	40.7	42.3	38.7	41.6	60.5	57.1	46.2
RO	20.7	21.9	22.0	18.8	16.5	19.1	31.9	24.2	18.5
SI	35.1	41.0	41.2	26.8	20.4	18.5	37.7	43.1	31.7
SK	24.9	26.8	27.4	22.0	17.0	25.2	52.2	29.0	17.0
FI	51.4	55.4	56.2	47.3	53.3	32.7	48.1	59.1	45.8
SE	44.6	50.9	51.6	39.0	40.1	23.5	50.9	54.2	47.7
UK	38.1	43.7	43.8	33.8	28.5	22.7	32.4	47.9	35.5
HR	30.6	37.3	38.2	24.7	19.8	24.6	53.4	35.6	30.7
TR	31.4	35.3	35.7	24.6	28.5	14.9	24.6	28.2	22.3
NO	35.5	41.0	41.8	30.9	32.7	11.4	30.8	50.0	38.1

Note:
Data missing for FR. EU-27 does not include FR except for Manufacturing.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_prod)

The analysis by NACE (Statistical Classification of Economic Activities in the European Community) highlights the economic sectors in which the innovative enterprises are most represented.

At EU level, the share of innovative enterprises in the manufacturing sector is slightly higher than in the services sector. A further analysis of the services sector reveals a need to differentiate between the different sectors of activity included in the services sector. This is because the share of innovative enterprises was much lower in the sector of transport, storage and communication (23 %) than in financial intermediation (45 %). The latter sector includes financial intermediation, except insurance and pension funding (J 65), insurance and pension funding, except compulsory social security (J 66) and activities auxiliary to financial intermediation (J 67).

In most countries the share of innovative enterprises was higher in the sector of Wholesale trade and commission trade than in the transport sector, except for motor vehicles and motorcycles (G51), but lower than in financial intermediation.

With the exception of Turkey, all countries shown in Table 5.5 have the highest shares of innovative enterprises in this sector. Unsurprisingly, all economic sectors linked to computer activities are highly significant for innovation.

Table 5.6: Number of employees and turnover of innovative enterprises (total number and AAGR)

	Total number of employees in 2004	Total number of employees in 2006	AAGR	Turnover in 2004 (in EUR 1000)	Turnover in 2006 (in EUR 1000)	AAGR
EU-27	:	:	:	:	9 048 157 750	:
BE	807 611	820 632	0.8	350 515 706	420 041 578	9.5
BG	357 712	365 634	1.1	12 092 844	19 098 003	25.7
CZ	1 090 574	1 104 181	0.6	95 537 700	137 762 275	20.1
DK	499 501	543 143	4.3	148 285 695	186 612 661	12.2
DE	:	9 702 112	:	:	3 343 106 000	:
EE	130 423	147 073	6.2	9 234 559	13 458 944	20.7
IE	:	348 901	:	:	199 354 741	:
EL	689 701	662 532	-2.0	73 365 034	97 312 895	15.2
ES	2 388 918	2 674 630	5.8	659 648 446	870 536 037	14.9
FR	:	:	:	:	:	:
IT	:	3 283 406	:	:	1 053 771 310	:
CY	39 032	41 020	2.5	7 194 445	9 161 255	12.8
LV	:	118 367	:	:	7 244 842	:
LT	159 905	167 566	2.4	10 809 643	14 572 543	16.1
LU	69 453	75 685	4.4	32 393 374	40 571 088	11.9
HU	515 378	531 951	1.6	77 293 331	92 901 781	9.6
MT	23 974	24 607	1.3	3 310 331	3 610 356	4.4
NL	1 178 386	1 147 869	-1.3	378 120 815	433 442 158	7.1
AT	872 580	900 397	1.6	213 074 058	273 199 108	13.2
PL	1 885 648	2 041 410	4.0	180 724 995	249 129 926	17.4
PT	645 688	652 774	0.5	103 206 900	113 256 093	4.8
RO	984 148	979 782	-0.2	41 351 843	62 054 812	22.5
SI	186 707	193 753	1.9	20 035 226	24 796 641	11.2
SK	359 150	357 067	-0.3	31 330 647	43 934 555	18.4
FI	:	565 684	:	:	209 569 036	:
SE	716 937	730 307	0.9	198 363 872	240 317 556	10.1
UK	:	:	:	:	889 341 556	:
HR	231 830	243 902	2.6	161 904 348	178 829 273	5.1
TR	:	1 307 045	:	:	1 036 192 927	:
NO	214 715	264 938	11.1	76 328 394	91 387 620	9.4

Note:
Data missing for FR. EU-27 does not include FR.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_bas)

Table 5.6 compares the number of employees and the turnover of innovative enterprises in 2004 and 2006.

In a majority of countries, innovative enterprises employed more people in 2006 than in 2004. However, the geographical data coverage is often limited, in particular for 2004, and this makes it difficult to compare average annual growth rates (AAGR).

In Greece, the Netherlands, Romania and Slovakia the total number of employees in innovative enterprises decreased slightly between 2004 and 2006. As these countries also recorded high growth rates in turnover, this could be an indication that innovative enterprises in these countries have increased their productivity.

In the other countries, positive growth rates in employment were correlated with an increase in turnover. Whereas the highest growth rates in employment were observed in Norway (11 %) and Estonia (6 %), the increases in the turnover of innovative enterprises in Bulgaria and Romania was 26 % and 23 % respectively per year.

5.3.2 Product (good or service) and process innovation

This section begins by providing a definition of product and process innovations and 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 direct to the customers.

The innovation (new or improved) must be new to the enterprise, but it does not have to be new to the sector or to the market.

Product innovations exclude the following:

- 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 compared to products made for other clients;
- Design changes that do not alter the function or technical characteristics of a good or service;
- The simple resale of new goods and services purchased from other enterprises, but including goods and services developed and produced by foreign affiliates for the respective enterprise.

Innovative goods

- Introducing entirely new products;
- Replacing inputs by materials with improved characteristics (breathable textiles, light but strong composites, environmentally-friendly plastics, etc.);
- Introducing new or improved components in existing product lines (Global Positioning Systems (GPS) in transport equipment, cameras in mobile telephones, fastening systems in clothing, etc.);
- Household appliances that incorporate software which improves user friendliness or convenience, such as toasters that automatically shut off when the bread is toasted.

Innovative services

- Improving customer access, such as a home pick-up and drop-off service for rental cars;
- DVD subscription service where, for a monthly fee, customers can order a pre-defined number of DVDs via the Internet with mail delivery to their home, and return them using a pre-addressed envelope;
- Internet services such as banking, bill-payment systems, electronic purchase and ticketing of travel and theatre tickets;
- New forms of warranty, such as an extended warranty on new or used goods, or bundling warranties together with other services, such as credit cards, bank accounts, or customer loyalty cards;
- Installing gas heaters in outdoor terraces of restaurants and bars.

Process innovations occur in both the service and manufacturing sectors 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 a production or supply activity, or to reduce environmental and safety hazards.

The innovation (new or improved) must be new to the enterprise, but it does not need to be new to the sector or to the market.

Process innovations exclude the following:

- Minor changes or improvements;
- An increase in production or service capabilities through the addition of manufacturing or logistical systems that are very similar to those already in use;
- Innovations that have an important client interface, such as a pick-up service (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 & operations

- Introduction of bar-coding or passive radio frequency identification (RFID) chips to keep track of 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 optimal delivery routes;
- New or improved software or routines for purchasing, accounting or maintenance systems.

Figure 5.7 divides innovative enterprises into three types of novel innovators:

- Product innovators,
- Process innovators,
- Product and process innovators,

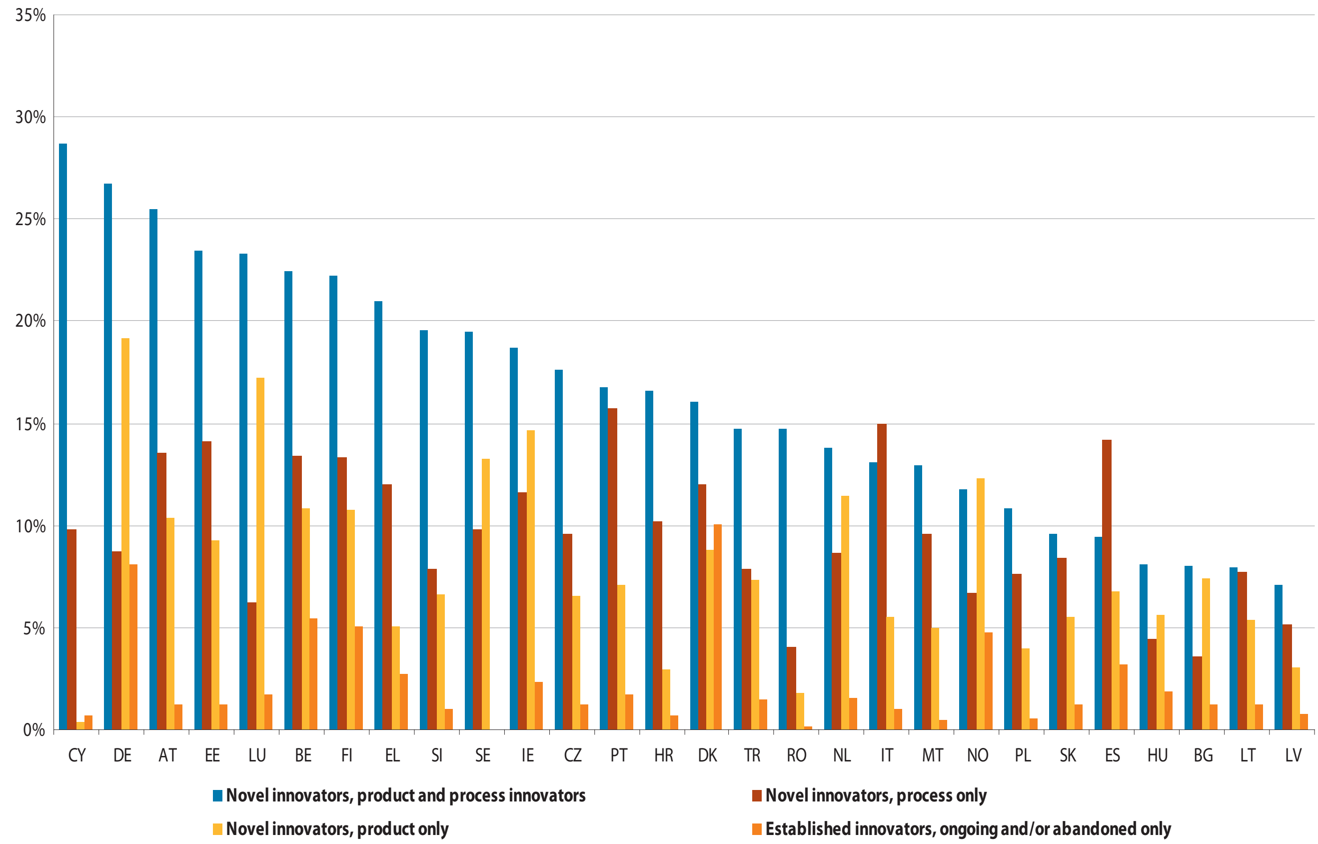
and established innovators (with ongoing and/or abandoned innovations). (See also page 129)

As explained above, 'products' can include both goods and services. The questionnaire distinguishes between three types of process innovations: improved methods of manufacturing or producing goods or services, improved distribution & operations and improved ancillary operations. (See above for definitions and examples).

The relatively high shares of innovative enterprises that are both product and process innovators suggests a strong correlation between the two types of innovation, as spill-over effects in process innovation drive product innovation, and vice versa. In Cyprus, Germany and Austria, more than 25 % of all enterprises were both product and process innovators. In Italy and Spain the share of process innovators was higher than that of product and process innovators. Most countries in Figure 5.7 counted a higher share of process innovators than product innovators. Nevertheless, product innovation plays a dominant role in some countries, such as Germany, Luxembourg and Norway. In Germany, Belgium, Finland and Denmark, between 5 % and 10 % of all enterprises were established innovators.

It should be noted that the percentages in Figure 5.7 do not add up to one hundred because only innovative enterprises are presented in this figure.

Figure 5.7: Breakdown of innovators by type of innovator — 2006
(as a percentage of all enterprises)



Note:
Data missing for FR and UK.
SE: unreliable data for established innovators, ongoing and/or abandoned only.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_prod)

Innovative enterprises were also requested to specify whether their product innovations were developed:

- mainly by the enterprise or enterprise group;
- by the enterprise together with other enterprises or institutions; or
- mainly by other enterprises or institutions.

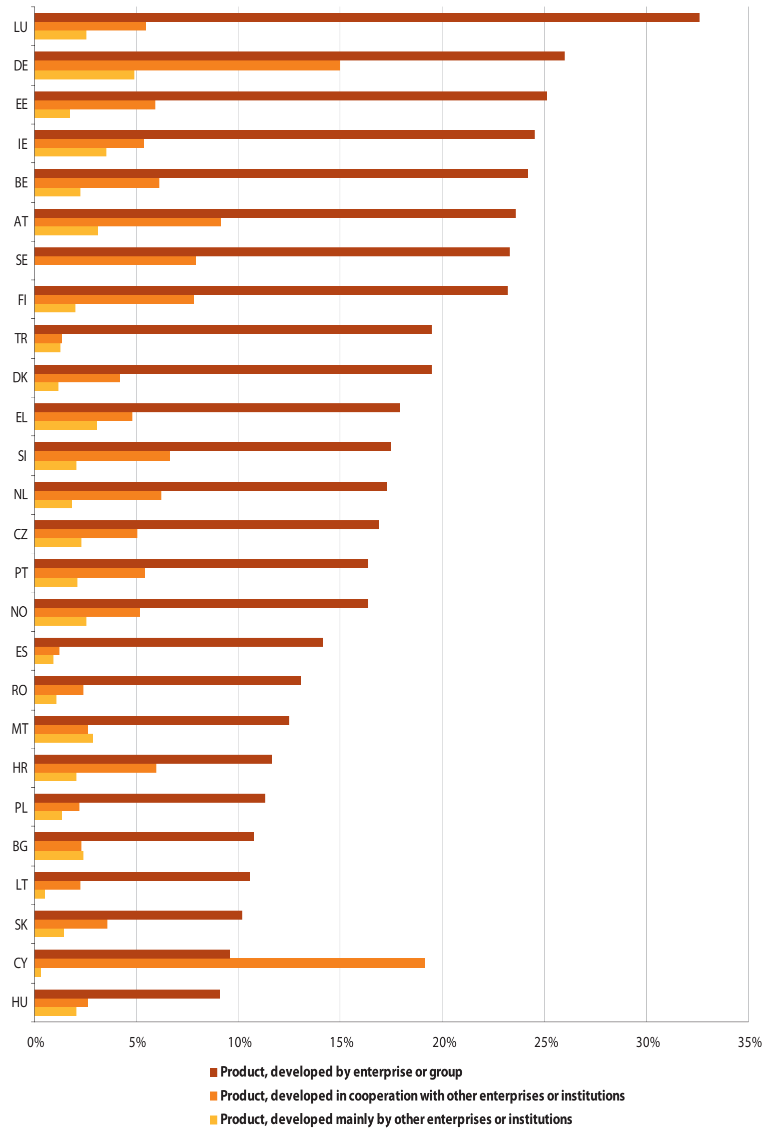
In most countries, by far the majority of innovative enterprises declared that their product innovations had been developed by the enterprise itself or the enterprise group.

The only exception was Cyprus, where 19 % of product innovations were developed in cooperation with other enterprises or institutions, which was more than twice the share of those that developed their product independently.

In Germany the share of innovative enterprises that cooperated with other enterprises or institutions in order to invent a new product was the second highest, at 15 %, while the share of independent product innovators stood at 26 %.

In all the countries under review, less than 5 % of innovative enterprises outsourced the development of product innovations.

Figure 5.8: Breakdown of innovative enterprises by developer of product innovation — 2006 (as a percentage of all innovative enterprises)



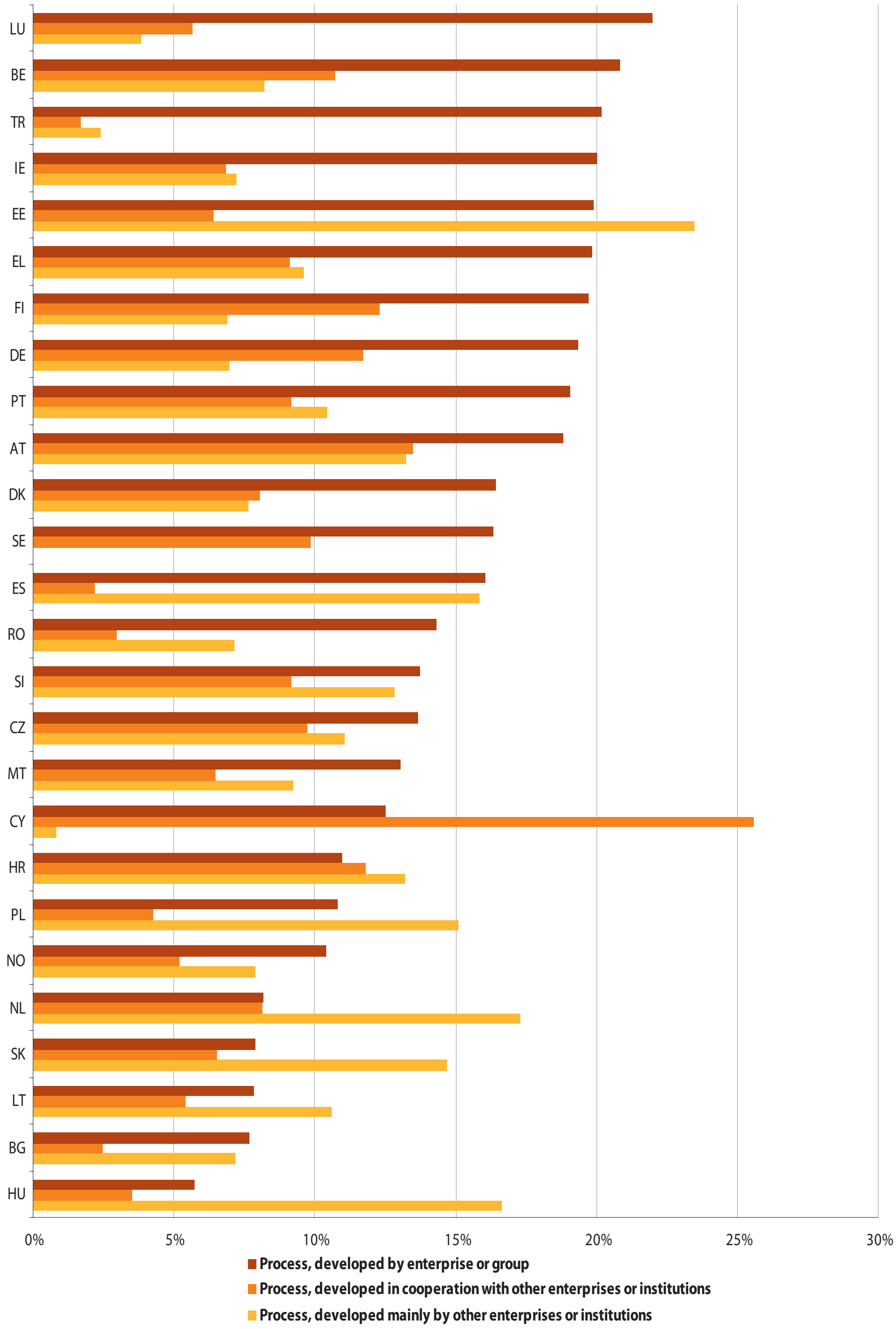
Note:
Data missing for FR, IT, LV and UK.
SE: unreliable data for product, developed mainly by other enterprises or institutions.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_prod)

The same question which was asked in relation to product innovation was also asked in relation to process innovation, although the results are quite different.

Here again, a majority of countries also show the highest shares for innovative enterprises that essentially developed the process innovation within their enterprise or enterprise group, but these shares are generally lower in process innovation than in product innovation. These lower shares are offset by higher shares in cooperation and in outsourcing.

Figure 5.9: Breakdown of innovative enterprises by developer of process innovation — 2006 (as a percentage of all innovative enterprises)



Note:
Data missing for FR, IT, LV and UK.
SE: unreliable data for process, developed mainly by other enterprises or institutions.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_prod)

In six countries, more than 10 % of innovative enterprises declared that they developed their process innovation in cooperation with other enterprises or institutions. In Cyprus this share was over 25 %.

Outsourcing was more widely used in the context of process innovation than in product innovation: in twelve countries, more than 10 % of the innovative enterprises outsourced the development of process innovations to other enterprises or institutions. Estonia, Spain, Poland, the Netherlands and Croatia reported shares in excess of 15 %.

Table 5.10: Turnover related to new or significantly improved products which are new to the enterprise but not new to the market, by sector — 2006 (as a percentage of total turnover of innovative enterprises)

	All NACE - Core NACE	Total industry (excluding construction)	Manufacturing	Core G_to_K Services	K: Core coverage	74 Core: Other business services
EU-27	10.4	11.9	:	8.7	:	:
BE	7.8	8.0	8.1	7.7	9.3	7.3
BG	9.1	5.0	5.2	20.5	11.7	17.6
CZ	7.6	7.3	8.7	8.3	10.3	6.5
DK	7.9	10.3	12.4	5.9	5.4	3.6
DE	11.3	15.4	16.3	7.3	12.0	10.8
EE	13.3	11.0	12.8	15.4	14.7	9.9
IE	7.2	6.2	6.5	8.6	:	5.9
EL	12.4	9.7	10.2	15.7	3.9	2.1
ES	12.1	13.6	14.9	10.2	10.3	10.3
FR	:	:	11.9	:	:	:
IT	7.3	7.2	8.4	7.5	10.0	14.0
CY	9.9	11.1	15.3	9.5	18.5	9.7
LV	3.0	2.5	3.2	3.3	0.4	0.1
LT	10.6	15.0	14.8	4.3	13.7	6.9
LU	8.2	5.4	4.9	9.4	6.0	:
HU	8.3	9.5	10.5	5.5	9.5	9.1
MT	6.5	6.3	6.4	6.7	23.8	:c
NL	8.1	7.7	7.9	8.5	11.2	2.6
AT	9.0	9.0	10.0	8.9	10.1	10.8
PL	9.2	10.1	12.8	7.7	7.5	5.2
PT	9.5	12.0	12.9	7.4	26.8	2.7
RO	28.6	32.9	31.6	23.5	29.4	31.9
SI	11.5	13.3	:	7.8	8.1	8.0
SK	15.5	17.6	19.6	9.9	4.2	2.6
FI	5.9	6.2	6.2	5.2	10.3	:
SE	u	u	u	u	u	u
UK	13.8	13.3	14.8	14.1	25.4	17.5
HR	16.3	18.7	18.8	12.2	12.4	12.4
TR	16.7	6.1	6.0	27.8	11.4	11.9
NO	7.5	7.4	9.2	7.5	12.7	10.8

Note:
FR: Manufacturing (NACE D) includes only enterprises with more than 50 employees.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_prod)

Table 5.10 presents the share of turnover related to new or significantly improved products which are new to the enterprise but not new to the market, broken down by economic activity.

The share of turnover related to new-to-the-firm products varied considerably between countries: in Latvia 3 % of the turnover of innovative enterprises was related to new-to-the-firm products, compared with 29 % in Romania. The EU average stood at 10 %.

Looking at the results country by country reveals no clear pattern. Sector K (Core coverage), which includes Computer and related activities (K 72), Architectural and engineering activities and related technical consultancy (K 74.2) and Technical testing and analysis (K 74.3), accounted for higher shares than in the total economy in many countries, particularly in Cyprus, Malta, Portugal, Finland and the United Kingdom.

However, in Bulgaria, Estonia, Greece and Turkey, higher shares of turnover related to new-to-the-firm products were reported throughout the services sector.

Moreover, in a third group of countries the manufacturing sector accounted for the highest shares of turnover for new-to-the-firm products. This was the case in Denmark, Germany, Spain, Poland, Slovakia and Croatia.

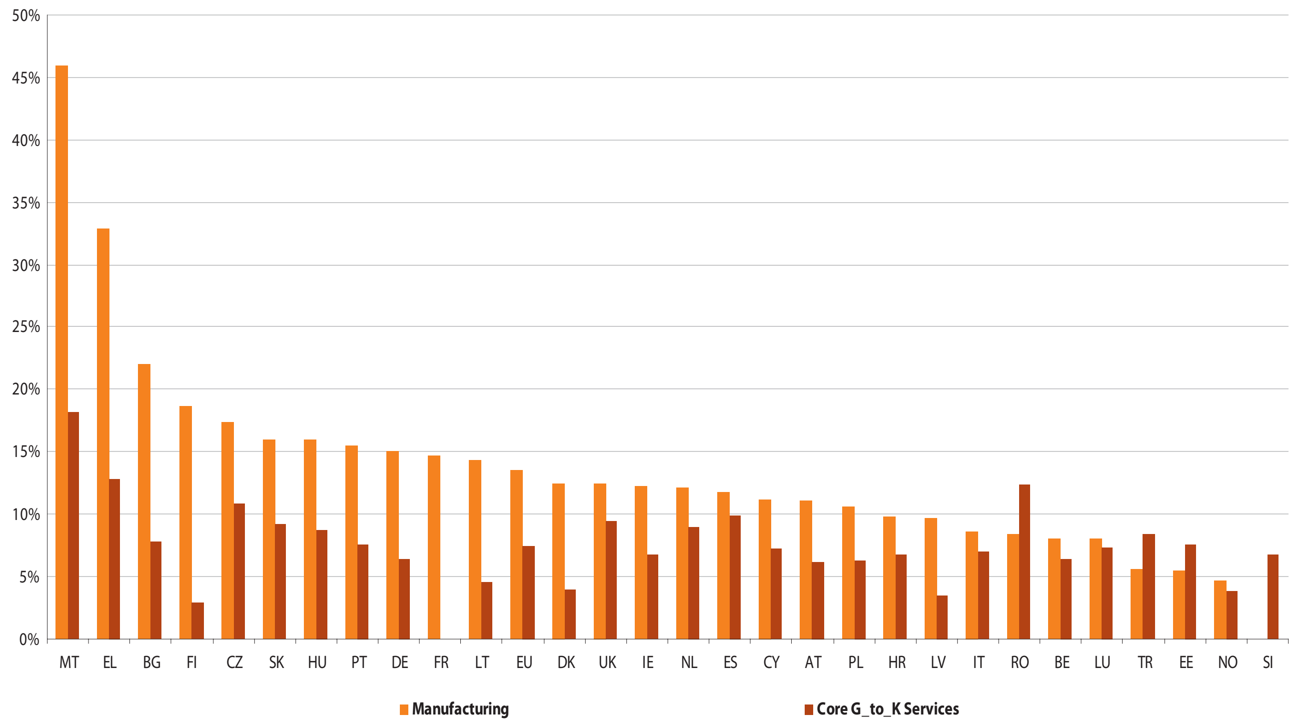
Lithuania, Romania and Slovenia registered the highest shares of turnover related to new-to-the-firm products in total industry (excluding construction).

The situation differs substantially when considering turnover related to new or significantly improved products which are new to the enterprise and new to the market (See Figure 5.11).

In most countries the share of turnover related to new-to-the-market products was higher in the manufacturing sector than in the services sector. The opposite pattern was observed in Romania, Turkey and Estonia.

However, the share of turnover related to new-to-the-market products varied substantially between countries, ranging from over 45 % in Malta to less than 5 % in Norway in the manufacturing sector. In the services sector, Malta was also in the lead with 18 %, whereas Finland reported the lowest share with less than 3 %. The high shares for Malta are quite exceptional, but can be partly explained by the size of the semiconductor industry in relation to the island's economy.

Figure 5.11: Turnover related to new or significantly improved products which are new to the enterprise and also new to the market, by sector — 2006 (as a percentage of total turnover of innovative enterprises)



Note:
Data missing for FR (Core G_TO_K Services due to the derogation) and SI (Manufacturing flagged as confidential).
Data for SE are unreliable.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_prod)

5.3.3 Innovation activity and expenditure

Enterprises tend to spend more on intramural R&D than on extramural R&D…

The surveyed enterprises were asked if they had "undertaken creative work within their enterprise to increase the stock of knowledge and its use to devise new and improved products and processes (including software development)" (CIS 2006 questionnaire). In this case their innovation activity is considered as intramural (carried out in-house).

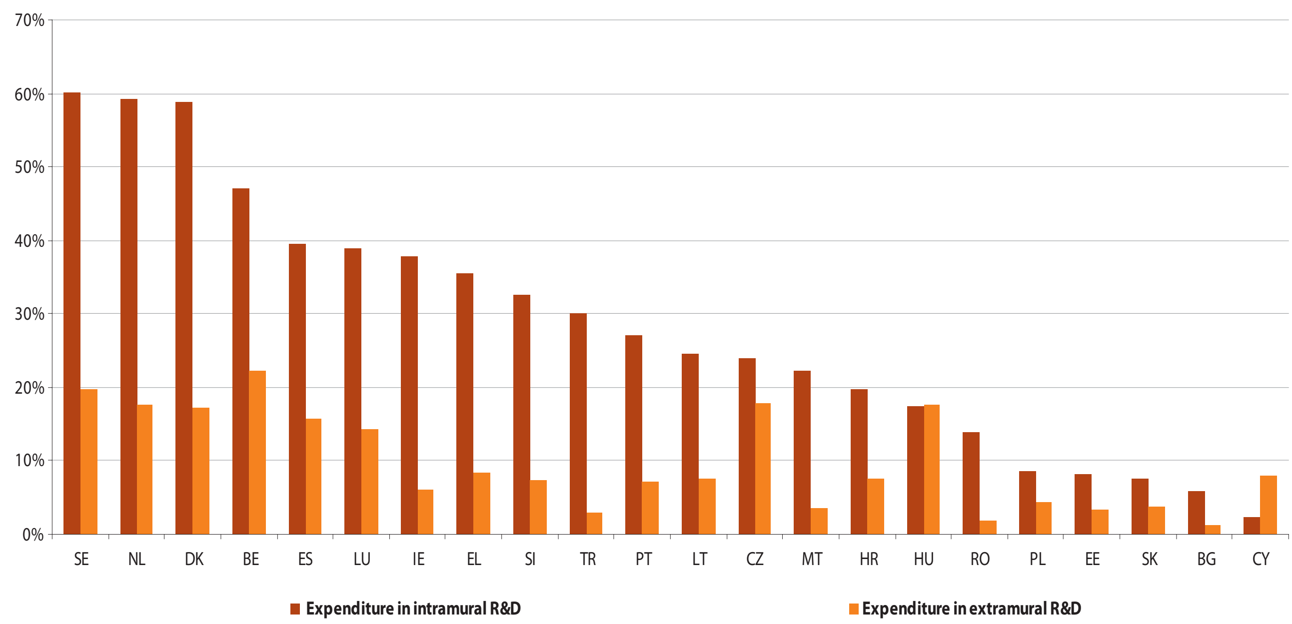
If these activities were performed by other companies (including other enterprises within the same enterprise group) or by public or private research organisations and purchased by the enterprise, the innovation activity is considered as extramural.

Figure 5.12 compares the shares of intramural and extramural expenditure for R&D. The percentages shown are ratios of the total innovation expenditure.

Intramural expenditure plays a dominant role in most of the countries for which data are available. Only Cypriot innovative enterprises reported higher expenditure on extramural R&D than on in-house R&D. In Hungary these two shares were fairly similar.

In Sweden, the Netherlands and Denmark, more than the half of total expenditure on R&D activities was carried out in-house.

Figure 5.12: Intramural and extramural expenditure of innovative enterprises — 2006 (as a percentage of total innovation expenditure)



Note:
Data missing for DE, FR, IT, LV, AT, FI and UK.
ES: total innovation expenditure includes also "Training", "Market introduction of innovations" and "Other preparations expenditures".

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_exp)

But the acquisition of machinery, equipment and software remains an essential way to innovate in many countries

Table 5.13 presents all four categories of innovation expenditure, to show how enterprises invest in innovation. In countries with low expenditure on intra- and extramural R&D, innovative enterprises tend to record high shares of expenditure on the acquisition of machinery, equipment and software. The innovative enterprises of countries which spent more than 50 % of their total innovation budget on the acquisition of machinery, equipment and software mainly include the EU Member States from the 2004 and 2007 enlargements and the candidate countries Croatia and Turkey.

These results are hardly surprising because they can be explained by the need of the new Member States and candidate countries to modernise their general equipment. This modernisation may take several years, but the shares of innovation expenditure spent in this category can be expected to decrease in the future and more funds are likely to be dedicated to R&D.

Beside these countries, only the innovative enterprises of Greece and Portugal seem to need to invest heavily in machinery, equipment and software. However, it should be pointed out that only acquisitions of machinery, equipment and software that are used to produce new or significantly improved products or processes are taken into account. Not all investments to modernise the equipment within the enterprise are considered.

The acquisition of external knowledge accounted for the lowest shares (often below 5 %) in most of the countries under review. Only Ireland, Luxembourg and Malta registered shares of 10 % and more, with 15 %, 10 % and 11 % respectively. This category includes patents, inventions, licences, trade marks, designs, consultancy services (excluding R&D), other know-how and software not classified elsewhere.

Table 5.13: Breakdown of innovation expenditure into four categories — 2006
(as a percentage of total innovation expenditure of innovative enterprises)

	Expenditure for acquisition of machinery, equipment and software	Expenditure for acquisition of other external knowledge	Expenditure in extramural R&D	Expenditure in intramural R&D
BE	29.4	1.3	22.2	47.1
BG	91.3	1.7	1.2	5.8
CZ	55.1	3.2	17.8	24.0
DK	18.9	5.0	17.2	59.0
DE	:	:	:	:
EE	87.1	1.4	3.4	8.1
IE	40.7	15.3	6.1	37.8
EL	54.9	1.3	8.4	35.4
ES	37.7	7.0	15.7	39.6
FR	:	:	:	:
IT	:	:	:	:
CY	84.9	4.7	8.1	2.4
LV	:	:	:	:
LT	65.2	2.5	7.7	24.6
LU	36.8	10.0	14.3	38.9
HU	61.3	3.6	17.7	17.4
MT	63.0	11.1	3.5	22.4
NL	20.8	2.3	17.6	59.3
AT	:	:	:	:
PL	83.3	3.6	4.4	8.7
PT	58.9	6.9	7.1	27.2
RO	81.6	2.6	1.9	14.0
SI	58.0	2.1	7.4	32.6
SK	86.2	2.4	3.9	7.6
FI	:	:	:	:
SE	:u	:u	19.8	60.2
UK	:	:	:	:
NO	:	:	:	:
HR	67.9	4.7	7.5	19.8
TR	62.5	3.9	3.0	30.2

Note:
ES: total innovation expenditure includes also "Training", "Market introduction of innovations" and "Other preparations expenditures".

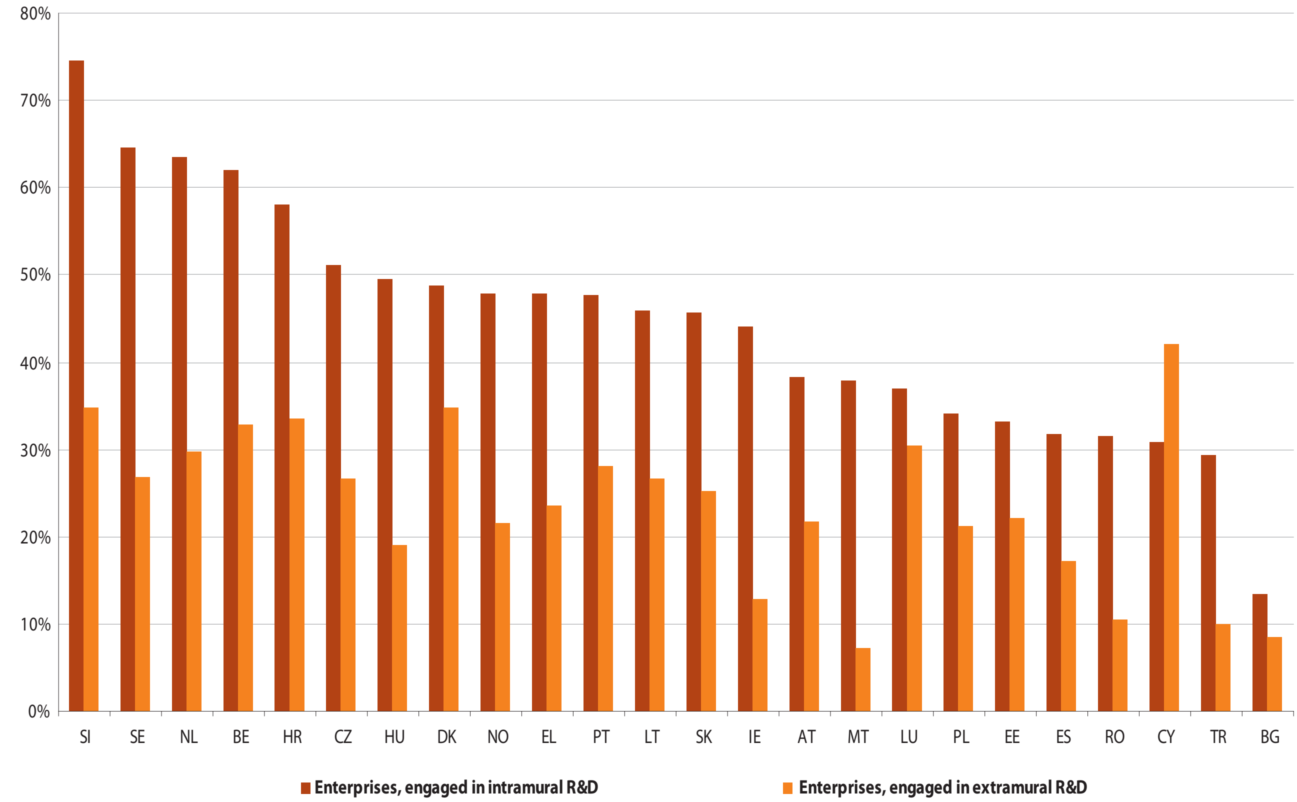
Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_exp)

Figure 5.14 does not consider the amounts spent on intramural and extramural R&D, but rather the number of innovative enterprises engaged in these activities.

With the exception of Cyprus, in all countries for which data are available the percentages of innovative enterprises engaged in intramural R&D were significantly higher than those engaged in extramural R&D. Shares of over 60 % were registered in Slovenia, Sweden, the Netherlands and Belgium. At the other end of the scale, Bulgaria recorded the lowest share, with less than 15 %.

For extramural R&D, the shares ranged from 42 % in Cyprus to 7 % in Malta.

Figure 5.14: Number of innovative enterprises engaged in intramural and extramural R&D — 2006 (as a percentage of innovative enterprises)



Note:
Data missing for DE, FR, IT, LV, FI and UK.
ES: The reference period is 2006 instead of 2004-2006 as it is requested in the harmonised CIS questionnaire.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_exp)

As enterprises can conduct several types of innovation at once, the questionnaire offered enterprises the possibility to choose more than one innovation activity.

It should be noted that the figures for Spain are much lower than those of the other countries, as they refer only to one year and not to the whole observation period of three years. As a result, data for Spain are not entirely comparable with those of the other countries.

Although enterprises in most EU-15 Member States spent a smaller share of their innovation budget on machinery, equipment and software to produce new or significantly improved products or processes, a majority of innovative enterprises in these countries were engaged in this category of innovation activities.

The comparison between innovation expenditure and innovation activities reveals a number of aspects:

Although in many countries around two thirds of all innovative enterprises are involved in the acquisition of machinery, equipment and software, this is not systematically correlated with high expenditure in the relevant category.

By contrast, being closely involved 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 share of expenditure in intramural R&D is in the form of salaries paid to researchers and highly skilled employees.

This correlation is the most obvious for Sweden, the Netherlands and Belgium. In Slovenia, by contrast, innovative enterprises reported the highest shares in terms of in-house R&D, with 75 %. However, innovative enterprises in Slovenia dedicated only 33 % of total innovation expenditure to in-house R&D. This could be due to the fact that the salaries of researchers and highly skilled employees are still significantly lower in Slovenia than in the EU-15 Member States.

Figure 5.15: Innovative enterprises engaged in four categories of innovative activities — 2006 (as a percentage of innovative enterprises)

	Acquisition of machinery, equipment and software	Other external knowledge	Extramural R&D	Intramural R&D
BE	71.4	23.6	32.8	62.0
BG	72.6	19.6	8.6	13.5
CZ	79.3	26.1	26.7	51.2
DK	61.1	33.7	34.9	48.9
DE	:	:	:	:
EE	89.0	35.5	22.1	33.3
IE	54.4	12.7	13.0	44.1
EL	82.2	21.0	23.6	47.9
ES	36.8	2.8	17.3	31.8
FR	:	:	:	:
IT	:	:	:	:
CY	99.0	60.4	42.1	30.8
LT	73.8	27.0	26.7	45.8
LV	:	:	:	:
LU	71.1	25.8	30.5	37.0
HU	73.7	17.4	19.1	49.6
MT	51.3	15.4	7.2	38.0
NL	54.3	14.5	29.8	63.6
AT	63.7	27.7	21.7	38.2
PL	89.7	14.1	21.2	34.0
PT	81.9	24.5	28.1	47.7
RO	76.0	9.9	10.6	31.6
SI	81.6	37.1	34.9	74.5
SK	82.1	21.1	25.3	45.7
FI	:	:	:	:
SE	62.2	35.6	26.8	64.6
UK	:	:	:	:
HR	87.3	27.3	33.6	58.0
TR	42.0	12.9	10.0	29.3
NO	:	:	21.6	48.0

Note:
ES: The reference period is 2006 instead of 2004-2006 as it is requested in the harmonised CIS questionnaire.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_exp)

5.3.4 Public funding for innovation

Enterprises can apply for public funds from different national and European authorities. In many countries the majority of innovative enterprises have received funding from the central government. However, there are exceptions. In Belgium and Spain 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 did central government. This was the case in Greece, Poland, Romania and Slovakia.

In many countries the share of innovative enterprises that received funding from the European Union was higher than the share turning to local or regional authorities as their source of funding.

The role of public funding is often a controversial issue in the economic literature. On the one hand, there is a consensus about the stimulating effect of public funding for innovative activities. On the other, there are always worries about the possible crowding-out effect of private financing.

Although public funding is necessary for R&D and innovation, its use must be targeted and meet fixed objectives that may not be achieved with private financing.

EU support focuses on essential areas of European research, by funding research projects that bring together universities, research institutes, small and large companies and governmental organisations across Europe.

The aim is to concentrate the maximum effort in the most critical areas where 'European added value' can have the greatest effect and to create a European Research Area (ERA).

"*The sixth framework programme should have a structuring effect on research and technological development in Europe, including the Member States, associated candidate countries and other associated countries and make a significant contribution to the establishment of the European Research Area and to innovation.*"(1)

(1) Decision No 1513/2002/EC of the European Parliament and of the Council of 27 June 2002 concerning the sixth framework programme of the European Community for research, technological development and demonstration activities, contributing to the creation of the European Research Area and to innovation (2002 to 2006).

Table 5.16: Breakdown of innovative enterprises receiving public funding for innovation by source of funds — 2006 (as a percentage of all innovative enterprises)

	Any source	Central government (including central government agencies or ministries)	Local or regional authorities	European Union	6th Framework Programme
BE	24.3	8.0	18.8	4.4	1.5
BG	8.1	4.9	0.6	4.4	1.1
CZ	16.0	10.2	2.5	6.5	3.0
DK	:	:	:	:	:
DE	14.0	8.0	6.1	3.3	:
EE	9.5	7.0	0.6	3.1	0.8
IE	:	:	:	:	:
EL	34.2	18.0	7.1	19.1	8.0
ES	23.0	10.1	15.6	2.1	0.9
FR	:	:	:	:	:
IT	:	:	:	:	:
CY	45.8	39.8	7.2	12.5	3.9
LV	:	:	:	:	:
LT	12.9	7.4	3.4	6.7	1.9
LU	15.5	13.2	3.1	4.5	3.6
HU	29.8	22.9	1.4	12.6	3.1
MT	16.4	13.9	0.0	5.6	2.1
NL	33.1	28.4	8.6	5.8	:
AT	30.8	23.5	17.9	8.0	2.8
PL	23.0	6.3	3.5	16.7	1.9
PT	11.9	8.7	1.4	4.7	1.4
RO	12.2	4.5	2.9	7.9	2.2
SI	22.7	17.4	2.8	9.6	3.5
SK	14.7	4.8	3.1	9.3	1.6
Fi	:	:	:	:	:
SE	:	:	:	:	:
UK	:	:	:	:	:
HR	20.0	17.8	3.3	1.0	0.2
TR	21.5	18.6	1.8	1.9	1.6
NO	:	:	:	:	:

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_exp)

5.3.5 Sources of information and cooperation for innovation activities

Knowledge transfer consists of information and cooperation

As information plays a key role for innovation, it is vitally necessary that the most important sources of information for innovative enterprises are identified.

Sources of information can be split into four main groups: internal sources, market sources, institutional sources and other sources. These main groups consist of one or more sub-groups (see below).

After identifying the sources of information and their use by innovative enterprises, the different forms of collaboration will be analysed.

There is no doubt that knowledge creation, which is the main objective of higher education, is an essential source of innovation. However, if this knowledge is to be useful, it has to be applied to the areas of life where it can make a difference. This is why **knowledge transfer** is a key element of innovation.

Knowledge is mainly transferred from the higher education sector to the wider world through the expertise and experience gained by graduates. However, small companies which could benefit from the knowledge of a highly skilled graduate are often reluctant to hire such a person.

Knowledge transfer takes place whenever the findings or research of academics are disseminated more widely. There are many ways in which this can be done. One important way that knowledge may be spread is through the training that higher education offers to industry.

Creating stronger links between universities and businesses is an important aim of the European innovation policy. One approach in this direction is the 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.

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

The CIS 2006 questionnaire distinguishes between two institutional sources of information:

- universities or other higher education institutes, and
- government or public research institutes.

As these information sources are quoted less frequently than internal or market sources in nearly all countries, these data are not included in the table below.

This was also the case for two other sources of information: scientific journals and trade/technical publications and professional and industry associations, as well as for consultants, commercial labs or private R&D institutes.

The fact that there is not a single institutional source among the five most important sources of information highlights the fact that the link between science and industry in Europe is weak and needs to be strengthened. One of the aims 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.

There can be no doubt that commercial research commissioned from universities is an important 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 finance public research.

Data in the table below are difficult to compare across countries because in some countries, such as Cyprus, reports from enterprises often reported as many as four sources of information, whereas in other countries the surveyed enterprises reported only one or two sources. In Cyprus the shares reported were consistently higher than in other countries.

With the exception of Greece, innovative enterprises in all the countries for which data are available reported that the most used source of information for innovation was the enterprise itself or the enterprise group. Two very different groups – namely clients and customers and suppliers – dispute second and third place for the most used source.

In the case of rank four, the choice varies for most countries between competitors on the one hand and commercial events such as conferences, trade fairs and exhibitions on the other.

The results for Greek innovative enterprises were the exception: 26 % of Greek innovative enterprises selected 'Competitors or other enterprises of the same sector' as the most used source of information, followed by 'Professional and industry associations' (22 %) and 'Scientific journals and trade/technical publications' (20 %).

Table 5.17: The five most used sources of information — 2004-2006 (as a percentage of innovative enterprises)

	Within the enterprise or enterprise group	Clients or customers	Suppliers of equipment, materials, components or software	Competitors or other enterprises of the same sector	Conferences, trade fairs, exhibitions
BE	53.3	25.1	28.2	9.6	11.9
BG	32.2	27.5	28.3	16.6	16.5
CZ	37.4	33.7	24.8	15.9	12.0
DK	:	:	:	:	:
DE	:	:	:	:	:
EE	31.0	17.5	24.6	8.9	9.4
IE	:	:	:	:	:
EL	7.3	16.1	12.7	25.9	12.5
ES	43.4	16.5	25.1	8.8	7.8
FR	:	:	:	:	:
IT	:	:	:	:	:
CY	92.6	49.5	80.5	35.7	45.2
LV	:	:	:	:	:
LT	29.9	24.4	22.1	8.5	19.1
LU	65.5	36.5	33.1	21.8	23.6
HU	40.5	33.9	21.5	19.8	13.1
MT	39.5	25.6	23.1	14.4	9.2
NL	42.9	26.7	18.8	8.3	5.2
AT	60.1	47.7	28.0	20.0	18.3
PL	53.0	29.3	20.0	17.9	16.3
PT	46.1	32.8	26.9	13.5	18.3
RO	41.8	33.0	34.0	19.3	20.8
SI	57.1	44.8	29.8	20.1	17.4
SK	44.0	28.7	23.0	12.7	12.5
FI	:	:	:	:	:
SE	:	:	:	:	:
UK	:	:	:	:	:
HR	43.6	35.2	27.8	15.3	22.4
TR	46.3	36.6	29.8	18.2	23.5
NO	:	:	:	:	:

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_sou)

A very efficient means of knowledge transfer is cooperation. Innovation cooperation involves active participation with other enterprises or non-commercial institutions on innovation activities. Neither partner needs to benefit commercially, but pure contracting out of work with no active cooperation is not possible.

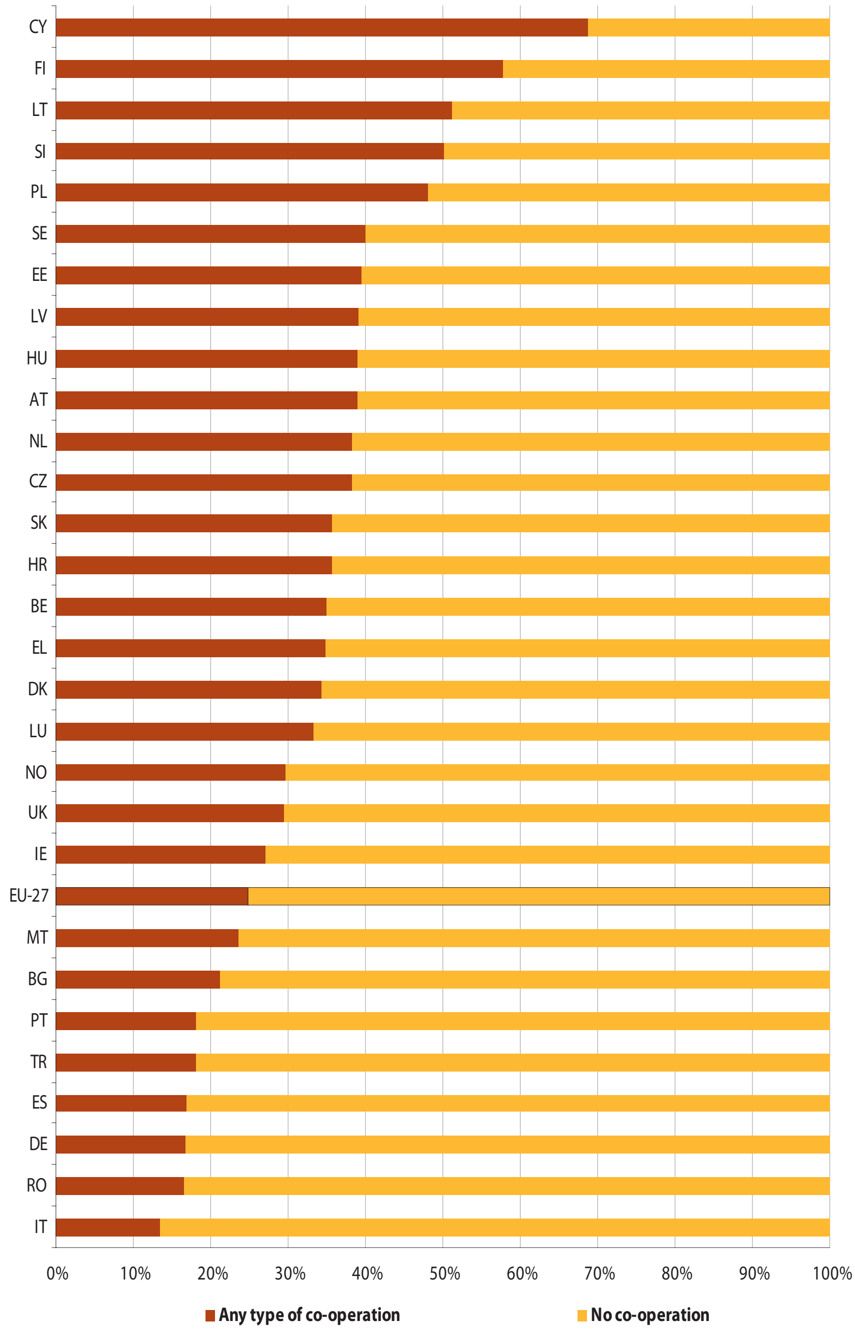
The CIS 2006 asks whether an enterprise is cooperating and with whom, but not why. This aspect would be interesting to analyse in order to learn more about the motivations of cooperation.

Economic literature distinguishes between four motivations[1]:

- Sharing the cost of developing innovative products and processes,
- Accessing external knowledge,
- Scaling-up production,
- Commercialization.

[1] Discussion Paper No. 07-018, Motives for Innovation Cooperation – Evidence from the Canadian Survey of Innovation, Tobias Schmidt. ftp://ftp.zew.de/pub/zew-docs/dp/dp07018.pdf

Figure 5.18: Innovative enterprises broken down into those that cooperate and those that do not cooperate — 2004-2006 (as a percentage of innovative enterprises)



Note:
Data missing for FR. EU-27 does not include FR.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_coop)

Figure 5.18 shows how only one quarter of innovative enterprises in the EU-27 are engaged in cooperation. However, this average value covers wide national differences. The share of innovative enterprises engaged in cooperation for innovation ranges from 13 % in Italy to 69 % in Cyprus.

In addition to Cyprus, at least half of the innovative enterprises in three other countries namely Finland, Lithuania and Slovenia are active in the field of cooperation.

Apart from Cyprus, which also reported a high share of innovative enterprises engaged in extramural R&D, the results of CIS 2006 provide no further indication as to why innovative enterprises in some countries tend to cooperate more than others. The four countries with the highest shares are substantially different from one another; the same applies to countries which reported the lowest shares of cooperation.

However, countries with the highest shares of cooperation for innovation tend to include the smaller economies (except the Nordic countries, such as Finland or Sweden). Conversely, the reverse is not the case, as not all small economies are actively engaged in cooperation. They may even behave very differently in cooperation matters[1].

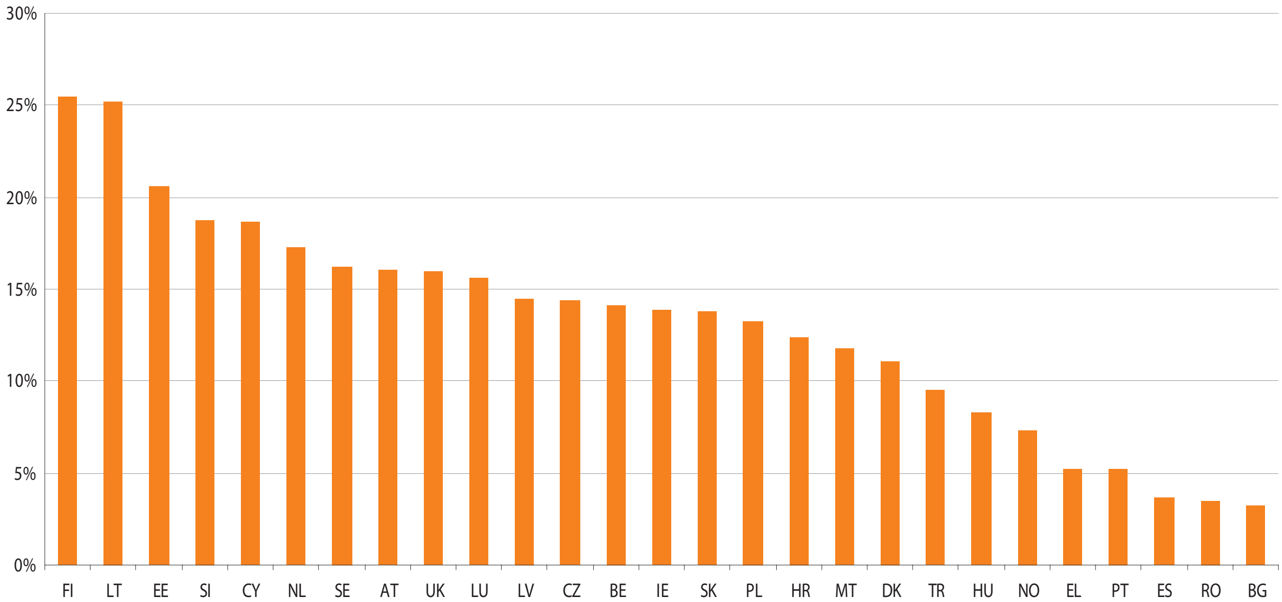
The CIS 2006 questionnaire differentiates between seven different cooperation partners:

- other enterprises within the same 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.

Figures 5.19 to 5.25 present the share of innovative enterprises by country for each type of cooperation partner.

[1] See: DRUID Working Paper No. 07-12, R&D Internationalization, R&D Collaboration and Public Knowledge Institutions in Small Economies: Evidence from Finland and the Netherlands, Cees van Beers, Elina Berghäll and Tom Poot http://www.druid.dk/wp/pdf_files/07-12.pdf. See also: Europe Innova Report, April 2008, Collaboration in Innovation and Foreign Ownership across Industries in Europe, Knell, M. and M. Srholec.

Figure 5.19: Cooperation partner: other enterprises within the own enterprise group — 2004-2006 (as a percentage of innovative enterprises)



Note:
Data missing for DE, FR and IT.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_coop)

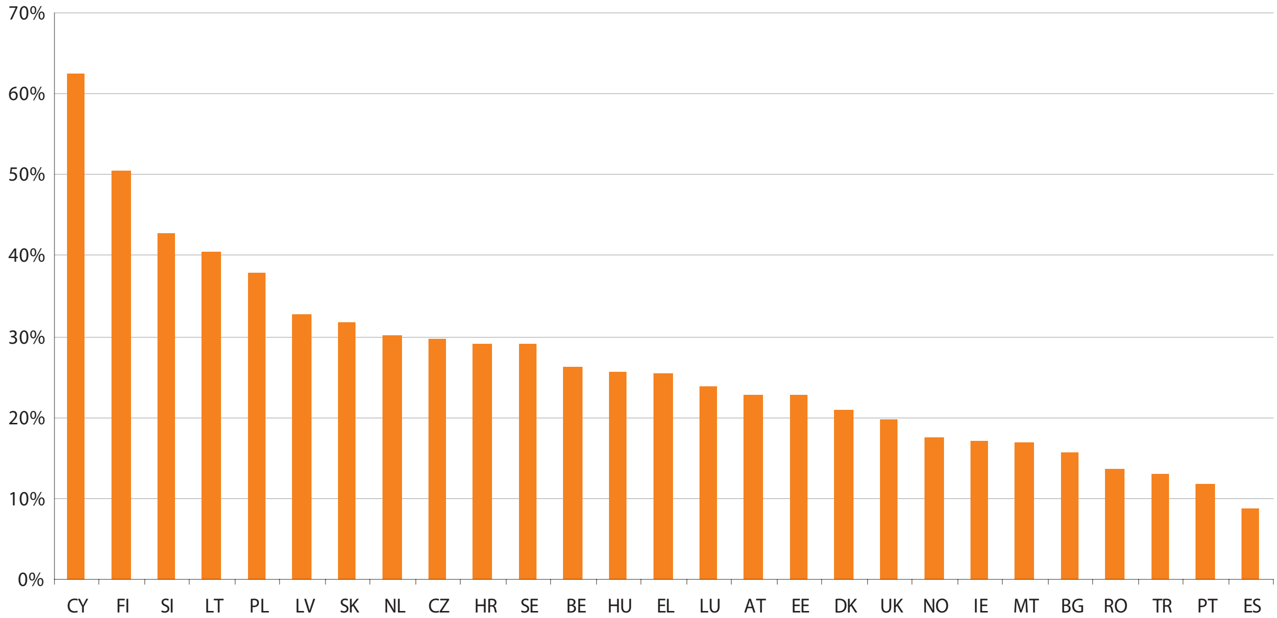
Figure 5.19 presents the share of innovative enterprises cooperating within the same group. In the countries under review, only a fairly low share of innovative enterprises cooperate in this way. This may be due the fact that the enterprises surveyed do not always regard collaborating with other enterprises of their own group as cooperation. It should also be noted that small enterprises generally account for a very large share of all enterprises in any given country.

In Finland, Lithuania and Estonia, over 20 % of enterprises cooperate with other enterprises within their own enterprise group. In contrast, the respective share in Spain, Romania and Bulgaria was 5 %.

In contrast, cooperation levels were much higher for suppliers of equipment, materials, components or software: more than 60 % of innovative enterprises in Cyprus cooperate with their suppliers on innovation activity. In Finland more than half of all innovative enterprises cooperate with their suppliers, compared with more than 40 % in Slovenia and Lithuania. Spain was the only country to report cooperation shares below 10 %.

Cooperation with suppliers may be driven by the need for essential know-how which could add value to the work of the innovative enterprise.

Figure 5.20: Cooperation partner: suppliers of equipment, materials, components or software —2004-2006 (as a percentage of innovative enterprises)



Note:
Data missing for DE, FR, IT and SE.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_coop)

Collaboration with suppliers of equipment, materials, components or software was the most widespread form of cooperation.

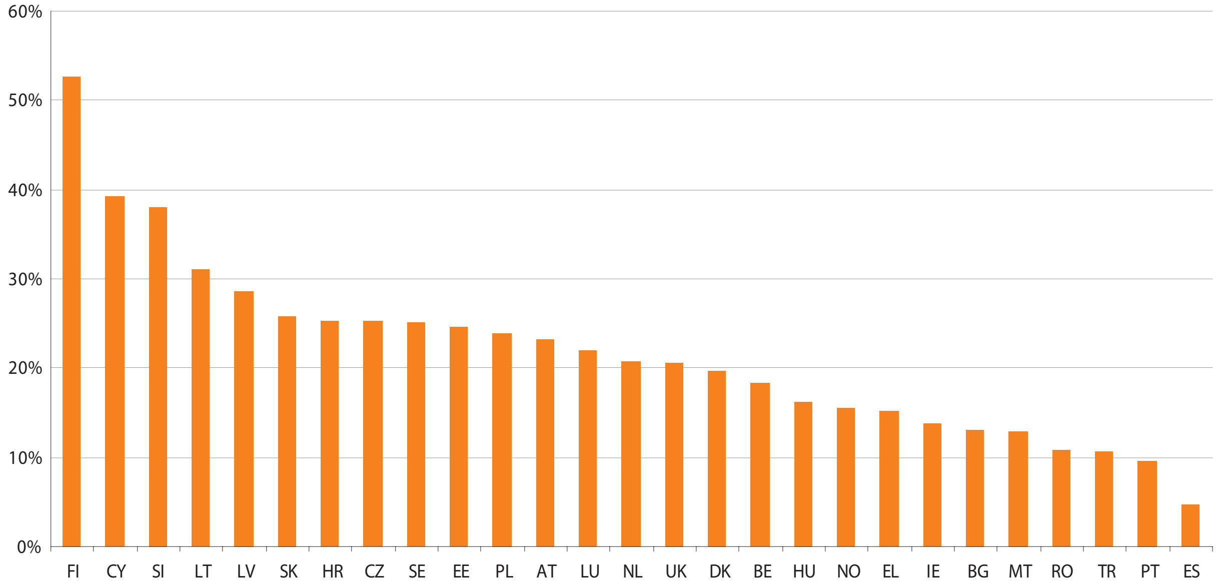
During 2004-2006, 62 % of the innovative enterprises in Cyprus cooperated with suppliers of equipment, materials, components or software. This was also the case for more than half of innovative enterprises in Finland. Between 30 % and 40 % of innovative enterprises in Slovakia, Latvia, Poland, Lithuania and Slovenia also relied on suppliers as cooperation partners. However, this trend was not observed across the EU-27, as countries such as Portugal or Spain reported low shares of cooperation with suppliers.

ER&D Cooperation and Innovation Activities of Firms
Evidence for the German Manufacturing Industry

"Firms engaged in the innovation process are aware of the necessity of establishing R&D cooperation to obtain expertise which cannot be generated in-house. Thus, internal capabilities to develop new products are improvable. Collaborations with other firms and institutions in R&D offer a crucial way for innovative firms to make external resources usable because they offer possibilities of intensive knowledge transfer, resource exchange and organizational learning. Complementary assets and capabilities can be combined and merged generating synergies and cross-fertilization effects."

Source: Wolfgang Becker and Jürgen Dietz, University of Augsburg, Germany

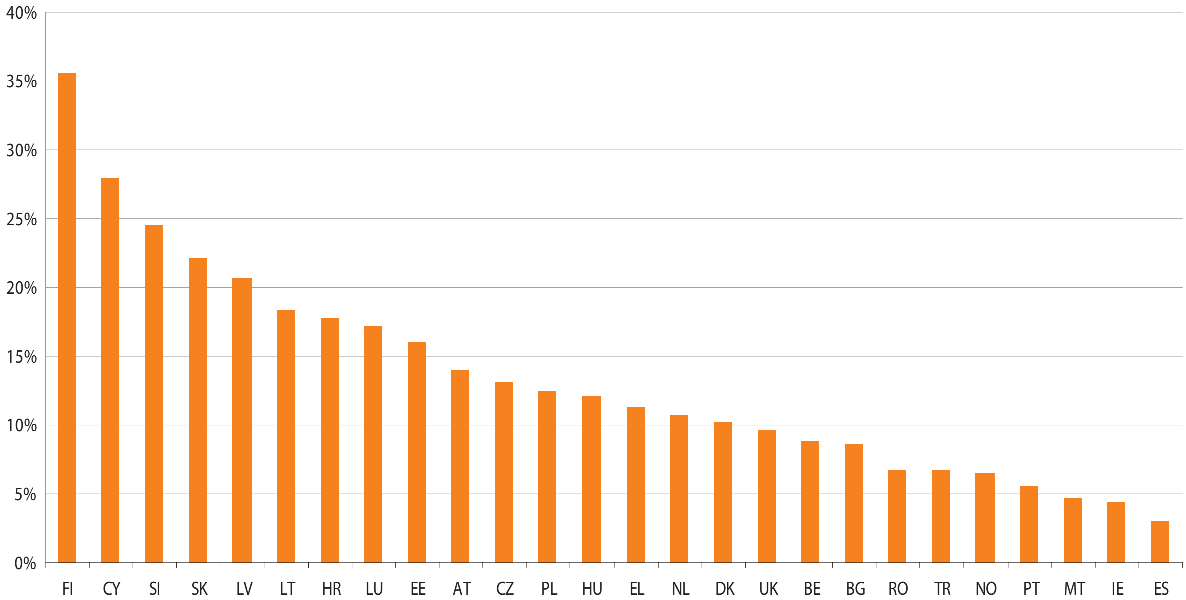
Figure 5.21: Cooperation partner: clients or customers — 2004-2006
(as a percentage of innovative enterprises)



Note:
Data missing for DE, FR and IT.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_coop)

Figure 5.22: Cooperation partner: competitors or other enterprises of the same sector — 2004-2006
(as a percentage of innovative enterprises)



Note:
Data missing for DE, FR and IT.

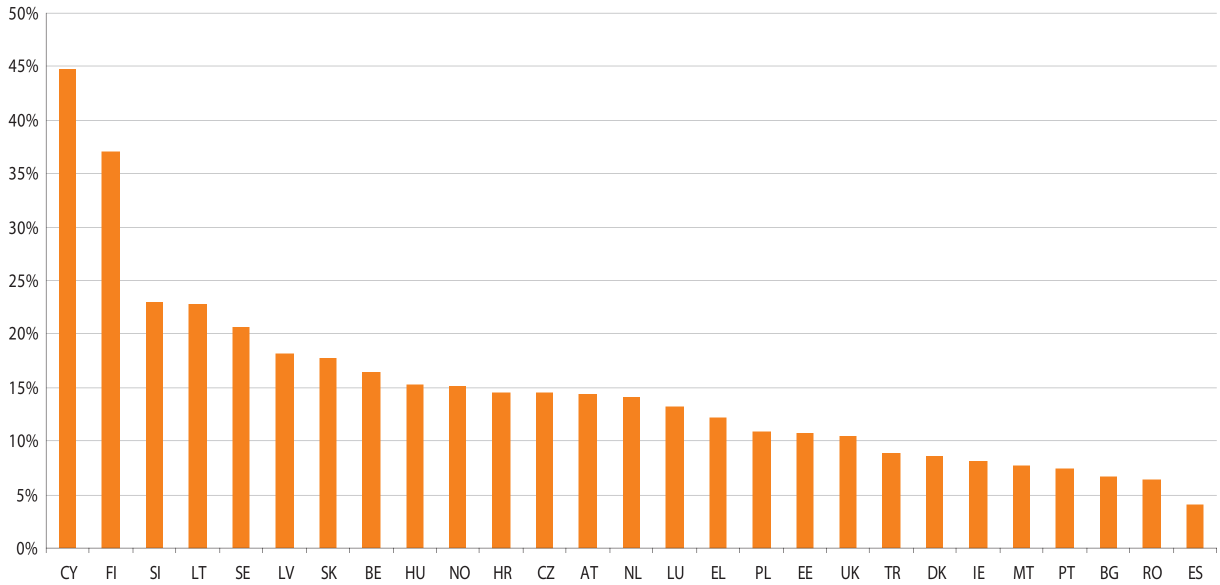
Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_coop)

In 15 out of the 29 European countries under review, more than 20 % of innovative enterprises cooperate with their clients or customers (see Figure 5.21). Only 4 % of innovative enterprises in Spain cooperate with their clients or customers, compared to 53 % in Finland.

Figure 5.22 shows that Finland reported the highest concentration of enterprises cooperating with competitors or other enterprises in the same sector (36 %). Cooperation with competitors can generate more competition between enterprises and foster innovation. Cyprus came second after Finland, with 28 % of innovative enterprises cooperating with competitors.

At the other end of the spectrum, cooperation with competitors was under 5 % in Malta, Ireland and Spain.

Figure 5.23: Cooperation partner: consultants, commercial labs, or private R&D institutes — 2004-2006 (as a percentage of innovative enterprises)

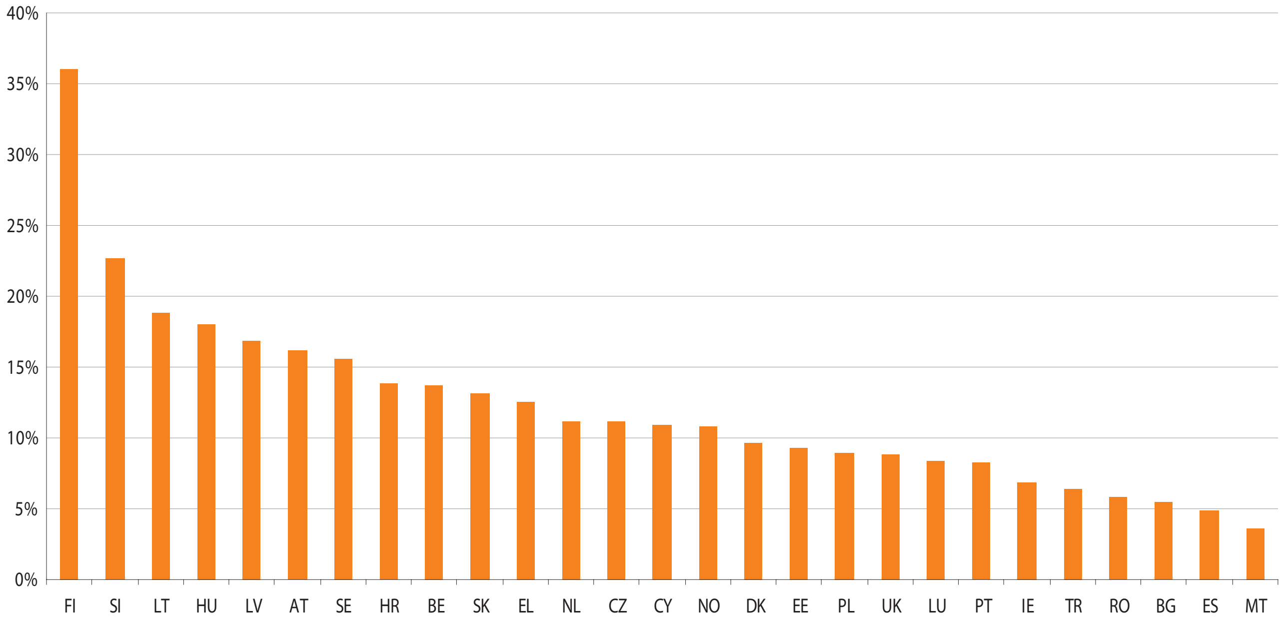


Note:
Data missing for DE, FR and IT.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_coop)

Cyprus and Finland, with 45 % and 37 % respectively, also reported the highest shares of innovative enterprises cooperating with consultants, commercial labs, or private R&D institutes. In the remaining countries, cooperation levels varied between 5 % and 25 %, except for Spain, where cooperation levels were below 5 %.

Figure 5.24: Cooperation partner: universities or other higher education institutions — 2004-2006 (as a percentage of innovative enterprises)



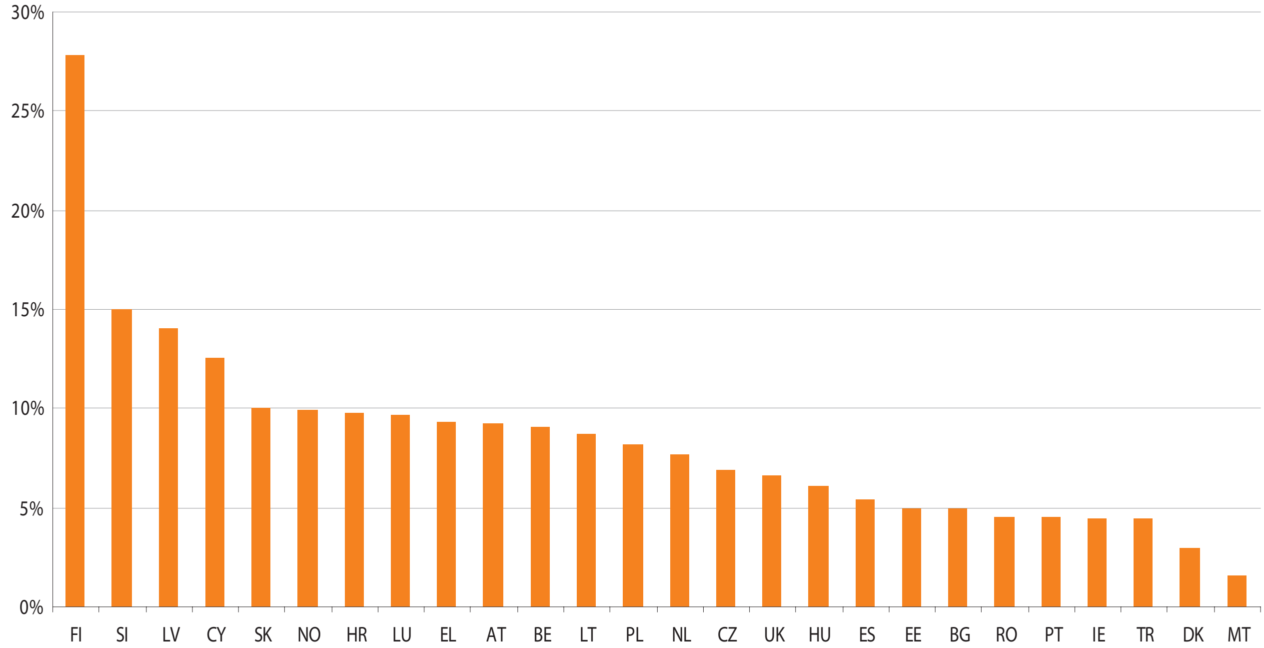
Note:
Data missing for DE, FR and IT.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_coop)

Knowledge transfers from higher education to the business enterprise sector are a crucial element of innovation. This is why cooperation between the business enterprise sector and both the government sector and the higher education sector needs to be strengthened. Almost 36 % of innovative enterprises in Finland cooperate with universities and higher education institutions in the development of innovations. Slovenia also reported high shares of academic cooperation (23 %), followed by Lithuania, Hungary, Latvia and Austria (all more than 15 %).

In Malta, on the other hand, only 3 % of innovative enterprises cooperated with universities and higher education institutions, although this can be explained by the comparatively small size of the higher education system in Malta in relation to the other countries under review.

Figure 5.25: Cooperation partner: government or public research institutes — 2004-2006
(as a percentage of innovative enterprises)



Note:
Data missing for DE, FR and IT.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_coop)

Having the Government or a public research institution as a cooperation partner is a common trend in the EU countries observed. Finland reported the highest shares of cooperation with government or public research institutions (28 %), followed by Slovenia (15 %). Only eight of the countries studied reported shares of less than 5 %; they were Estonia, Bulgaria, Romania, Portugal, Ireland, Turkey, Denmark and Malta.

Table 5.26: Most valuable cooperation partners — 2004-2006
(as a percentage of innovative enterprises)

	Other enterprises within your enterprise group	Competitors or other enterprises of the same sector	With clients or customers	With suppliers of equipment, materials, components or software	With universities or other higher education institutions	With government or public research institutes	With consultants, commercial labs, or private R&D institutes
BE	4.4	1.4	6.4	8.2	3.7	1.6	3.3
BG	1.8	1.5	6.2	8.2	0.9	:c	1.4
CZ	7.3	1.6	13.0	12.0	1.5	0.8	2.2
DK	:	:	:	:	:	:	:
DE	:	:	:	:	:	:	:
EE	14.2	3.2	10.2	8.9	1.1	0.2	1.8
IE	:	:	:	:	:	:	:
EL	1.1	1.8	3.9	11.4	4.4	1.5	4.6
ES	2.3	1.3	2.0	5.2	2.0	2.7	1.5
FR	:	:	:	:	:	:	:
IT	:	:	:	:	:	:	:
CY	6.6	3.3	11.1	25.1	0.6	1.4	12.9
LV	10.9	4.2	8.1	14.6	0.1	0.4	0.8
LT	12.3	1.0	6.6	20.7	7.7	c	2.9
LU	5.8	4.5	5.7	12.3	1.4	0.6	2.4
HU	5.9	2.3	6.0	11.2	7.5	1.4	4.6
MT	8.7	:	6.2	6.2	:c	:	2.1
NL	7.9	1.4	8.1	15.2	1.9	0.3	3.5
AT	:	:	:	:	:	:	:
PL	8.4	1.9	8.8	21.4	1.9	3.1	2.7
PT	2.8	1.8	3.9	4.2	2.7	0.8	1.9
RO	1.7	0.8	4.9	6.1	0.9	0.5	1.6
SI	6.5	3.8	16.2	17.1	3.1	0.7	3.0
SK	8.0	0.8	5.5	17.3	1.2	0.6	2.3
FI	10.7	2.4	16.4	11.4	4.4	3.3	3.0
SE	:	:	10.1	16.2	:	:	:
UK	:	:	:	:	:	:	:
HR	5.6	2.9	10.9	11.6	1.6	0.5	2.6
TR	:	:	:	:	:	:	:
NO	:	:	:	:	:	:	:

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_coop)

Right across Europe, private sector cooperation partners seem to be more valuable than public institutions. This was observed as a general trend in all the enterprises surveyed.

The question about the most valuable method of cooperation (Table 5.26) is not a real plebiscite of enterprises. The suppliers of equipment, materials, components or software collected the highest number of votes in many countries, but not in all. In Finland and the Czech Republic, innovative enterprises preferred their clients and customers as cooperation partners. The innovative enterprises in Malta were more favourable to cooperating with other enterprises of their enterprise group, and the same was observed for Estonia.

To summarise the results on cooperation and the different methods, it should be said that innovative enterprises do cooperate, but they could do so to a much higher degree. As the situation of cooperation varies according to the methods and across countries, it needs to be studied in detail. It is important to determine what are the barriers to cooperation in order to introduce the necessary reforms and other actions that may encourage cooperation.

5.3.6 Effects of innovation between 2004 and 2006

Innovative enterprises give priority to the improvement of quality in goods and services

The CIS 2006 questionnaire distinguished between three groups of effects of innovation. The innovative enterprises surveyed were asked to give an appropriate rating to the nine observed effects. In the following analysis only the effects chosen as highly important are taken into account.

Product-oriented effects

o Increased range of goods or services
o Entry into new markets or increased market share
o Improved quality of goods or services

Process-oriented effects

o Improved flexibility of production or service provision
o Increased capacity of production or service provision
o Reduced labour costs per unit output
o Reduced materials and energy per unit output

Other effects

o Reduced environmental impacts or improved health and safety
o Regulatory requirements met

Table 5.27: Product-oriented effects of innovation — 2004-2006
(as a percentage of innovative enterprises)

	Increased range of goods and services	Entered new markets or increased market share	Improved quality in goods or services
BE	:	:	:
BG	38.2	30.1	38.9
CZ	39.3	28.8	38.2
DK	18.6	15.8	16.6
DE	:	:	:
EE	29.8	25.7	27.2
IE	:	:	:
EL	9.1	11.6	5.8
ES	25.2	18.6	33.5
FR	:	:	:
IT	:		
CY	45.4	38.0	57.5
LV	27.9	15.8	26.6
LT	32.4	28.0	34.4
LU	57.7	45.1	62.1
HU	32.4	26.2	37.2
MT	27.7	15.9	31.3
NL	44.8	38.8	44.0
AT	39.4	33.7	48.7
PL	36.1	26.9	38.1
PT	34.1	25.4	44.3
RO	37.0	29.4	41.7
SI	:	:	:
SK	38.1	23.1	41.6
FI	16.5	15.5	17.0
SE	33.0	24.3	34.2
UK	:	:	:
HR	39.1	32.8	52.3
TR	38.3	32.6	49.5
NO	:	:	:

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_eff)

In terms of the product-oriented effects of innovation, improved quality in goods and services was the main effect in most of the enterprises in 13 of the countries studied and in two candidate countries (Croatia and Turkey).

In Luxembourg, 62 % of innovative enterprises stated that improved quality of goods or services was the main effect of innovation, as compared to 58 % of innovative enterprises in Cyprus.

A majority of enterprises in the Czech Republic, Denmark, Estonia, Latvia, the Netherlands and Finland reported that an increased range of goods and services was the main product-oriented effect of innovation.

Greece was the only country where the majority of innovative enterprises (12 %) considered that the most important effect of product innovation was to gain access to new markets or increase market share.

Table 5.28: Process-oriented effects of innovation — 2004-2006
(as a percentage of innovative enterprises)

	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
BE	:	:	:	:
BG	21.0	21.7	15.9	13.3
CZ	25.4	26.1	18.2	14.2
DK	15.3	18.8	11.5	7.3
DE	:	:	:	:
EE	20.0	20.5	14.3	7.8
IE	:	:	:	:
EL	8.3	9.2	26.2	20.8
ES	22.6	27.4	12.9	8.5
FR	:	:	:	:
IT	:	:	:	:
CY	69.8	62.4	29.2	19.9
LV	16.4	17.3	6.2	5.4
LT	25.0	30.5	10.7	8.5
LU	35.2	33.6	12.9	6.8
HU	21.9	22.3	6.2	7.2
MT	21.0	18.5	11.8	7.7
NL	31.8	31.6	16.6	10.5
AT	30.0	27.8	11.9	9.7
PL	20.8	25.7	13.8	11.6
PT	31.2	36.5	22.4	15.0
RO	28.2	34.1	18.3	14.8
SI	:	:	:	:
SK	28.5	27.2	8.0	10.8
FI	14.5	15.3	10.7	5.2
SE	18.4	23.1	17.0	u
UK	:	:	:	:
HR	34.5	32.2	19.9	15.1
TR	39.4	39.4	18.0	10.2
NO	:	:	:	:

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_eff)

In terms of the process-oriented effect of innovation, increased capacity of production or service provision seems to be the most noticeable effect of innovation. This is true for thirteen of the countries studied.

A majority of innovative enterprises in seven EU-27 countries and two candidate countries reported that improved flexibility of production or service provision was the most notable effect of process innovation. For most innovative enterprises in Greece, reduced labour costs per unit output was the most significant effect of process innovation.

Reduced materials and energy per unit of output were a significant effect of process innovation for enterprises in Greece and Cyprus, but this was less true of innovative enterprises in the remaining countries.

Table 5.29: Other effects of innovation — 2004-2006
(as a percentage of innovative enterprises)

	Reduced environmental impacts or improved health and safety	Met regulation requirements
BE	:	:
BG	20.9	25.3
CZ	13.8	7.2
DK	5.3	9.2
DE	:	:
EE	8.4	6.8
IE	:	:
EL	12.9	11.4
ES	13.4	19.8
FR	:	:
IT	:	:
CY	38.0	56.1
LV	6.3	13.9
LT	9.9	25.2
LU	12.9	28.5
HU	13.6	19.8
MT	8.7	20.0
NL	11.7	14.6
AT	13.4	18.5
PL	18.5	24.7
PT	24.1	25.6
RO	23.7	20.9
SI	:	:
SK	13.8	13.4
FI	7.2	9.7
SE	14.0	17.8
UK	:	:
HR	18.1	31.5
TR	21.6	28.8
NO	:	:

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_eff)

Innovative enterprises in the countries surveyed generally consider that the most important side effect of innovation is the need to meet regulation requirements.

Most of the innovative enterprises in the countries under review consider that meeting regulation requirements was the most significant complementary effect of innovation. However, in the Czech Republic, Greece and Romania, innovative enterprises tended to highlight the importance of innovation in reducing environmental impacts or in improving health and safety conditions.

5.3.7 Factors hampering innovation activities during 2004 and 2006

It is important for policy-makers to understand the barriers to innovation. Political interventions can only be successful if they are targeted. However, as we will see later, not all barriers are located outside the enterprise. There are some obstacles that the enterprise has to overcome itself.

All enterprises were asked to classify eleven factors hampering innovation according their degree of importance. These factors covered 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

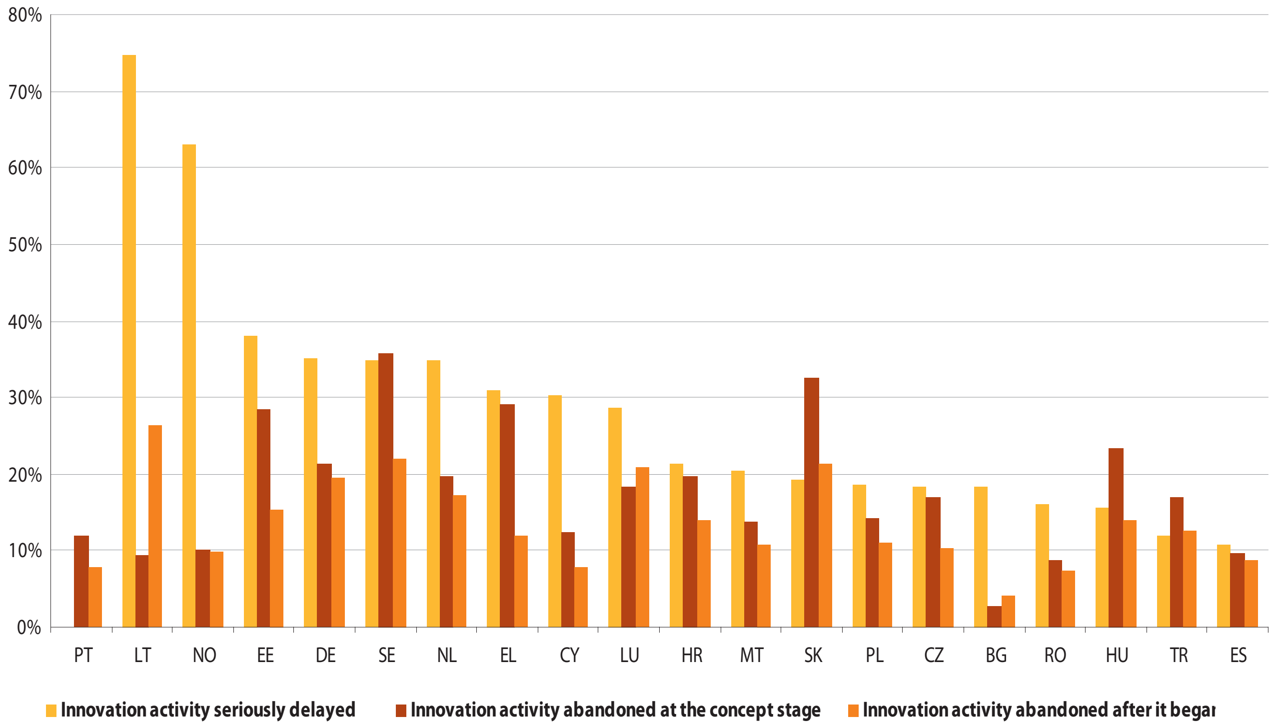
Market factors

- o Market dominated by established enterprises
- o Uncertain demand for innovative goods or services

Reasons not to innovate

- o No need due to earlier innovations
- o No need because there is no demand for innovations

Figure 5.30: Factors hampering innovation — 2004-2006
(as a percentage of innovative enterprises)



Note:
Data missing for BE, DK, IE, FR, IT, LV, AT, SI, FI and UK.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_ham)

Innovation activities are subject to external factors that might complicate their implementation.

Figure 5.30 shows that, in many innovative enterprises in Europe, innovation activities can be seriously delayed, and that creates an obstacle to the development of innovation.

In Sweden, 36 % of innovative enterprises declared that many innovation ideas are abandoned at the concept stage. This was also the case for 33 % of Slovakian enterprises, 29 % of Greek enterprises and 28 % of Estonian enterprises, which shows that it is difficult for small enterprises to get on the ladder of the innovation process.

It is also true that innovation activity is likely to be abandoned after it has begun for a number of different reasons, and a large percentage of enterprises (26 % in Lithuania, 22 % in Sweden, and 21 % in Luxembourg) highlighted this hampering effect of innovation.

Cost factors are generally considered as highly important factors hampering innovation. The following analysis will take a closer look at the three different cost factors, broken down by country.

Lack of funds within the enterprise or enterprise group appears to be the most important hampering factor for innovative enterprises in the Czech Republic, Estonia, Ireland, Greece, Luxembourg, Hungary, the Netherlands, Austria and Sweden. This is also true for Croatia.

Financing from outside sources is very important in the development of innovation activities. However, only innovative enterprises in Romania regard this as the most important financial factor hampering innovation.

More important for enterprises is the net cost of innovation. In nine countries, namely Bulgaria, Spain, Cyprus, Latvia, Lithuania, Malta, Poland, Portugal and Slovakia, the high cost of innovation is the most significant obstacle to innovation. Innovative enterprises in Turkey and Norway also consider this obstacle as highly relevant.

Table 5.31: Cost factors hampering innovation — 2004-2006
(as a percentage of innovative enterprises)

	Lack of funds within your enterprise or enterprise group	Lack of finance from sources outside your enterprise	Innovation costs too high
BE	:	:	:
BG	19.6	15.3	23.6
CZ	21.9	12.6	17.7
DK	:	:	:
DE	:	:	:
EE	21.6	16.3	16.5
IE	18.6	12.2	16.3
EL	18.5	16.2	9.5
ES	25.7	23.3	34.8
FR	:	:	:
IT	:	:	:
CY	18.9	19.1	28.5
LV	28.9	23.1	36.5
LT	25.1	19.8	29.5
LU	15.7	6.1	12.1
HU	28.8	19.9	27.3
MT	12.8	10.8	16.9
NL	8.5	4.7	7.6
AT	21.0	14.7	18.6
PL	28.8	25.0	29.7
PT	26.8	26.2	36.6
RO	30.6	31.0	28.6
SI	:	:	:
SK	20.2	14.5	22.2
FI	:	:	:
SE	15.5	u	11.5
UK	:	:	:
HR	35.9	27.2	35.8
TR	27.3	17.0	34.4
NO	14.0	9.0	15.7

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_ham)

Table 5.32: Knowledge factors hampering innovation — 2004-2006
(as a percentage of innovative enterprises)

	Lack of qualified personnel	Lack of information on technology	Lack of information on markets	Difficulty in finding cooperation partners for innovation
BE	:	:	:	:
BG	10.7	5.3	6.1	9.5
CZ	15.4	2.1	2.7	3.0
DK	:	:	:	:
DE	:	:	:	:
EE	23.1	4.0	4.9	5.9
IE	10.1	3.4	6.1	6.2
EL	26.2	30.5	35.6	19.5
ES	16.6	11.1	8.5	11.9
FR	:	:	:	:
IT	:	:	:	:
CY	15.2	6.2	2.7	7.0
LV	20.8	11.9	1.3	14.8
LT	25.2	2.7	5.0	8.9
LU	:	:	:	:
HU	14.0	3.6	3.8	6.6
MT	7.2	2.1	5.6	6.2
NL	7.0	2.6	2.7	2.0
AT	16.7	3.4	4.1	6.7
PL	7.3	4.3	4.4	8.7
PT	13.3	5.5	6.9	12.6
RO	13.5	5.5	5.3	14.4
SI	:	:	:	:
SK	9.6	1.7	1.8	5.3
FI	:	:	:	:
SE	15.9	u	u	u
UK	:	:	:	:
HR	20.6	6.6	5.7	10.5
TR	17.6	9.2	6.1	10.7
NO	13.8	3.2	3.8	3.8

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_ham)

Knowledge and innovation are closely linked. Knowledge can be transferred by different means, such as human resources, information and cooperation.

Knowledge factors can also be important barriers to innovation, especially for small enterprises.

Table 5.32 shows that, in most of the countries studied, the lack of qualified personnel is a major barrier to innovation.

By creating a knowledge economy, policy-makers are endeavouring to increase the stock of qualified personnel, but it seems that their efforts are not sufficient for European enterprises.

For innovative enterprises in Greece, the lack of market information was the most significant knowledge factor hampering innovation (35.6 %), followed by the lack of information on technology (30.5 %). However, this trend does not apply to the remaining countries, for whom a lack of information on technology was the least important factor.

The difficulty in finding cooperation partners for innovation seems to be the most substantial innovation barrier in Poland and Romania, and the second most important hampering factor in the remaining countries.

Table 5.33: Market factors hampering innovation — 2004-2006
(as a percentage of innovative enterprises)

	Uncertain demand for innovative goods or services	Markets dominated by established enterprises
BE	:	:
BG	10.3	12.0
CZ	9.0	14.1
DK	:	:
DE	:	:
EE	4.9	10.2
IE	14.1	14.9
EL	23.2	24.2
ES	18.8	18.7
FR	:	:
IT	:	:
CY	14.2	7.8
LV	17.8	22.4
LT	7.2	17.8
LU	12.9	14.9
HU	14.0	15.4
MT	11.3	10.8
NL	4.0	4.8
AT	9.4	12.4
PL	14.6	16.0
PT	16.3	15.1
RO	13.3	18.9
SI	:	:
SK	8.2	12.6
FI	:	:
SE	u	14.4
UK	:	:
HR	8.2	17.9
TR	14.3	13.0
NO	6.9	6.6

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_ham)

As Table 5.33 shows, market factors can also be regarded as major barriers to innovation. At national level, approximately 15 % of innovative enterprises felt affected by such factors.

The results vary significantly between countries. Less than 5 % of innovative enterprises in Estonia and the Netherlands rated "uncertain demand for innovative good and services" as highly important, compared with 23 % in Greece.

Except for Spain, Cyprus, Malta, Turkey and Norway, market domination by other established enterprises - as a market factor hampering innovation - appears to play a rather more fundamental role in most countries than uncertainty of demand.

Table 5.34: Reasons not to innovate — 2004-2006
(as a percentage of non-innovative enterprises)

	No need to innovate because no demand for innovations	No need to innovate due to prior innovations
BE	:	:
BG	5.2	4.1
CZ	4.6	2.9
DK	:	:
DE	:	:
EE	5.9	4.3
IE	5.9	6.8
EL	29.0	23.4
ES	10.0	6.1
FR	:	:
IT	:	:
CY	:	:
LV	6.8	2.8
LT	1.9	3.0
LU	6.4	6.1
HU	4.0	2.3
MT	4.1	:c
NL	1.1	0.9
AT	4.5	3.1
PL	5.0	4.1
PT	5.8	4.5
RO	2.1	2.9
SI	:	:
SK	:	:
FI	:	:
SE	u	u
UK	:	:
HR	4.3	3.5
TR	8.1	7.8
NO	2.8	2.5

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_ham)

In contrast with the three previous tables, which displayed the results for the factors rated as highly important in terms of hampering innovation by innovative enterprises, Table 5.34 presents the two most often cited reasons not to innovate.

In nearly all countries for which data are available, prior innovations were rated more important than the lack of demand for innovation. The only exceptions were Cyprus and Lithuania.

Possible reasons for not innovating are either the existence of prior innovations or the lack of demand for innovation. The results are distributed relatively widely across countries. While only 5 % of the non-innovative enterprises in Malta considered prior innovations to be a highly important reason not to innovate, the corresponding percentage in Cyprus was 31 %. On the other hand, while once again 4 % of the non-innovative enterprises in Malta chose the reason "no need to innovate because of no demand for innovation", nearly one third of non-innovative enterprises in Cyprus considered the lack of demand to be a very important reason.

5.3.8 Intellectual property rights

How enterprises protect their innovations

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

All surveyed enterprises were asked to provide information on their innovation activities between 2004 and 2006 that led to the granting of intellectual property rights (IPR). The CIS 2006 questionnaire divides the protection methods into:

- Patent applications;
- Registration of an industrial design;
- Registration of a trademark, and
- Copyright claimed.

There are different methods of protection depending on what has to be protected.

Patents protect the technical and functional aspects of products and processes. An invention is patentable when it fulfils the criteria of industrial applicability, novelty, inventiveness and patentable subject matter. Patenting is a relatively expensive procedure that requires a considerable amount of "red tape".

Registered trademarks protect signs or combinations of signs that can distinguish the goods and services of different traders.

Office for Harmonisation in the Internal Market (Trade Marks and Designs) (OHIM)

"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.

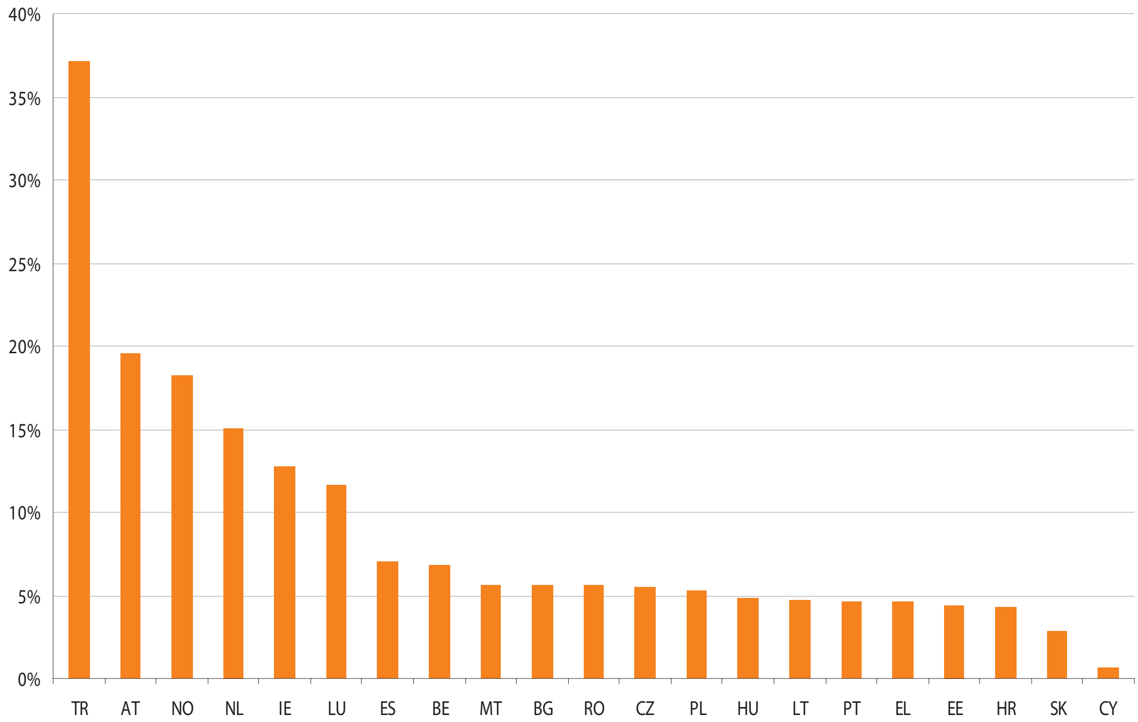
A uniform law applies to trade marks and designs, thereby providing strong and unique protection throughout the European Union. The simplification results in considerably reduced costs as compared with the overall costs of national registration in all countries of the European Union.

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

See also: http://oami.europa.eu/ows/rw/pages/index.en.do

Figure 5.35: Innovative enterprises that applied for a patent — 2004-2006 (as a percentage of innovative enterprises)



Note:
Data missing for DK, DE, FR, IT, LV, AT, SI, FI and UK.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_pat)

A patent is a legal title granting its holder the right to prevent third parties from commercially exploiting an invention without authorisation.

Between 2004 and 2006, 37 % of innovative enterprises in Turkey applied for a patent. They were the most active users of this form of protection. In three European countries under review, more than 15 % of the innovative enterprises applied for a patent (Austria, Norway and the Netherlands).

At the other end of the scale, in eight European countries less than 5 % of the innovative enterprises applied for a patent during the three years from 2004 to 2006, with Cyprus registering the lowest percentage (1 %).

WHAT IS A PATENT

"Articles 52 and 53 of the European Patent Convention (EPC) stipulate what can and what cannot be patented. European patents are granted for inventions that

- are new,
- involve an inventive step, and
- are susceptible of industrial application.

An invention can belong to any field of technology.

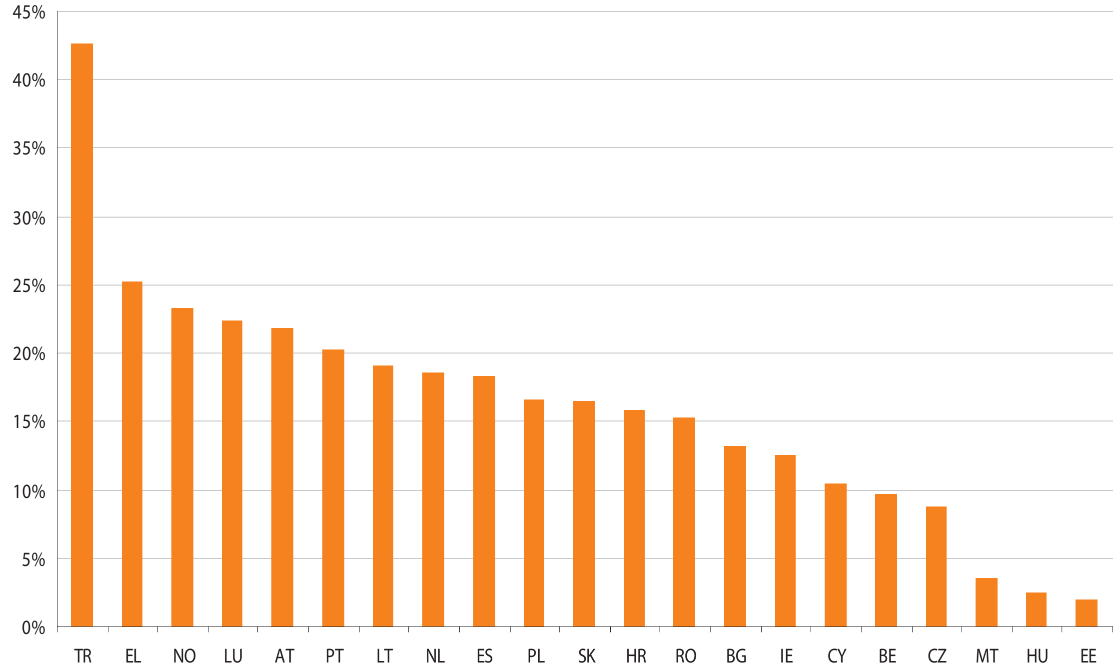
Furthermore,

- discoveries, scientific theories and mathematical methods
- aesthetic creations
- schemes, rules and methods for performing mental acts, playing games or doing business
- programs for computers, and
- presentations of information

are not considered to be inventions if the European patent application only relates to such subject-matter or activities as such."

Source: http://www.epo.org

Figure 5.36: Innovative enterprises that registered a trademark — 2004-2006 (as a percentage of innovative enterprises)



Note:
Data missing for DK, DE, FR, IT, LV, AT, SI, FI and UK.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_pat)

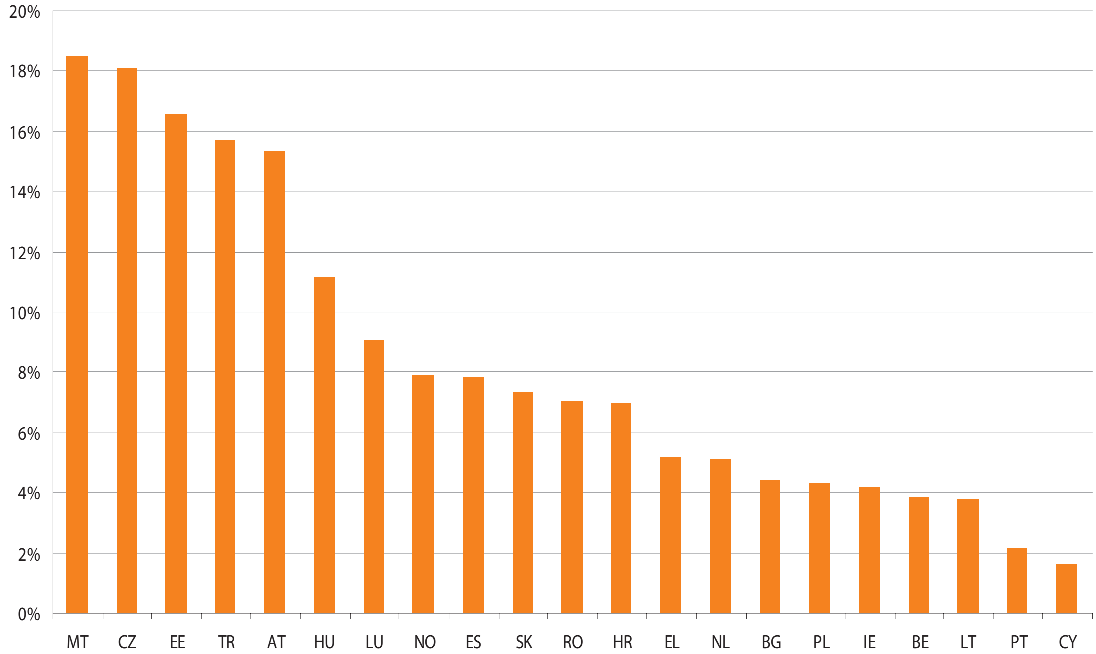
Registered trademarks protect signs or combinations of signs that identify the goods and services of individual traders.

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.

Once again, Turkey registered the most trademarks between 2004 and 2006 (43 %), followed by Greece (25 %).

Over the same period less than 10 % of innovative enterprises in Belgium and the Czech Republic registered a trademark, compared with less than 5 % in Malta, Hungary and Estonia.

Figure 5.37: Innovative enterprises that registered an industrial design — 2004-2006 (as a percentage of innovative enterprises)



Note:
Data missing for DK, DE, FR, IT, LV, AT, SI, FI and UK.

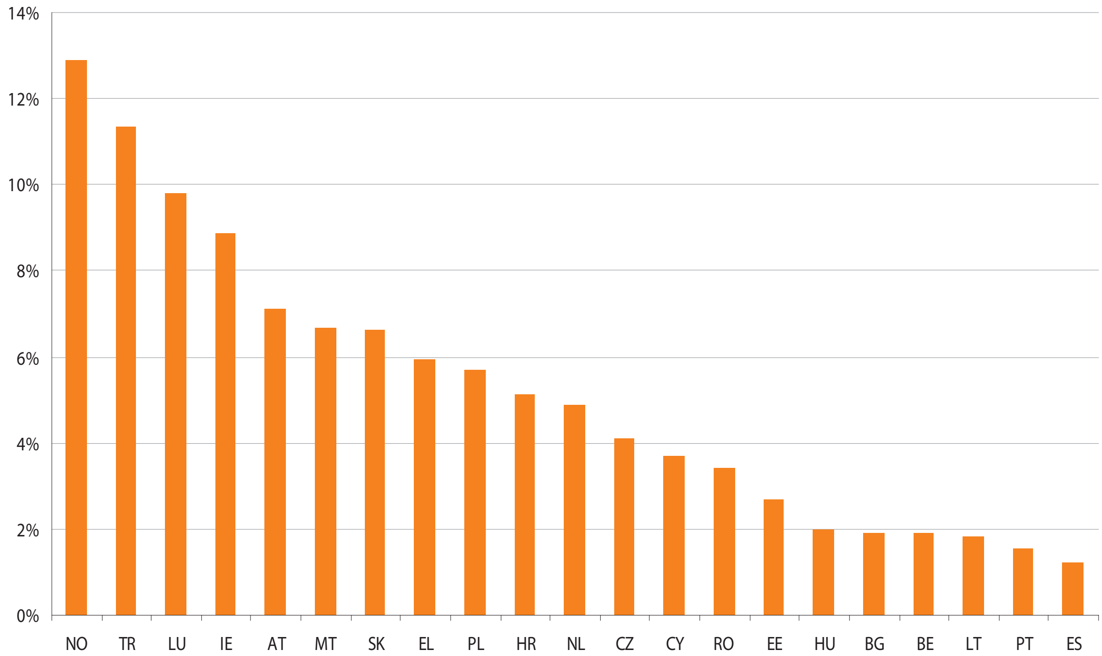
Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_pat)

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, housewares, appliances, transport, tools, farm equipment, medical/electronic instruments, the human interface and recreational support equipment.

Whereas, in Malta, between 2004 and 2006, 19% of innovative enterprises registered an industrial design, in Cyprus only 2% of the innovative enterprises used this form of protection.

Figure 5.38: Innovative enterprises that claimed a copyright — 2004-2006
(as a percentage of innovative enterprises)



Note:
Data missing for DK, DE, FR, IT, LV, AT, SI, FI and UK

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_pat)

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.

Among the enterprises surveyed, copyrights are a less important method of protection. Nevertheless, more than 12 % of the innovative enterprises in Norway claimed at least one copyright in the period under review. By contrast, less than 2 % of the innovative enterprises in Bulgaria, Belgium, Lithuania, Portugal and Spain claimed at least one copyright over the same period.

5.3.9 Organisational and marketing innovations

Organisational innovations

Organisational innovations involve the implementation of a significant change in business practices, workplace organisation or external relations, intended to improve the firm's innovative capacity or performance characteristics, such as the quality or efficiency of work flows. 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 *exclude the following*:

- Changes in management strategy, unless accompanied by the introduction of significant organisational change;
- Introduction of new technology that is only used by one division of a firm (for example, in production). These are usually process innovations.

Knowledge management systems

- Establishment of formal or informal work teams to improve the access 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 optimize the allocation of resources from sourcing inputs to the 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 the management of marketing and production into two divisions.

Changes in external relations

- First use of outsourcing of research or production if it requires a change in how work flows are organised within the firm.

Marketing innovations

Marketing innovations cover significant changes in how your enterprise markets your goods and services, including changes to design and packaging.

Marketing innovations *exclude the following*:

- Routine or seasonal changes, such as clothing fashions;
- Advertising, unless based on the 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 for specific markets (different covers and typeface for children and adult versions of the same book).

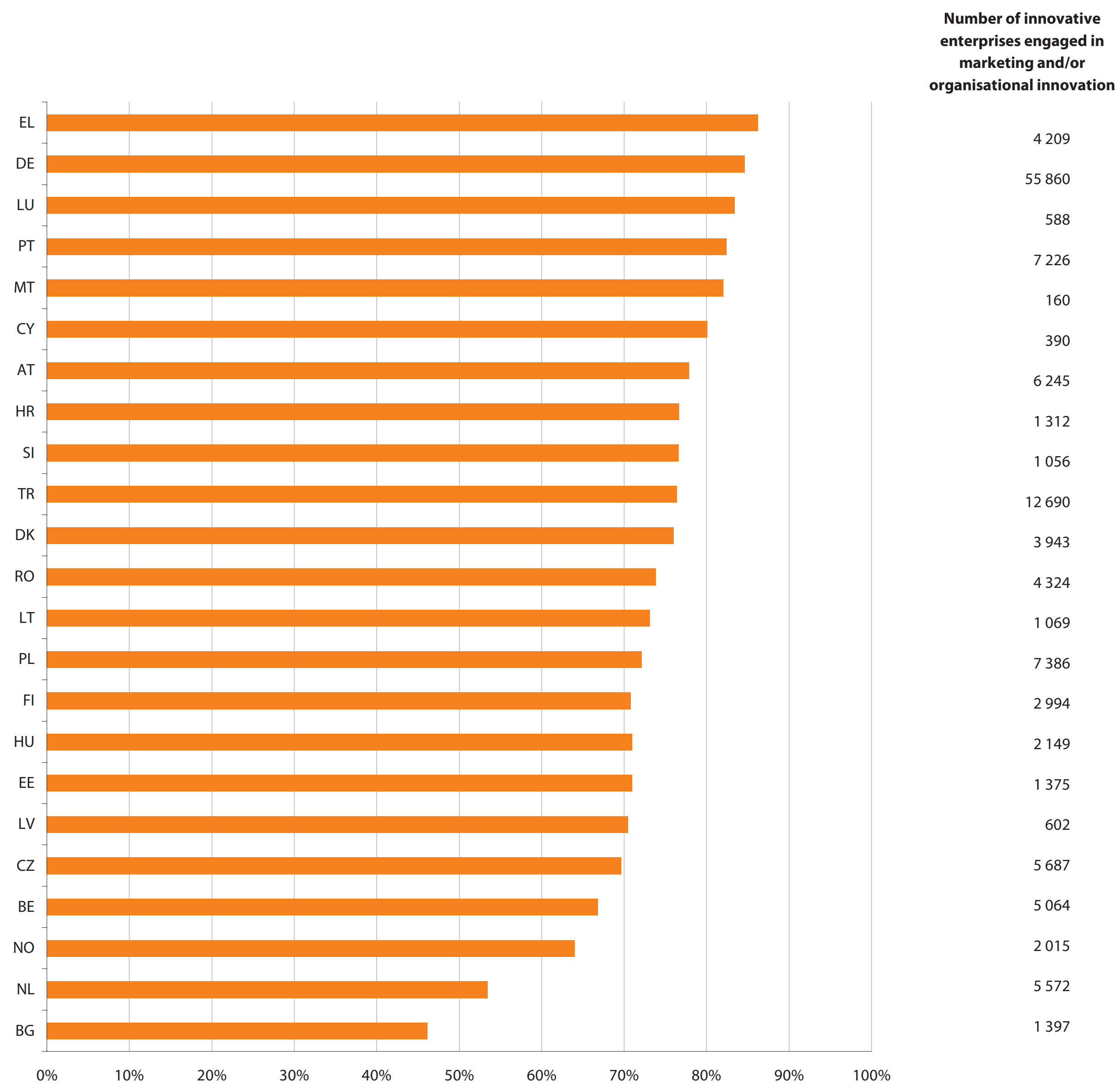
New sales methods

- Bundling existing goods or services in new ways to appeal to market segments;
- Developing trademarks for new product lines;
- Targeting marketing at sub-populations using personalized information. This information can be collected at an individual level from individuals that visit websites for information or join 'frequent user or buyer' reward plans;
- Product seeding through 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 containing educational programming material to stimulate specific product sales;
- In-store sales that are only accessible to holders of the store's credit card or reward card.

The enterprises surveyed were asked to evaluate the importance of four different effects of organisational innovation.

- Responding more quickly to customer or supplier needs;
- Improved quality of your goods or services;
- Reduced costs per unit output;
- Improved employee satisfaction and/or reduced rates of employee turnover.

Figure 5.39: Number of innovative enterprises that introduced organisational and/or marketing innovations — 2004-2006 (as a percentage of innovative enterprises and total number)



Note:
Data missing for FR, IT, AT, SK, SE and UK.

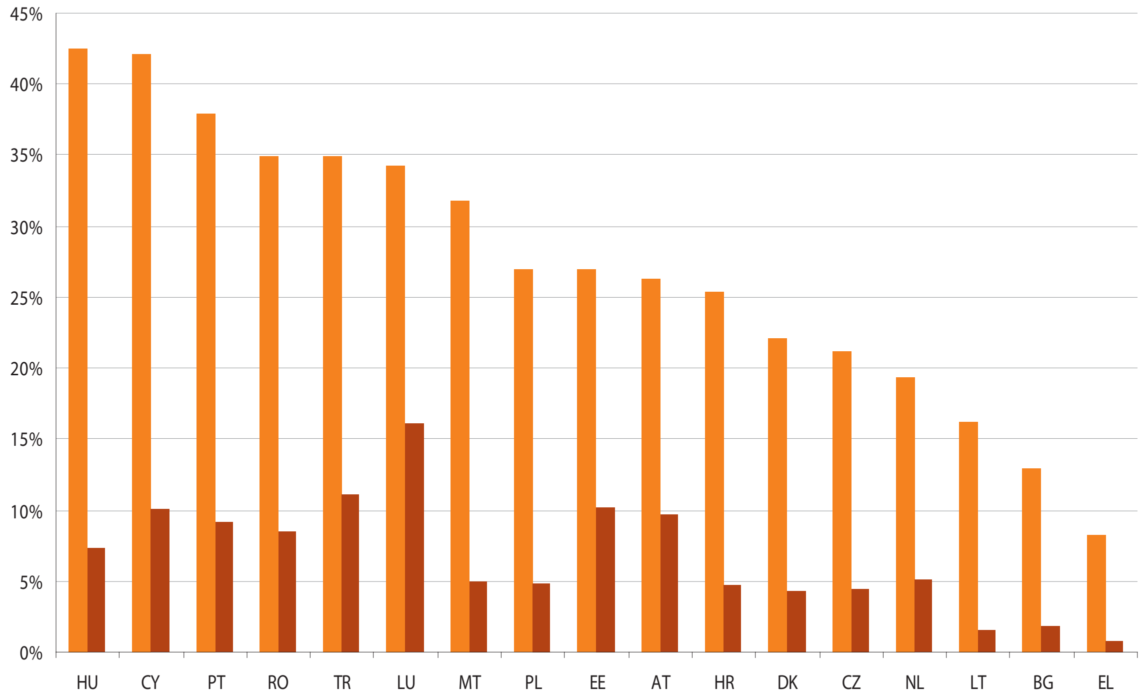
Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_mo)

Figure 5.39 shows, both in absolute and in relative terms, the quantity of innovative enterprises that have introduced organisational and/or marketing innovations. As a general trend, innovations of this kind are very popular within innovative enterprises in Europe, as evidenced by the fact only one Member State (Bulgaria) had less than 50 % of innovative enterprises involved in activities of this kind.

Innovative enterprises in Greece ranked first in relative terms, meaning that 86 % of the Greek innovative enterprises introduced organisational and /or marketing innovations during the three years from 2004 to 2006. After them came innovative enterprises from Germany (85 %), Luxembourg (83 %), Portugal and Malta (82 % each) and Cyprus (80 %).

In absolute terms, Germany ranked first, with 55 860 innovative enterprises, followed by Turkey with 12 690, Poland with 7 386 and Portugal with 7 226.

Figure 5.40: Reduced time to respond to customer or supplier needs — 2004-2006 (as a percentage of innovative and non-innovative enterprises)



Note:
Data missing for BE, DE, IE, ES, FE, IT, LV, SI, SK, FI, SE, UK and NO.

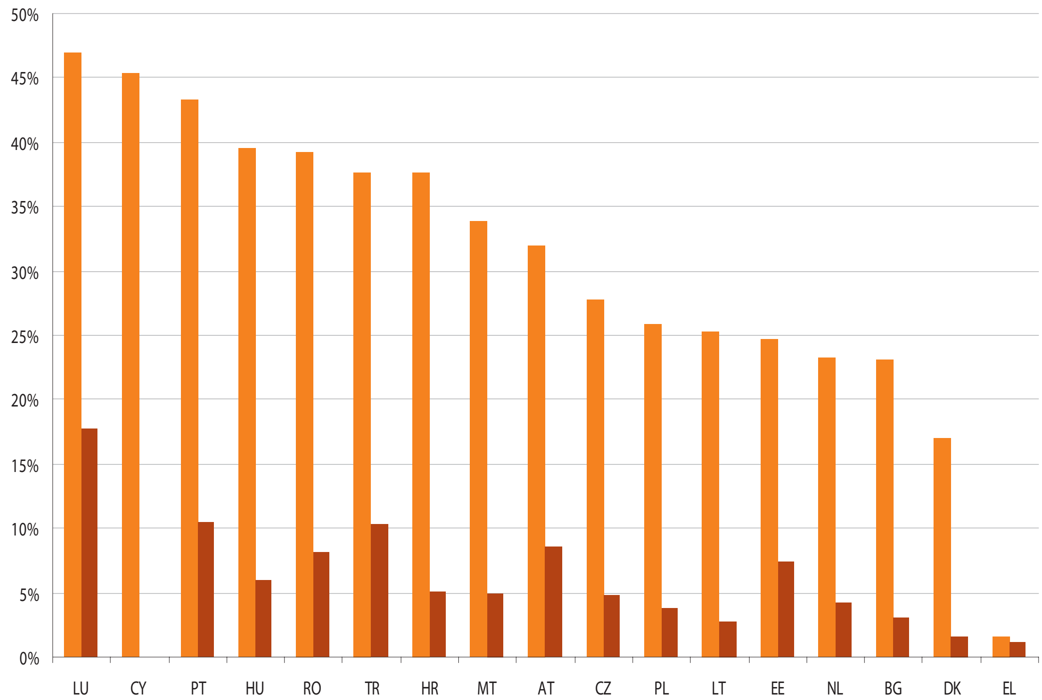
Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_mo)

The number of innovative enterprises that considered "reduced time to respond to customer or supplier needs" as a highly important effect of organisational innovation ranged from 42 % (Hungary) to 8 % (Greece).

In general, this effect was very important for the enterprises in the countries studied. Most innovative enterprises seem to regard time savings more as a positive collateral effect of innovation which does not play a large part in the enterprise's overall innovation strategy.

As for the enterprises with non-innovation activities, 16 % of the enterprises in Luxembourg considered "reduced time to respond to customer or supplier needs" as an important factor, whereas only 1 % of non-innovative enterprises in Greece took that view.

Figure 5.41: Improved quality of goods or services — 2004-2006
(as a percentage of innovative and non-innovative enterprises)



Note:
Data missing for BE, DE, IE, ES, FE, IT, LV, SI, SK, FI, SE, UK and NO.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_mo)

The more innovative enterprises seem to consider "Improved quality of goods and services" as a highly important effect of organisational innovation, much more so than "reduced time to respond to customers and suppliers". The percentages of innovative enterprises selecting this answer ranged from 47 % for Luxembourg to 2 % for Greece. In the majority of the countries featured in Figure 5.41, more than 15 % of the innovative enterprises rated this effect as highly important.

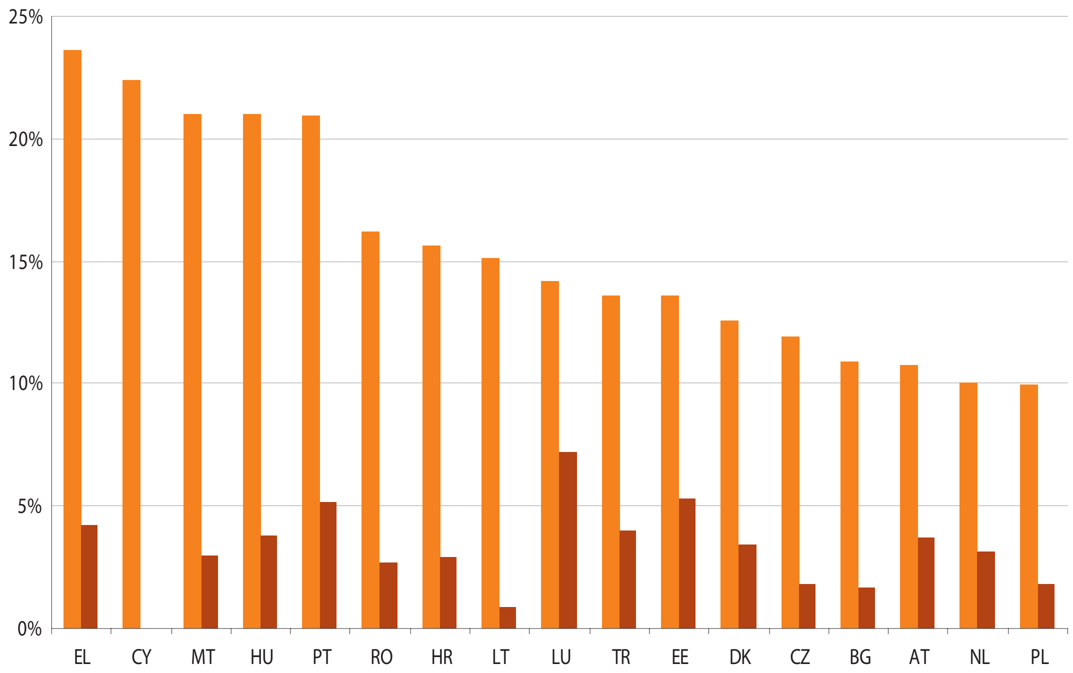
This result is in line with the figures in Table 5.27, where innovative enterprises were asked to evaluate the same effect; however, in that case a the result was due to a product and/or process innovation.

Non-innovative enterprises also consider this factor to be important. 18 % of the non-innovative enterprises in Luxembourg specifically mentioned this factor, as did 10 % of those in Portugal and Turkey.

For many innovative enterprises the quality of their goods and services seems to be of primary importance. 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. However, improving the output of the enterprise is not the ultimate aim: it is also a way to make more profit.

Figure 5.42: Reduced costs per unit output — 2004-2006
(as a percentage of innovative and non-innovative enterprises)



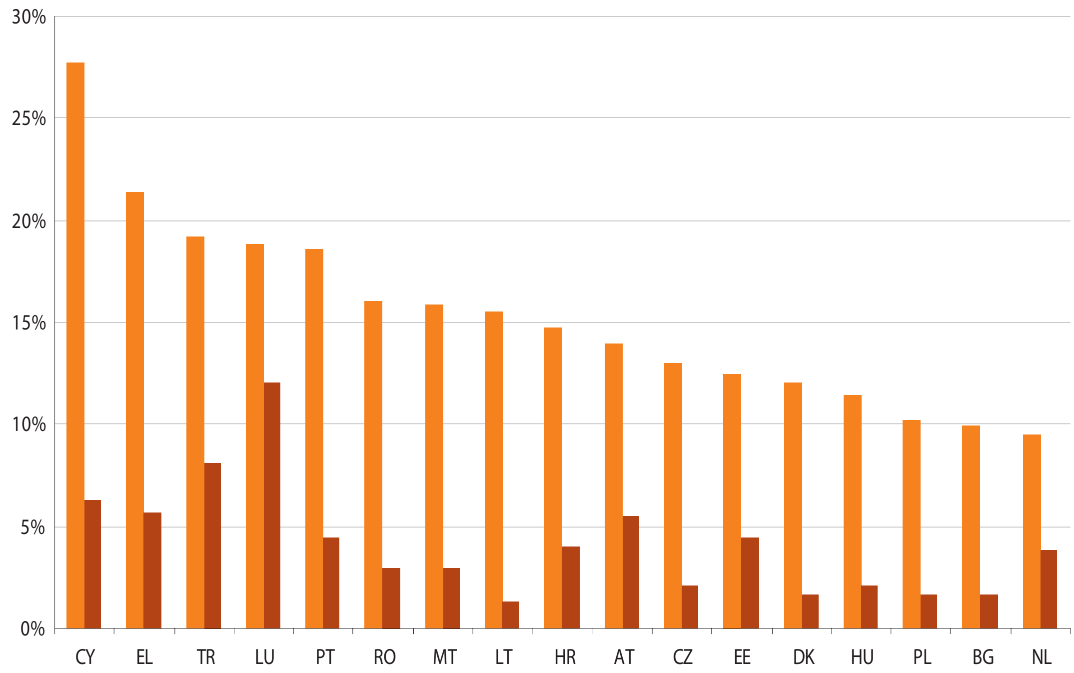
Note:
Data missing for BE, DE, IE, ES, FE, IT, LV, SI, SK, FI, SE, UK and NO.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_mo)

Reduced costs per unit output" seems to be a less important effect of organisational innovation for innovative enterprises than the two effects discussed above. More than 20 % of innovative enterprises in Greece, Cyprus, Malta and Hungary felt that this effect concerned them the most. The lowest score was in Poland, with 9 %.

This factor is not so relevant for the non-innovative enterprises. The only countries where more than 5 % of the non-innovative enterprises considered it to be an issue were Portugal, Luxembourg and Estonia.

Figure 5.43: Improved employee satisfaction and/or reduced rates of employee turnover — 2004-2006 (as a percentage of innovative and non-innovative enterprises)



Note:
Data missing for BE, DE, IE, ES, FE, IT, LV, SI, SK, FI, SE, UK and NO.

Source: Eurostat, Community Innovation Statistics 2006 (inn_cis5_mo)

The results for "improved employee satisfaction and/or reduced rates of employee turnover" are very close to those relating to "reduced costs per unit output". Once again, the highest proportion of innovative enterprises is in Cyprus (28 %) and Greece (21 %) and the lowest in Bulgaria and the Netherlands, with around 10 %.

These results are not particularly surprising because these effects do not really concern the main objective of the enterprises: namely to maximise the profit from selling goods and services. These effects are often regarded as collateral effects rather than priorities.

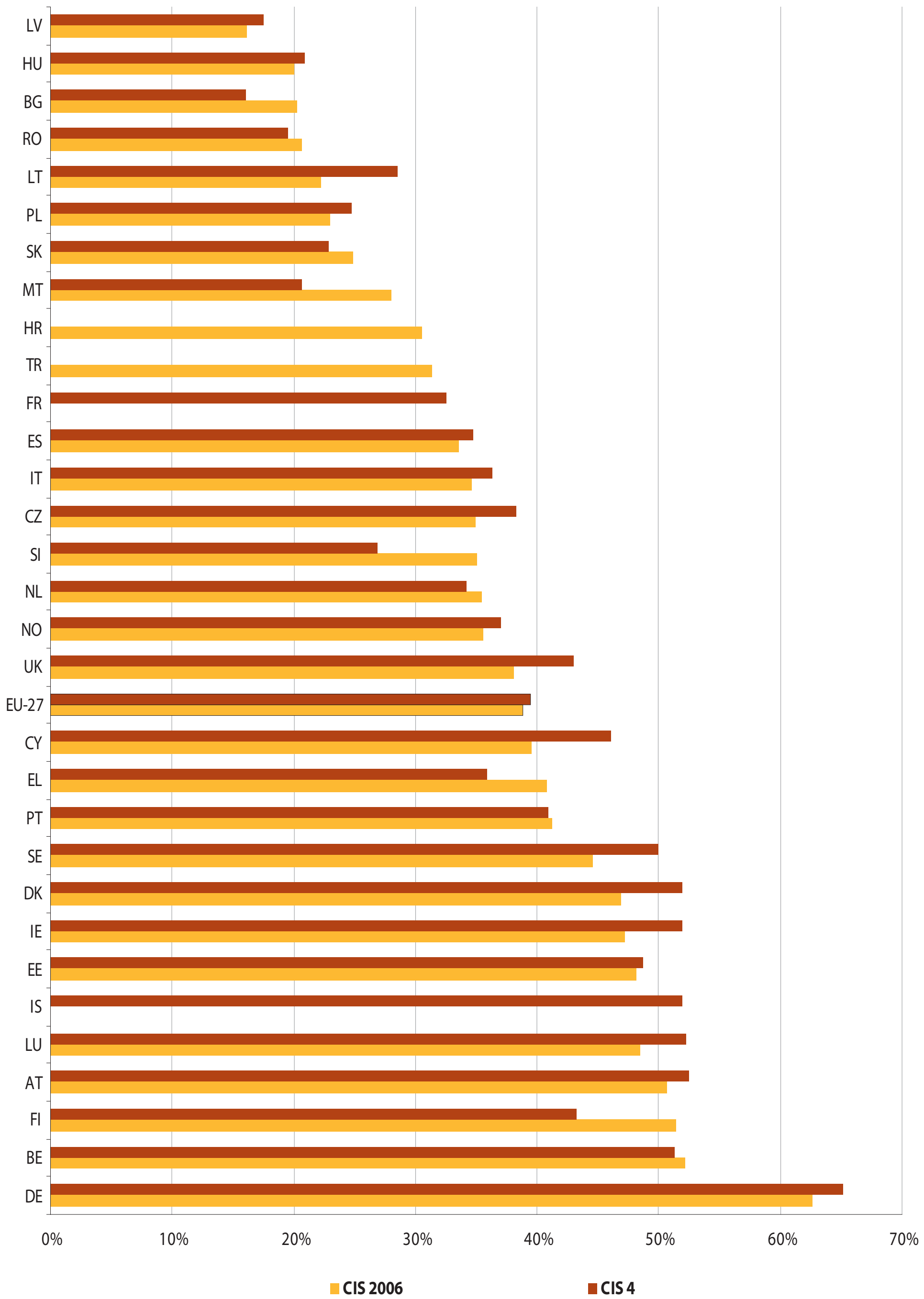
Non-innovative enterprises in Luxembourg were the most concerned about this factor (12 %), although among the remaining non-innovative enterprises in the other countries studied Cyprus, Greece, Austria and Turkey reached 5 %.

5.4 Comparison between CIS 4 and CIS 2006

This section compares the fifth Community innovation survey (CIS 2006) with the fourth (CIS 4), by looking more closely at some of the main results of the two surveys.

The CIS data produced are based on harmonised survey questionnaires.

Figure 5.44: Enterprises with innovation activity in CIS 4 and CIS 2006 — 2004 and 2006 (as a percentage of all enterprises)



Note:
Data missing for FR. EU-27 for CIS 2006 does not include FR.

Source: Eurostat, Community Innovation Statistics 2004 (inn_cis4_prod) and 2006 (inn_cis5_prod)

The landscape of European innovation is characterised by sharp contrasts, as can be seen from the proportions of innovative enterprises in CIS 2006, ranging from 63 % in Germany to 16 % in Latvia.

From 2004 to 2006 the proportion of innovative enterprises fell by 1%[1] the EU-27 and in most EU Member States. By contrast, in Belgium, Finland, Greece, the Netherlands, Slovakia, Malta and Romania, it rose during the reference period 2004-2006. Finland and Malta, with 8 % and 7 % respectively, posted the biggest increases.

(1) Data from France are not included in the EU average due to CIS 2006 derogation.

Table 5.45: Novel inventors in CIS 4 and CIS 2006 by type of inventor — 2004 and 2006 (as a percentage of all enterprises)

	CIS 4			CIS 2006		
	Process innovators only	Product innovators only	Product and process innovators	Process innovators only	Product innovators only	Product and process innovators
BE	13.2	12.0	23.0	13.4	10.8	22.5
BG	1.2	7.2	7.2	3.6	7.4	8.1
CZ	10.1	7.3	19.8	9.6	6.5	17.7
DK	13.6	13.6	19.2	12.0	8.8	16.0
DE	12.9	20.1	23.3	8.7	19.1	26.7
EE	10.3	14.6	22.5	14.1	9.3	23.5
IE	13.4	8.6	29.3	11.6	14.6	18.7
EL	10.1	3.3	21.8	12.0	5.1	21.0
ES	14.1	5.7	13.0	14.2	6.8	9.4
FR	12.2	6.3	13.1	:	:	:
IT	17.0	6.2	12.2	15.0	5.6	13.1
CY	25.9	1.2	18.8	9.8	0.4	28.7
LV	:	:	:	5.2	3.1	7.1
LT	9.5	6.4	10.9	7.7	5.4	8.0
LU	11.8	14.4	24.1	6.3	17.3	23.3
HU	4.8	6.0	8.1	4.5	5.6	8.1
MT	2.0	5.3	8.4	9.6	5.0	12.9
NL	8.4	10.2	14.3	8.7	11.5	13.8
AT	12.8	10.2	27.6	13.6	10.3	25.5
PL	9.0	4.7	10.4	7.7	4.0	10.9
PT	16.3	5.5	17.4	15.7	7.1	16.8
RO	4.6	1.8	13.0	4.1	1.8	14.7
SI	c	c	c	7.9	6.6	19.5
SK	7.2	4.5	10.1	8.5	5.6	9.6
FI	9.1	10.9	18.8	10.8	13.4	22.2
SE	10.6	15.7	21.3	9.8	13.3	19.5
UK	:	:	:	:	:	:
HR	:	:	:	10.2	3.0	16.6
TR	:	:	:	7.9	7.3	14.7
NO	6.3	12.6	12.8	6.7	12.3	11.7

Source: Eurostat, Community Innovation Statistics 2004 (inn_cis4_prod) and 2006 (inn_cis5_prod)

When one compares the results of CIS 4 and CIS 2006 for novel innovators, a slightly downward overall trend in the proportions of product and process innovators is revealed.

Between CIS 4 and CIS 2006, the only countries in which the proportion of process innovators, product innovators and products and process innovators increased were Bulgaria and Finland.

In contrast, the Czech Republic, Denmark, Lithuania and Sweden reported a decrease in the three classifications between CIS 4 and CIS 2006.

The proportion of process innovators increased only in Belgium, Bulgaria, Estonia, Greece, Spain, Malta, the Netherlands, Austria, Slovakia, Finland and Norway. The greatest increase was noted in Malta (8 percentage points).

The product innovators are in a similar situation. Ireland reported the largest increase, with 6 percentage points, while Denmark reported a fall of 5 percentage points.

Looking at product and process innovators in Table 5.45, it is noticeable that the share of enterprises in Cyprus grew from 19 % in CIS 4 to 29 % in CIS 2006, while those in Ireland decreased from 29 % in CIS 4 to 19 % in CIS 2006.

Table 5.46: Enterprises with innovation activity in CIS 4 and CIS 2006 which introduced new or improved products for the market by size-class — 2004 and 2006 (as a percentage of innovative enterprises)

	CIS 4				CIS 2006			
	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
EU-27	35.9	33.2	39.6	49.2	36.8	47.5	32.6	29.7
BE	40.7	38.5	44.0	53.1	44.1	65.3	41.4	38.6
BG	56.4	57.6	52.9	58.6	46.2	45.7	41.3	38.6
CZ	41.5	39.0	44.4	48.2	48.3	51.3	38.9	32.5
DK	47.7	46.2	49.3	57.9	37.9	50.6	33.8	30.9
DE	26.9	22.7	31.7	42.1	35.3	47.7	30.4	25.9
EE	41.9	43.7	35.3	45.0	32.1	37.0	32.8	32.9
IE	44.5	38.0	57.2	62.8	47.0	51.6	40.8	38.0
EL	44.4	43.3	47.6	54.3	50.2	70.7	49.5	48.1
ES	20.9	18.0	28.2	43.2	26.0	39.5	18.3	14.8
FR	38.6	34.1	43.3	57.9	:	:	:	:
IT	31.1	28.7	37.9	52.2	37.2	50.1	29.5	26.8
CY	14.7	11.7	21.7	40.9	42.3	52.2	34.5	30.9
LV	34.6	33.9	36.4	34.2	33.8	41.9	44.7	49.7
LT	34.5	30.9	38.4	43.8	32.4	38.5	36.0	36.8
LU	51.6	51.3	48.9	64.3	52.6	75.4	58.9	59.3
HU	36.3	36.5	33.9	40.7	29.6	38.2	30.9	30.1
MT	25.0	25.0	25.0	25.0	29.2	47.6	31.3	29.4
NL	48.3	47.5	48.3	56.8	50.8	59.5	48.1	46.1
AT	48.4	47.3	47.1	64.7	48.8	65.0	45.4	42.1
PL	46.4	44.8	47.6	50.4	30.6	37.5	32.7	33.1
PT	30.1	27.3	35.8	44.5	37.1	48.5	29.8	26.5
RO	27.9	25.1	29.2	36.2	26.6	33.9	24.7	22.1
SI	46.6	40.8	50.2	58.1	44.9	59.4	51.1	52.5
SK	41.6	39.8	42.6	45.1	39.8	43.8	37.6	34.7
FI	49.6	47.4	52.2	58.0	40.7	58.1	44.6	44.3
SE	52.4	52.8	49.9	56.4	55.8	58.4	51.3	49.3
UK	47.8	47.3	48.2	51.8	31.7	39.8	31.6	31.0
HR	:	:	:	:	33.1	47.5	31.7	28.5
TR	:	:	:	:	50.5	52.9	59.6	62.3
IS	77.6	82.4	59.6	89.5	:	:	:	:
NO	36.5	37.6	32.5	38.6	37.0	42.0	39.9	40.6

Source: Eurostat, Community Innovation Statistics 2004 (inn_cis4_prod) and 2006 (inn_cis5_prod)

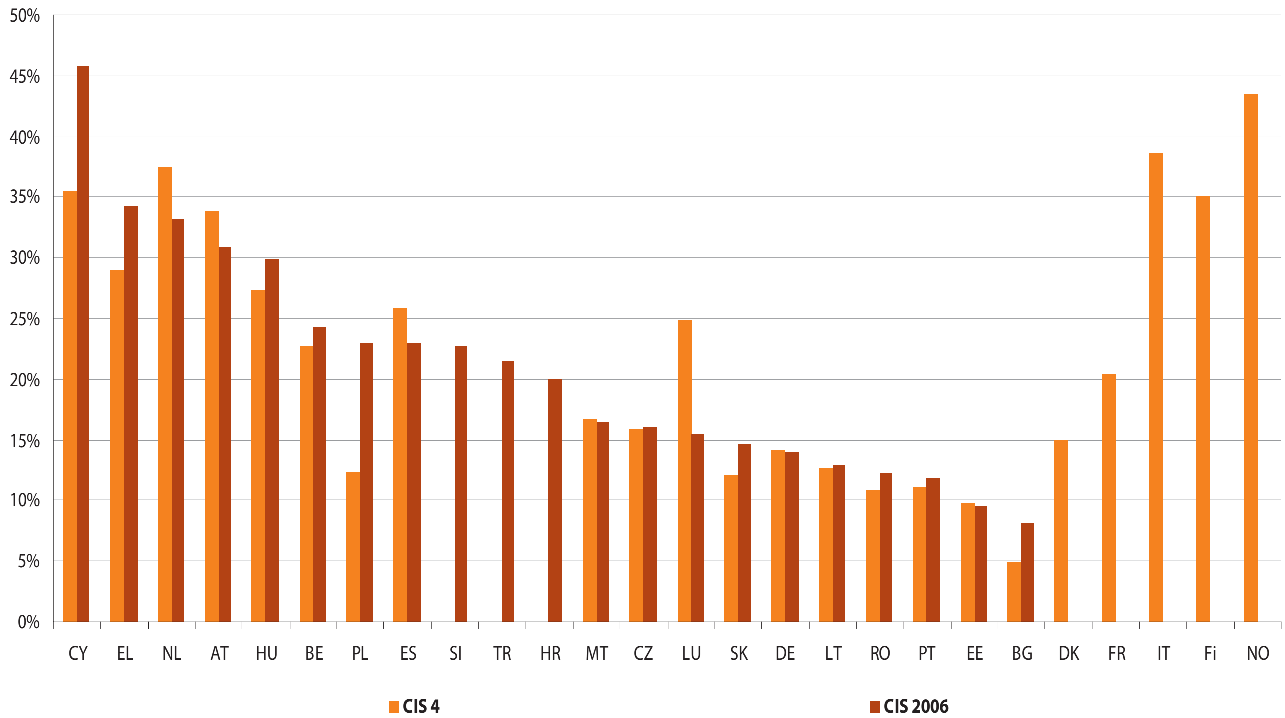
During the three years from 2004 to 2006 new or significantly improved products were introduced onto the market by almost 37 % of innovative enterprises in the EU-27.

At EU-27 level, there is a negative correlation between the size of an enterprise and its propensity to introduce innovative products: new products were brought to the market by 48 % of all enterprises with 10 to 49 employees, 33 % of enterprises with 50 to 249 employees and only 30 % of enterprises with more than 250 employees.

This correlation holds true in all Member States except in Latvia, where 50 % of enterprises with more than 250 employees introduced new products.

Small innovative enterprises (with 10 to 49 employees) were generally keener to introduce improved products, except in Estonia.

Figure 5.47: Enterprises with innovation activity in CIS 4 and CIS 2006 that received public funding (as a percentage of innovative enterprises) — 2004 and 2006



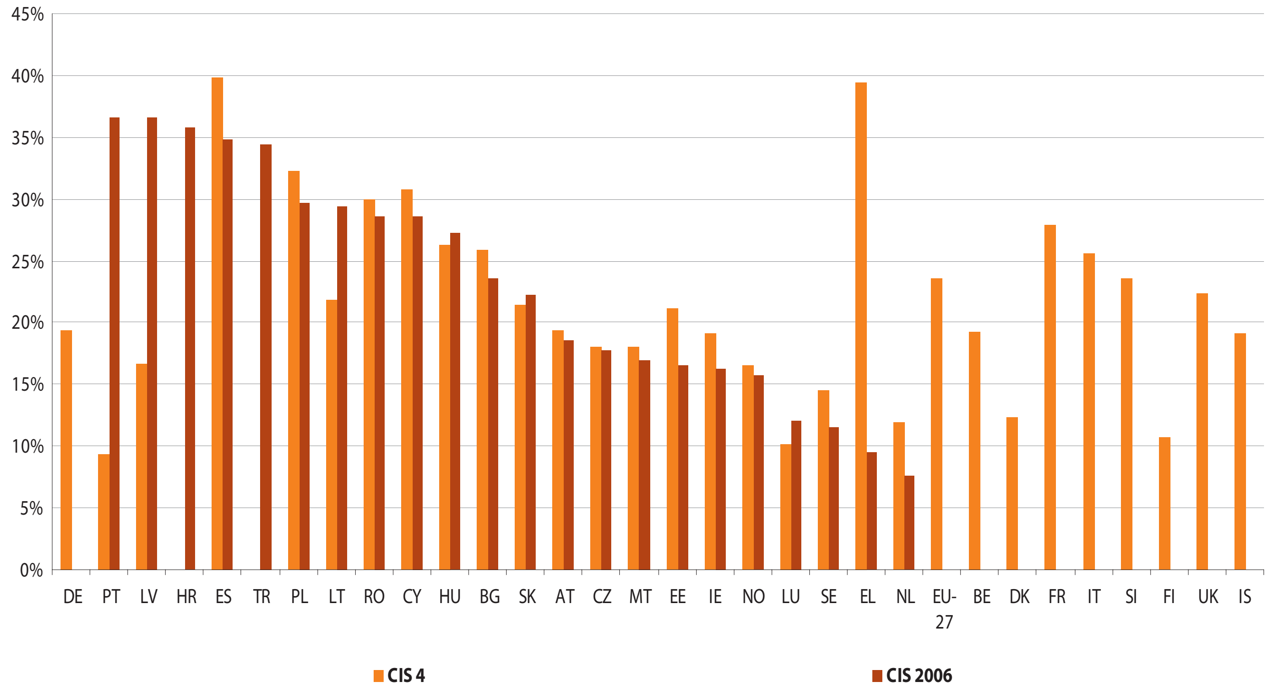
Note:
Data missing for LV and UK.

Source: Eurostat, Community Innovation Statistics 2004 (inn_cis4_pub) and 2006 (inn_cis5_pub)

Innovative enterprises can rely on public funding as one of their sources of financing. Figure 5.47 shows that in 13 Member States, public financing has increased between CIS 4 (2002-2004) and CIS 2006 (2004-2006). Poland and Cyprus, reported the largest increases between CIS 4 and CIS 2006, by 11 percentage points in each case.

However, the percentage of enterprises receiving public funding has decreased significantly in countries such as Luxembourg (from 25 % in CIS 4 to 16 % in CIS 2006) or the Netherlands.

Figure 5.48: Enterprises with innovation activity in CIS 4 and CIS 2006 declaring that high innovation costs are considerable barrier to innovation — 2004 and 2006 (as a percentage of innovative enterprises)



Source: Eurostat, Community Innovation Statistics 2004 (inn_cis4_ham) and 2006 (inn_cis5_ham)

As we have seen previously, CIS 2006 reveals two factors that most hamper innovation in the EU. The first is that innovation costs are too high and the second is the lack of finance from sources outside the enterprise.

In CIS 4, "innovation costs too high" was perceived as the highest barrier to innovative enterprises in Spain (40 %) and Greece (40 %). Four years later this factor had become even more significant in Portugal (37 %) Latvia (37 %) and Croatia (36 %), followed by Spain, Turkey and Poland. In general, comparing the results of CIS 4 and CIS 2006, for innovative enterprises this factor appears to be gaining in importance.

Table 5.49: Enterprises with innovation activity in CIS 4 and CIS 2006 which are engaged in intramural R&D — 2004 and 2006 (as a percentage of innovative enterprises)

	CIS 4		CIS 2006	
	engaged continuously in intramural R&D	engaged occasionally in intramural R&D	engaged continuously in intramural R&D	engaged occasionally in intramural R&D
BE	35.6	16.8	37.7	23.6
BG	3.3	5.3	2.4	11.0
CZ	27.0	21.8	26.0	25.2
DK	20.8	6.0	:	:
DE	29.3	24.5	28.2	23.8
EE	28.6	14.6	16.6	16.7
IE	:	:	:	:
EL	29.8	20.9	27.1	20.8
ES	21.2	13.7	22.2	9.6
FR	36.9	33.3	:	:
IT	32.3	26.7	:	:
CY	12.0	12.4	7.8	23.0
LV	:	:	:	:
LT	19.4	10.2	24.8	21.1
LU	31.7	13.2	27.7	8.4
HU	17.4	25.0	23.1	26.5
MT	23.6	32.6	22.6	15.4
NL	47.8	19.6	45.7	17.9
AT	:	:	26.6	11.6
PL	6.4	19.8	9.6	24.4
PT	20.9	22.9	21.1	26.6
RO	14.3	13.4	13.8	17.9
SI	c	c	31.2	43.2
SK	25.8	29.1	19.7	25.9
FI	:	:	:	:
SE	34.7	31.4	34.3	30.4
UK	:	:	:	:
HR	:	:	13.8	44.2
TR	:	:	16.7	12.6
NO	34.3	33.1	:	:

Note:
SI: Data are confidential.

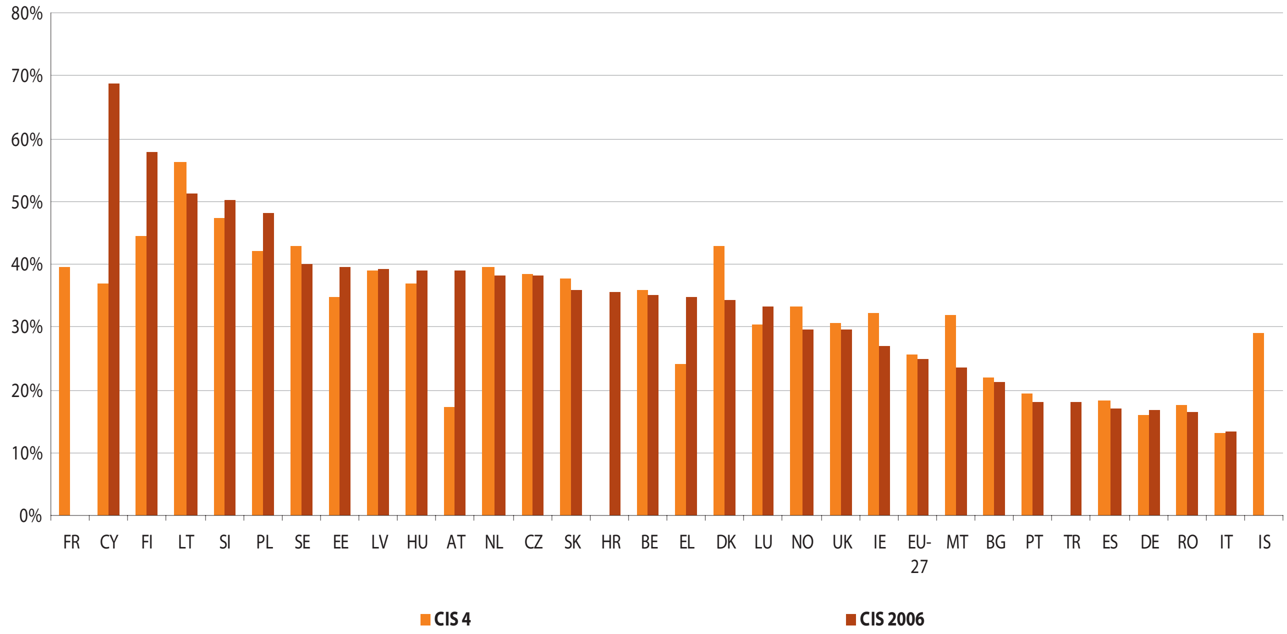
Source: Eurostat, Community Innovation Statistics 2004 (inn_cis4_exp) and 2006 (inn_cis5_exp)

Although enterprises with innovation activities are usually engaged in intramural R&D there are noticeable differences between CIS 4 and CIS 2006.

In only six of the countries surveyed - namely Belgium, Spain, Lithuania, Hungary, Poland and Portugal - the percentage of innovative enterprises that were engaged continuously in intramural R&D rose between CIS 4 and CIS 2006. The remaining countries experienced a drop, particularly Estonia, where the percentage of innovative enterprises engaged continuously in intramural R&D fell from 29 % in CIS 4 to 17 % in CIS 2006.

In the case of innovative enterprises engaged occasionally in intramural R&D, a substantial increase was noted in Lithuania and in Cyprus (of 11 percentage points from CIS 4 to CIS 2006. However, the share of innovative enterprises in Malta engaged occasionally in intramural R&D decreased from 33 % in CIS 4 to 15 % in CIS 2006.

Figure 5.50: Enterprises with innovation activity in CIS 4 and CIS 2006 that were engaged in any kind of innovation cooperation — 2004 and 2006 (as a percentage of innovative enterprises)



Source: Eurostat, Community Innovation Statistics 2004 (inn_cis4_coop) and 2006 (inn_cis5_coop)

Innovation cooperation became slightly less popular in the EU-27 in 2006, slipping back by almost one percentage point[(1)].

However, at national level, countries such as Cyprus, Austria, Finland and Greece have experienced a substantial increase (32 %, 22 %, 13 % and 11 % respectively) from CIS 4 to CIS 2006.

(1) Data from France is not included in the EU average due to CIS 2006 derogation.

Denmark sustained the greatest decrease (9 %) from CIS 4 followed by Malta (-8 %), Ireland (-6 %) and Lithuania (-5 %).

Candidate countries such as Croatia and Turkey reported a high level of innovation cooperation in 2006 (36 % and 18 % respectively).

6

Patents

6.1 Introduction

Converting technological knowledge into economic growth and welfare is one of the keys to boosting the competitiveness of modern economies. This is a complex process, and evaluating how countries perform in developing and commercialising technology is no easy task.

Patent statistics have made rapid progress in recent years. They are increasingly being used by decision-makers in innovation policy or in patent offices in order to monitor trends. The Worldwide Patent Statistical Database (PATSTAT), produced by the European Patent Office (EPO), offers a unique tool for analysts and producers of patent data and indicators. PATSTAT is published twice a year, in April and October.

An invention has to fulfil several conditions to be patentable: it must be new, involve an inventive step, be capable of industrial application and not be 'excluded'. 'Excluded' inventions comprise 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, and computer programs.

However, creations that cannot be protected by a patent may be protected by other intellectual property rights (IPR) such as copyright, trademark or industrial design.

A patent is an intellectual property right for inventions of a technical nature. A patent is valid in a country if it is granted by that country's national patent office; the validity period is usually 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. In July 2009, the Convention was in force in 36 countries (all the EU Member States plus Switzerland, Iceland, Liechtenstein, Norway, Monaco, San Marino, Croatia, the former Yugoslav Republic of Macedonia and Turkey). In addition to the Contracting States, three other countries (Albania, Serbia and Bosnia and Herzegovina) have concluded an 'extension agreement' with the EPO, by which these states can also be designated in a European patent application.

Although patents do not cover every kind of innovation, they do include many of them. Patents have become one of the most widely used sources of data in the construction of indicators on inventive output, as they are closely linked to invention and provide detailed information in relatively long time series.

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 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 have commercial applications and/or lead to major technological improvements.

This chapter analyses the structure and development of patenting in the EU-27, Iceland, Liechtenstein, Norway, Switzerland, the candidate countries (Croatia and Turkey), Japan and the United States. Several tables and graphs also present data for Australia, Canada, China, India, Israel, South Korea, Russia, and Taiwan. The countries were selected on the basis of their economic size and/or their high patent activity. For some tables and graphs the low number of patent applications per country explains why the data could not be shown, as the analysis would not have been representative. In these cases a cut-off number is given below the table or graph.

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. In this edition, few USPTO data are shown owing to a lack of space. On the other hand, providing the entire dataset for USPTO data would not offer significantly more information to the user.

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 1995 to 2005 for the EPO data, whereas the USPTO and triadic patent family time series cover the period from 1993 to 2002.

Eurostat is constantly endeavouring to enlarge the range of patent indicators. In May 2009, a set of new indicators on co-patenting and patent citations was made available in Eurostat's reference database. Furthermore, new indicators on nanotechnology patent applications were added in September 2009. Examples of these new indicators are given in this chapter at the end of the section relating to national data.

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. Data are revised in the months following the publication of an update of PATSTAT. As revisions involve changes in many years — and not only recent years — Eurostat replaces the entire time series at every update.

The EPO data refer to patent applications by priority year, whereas the USPTO data refer to patents granted. The 'priority year' is the year in which the first application was submitted. In general, inventors first apply for a patent at their national patent office. Following this, they also have 12 months to apply to another patent office, such as the EPO or the USPTO.

Although patent applications are not always granted, each one 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 at any patent office. They refer to applications filed at the European Patent Office (EPO) and the Japan Patent Office (JPO), and to patents granted by the United States Patent and Trademark Office (USPTO).

When interpreting the data at international level, it should be borne in mind that, thanks to 'home advantage', European countries are leaders in the European patent system, whereas the United States has the advantage in the US patent system. 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 patent applications filed at the EPO and the JPO, and patents 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 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 EPO, 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 website.

Patents
Commission sets out next steps for creation of unified patent litigation system

The European Commission has adopted a Recommendation to the Council that would provide the Commission with negotiating directives for the conclusion of an agreement creating a Unified Patent Litigation System (UPLS). The UPLS would increase legal certainty, reduce costs and improve access to patent litigation for businesses, in particular SMEs. The court structure to be established in the framework of the UPLS would have jurisdiction both for existing European patents and for future Community patents. This constitutes a further significant step in the pursuit of the EU's patent reform agenda.

Background

The current fragmentation of the patent system in Europe and in particular the lack of a unitary title and the absence of a unified patent litigation system renders access to the patent system complex and costly and hampers effective enforcement of patents, especially for SMEs.

Innovators wishing to protect their invention in various Member States of the Community can currently achieve this protection through separate national patents or through a European patent. European patents are granted by the European Patent Office (EPO), which was established by the European Patent Convention and currently has 35 contracting parties. Besides the EU Member States these include among others Switzerland, Croatia, Iceland, Liechtenstein and Norway.

This system entails multi-forum litigation since companies may have to litigate in parallel in all countries where the patent is validated. Stakeholders have repeatedly reported that this involves considerable cost, complexity and legal insecurity resulting from the risk of contradictory court decisions in different Member States. Moreover, stakeholders have regularly claimed that the current litigation system leads to legal insecurity, in particular as regards patent issues with a cross-border dimension. At present patent litigation is unnecessarily costly and risky for all parties involved. The risks associated with patent litigation together with the lack of a unitary title hamper in particular access to the patent system for SMEs and individual inventors and are a drawback for European innovation and competitiveness.

A recent economic cost-benefit analysis (Harhoff, 2009) came to the conclusion that there would be substantial financial and other benefits for litigants and the overall European economy by avoiding duplication of patent infringement and revocation actions. It is predicted that by 2013 the creation of the UPLS would result in total private cost savings of between 148 and 289 million euro per annum. Moreover the UPLS would reduce legal uncertainty. Finally, by providing fast and low-cost revocation proceedings it would increase patent quality and tackle potential patent abuses."

The Recommendation is available at:

http://ec.europa.eu/internal_market/indprop/patent/index_en.htm

Key elements of the Community patent project

- Accession of the EC to the European Patent Convention
- Adoption of an EC Regulation on the Community patent
- Creation of a litigation system for both Community and European patents
- Coexistence of national patents with European and Community patents
- NPOs and EPO will keep their prerogatives

6.2 Triadic patent families

High concentration of triadic patent families

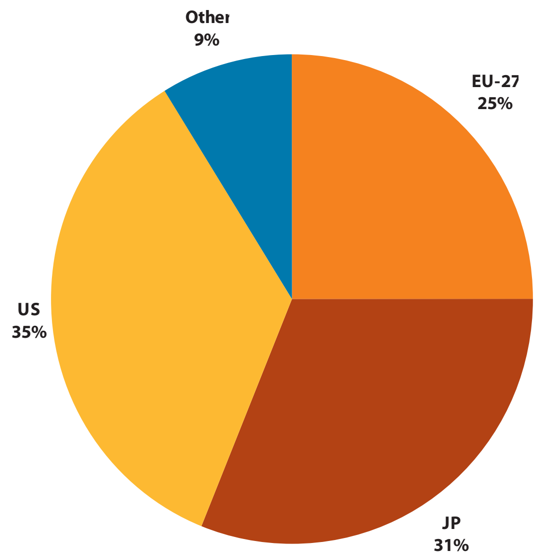
A patent is a member of the triadic patent family if and only if it has been applied for and filed at the European Patent Office (EPO) and the Japan Patent Office (JPO), and if it has been granted by the United States Patent and Trademark Office (USPTO).

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 because applying for a patent at these three offices involves additional costs and administrative work.

In terms of geographical distribution (see Figure 6.1), the EU and Japan accounted for respectively 25 % and 31 % of all triadic patent families in 2002. The largest share was held by the United States, with 35 %, and the smallest by the rest of the world, with 9 %. Triadic patent family applications and grants are therefore concentrated in these three main economies.

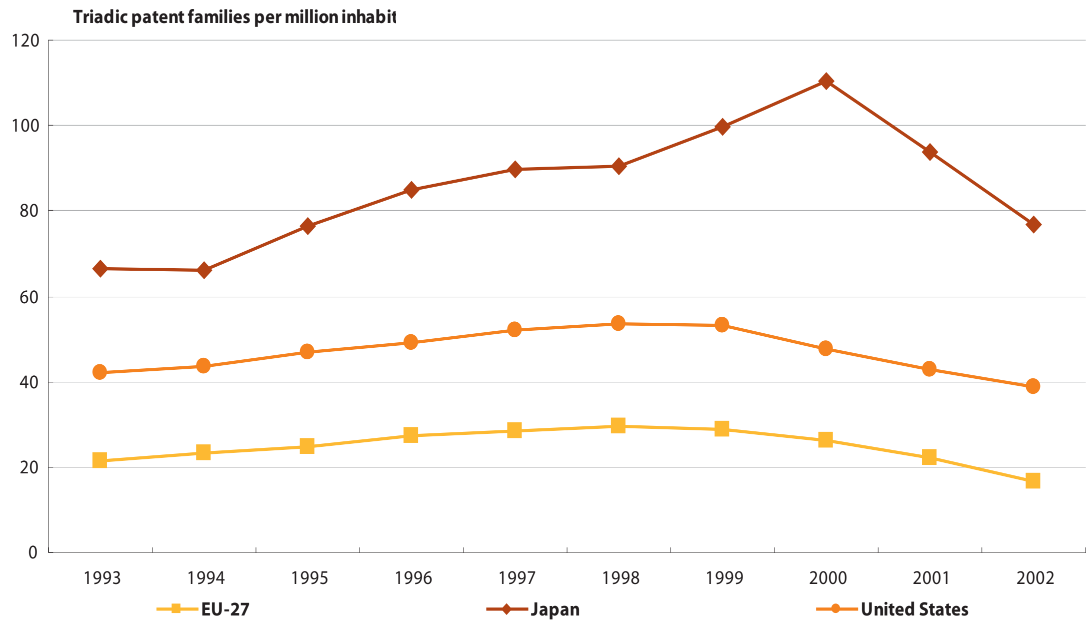
The picture is quite different when triadic patenting activity is compared to the population size (see Figure 6.2). Looking at triadic patent families per million inhabitants, Japan led by a wide margin over the entire reference period, between 1993 and 2002. The United States ranked second, followed by the EU-27. Whereas this trend was more or less stable for the United States and the EU-27, in Japan this indicator fell very slightly in the early 1990s before experiencing a strong recovery and a stable increase until 2000. In 2002, the EU-27 registered 16.5 triadic patent families per million inhabitants, having fallen below 20 after many years above this mark. In 2000, Japan peaked at 110.4 triadic patent families per million inhabitants, more than twice as much as in the United States (47.7) in the same year.

Figure 6.1: Distribution of triadic patent families as a percentage of total, EU-27, Japan, the United States and other — 2002



Source: Eurostat (pat_td_ntot)

Figure 6.2: Triadic patent families per million inhabitants, EU-27, Japan and the United States — 1993 to 2002



Source: Eurostat (pat_td_ntot)

6.3 Total patent applications to the EPO and patents granted by the USPTO

Germany was the leading European country in terms of patent applications in 2005

The intensity of patenting activity varies considerably from one country to another. As explained in the introduction, patenting procedures differ in Europe and in the United States. USPTO statistics are based on patents granted, while EPO statistics are founded on patent applications filed. Given the differences in the underlying methodologies, data relating to these two patent offices should not be compared.

Table 6.3: Patent applications to the EPO: total number and as a percentage of GDP, EU-27 and selected countries — 2005, and Patents granted by the USPTO: total number and as a percentage of GDP, EU-27 and selected countries — 2002

	Patent applications to the EPO 2005		Patents granted by the USPTO 2002	
	Total	As a % of GDP	Total	As a % of GDP
EU-27	55 079	5.0	21 432	2.2
BE	1 408	4.7	547	2.0
BG	24	1.1	5	0.3
CZ	105	1.1	44	0.6
DK	1 078	5.2	339	1.8
DE	23 364	10.4	9 280	4.3
EE	6	0.6	1	0.1
IE	262	1.6	151	1.2
EL	110	0.6	25	0.2
ES	1 331	1.5	298	0.4
FR	8 191	4.8	2 977	1.9
IT	4 797	3.4	1 508	1.2
CY	16	1.2	3	0.3
LV	18	1.4	3	0.3
LT	9	0.4	8	0.5
LU	97	3.2	32	1.3
HU	134	1.5	54	0.8
MT	11	2.4	2	0.5
NL	3 379	6.6	1 193	2.6
AT	1 468	6.0	491	2.2
PL	118	0.5	33	0.2
PT	114	0.8	15	0.1
RO	29	0.4	8	0.2
SI	106	3.7	20	0.8
SK	31	0.8	6	0.2
FI	1 288	8.2	660	4.6
SE	2 328	7.9	948	3.6
UK	5 258	2.9	2 784	1.6
HR	33	1.1	23	1.0
TR	163	0.4	20	0.1
IS	30	2.3	22	2.3
LI	25	8.5	14	5.0
NO	481	2.0	192	0.9
CH	3 068	10.3	1 053	3.6
AU	1 067	1.9	698	1.7
CA	2 262	2.5	3 749	4.8
CN	1 609	0.9	771	0.5
IL	1 334	12.8	1 076	9.3
IN	572	:	633	:
JP	20 913	5.7	33 748	8.1
KR	4 963	7.8	6 137	10.6
RU	299	0.5	166	0.5
TW	735	2.7	7 209	23.2
US	34 022	3.4	93 147	8.4

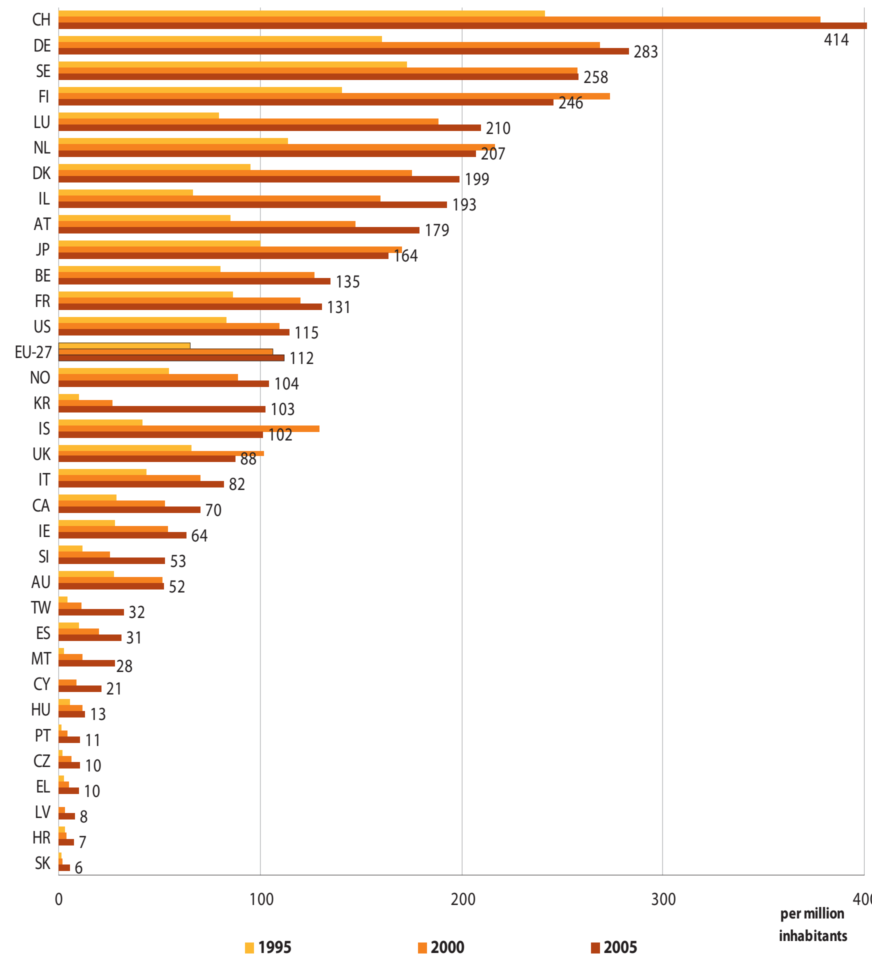
Source: Eurostat (pat_ep_ntot and pat_us_ntot)

With 55 079 patent applications in 2005, the EU-27 was the most active world economy in terms of patents filed at the EPO. Germany accounted for more than half of all patent applications filed by the EU Member States, with 23 364 applications, followed by France (8 191) and the United Kingdom (5 258). Germany also led in relative terms, with patent applications accounting for 10.4 % of GDP. Finland ranked second and Sweden third with 8.2 % and 7.9 % of GDP respectively. None of the new Member States (2004 and 2007 enlargements) reached the average EU-27 ratio of 5.0 % of GDP.

The best-performing non-EU countries in terms of patent applications to the EPO were Israel (12.8 % of GDP), Switzerland (10.3 %), Liechtenstein (8.5 %) and South Korea (7.8 %).

The lower numbers of patents granted by the USPTO to EU Member States can be explained by the 'home advantage' of the United States. Besides the United States (93 147 patents granted in 2002), other countries were also very active in patenting, as shown by the number of patents granted by the USPTO: Japan (33 748), Taiwan (7 209) and South Korea (6 137).

Figure 6.4: Patent applications to the EPO per million inhabitants, EU-27 and selected countries — 1995, 2000 and 2005



Note:
Cut-off: at least 5 patent applications per million inhabitants in 2005

Source: Eurostat (pat_ep_ntot)

Looking at 1995, 2000 and 2005 data, patenting activity per million inhabitants increased significantly in almost all European countries over the period considered. The only exceptions were Finland, the Netherlands, Japan, Iceland and the United Kingdom, where the number of patent applications per million inhabitants grew strongly from 1995 to 2000, but then dropped slightly in 2005.

Compared with 2000, Finland lost its first place at EU level in 2005. Among the EU-27 countries, Germany ranked first in 2005 with 283 patent applications per million inhabitants to the EPO, followed by Sweden (258) and Finland (246). This number was even higher in Switzerland, with 414 patent applications per million inhabitants to the EPO (see Figure 6.4). Most new Member States recorded a fairly low number of EPO patent applications per million inhabitants. Slovenia was something of an exception, with 53 patent applications per million inhabitants in 2005.

6.3.1 Patent applications to the EPO by IPC section

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 — 2005

	Total	IPC section							
		Human necessities	Performing operations; transporting	Chemistry; metallurgy	Textiles; paper	Fixed constructions	Mechanical engineering; lighting; heating; weapons; blasting	Physics	Electricity
EU-27	55 079	16.8	21.0	12.4	2.0	4.6	11.6	15.2	16.5
BE	1 408	17.9	20.0	23.1	2.4	3.2	4.8	13.4	15.1
BG	24	15.9	9.1	30.6	0.0	2.1	11.5	13.0	17.8
CZ	105	19.3	19.5	20.2	6.5	3.3	6.2	13.4	11.6
DK	1 078	31.1	12.2	18.0	0.6	6.0	9.4	9.9	12.8
DE	23 364	14.1	23.7	12.2	2.1	4.4	14.3	14.2	14.9
EE	6	10.0	0.0	19.3	0.0	0.0	0.0	31.4	39.2
IE	262	30.5	13.8	7.5	0.1	5.5	7.6	19.0	15.7
EL	110	22.5	22.2	12.7	1.7	5.7	9.9	13.8	11.5
ES	1 331	25.1	22.0	14.9	2.3	8.2	9.4	8.7	9.4
FR	8 191	16.4	21.0	10.5	0.9	4.3	10.9	16.5	19.6
IT	4 797	20.5	26.0	9.6	3.5	6.4	12.8	10.0	11.1
CY	16	22.1	8.5	3.7	10.0	35.8	11.3	6.5	2.1
LV	18	30.5	12.6	26.5	0.0	0.0	0.0	20.9	9.5
LT	9	21.5	16.8	19.0	0.0	0.0	11.2	26.9	4.5
LU	97	6.6	36.4	13.8	0.0	4.5	18.8	11.2	8.6
HU	134	24.6	16.5	26.1	0.0	3.6	4.3	8.9	16.1
MT	11	62.2	4.4	10.4	0.0	6.7	0.0	2.2	14.0
NL	3 379	17.9	14.5	13.2	1.4	3.7	5.2	24.9	19.3
AT	1 468	13.6	21.2	11.1	3.6	9.4	13.2	12.8	15.0
PL	118	15.7	13.2	19.0	1.0	5.5	15.5	12.0	18.2
PT	114	11.7	12.7	12.7	2.6	8.2	15.9	10.5	24.8
RO	29	20.2	22.4	1.7	0.0	12.8	19.2	14.4	9.3
SI	106	39.7	11.3	20.5	2.4	6.5	7.2	6.8	5.6
SK	31	4.1	9.8	22.7	2.9	3.3	21.2	3.6	32.5
FI	1 288	7.5	12.3	8.3	4.5	2.8	5.5	18.0	41.2
SE	2 328	17.8	19.8	9.1	1.9	4.0	10.0	14.2	23.2
UK	5 258	21.2	13.7	15.5	0.9	3.6	8.2	20.3	16.6
HR	33	48.5	0.5	33.0	0.0	0.0	4.0	3.6	10.3
TR	163	16.4	12.0	7.9	9.7	6.3	30.8	7.3	9.6
IS	30	58.9	13.4	10.0	0.0	0.0	3.4	13.2	1.1
LI	25	22.5	28.5	13.6	2.0	3.3	10.4	6.8	13.0
NO	481	17.0	18.9	13.4	0.6	12.7	10.5	16.2	10.7
CH	3 068	22.4	19.6	13.0	2.8	4.4	6.3	20.3	11.2
AU	1 067	28.7	15.8	13.9	0.7	5.9	6.4	18.0	10.6
CA	2 262	17.3	9.2	11.6	0.5	2.2	5.9	23.5	29.9
CN	1 609	14.1	7.8	8.2	0.7	1.1	3.7	12.9	51.4
IL	1 334	34.2	7.2	11.9	0.4	1.5	3.7	25.7	15.4
IN	572	25.7	5.6	41.0	1.3	0.4	3.1	12.4	10.6
JP	20 913	10.0	18.2	14.2	1.1	0.6	8.9	22.2	25.0
KR	4 963	7.2	5.6	8.0	2.3	0.9	6.2	23.2	46.7
RU	299	23.1	9.6	19.5	0.9	1.0	10.9	18.8	16.3
TW	735	14.0	16.2	3.7	2.3	1.6	6.4	23.4	32.4
US	34 022	24.4	11.5	15.5	0.9	1.4	5.6	21.4	19.4

Source: Eurostat (pat_ep_nipc)

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 more than one IPC class. 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 subgroups. 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 presents patent applications by IPC section. The following analysis only considers countries with more than 100 patent applications to the EPO, focusing on relative specialisation at national level in one IPC section. In many countries, 25 % or more of all national applications were registered in one IPC section. Denmark, Ireland, Spain, Slovenia, Australia and Israel specialised in patenting linked to 'human necessities' (IPC section A). 'Performing operations; transporting' (section B) accounted for the biggest shares in Germany, Italy and Austria, whereas 20 % or more of national patent applications from Belgium, the Czech Republic, Hungary and India were filed in 'chemistry; metallurgy' (section C). In contrast, patenting was less frequent in 'textiles; paper' (section D) and 'fixed constructions' (section E). Close to one in three Turkish patent applications concerned 'mechanical engineering; lighting; heating; weapons; blasting' (section F). In the Netherlands most patent applications were filed in the field of 'physics' (section G). In Finland, a majority of patent applications were filed in the field of 'electricity' (section H). Electricity was also the most important IPC section for Portugal, Sweden, Canada, China, South Korea and Taiwan.

The absolute figures by IPC section are not shown here, but they should also be mentioned as they were used to create Table 6.5. At EU-27 level, Germany registered the highest number of patent applications overall, followed by France, the United Kingdom and Italy. IPC section D 'textiles; paper' was an exception, with Italy taking second place in this category.

In four IPC sections (B, D, E and F), Germany surpassed even the United States in the number of patent applications per section.

Patenting in the European Union is highly concentrated in a limited number of Member States. In 2005, Germany generated the most patent applications (see also Table 6.3), accounting for more than 40 % of overall patent activity in the EU-27.

France followed in second place, with about 15 %, and the United Kingdom ranked third, with 10 %. 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.

6.3.2 Patent applications to the EPO by economic activity (NACE)

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 2005, at EU-27 level the two main manufacturing activities involved in patenting were 'Manufacture of electrical and optical equipment' (33.6 %), and 'Manufacture of chemicals, chemical products and man-made fibres' (22.0 %). Two other sections ('Manufacture of transport equipment' and 'Manufacture of machinery and equipment n.e.c.') each accounted for shares of patent applications of around 13 %. Patenting activity in all other branches of manufacturing was less significant (see Table 6.6).

In 18 Member States 'Manufacture of electrical and optical equipment' was the main manufacturing activity in terms of patent applications, followed by 'Manufacture of chemicals, chemical products and man-made fibres'. This order was reversed in eight other Member States.

In most Member States the shares at national level are close to those at European level. Significantly higher shares were found almost exclusively in countries with low patent activity.

Table 6.6: Breakdown of patent applications to the EPO by economic activity (NACE), total number and as a percentage of total, EU-27 and selected countries — 2005

	Total	Manufacturing 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	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	55 079	2.4	0.5	0.2	0.1	1.2	1.5	22.0	2.3	1.8	5.2	12.8	33.6	13.6	1.8
BE	1 408	3.5	0.5	0.1	0.1	1.5	2.0	30.5	2.4	2.2	4.3	10.5	31.3	8.5	1.5
BG	24	3.9	0.4	0.1	0.0	0.7	5.2	34.3	1.2	1.0	2.5	9.0	29.4	10.8	0.4
CZ	105	2.6	0.8	0.1	0.1	1.4	2.0	29.4	1.9	2.1	5.2	12.0	29.3	11.6	1.4
DK	1 078	4.9	0.5	0.1	0.1	1.3	1.2	33.9	1.9	1.5	4.4	10.2	29.3	8.2	1.7
DE	23 364	2.0	0.5	0.2	0.1	1.2	1.6	20.6	2.3	1.8	5.7	14.3	30.9	16.1	1.6
EE	6	1.5	0.2	0.0	0.0	0.5	0.3	23.5	0.3	0.7	1.3	5.1	59.9	6.2	0.3
IE	262	2.9	0.4	0.3	0.1	1.4	0.9	22.8	1.6	1.9	3.5	9.3	43.2	7.3	2.8
EL	110	2.5	0.4	0.1	0.1	1.1	1.4	25.3	1.8	3.4	6.7	13.5	28.5	11.9	1.6
ES	1 331	3.8	0.5	0.2	0.3	1.4	1.2	30.7	2.6	2.1	5.9	12.7	23.5	12.1	2.3
FR	8 191	2.1	0.4	0.2	0.1	1.1	1.4	20.1	2.4	1.7	5.1	11.1	36.1	14.9	1.7
IT	4 797	2.7	0.6	0.4	0.2	1.5	1.6	21.2	3.0	2.1	6.3	16.3	27.4	13.0	2.9
CY	16	1.7	1.1	0.2	0.2	2.2	0.9	26.8	2.6	2.8	12.3	9.8	16.5	14.6	2.0
LV	18	3.5	0.3	0.0	0.0	1.1	0.8	49.7	1.7	0.8	2.4	5.3	23.8	5.0	0.2
LT	9	12.9	0.3	0.1	0.0	2.5	1.0	25.1	2.1	1.0	2.9	12.1	25.7	13.8	0.4
LU	97	1.7	0.7	0.2	0.1	1.3	1.5	17.7	4.8	1.8	8.1	13.4	23.5	23.8	1.4
HU	134	4.0	0.4	0.2	0.1	1.0	1.4	42.0	1.6	2.5	3.5	6.3	27.2	8.8	0.8
MT	11	2.5	0.4	0.1	0.1	1.0	0.5	21.0	1.6	1.0	4.5	41.3	16.4	6.1	3.6
NL	3 379	3.9	0.4	0.1	0.1	1.2	1.6	22.4	1.7	1.6	3.5	10.9	43.1	7.5	1.4
AT	1 468	1.7	0.6	0.2	0.2	1.5	1.5	19.2	2.5	2.5	6.7	14.5	31.8	13.7	3.2
PL	118	4.1	0.5	0.1	0.1	1.2	2.2	27.8	2.0	2.5	5.5	11.8	30.7	10.7	0.5
PT	114	1.8	0.5	0.4	0.1	1.0	1.1	21.2	1.8	2.1	5.6	11.5	37.9	11.8	1.8
RO	29	1.7	0.5	0.2	0.1	1.0	1.2	20.6	2.3	3.9	6.1	15.6	29.1	14.7	2.9
SI	106	4.6	0.3	0.2	0.1	0.9	1.2	43.1	1.9	1.4	4.9	12.4	18.2	7.2	3.2
SK	31	2.4	0.7	0.2	0.0	1.1	1.4	24.4	1.9	1.1	4.3	15.4	32.2	12.8	2.1
FI	1 288	1.3	0.4	0.1	0.1	1.5	1.3	13.7	1.3	1.5	3.3	9.7	55.9	8.3	0.8
SE	2 328	1.6	0.4	0.1	0.1	1.4	1.0	19.1	1.9	1.5	4.8	11.3	40.8	13.3	1.6
UK	5 258	2.6	0.4	0.1	0.1	1.2	1.6	27.2	1.9	1.4	4.1	9.7	37.1	9.6	1.7
HR	33	3.6	0.3	0.1	0.1	1.1	0.8	55.3	0.8	1.5	3.5	3.6	22.6	3.7	3.1
TR	163	3.7	0.4	0.3	0.1	1.0	1.1	16.8	2.3	2.1	6.1	23.4	28.0	11.9	2.9
IS	30	2.6	0.5	0.0	0.1	2.2	1.1	39.7	1.7	1.4	3.3	10.2	32.7	3.9	0.5
LI	25	1.4	0.6	0.9	0.1	1.3	1.5	22.8	1.9	2.7	8.4	12.0	29.3	11.6	5.4
NO	481	3.7	0.6	0.2	0.1	1.3	2.6	23.9	2.5	1.9	5.4	14.8	27.9	11.2	2.9
CH	3 068	2.8	0.5	0.1	0.1	1.5	1.5	25.4	2.2	1.9	5.0	12.4	34.6	9.2	1.8
AU	1 067	2.6	0.4	0.2	0.2	1.4	1.7	27.7	2.0	1.7	4.8	10.0	34.3	8.4	2.4
CA	2 262	2.4	0.3	0.1	0.1	0.9	1.1	22.1	1.3	1.1	3.0	7.4	49.6	7.5	1.1
CN	1 609	1.5	0.3	0.1	0.0	0.7	0.8	15.4	0.8	1.0	2.7	6.4	61.4	6.5	1.3
IL	1 334	2.6	0.4	0.1	0.0	1.3	1.0	30.3	0.9	1.1	2.8	5.7	45.4	5.6	1.3
IN	572	4.4	0.3	0.0	0.0	1.0	1.7	56.5	1.0	1.0	1.9	4.2	22.3	4.6	0.4
JP	20 913	1.5	0.4	0.1	0.1	1.0	1.3	18.9	1.6	1.6	4.0	9.5	45.4	12.3	1.2
KR	4 963	1.1	0.3	0.1	0.0	0.5	0.8	11.9	0.7	1.2	2.5	8.9	63.7	6.8	0.8
RU	299	3.1	0.4	0.1	0.1	1.0	2.7	30.3	1.1	1.5	3.9	9.2	33.8	9.6	1.3
TW	735	1.3	0.4	0.2	0.1	0.9	0.8	11.0	1.5	1.1	4.7	10.0	52.9	10.2	3.5
US	34 022	2.5	0.4	0.1	0.1	1.2	1.5	27.5	1.4	1.4	3.1	7.8	42.3	7.8	1.2

Source: Eurostat (pat_ep_nnac)

6.3.3 Patent applications to the EPO by institutional sector

Table 6.7: Breakdown of patent applications to the EPO by institutional sector, total number and as a percentage of total, EU-27 and selected countries — 2005

	Total	Business enterprise sector	Government sector	Hospitals	Individual applicants	Private non-profit sector	Higher education sector	Sector unknown
EU-27	55 079	85.7	1.4	0.1	6.3	1.6	1.8	2.9
BE	1 408	79.9	0.5	0.0	6.4	2.0	7.9	3.2
BG	24	46.1	0.0	0.0	51.8	0.0	2.1	0.0
CZ	105	70.6	0.4	1.9	15.1	2.4	3.6	6.0
DK	1 078	80.8	0.4	0.0	4.1	0.7	3.2	10.9
DE	23 364	90.8	0.1	0.1	5.2	2.1	1.1	0.5
EE	6	48.9	0.0	0.0	0.0	0.0	19.6	31.4
IE	262	72.7	0.9	0.1	16.0	0.3	9.5	0.4
EL	110	56.6	0.4	0.9	33.0	2.7	2.3	4.1
ES	1 331	74.4	1.1	0.3	13.1	1.6	4.3	5.3
FR	8 191	74.4	6.7	0.1	5.2	1.0	1.4	11.2
IT	4 797	83.7	0.8	0.2	10.9	0.4	1.4	2.6
CY	16	62.3	0.0	0.0	36.9	0.0	0.8	0.0
LV	18	66.4	0.0	0.0	10.8	4.3	13.1	5.4
LT	9	41.6	0.0	0.0	26.1	2.8	12.6	16.8
LU	97	86.4	0.0	0.0	8.3	0.7	0.0	4.6
HU	134	63.6	0.7	2.6	16.1	0.3	1.0	15.6
MT	11	99.0	0.0	0.0	0.0	0.5	0.0	0.5
NL	3 379	88.7	0.2	0.3	2.3	5.0	1.8	1.7
AT	1 468	80.3	0.1	0.0	16.4	0.1	2.0	1.0
PL	118	52.1	0.8	0.0	15.0	8.1	2.4	20.8
PT	114	66.5	1.3	0.0	7.7	3.9	11.1	9.6
RO	29	51.5	2.3	0.0	41.8	0.0	0.9	3.5
SI	106	64.8	0.4	0.0	14.0	3.1	1.6	16.1
SK	31	63.4	0.0	0.0	33.1	3.5	0.0	0.0
FI	1 288	94.5	0.0	0.0	2.6	1.2	0.2	1.5
SE	2 328	94.5	0.1	0.0	4.4	0.3	0.0	0.6
UK	5 258	86.3	2.5	0.2	6.4	0.4	3.8	0.4
HR	33	75.7	0.0	0.0	18.2	3.0	0.0	3.0
TR	163	24.0	1.0	0.0	11.5	0.0	1.3	62.2
IS	30	83.8	0.0	0.0	1.7	0.0	1.5	13.0
LI	25	83.5	0.0	0.0	12.0	0.5	0.0	4.0
NO	481	83.6	0.0	0.3	11.7	0.8	1.6	1.8
CH	3 068	88.9	0.1	0.1	6.2	1.3	2.4	1.0
AU	1 067	79.1	2.5	0.2	12.1	1.1	3.7	1.2
CA	2 262	88.1	2.0	0.2	5.6	0.6	3.0	0.6
CN	1 609	82.5	0.5	0.1	11.9	1.4	3.1	0.5
IL	1 334	81.3	1.5	0.0	9.6	0.4	6.2	0.9
IN	572	85.6	3.6	0.0	6.7	1.6	1.3	1.2
JP	20 913	96.6	0.5	0.0	1.1	0.5	1.3	0.1
KR	4 963	89.9	0.8	0.0	4.0	3.0	1.5	0.7
RU	299	55.6	1.0	0.0	20.9	4.5	1.5	16.5
TW	735	70.8	1.6	0.1	25.6	0.6	0.5	0.7
US	34 022	89.8	1.2	0.4	4.0	0.8	3.6	0.4

Source: Eurostat (pat_ep_nic)

Data in Table 6.7 are based on a study that was conducted by Eurostat in collaboration with the Faculty of Economics & Applied Economics, K.U. Leuven (Steunpunt O&O Statistieken and Research Division Incentim - KUL) in order to define a method for allocating patents to institutional sectors[(1)]. In terms of sector allocation, a dual method combining a rule- and case-based logic is applied to the names of the applicants. Patent applications can thus be broken down into seven groups. Four of these groups correspond to the sector classification mainly used by Eurostat and the OECD for surveys on research and experimental development outlined in the *Frascati Manual* (2002)[(2)] : 'business enterprise sector' (BES), 'government sector' (GOV), 'higher education sector' (HES) and 'private non-profit sector' (PNP). As it is not possible to infer from the applicant's name if a hospital is part of the private or public sector, and as a certain number of hospitals have a mixed status, these applicants are kept as a separate group called Hospitals (HOS). In many patent applications the applicant and the inventor are the same person, which means that it is difficult to assign the individual to an economic sector.

The sector allocation method is applied to the patent data after their quality has been improved by a name harmonisation method. The main steps in the harmonisation of applicants' names involve cleaning and standardising characters, removing the indication of the company's legal form, removing non-significant characters, approximate string searching, keyword searching, etc. The name harmonisation method helps to reduce considerably the diversity of names, but a number of applicants still cannot be precisely allocated to one sector. This explains the existence of the last group 'sector unknown'. This method was also developed for Eurostat by KUL[(3)].

A revision of both sector allocation and name harmonisation methods is currently ongoing and the results will be published at the end of 2009.

Table 6.7 shows that a large majority of patent applications are filed by the business enterprise sector (BES). However, it should also be noted that the decision to classify an applicant in an institutional sector is not always straightforward. Many patent applications are the result of cooperation between institutions in two or more sectors. For instance, a scientific project can be financed by the business enterprise sector but executed by a state-owned university.

(1) Data Production Methods for harmonised Patent Statistics: Assignee Sector Allocation, Working papers, Eurostat, 2006, http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-AV-06-001/EN/KS-AV-06-001-EN.PDF

(2) Standard method proposed for research and experimental development surveys — *Frascati Manual*, OECD, 2002

(3) Data Production Methods for harmonised Patent Statistics: Patentee Name Harmonisation, Working paper, Eurostat, 2006, http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-AV-06-002/EN/KS-AV-06-002-EN.PDF

At EU level, the BES accounted for 85.7 % of all patent applications. In Sweden, Finland and Germany this sector filed 90 % or more of all patent applications. The share of individual applications tends to be higher in countries where the share of the BES is lower than the EU average.

The shares of individual applicants vary considerably across countries. Whereas at EU level 6.3 % of patent applications are filed by individual applicants, this share rises to 15 % or more in the Czech Republic, Ireland, Greece, Hungary, Austria and Poland — taking into account only countries with at least 100 patent applications.

Whereas at EU level only 1.8 % of the patent applications are filed by the higher education sector, the corresponding share varies between 7.9 % and 11.1 % in Belgium, Ireland and Portugal.

The share of the private non-profit sector is very small in most countries. However, in the Netherlands and Poland, this sector accounted for respectively 5.0 % and 8.1 % of all patent applications.

The shares of patents filed by the government sector are even smaller in most EU countries, the exception being France with 6.7 %.

Three KUL/Eurostat working papers

- Data Production Methods for harmonised Patent Statistics: Patentee Name Harmonisation (will be updated at the end of 2009)
- Data Production Methods for harmonised Patent Statistics: Assignee Sector Allocation (will be updated at the end of 2009)
- Data Production Methods for harmonised Patent Statistics: Regionalizing Patent Data – EU-27: Methodological outline (to come)

For further information see:

Eurostat – Statistics explained

http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Patent_statistics

6.3.4 Foreign ownership

Foreign ownership of domestic inventions in patent applications is one of three indicators of international cooperation in patenting. The other two are domestic ownership of foreign inventions in patent applications and patent applications with foreign co-inventors.

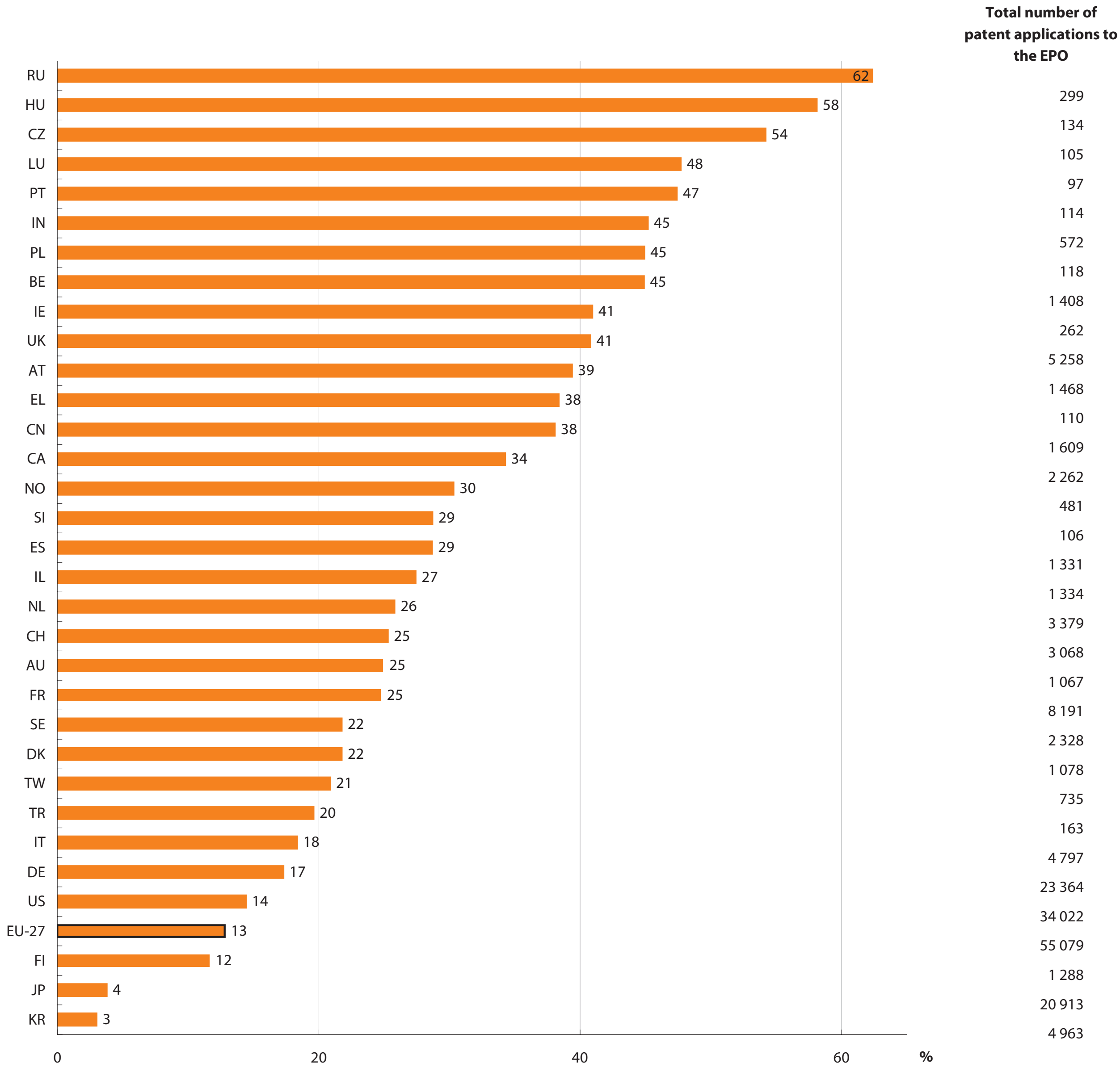
These indicators simply count the number of patent applications from the inventor country (or countries) and from the applicant country (or countries). It should be noted that it is not the nationality of the inventor or applicant that is taken into account, but the place of residence. The total number of patent applications from each country therefore comprises 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 instance 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 aggregated 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 involving 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 2005.

At EU level, Hungary recorded the highest rate (58 %), followed by the Czech Republic (54 %), Luxembourg (48 %) and Portugal (47 %). Outside Europe, Russia (62 %) and India (45 %) registered the highest rates of foreign ownership of domestic inventions in patent applications to the EPO. The EU-27 rate is relatively low (13 %) because those patent applications are counted as having one or several inventors living in the EU and one or more applicants residing in a non-EU country. For example, a patent application with a German inventor and a French applicant is not counted at EU level but only in the data for Germany.

The lowest rate at EU level was recorded in Finland, with only 12 %. Japan and South Korea were also situated at this end of the scale, with respectively 4 % and 3 %.

Figure 6.8: Foreign ownership of domestic inventions in patent applications to the EPO, as a percentage of all national applications, selected countries — 2005



Note:
Cut-off: at least 50 patent applications in 2005

Source: Eurostat (pat_ep_nfgn)

6.3.5 PCT applications

The Patent Cooperation Treaty (PCT) was signed in Washington on 19 June 1970 and came into force on 1 June 1978. It was amended on 28 September 1979, 3 February 1984, and 3 October 2001.

The PCT enables an international patent application to have the same effect as a national application in each of the contracting states (numbering 141 in June 2009) designated in the application.

In the cases where 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 and/or regionally.

All PCT applications are centralised through the World Intellectual Property Organisation (WIPO)[1]. In September 2009, 184 States were members of the WIPO.

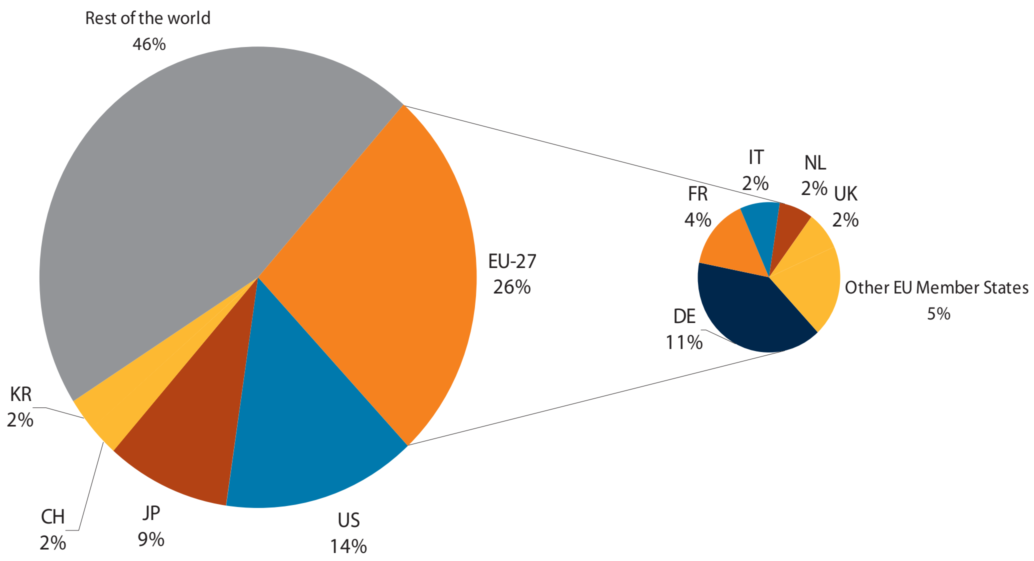
For a patent application filed as Euro-PCT, two phases are identified: the international phase and the national or regional (European) phase. A search is carried out during the international phase, and the application is published eighteen months after the priority date (the date of the first application at any patent office). When the international search report is finalised, the applicant can choose between three options: 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); choosing 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 or refused, or withdrawn by the applicant.

Owing to the methodological differences explained above, the data shown in Figure 6.9 cannot be compared with the data on patent applications to the EPO.

In 2005, more than a quarter of all PCT applications designated the EPO as receiving office. More than 40 % of these applications came from Germany.

(1) http://www.wipo.int

Figure 6.9: Breakdown of PCT applications designating the EPO as receiving office, by main country — 2005



Source: Eurostat (pat_ep_npct)

6.4 Patent applications in technological fields

The IPC makes it possible to aggregate patents allocated to certain IPC classes into technological fields. In 2008, Eurostat slightly modified the methodology for allocating patent applications in these fields. Previously, only the 'main IPC' code was taken into account in allocating a patent application to a technical field. As a patent application can be linked to several domains, and as more than one IPC code is often used to describe the application, the concept of designating one main IPC code became disputable. Whereas former data sources allowed a main IPC code to be singled out, such identification is no longer possible now that PATSTAT is used. This being the case, Eurostat decided that the allocation to technical fields should take into account all IPC codes listed in a patent application.

6.4.1 High-tech patent applications

One of the technical fields is 'high technology'.[1]

In 2005, most high-tech patent applications to the EPO came from Germany (3 269), followed by France (1 889) and the United Kingdom (1 285). In terms of high-tech patent applications per million inhabitants, Finland led by a wide margin, with 120 applications. Sweden ranked second with 65 applications, followed by the Netherlands with 56. Countries with fewer than 100 high-tech patent applications are not taken into consideration in the analysis set out below. High technology accounted for 18.7 % of all patent applications filed by the EU-27. The leading countries in this respect were Finland (48.9 %) and the Netherlands (27.1 %).

Whereas in the first observation period (1995 to 2000) the average annual growth rates were often higher for high-tech patent applications than they were for total patent applications, this was no longer true during the second observation period (2000 to 2005). However, growth rates for countries with only very few high-tech patent applications cannot be considered, due to excessive fluctuations in growth rates.

Some countries performed better than others, however, and exceeded the EU-27 average of 18.1 % in the first observation period. In Spain (28.4 %) and in the Netherlands (23.2 %), growth rates of high-tech patent applications were particularly high in the first period. In the second observation period, the EU-27 registered a negative average annual growth rate. The comparatively good performance of Austria, with an AAGR of 9.6 %, and Spain (6.5 %) in the second observation period should also be pointed out here.

Considering the average annual growth rates of total patent applications to the EPO, Spain (15.5 %), the Netherlands (14.4 %) and Finland (14.6 %) recorded significantly higher rates than the EU-27 average (10.5 %) between 1995 and 2000. In the second period (2000 to 2005) only Spain (10.8 %) and Austria (4.5 %) performed well above the EU-27 average (1.4 %), which also dropped considerably.

The aggregate 'high-tech patent applications' can be broken down into six groups[2] :

- AVI Aviation;
- CAB Computer and automated business equipment;
- CTE Communications technology;
- LSR Lasers;
- MGE Micro-organisms and genetic engineering;
- SMC Semi-conductors.

[1] The definition and the IPC codes used can be found in the methodological notes.

[2] Data broken down by high-tech group are available in Eurostat's reference database.

Table 6.10: High-tech patent applications to the EPO and average annual growth rates, EU-27 and selected countries — 1995 to 2005

	High-tech patent applications in 2005			Average annual growth rates in %			
				High-tech patents		All patents	
	Total	Per million inhabitants	As % of all patents	1995-2000	2000-2005	1995-2000	2000-2005
EU-27	10 294	21	18.7	18.1	-2.0	10.5	1.4
BE	324	31	23.0	9.9	4.5	9.8	1.6
BG	7	1	27.3	7.3	35.6	-1.9	26.2
CZ	17	2	15.9	21.8	34.8	29.9	9.6
DK	221	41	20.5	18.2	-0.7	13.5	2.9
DE	3 269	40	14.0	21.0	-3.8	11.1	1.1
EE	5	4	76.5	3.2	33.0	13.2	2.7
IE	58	14	22.2	25.3	-0.3	15.3	5.1
EL	16	1	14.8	19.3	7.5	14.4	14.9
ES	173	4	13.0	28.4	6.5	15.5	10.8
FR	1 889	30	23.1	14.9	1.4	7.2	2.4
IT	563	10	11.7	12.3	4.4	10.0	3.7
CY	0	1	2.9	:	-1.7	:	20.9
LV	2	1	10.8	17.1	17.8	:	20.3
LT	2	1	20.2	:	-2.4	9.3	13.7
LU	7	15	7.1	:	-2.5	20.3	3.4
HU	23	2	17.6	50.2	-6.1	17.0	2.1
MT	1	2	8.9	:	:	:	20.1
NL	915	56	27.1	23.2	-5.4	14.4	-0.3
AT	227	28	15.5	13.3	9.6	11.7	4.5
PL	23	1	19.8	35.0	39.2	25.8	22.5
PT	34	3	29.7	25.0	49.3	24.6	22.2
RO	6	0	21.5	:	25.3	-4.0	36.2
SI	5	2	4.5	-4.0	4.6	16.1	15.8
SK	4	1	11.7	6.7	21.0	10.2	22.3
FI	630	120	48.9	22.2	-1.3	14.6	-1.9
SE	588	65	25.3	15.0	-1.9	8.4	0.4
UK	1 285	21	24.4	15.3	-6.5	9.4	-2.5
HR	3	1	8.6	-23.4	53.7	1.7	16.2
TR	8	0	4.7	:	10.0	56.8	30.0
IS	5	17	16.4	46.9	-15.6	26.5	-3.8
LI	6	173	24.0	32.0	24.6	13.0	0.9
NO	76	16	15.7	22.3	0.8	10.8	3.9
CH	398	54	13.0	22.8	-2.5	9.8	2.5
AU	266	13	25.0	17.3	-2.6	14.6	1.5
CA	1 000	31	44.2	18.6	13.1	14.4	6.8
CN	905	1	56.3	76.4	55.9	43.0	38.3
IL	416	60	31.2	30.6	-1.0	22.3	5.9
IN	128	:	22.4	63.3	28.9	41.5	26.2
JP	6 447	50	30.8	13.3	-1.8	11.5	-0.7
KR	2 174	45	43.8	24.3	33.4	22.3	31.5
RU	65	0	21.8	10.1	6.1	10.2	5.7
TW	266	12	36.1	31.4	29.8	20.4	24.1
US	10 204	34	30.0	10.7	-1.8	7.3	1.9

Source: Eurostat (pat_ep_ntec and pat_ep_ntot)

6.4.2 ICT patent applications

The technological field of Information and Communication Technology (ICT)[1] is divided into four sub-categories:

- Consumer electronics;
- Computers, office machinery;
- Other ICT;
- Telecommunications.

Due to the methodology applied and to the fact that very often more than one IPC code is applied to one single patent application, a patent application can be classified in more than one ICT sub-category. This also explains why the sum of the sub-categories is higher than the total value of all ICT patent applications.

In 2005, the three main world economies (the EU-27, the United States and Japan) were in the lead regarding the total number of ICT patent applications to the EPO.

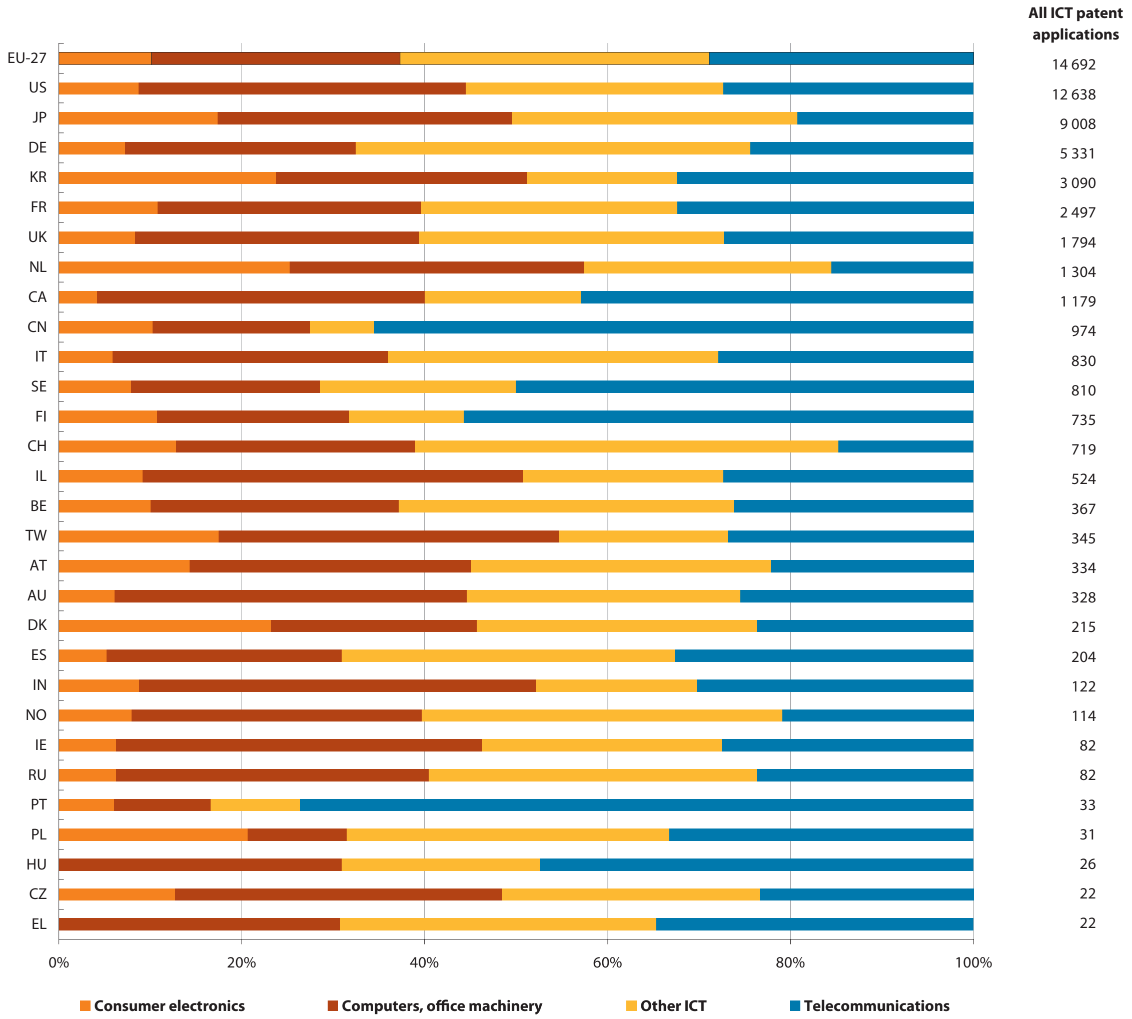
In the EU-27, patenting in the 'consumer electronics' ICT group played only a minor role (10 %). The largest share was recorded by 'other ICT', followed by shares of around 28 % in 'computers, office machinery' and 'telecommunications'.

However, this overall picture hides discrepancies at national level. In the Czech Republic, Ireland and the Netherlands, the largest ICT group in terms of patenting was 'computers, office machinery'.

Finland and Sweden filed respectively 56 % and 50 % of all ICT patent applications in ICT group 'telecommunications', denoting a clear specialisation in this field. China and Canada also specialised in this group, whereas more than 35 % of all the ICT patent applications made by Australia, India, Israel, Taiwan and the United States dealt with 'computers, office machinery'.

[1] The definition and the IPC codes used can be found in the methodological notes.

Figure 6.11: Breakdown of ICT patent applications to the EPO by sub-category, as a percentage of total, EU-27 and selected countries — 2005



Note:
Cut-off: at least 20 ICT patent applications in 2005

Source: Eurostat (pat_ep_nict)

6.4.3 Biotechnology patent applications

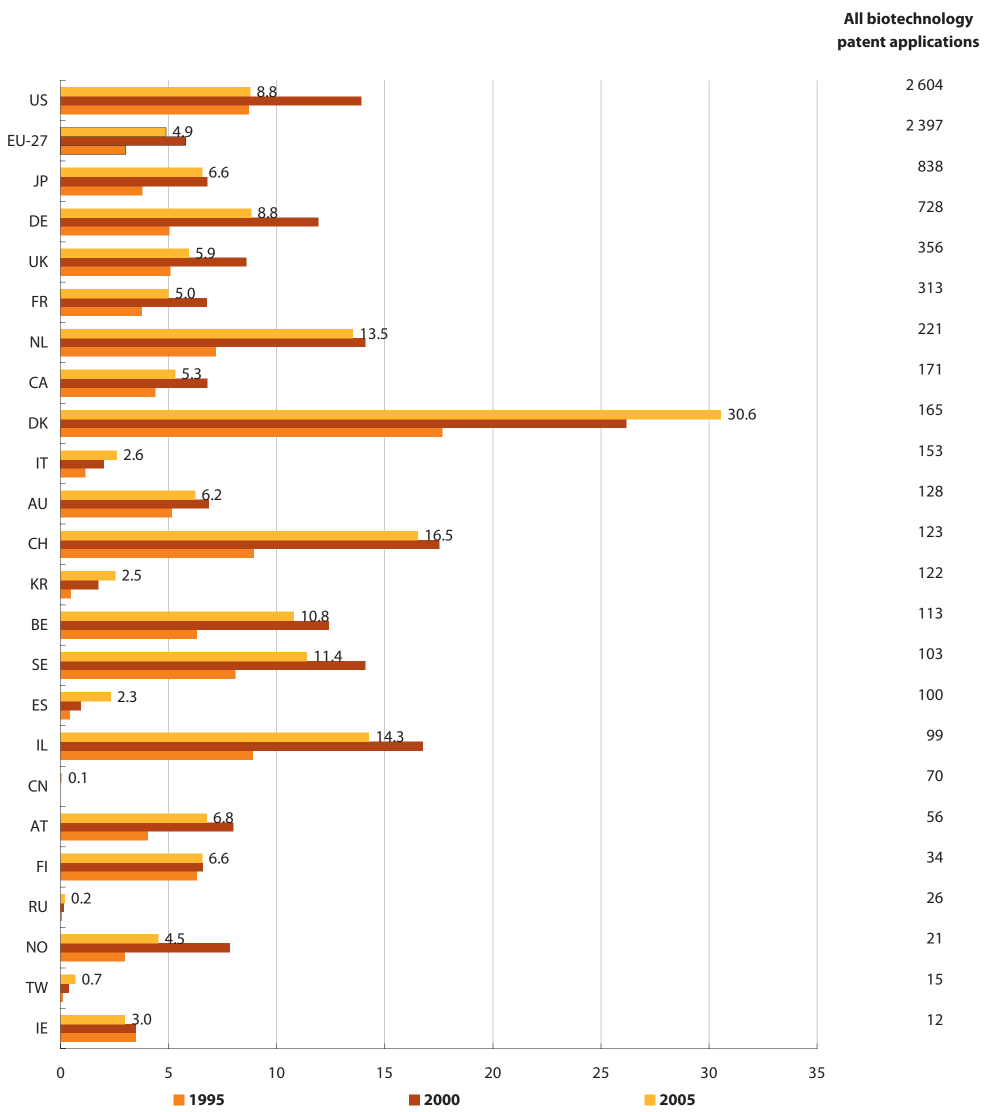
Biotechnology[1] is another interesting field in terms of patent applications. Considering the number of biotechnology patent applications to the EPO in 2005, the United States was in the lead, followed by the EU27 and Japan.

However, the ratio per million inhabitants reveals a very different ranking, with Denmark far ahead, followed by Switzerland and Israel. The next ranked EU Member States were the Netherlands and Sweden.

A closer look at the results for 1995, 2000 and 2005 reveals a mixed picture. Whereas increases were observed across the board between 1995 and 2000, the comparison of 2000 with 2005 figures brings no common trend to light. While this ratio increased in seven countries, it fell in others. The most significant increase was recorded in Denmark, while the United States reported the largest decrease.

[1] The definition and the IPC codes used can be found in the methodological notes.

Figure 6.12: Biotechnology patent applications to the EPO, total number and per million inhabitants, EU-27 and selected countries — 1995, 2000 and 2005



Note:
Cut-off: at least 10 biotech patent applications in 2005

Source: Eurostat (pat_ep_nbio)

6.4.4 Nanotechnology patent applications

"Nanotechnology is an area which has highly promising prospects for turning fundamental research into successful innovations. Not only to boost the competitiveness of our industry but also to create new products that will make positive changes in the lives of our citizens, be it in medicine, environment, electronics or any other field."

Source: European Commissioner for Science & Research, Janez Potočnik

In 2009, Eurostat added nanotechnology alongside the existing technological fields.

In contrast to the data of the other technological fields shown above, nanotechnology patent applications are not directly based on an aggregation of patent applications with the same IPC codes.

The EPO introduced 'Y01N' tags to label nanotechnology in its databases because, due to the interdisciplinary nature of the field, it was too difficult to retrieve these specific patent data from the available databases.

The EPO uses a highly efficient tagging system, which follows the structure of the Office's internal patent classification system which is much more detailed than the IPC. Each time a document containing nanotechnology is added to the databases, the EPO assigns a 'Y01N' tag so that it can be retrieved later.

These tags are available to the public on the EPO 'esp@cenet' worldwide patent database at www.espacenet.com.

The Y01N code is not static, but is constantly updated and improved as new aspects of this young technology emerge.

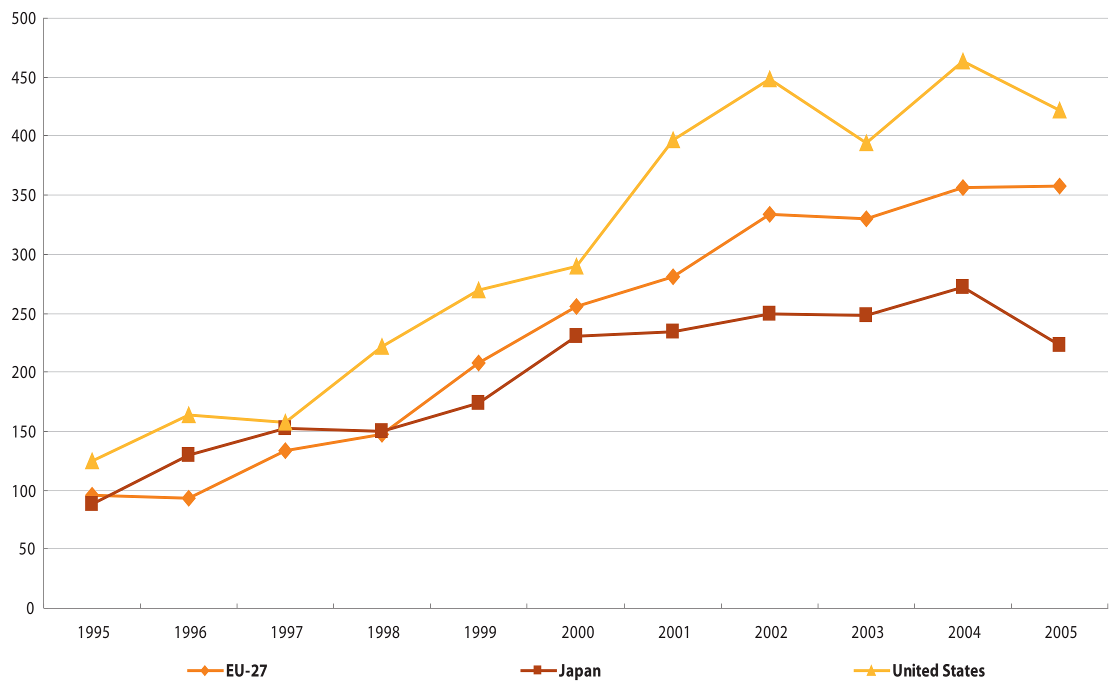
Y01N is divided into six main groups (from Y01N2 to Y01N12), with each group collecting nanotechnology patents of similar technological backgrounds.

The six subgroups are:

- Nano-biotechnology (Y01N2)
- Nanotechnology for information processing, storage and transmission (Y01N4)
- Nanotechnology for materials and surface science (Y01N6)
- Nanotechnology for interacting, sensing or actuating (Y01N8)
- Nano-optics (Y01N10)
- Nanomagnetics (Y01N12)

Figure 6.13 indicates that patenting in nanotechnology gained in importance from the end of the 1990s. The United States was in the lead, followed by the EU-27 and Japan. Data for 2005 can be considered as final at the time of writing, but due to the long patenting procedures data may be revised and the downward trend observed for the United States and Japan in 2005 may not be confirmed in the future.

Figure 6.13: Nanotechnology patent applications to the EPO, total number, EU-27, the United States and Japan — 1990-2005



Source: Eurostat (pat_ep_nnano)

Nanotechnology

"Nanotechnology is the study of phenomena and fine-tuning of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at a larger scale. Products based on nanotechnology are already in use and analysts expect markets to grow by hundreds of billions of euros during this decade. These advances can contribute to the European Union's growth, competitiveness and sustainable development objectives and many of its policies including public health, employment and occupational safety and health, information society, industry, innovation, environment, energy, transport, security and space.

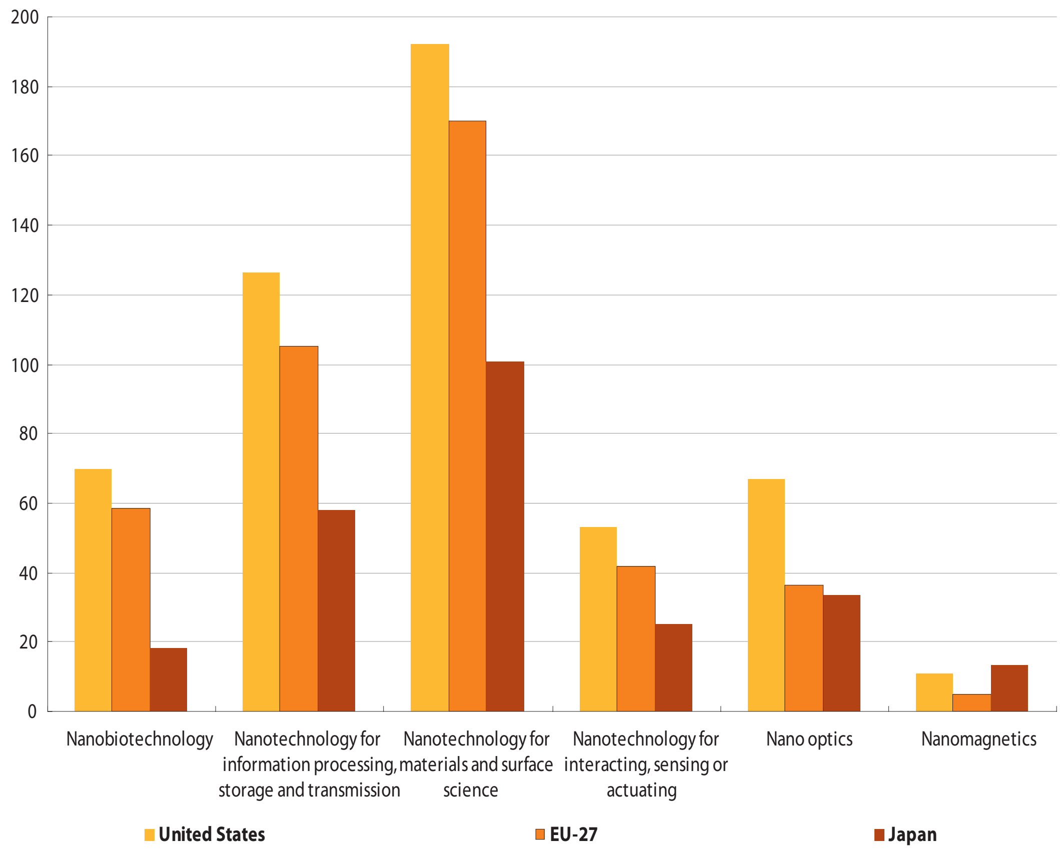
Nanotechnology research portal of the European Commission:

http://cordis.europa.eu/nanotechnology/

It offers website access to funding opportunities and EU-funded projects, information on international cooperation, financing and innovation, education and mobility, health, environment and safety aspects, and communication and debate. The site also includes publications and events in the nanotechnology field, the latest nano-related news, and press material on nanotechnology in general and on specific funded projects. It also presents information on the European Strategy and the Action Plan on nanotechnology."

Source: http://ec.europa.eu/nanotechnology/index_en.html

Figure 6.14: Nanotechnology patent applications to the EPO by subgroup, total number, United States, EU-27 and Japan — 2005

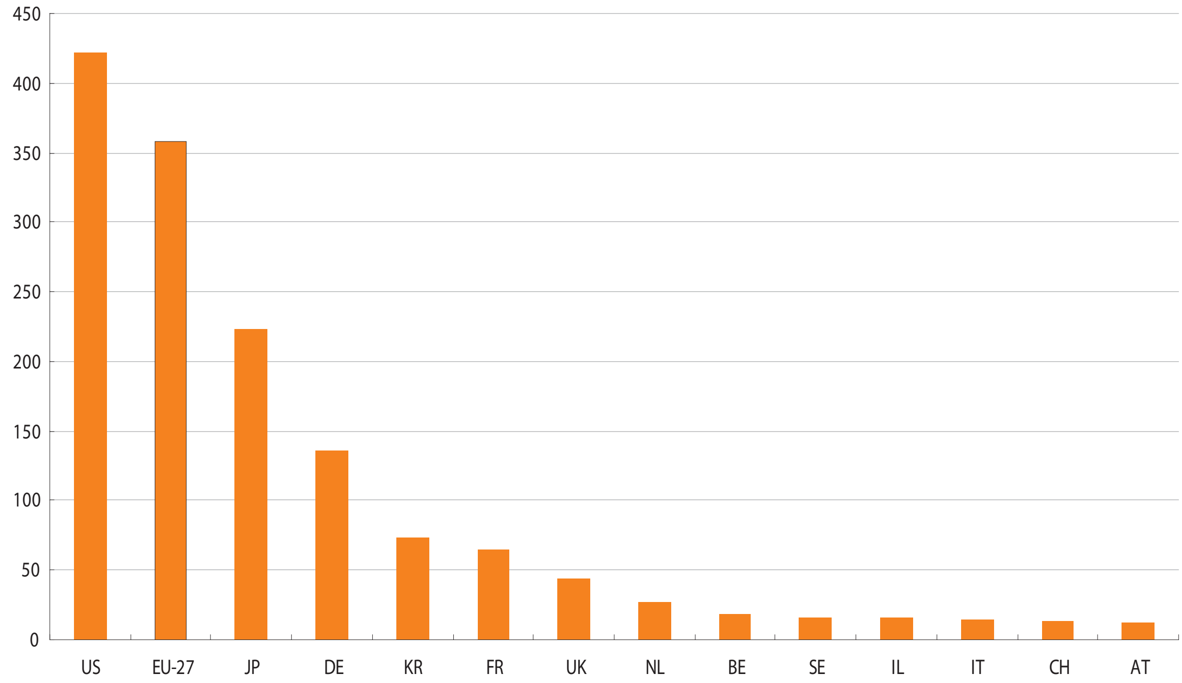


Source: Eurostat (pat_ep_nnano)

Figure 6.14 shows the breakdown by nanotechnology subgroups in the number of patent applications in 2005. Japan recorded the highest number of patent applications only in the 'nanomagnetics' subgroup. The United States were in the lead in all other subgroups, followed by the EU-27 and Japan.

Figure 6.15 presents the number of nanotechnology patent applications to the EPO in decreasing order of countries which in 2005 applied for at least 10 nanotechnology patents. The most active EU countries in nanotechnology patenting were Germany, France and the United Kingdom.

Figure 6.15: Nanotechnology patent applications to the EPO, total number, EU-27 and selected countries — 2005



Note:
Cut-off: at least 10 nanotech patent applications in 2005

Source: Eurostat (pat_ep_nnano)

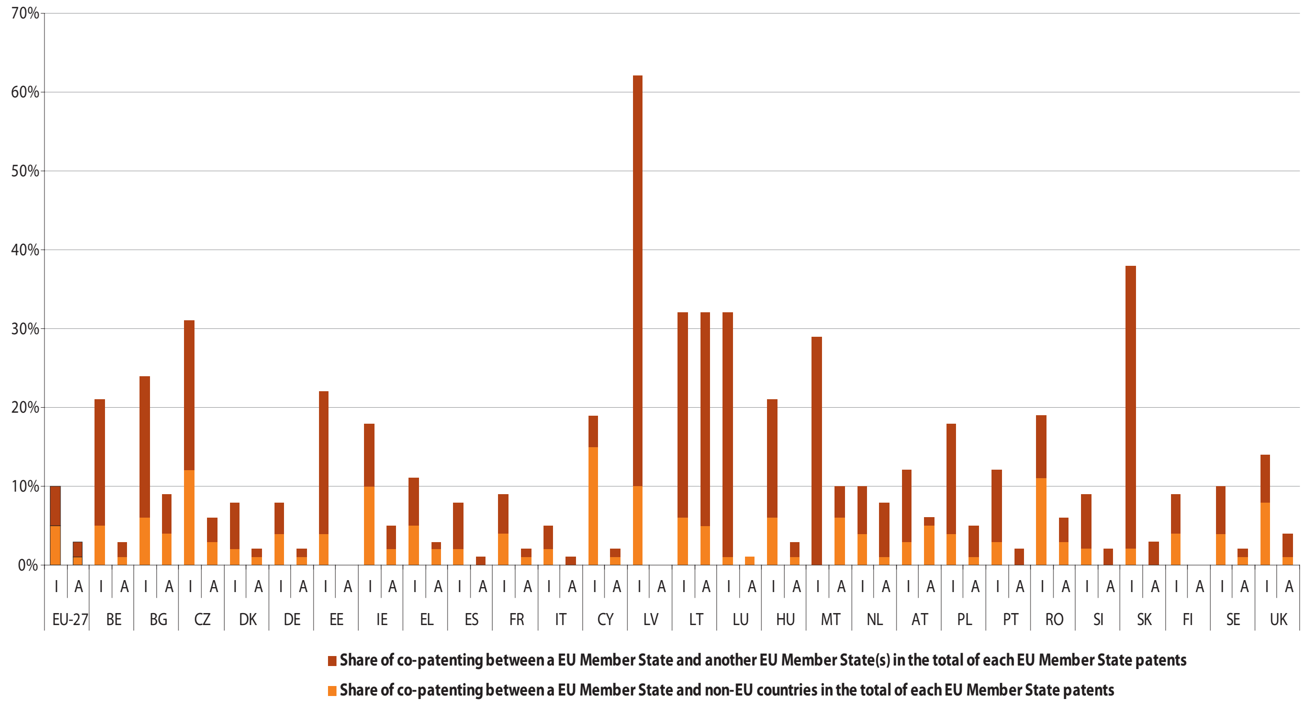
6.5 European and international co-patenting

In May 2009 Eurostat began publishing two sets of new patent indicators in its reference database.

The first set comprises indicators on European and international co-patenting and the second covers indicators on EU patent citations.

The new patent indicators aim to monitor the intensity of technological collaboration within the European Research Area (ERA). The calculated indicators provide information on the level and growth of international intra-European co-patenting as compared to other international co-patenting.

Figure 6.16: Co-patenting at the EPO according to the country of residence of inventors and applicants as a percentage of all patents in the EU-27 and in each EU Member State — 2005



Note:
I: inventors; A: applicants

Source: Eurostat (pat_ep_cpa and pat_ep_cpi)

All indicators are available according to the country of residence of inventors and applicants. As shown in Figure 6.16, the results vary significantly depending on whether the data are presented according to inventors' or applicants' country of residence.

In general, co-patenting is more widespread among inventors than among applicants.

At EU level, co-patenting accounted for 10 % of all patents filed at the EPO when considering the country of residence of inventors, compared to only 3 % when considering the country of residence of applicants.

Small economies often record high co-patenting shares. However in many cases these shares are not the result of a high cooperation intensity, but of low national patenting activity.

To avoid any misinterpretation of Figure 6.16, Table 6.17 should be consulted in parallel, as it provides data broken down by country.

At EU level, single investors account for 37 % of all patent applications. However, the EU average hides national disparities. Half of all Italian patent applications were filed by single inventors. Apart from Italy, in most countries that recorded a large number of patent applications, between 40 % and 60 % of such applications involved several inventors from the declaring country.

At EU level less than 10 % of co-patent applications involved co-inventors residing in countries other than the declaring country. A very similar share was recorded for co-patents involving inventors from the declaring country and one or more non-EU countries and for co-patents produced by inventors from the declaring country and one or more EU Member States.

The lowest shares of co-patenting activity were recorded for co-patents involving co-inventors from the declaring country, one or more EU Member States and one or more non-EU countries.

Table 6.17: Co-patenting at the EPO according to inventors' country of residence, total number and as a percentage of total, EU-27 and selected countries — 2005

	Total patents in the declaring country	Single inventors		Co-patents involving inventors from the declaring country		Co-patents involving inventors from the declaring country and one or more non-EU countries		Co-patents involving inventors from the declaring country and one or more EU Member States		Co-patents involving inventors from the declaring country, one or more EU Member States and one or more non-EU countries	
	number	number	%	number	%	number	%	number	%	number	%
EU-27	55 077	20 357	37.0	29 690	53.9	2 589	4.7	2 441	4.4	:	:
BE	1 408	498	35.4	619	44.0	69	4.9	201	14.3	21	1.5
BG	24	9	37.8	9	37.8	2	6.3	4	17.4	0	0.7
CZ	105	26	24.7	47	44.7	13	12.0	18	17.3	1	1.3
DK	1 078	471	43.7	514	47.7	26	2.4	60	5.6	7	0.7
DE	23 363	7 979	34.2	13 604	58.2	933	4.0	742	3.2	105	0.4
EE	6	2	31.4	3	47.1	0	3.9	1	11.8	0	5.8
IE	261	94	36.0	119	45.6	27	10.2	17	6.6	4	1.6
EL	111	61	55.1	37	33.4	6	5.1	6	5.5	1	0.9
ES	1 331	610	45.8	602	45.2	33	2.4	77	5.8	9	0.7
FR	8 191	2 826	34.5	4 623	56.4	336	4.1	349	4.3	56	0.7
IT	4 797	2 401	50.1	2 172	45.3	82	1.7	129	2.7	13	0.3
CY	16	13	81.0	:	:	2	:	1	:	:	:
LV	18	3	16.2	4	21.6	2	10.4	9	50.6	0	1.1
LT	9	3	33.6	3	33.6	1	6.3	2	25.8	0	0.7
LU	97	45	46.5	20	20.7	1	1.5	29	30.2	1	1.1
HU	134	21	15.7	85	63.6	8	5.9	17	12.8	3	2.0
MT	11	8	71.1	:	:	:	:	3	28.9	:	:
NL	3 379	1 094	32.4	1 967	58.2	119	3.5	177	5.2	22	0.6
AT	1 468	661	45.0	626	42.6	48	3.3	122	8.3	11	0.8
PL	118	54	45.8	43	36.4	5	4.1	14	12.0	2	1.7
PT	114	49	42.9	52	45.5	3	3.0	9	8.2	1	0.5
RO	29	14	48.8	9	31.4	3	11.3	1	5.0	1	3.5
SI	106	31	29.4	65	61.6	2	1.9	7	6.7	1	0.5
SK	31	14	45.6	5	16.3	1	2.3	10	33.6	1	2.2
FI	1 288	488	37.9	685	53.2	48	3.7	54	4.2	12	1.0
SE	2 328	927	39.8	1 180	50.7	83	3.6	123	5.3	15	0.6
UK	5 258	1 955	37.2	2 597	49.4	398	7.6	256	4.9	52	1.0
HR	33	9	27.4	17	51.7	1	1.5	6	19.4	:	:
TR	163	59	36.1	88	53.9	10	6.1	6	3.6	1	0.3
IS	30	11	36.9	13	43.6	4	15.0	1	4.3	0	0.2
LI	25	14	55.9	:	:	3	13.7	4	17.0	3	13.5
NO	481	234	48.6	185	38.4	11	2.3	49	10.3	2	0.4
CH	3 068	1 223	39.9	1 215	39.6	90	2.9	497	16.2	43	1.4
IL	1 334	402	30.1	802	60.1	90	6.8	33	2.5	7	0.5

Source: Eurostat (pat_ep_cpi)

It should be noted that co-patenting indicators are not based on the nationality of inventors, but on their country of residence.

Patents from inventors who are cross-border commuters are counted as co-patents involving inventors from countries other than the declaring country.

Table 6.18 shows the same indicators as Table 6.17, but for patents granted by the USPTO in 2002.

Figures for European countries are always lower at the USPTO than at the EPO because European inventors are usually more interested in protecting their inventions on their home market. International protection is generally only sought for inventions that can generate substantial returns.

In the EU, the share of co-patents involving inventors from the declaring country and one or more non-EU countries stood at 7.5 % in 2002. It may be assumed that in many cases one of the inventors was an American resident who supported filing of the patent at the USPTO.

Table 6.18: Co-patenting at the USPTO according to inventors' country of residence, total number and as a percentage of total, EU-27 and selected countries — 2002

	Total patents in the declaring country	Single inventors		Co-patents involving inventors from the declaring country		Co-patents involving inventors from the declaring country and one or more non-EU countries		Co-patents involving inventors from the declaring country and one or more EU Member States		Co-patents involving inventors from the declaring country, one or more EU Member States and one or more non-EU countries	
	number	number	%	number	%	number	%	number	%	number	%
EU-27	21 501	7 266	33.8	11 727	54.5	1 604	7.5	904	4.2	:	:
BE	549	163	29.7	256	46.6	56	10.2	62	11.3	12	2.2
BG	5	2	40.7	1	20.3	1	15.2	1	23.8	:	:
CZ	45	16	35.4	16	35.4	7	14.9	5	10.3	2	3.9
DK	339	133	39.2	154	45.4	28	8.2	21	6.2	3	1.0
DE	9 295	2 863	30.8	5 618	60.4	493	5.3	273	2.9	47	0.5
EE	1	:	:	:	:	:	:	1	100.0	:	:
IE	152	44	28.9	74	48.7	28	18.1	5	3.5	1	0.8
EL	25	13	52.1	6	24.0	3	11.3	3	11.0	0	1.6
ES	297	115	38.8	123	41.5	28	9.4	28	9.5	2	0.8
FR	2 984	935	31.3	1 736	58.2	179	6.0	109	3.7	25	0.8
IT	1 526	608	39.8	816	53.5	53	3.5	43	2.8	6	0.4
CY	3	1	35.3	:	:	1	:	1	:	:	:
LV	3	:	:	1	32.3	1	19.4	2	48.4	:	:
LT	8	2	24.8	:	:	5	59.6	:	:	1	15.6
LU	32	7	22.1	8	25.3	7	21.1	9	29.8	1	1.7
HU	54	12	22.3	28	52.1	5	9.0	9	15.9	0	0.7
MT	2	2	100.0	:	:	:	:	:	:	0	:
NL	1 200	371	30.9	621	51.8	98	8.1	95	7.9	15	1.2
AT	492	215	43.7	193	39.3	26	5.2	51	10.4	7	1.4
PL	35	12	34.6	8	23.1	12	35.9	2	4.7	1	1.7
PT	15	5	34.2	8	54.8	1	6.8	1	3.4	0	0.8
RO	8	3	36.3	:	:	4	45.8	1	16.6	0	1.3
SI	20	5	25.2	11	55.5	2	12.2	1	3.8	1	3.4
SK	6	3	51.1	2	34.1	0	5.6	0	5.6	0	3.4
FI	661	247	37.4	351	53.1	32	4.8	29	4.4	2	0.3
SE	958	404	42.2	461	48.1	49	5.1	36	3.8	8	0.8
UK	2 788	1 085	38.9	1 235	44.3	325	11.6	115	4.1	28	1.0
HR	23	6	25.6	16	68.3	1	2.1	1	2.9	0	:
TR	19	7	36.9	6	31.7	4	19.1	2	12.3	:	:
IS	34	10	29.3	17	49.8	5	13.6	3	7.3	:	:
LI	14	4	27.9	:	:	0	1.4	7	46.5	3	24.2
NO	195	88	45.1	76	39.0	16	8.0	14	7.1	2	0.8
CH	1 049	402	38.3	418	39.9	60	5.7	151	14.4	18	1.7
IL	1 089	384	35.3	613	56.3	85	7.8	6	0.5	2	0.2

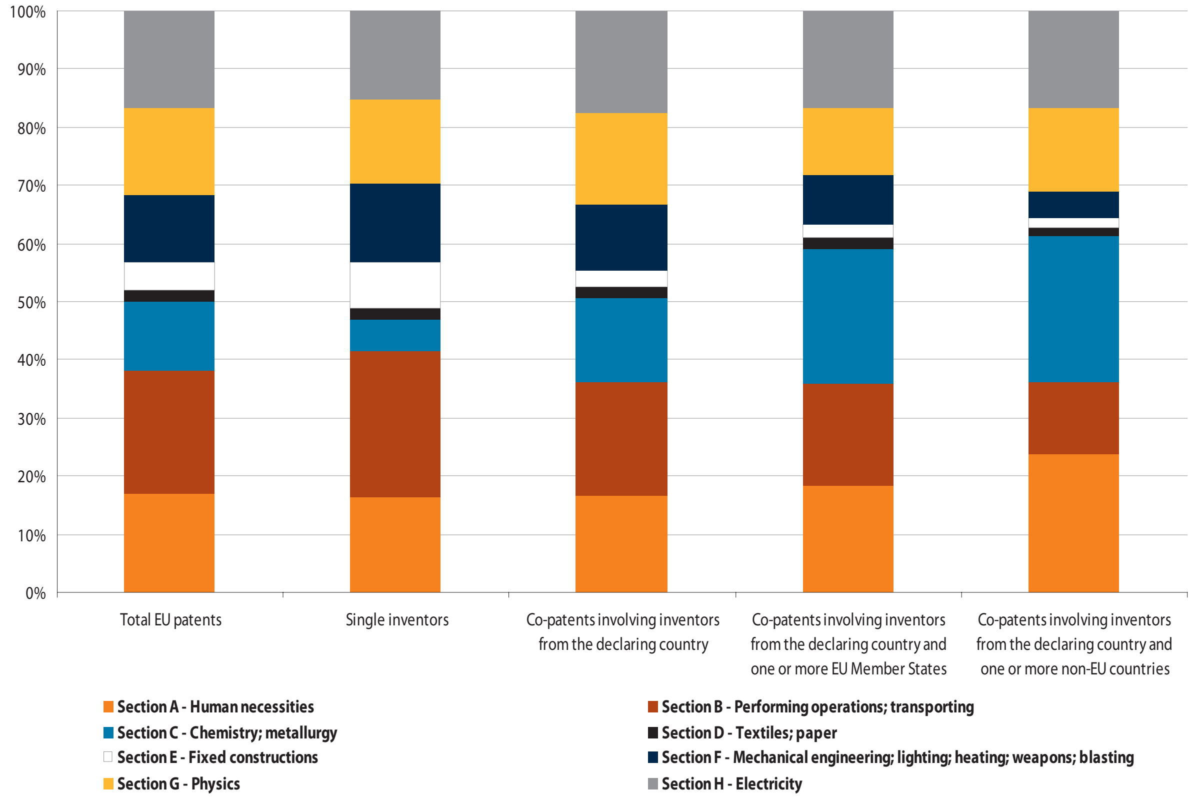
Source: Eurostat (pat_us_cpi)

At EU level co-patenting indicators are also available by IPC section. Whereas IPC sections B (performing operations; transporting), A (human necessities) and H (electricity) counted the most patent applications, a number of discrepancies were found at inventor level.

Section E (fixed constructions) accounted for a higher share among single inventors than among the other categories of co-patenting. At the same time a relatively small share was recorded for single inventors in section C (chemistry, metallurgy).

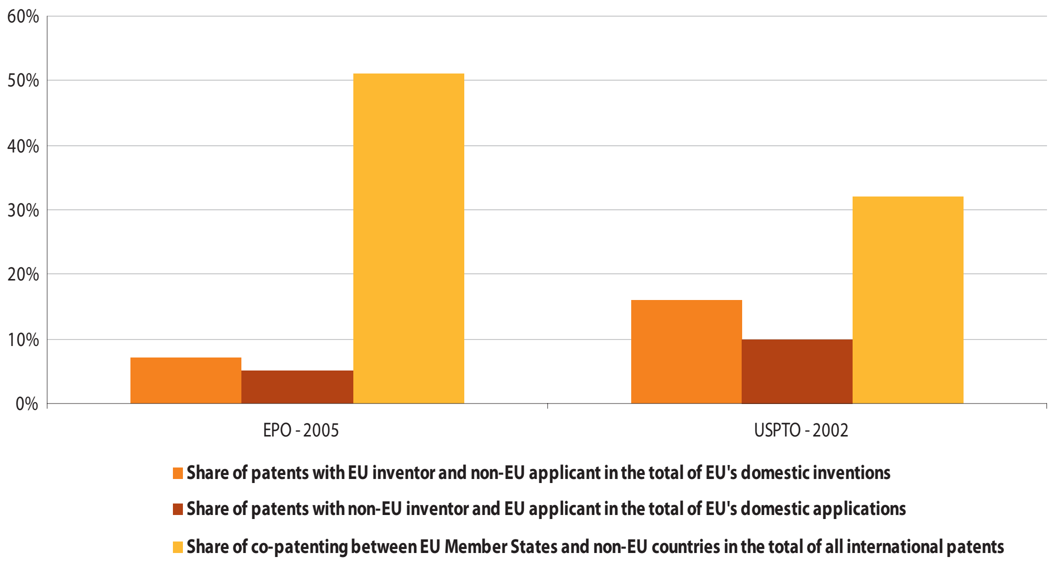
Patent applications related to section C mostly involve two or more inventors. Section C is also the field in which European and international co-patenting is the most frequent. Section C patent applications accounted for more than 20 % of co-patent applications involving co-inventors who are not residents of the declaring country.

Figure 6.19: EU co-patenting at the EPO according to inventors' country of residence by IPC section, as a percentage of total, EU-27 — 2005



Source: Eurostat (pat_ep_icpi)

Figure 6.20: Co-patenting at the EPO and USPTO: crossing inventors and applicants according to inventors' country of residence, EU-27 — 2002 and 2005



Source: Eurostat (pat_ep_cpci and pat_us_cpci)

The first two indicators shown in Figure 6.20 cross the countries of residence of the inventors with those of the applicants. The first one focuses on patents with EU inventors and non-EU applicants, whereas the second considers patents with non-EU inventors and EU applicants.

In 2005, 7 % of EPO patent applications made by EU inventors had a non-EU applicant. In 2002, 16 % of patents granted by the USPTO to EU inventors involved non-EU applicants.

At the EPO and the USPTO, the shares of non-EU inventors are lower when the applicant is a resident of an EU Member State.

EU total domestic inventions include all patent applications made by inventors residing in the EU-27.

EU total domestic applications include all patent applications made by applicants residing in the EU-27.

International co-patents include co-patent applications made by several inventors from different countries. This definition includes patents with inventors from several EU-27 Member States, patents with inventors from EU-27 and non-EU-27 countries and patents with non-EU-27 inventors only.

The third indicator focuses exclusively on the country of residence of the inventors. For example, in 2005, 51 % of the international patents filed at the EPO were the result of cooperation between inventors of EU Member States and non-EU countries.

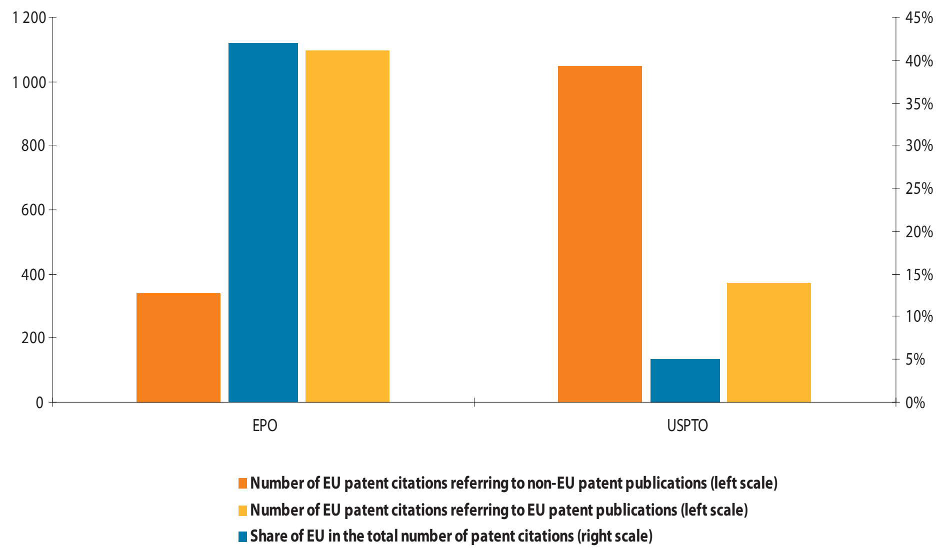
6.5.1 EU patent citations

The indicators on patent citations published by Eurostat are based exclusively on patent publications.

Figure 6.21 shows two different kinds of indicators. The first two indicators are measured on the left scale and show the number of EU patent citations referring to EU and non-EU patent publications for the EPO and the USPTO. Unsurprisingly, at the EPO the number of EU patents referring to EU patent publications was higher than the number of EU patents referring to non-EU patent publications. In contrast, the opposite was observed at the USPTO.

The third indicator, measured on the right scale, shows the share of EU patents cited in all patent publications. References to EU patents accounted for only 5 % of all USPTO patent publications. In contrast, this share was much higher at the EPO, reaching 42 %.

Figure 6.21: EU patent citations (EPO and USPTO) according to inventors' country of residence, total number (left scale) and as a percentage of total (right scale), EU-27 — 2005



Source: Eurostat (pat_ep_cti, pat_us_cti)

Note to the reader

Citations may refer either to patent publications or to non-patent literature (NPL).

Patent citations are citations of a patent in other patent applications. They are made by the examiner or author comprising a list of references of relevant prior art.

Patent publications include patent applications, bibliographical data, abstracts and claims.

Non-patent literature mainly covers relevant scientific publications which may cite patents or other scientific publications. Data on non-patent literature are not covered in this publication.

Table 6.22 compares the number of EU patent citations referring to non-EU and EU patent publications for the EPO and USPTO according to the country of residence of inventors and applicants between 1996 and 2005.

Unsurprisingly, EU patents far more frequently contain references to EU patent publications than to non-EU patent publications. However, the gradual decrease observed for both indicators should not be interpreted too strictly: as patent procedures are often lengthy, these figures may increase at the next revision.

Table 6.22: EU patent citations (EPO and USPTO) according to inventors' and applicants' country of residence, EU-27 — 1996 to 2005

	Number of EU patent citations referring to non-EU patent publications				Number of EU patent citations referring to EU patent publications			
	EPO		USPTO		EPO		USPTO	
	according to inventors' country of residence	according to applicants' country of residence	according to inventors' country of residence	according to inventors' country of residence	according to inventors' country of residence	according to inventors' country of residence	according to inventors' country of residence	according to inventors' country of residence
1996	4 241	4 276	45 148	44 429	5 957	5 579	13 247	11 546
1997	4 056	4 085	46 038	45 476	5 967	5 600	13 084	11 412
1998	3 841	3 868	39 658	38 750	5 925	5 505	12 135	10 666
1999	3 717	3 825	33 889	32 968	5 743	5 289	10 456	9 265
2000	3 188	3 229	28 347	27 232	4 882	4 508	9 831	8 702
2001	2 416	2 502	21 482	20 094	4 326	4 028	7 167	6 599
2002	1 915	1 900	13 428	12 501	3 539	3 313	4 400	3 916
2003	1 423	1 500	7 206	6 648	2 959	2 747	2 583	2 474
2004	862	880	3 252	2 879	2 200	2 058	1 224	1 236
2005	338	339	1 048	861	1 096	1 039	370	401

Source: Eurostat (pat_ep_ cti, pat_ep_cta, pat_us_cti, pat_us_cta)

Further reading on patent citations

Emanuele Bacchiocchiy, Fabio Montobbio, February 2009, International knowledge diffusion and home-bias effect. Do USPTO & EPO patent citations tell the same story?
http://portale.unibocconi.it/wps/wcm/connect/resources/file/eb50cd098ee9388/WP15_BacchiocchiMontobbio.pdf

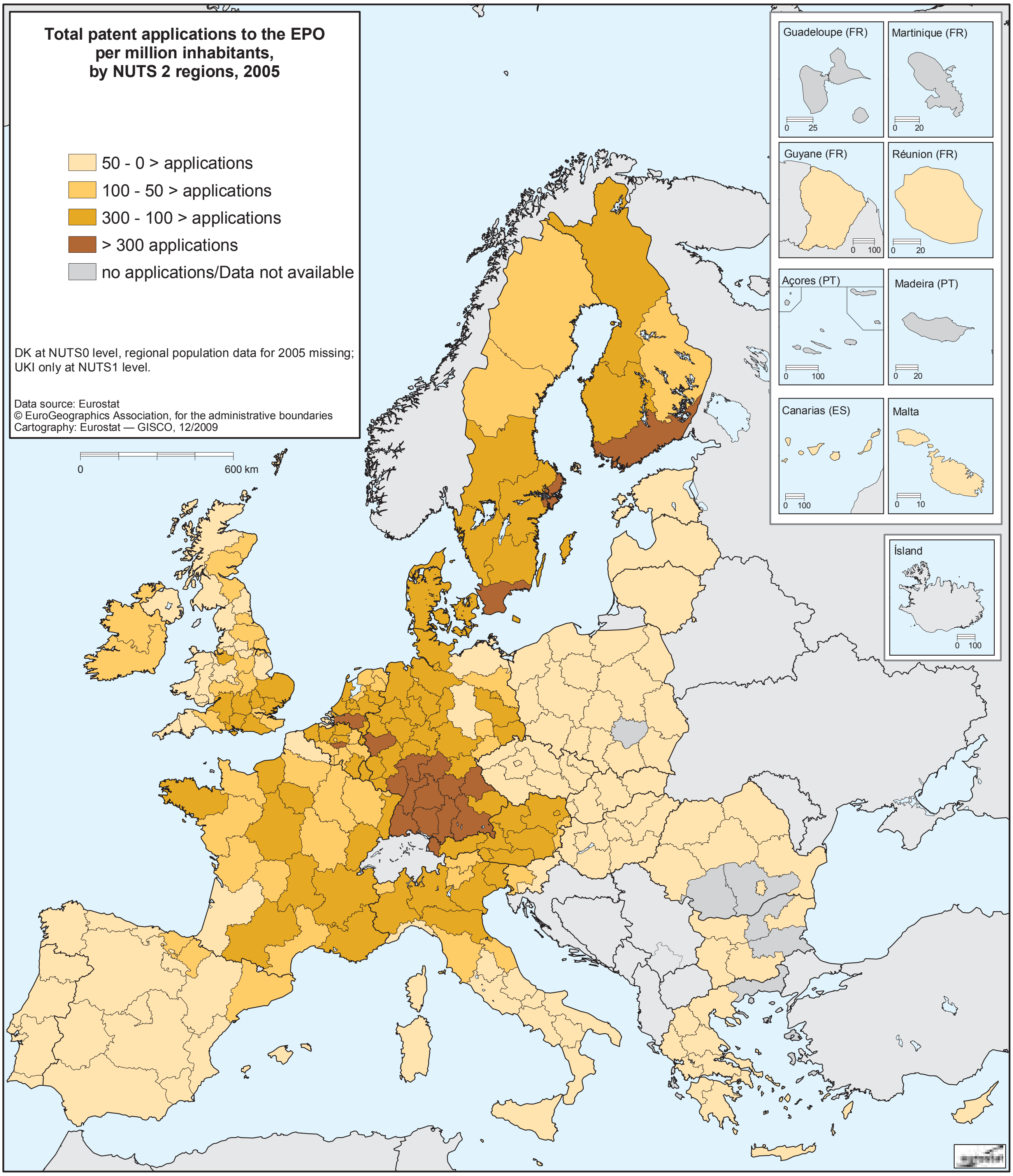
Önder Nomaler Bart Verspagen, June 2007, Knowledge Flows, Patent Citations and the Impact of Science on Technology
http://www.merit.unu.edu/publications/wppdf/2007/wp2007-022.pdf

Paola Criscuolo, Bart Verspagen, 2005, Does it matter where patent citations come from? Inventor versus examiner citations in European patents, 2005-018, MERIT-Infonomics Research Memorandum series
http://edocs.ub.unimaas.nl/loader/file.asp?id=1061

6.6 Performance at regional level

6.6.1 Total patent applications to the EPO

Map 6.23: Patent applications to the EPO per million inhabitants by EU-27 region (NUTS 2) — 2005



Source: Eurostat (pat_ep_rtot)

Map 6.23 illustrates the regional patenting activity in the EU. In most EU countries, national patenting is concentrated in certain regions. Active regions in patenting are often situated close together, forming economic clusters. This is for example the case in the southern part of Germany, the south-east of France and the north-west of Italy. The most active regions in terms of patenting (with 100 or more patent applications per million inhabitants) are situated in the Nordic countries and at the heart of the EU.

Table 6.24: Patent applications to the EPO, top three regions by country (NUTS 2), total number and per million inhabitants — 2005

	Total number		Per million inhabitants	
BE	Prov. Antwerpen	327	Prov. Brabant Wallon	346.0
	Prov. Vlaams-Brabant	230	Prov. Vlaams-Brabant	222.1
	Prov. Oost-Vlaanderen	190	Prov. Antwerpen	195.2
BG	Yugozapaden	8	Severoiztochen	4.0
	Severoiztochen	4	Yugozapaden	3.8
	Yuzhen tsentralen	3	Yuzhen tsentralen	1.6
CZ	Praha	26	Praha	21.9
	Severovychod	17	Severovychod	11.1
	Jihovychod	16	Stredni Cechy	9.9
DK	Hovedstaden	600	Denmark (NUTS0)	198.3
	Midtjylland	196		
	Syddanmark	136		
DE	Stuttgart	2 568	Stuttgart	641.5
	Oberbayern	2 413	Oberbayern	573.0
	Darmstadt	1 481	Freiburg	536.6
EE	Estonia	6	Estonia	4.7
IE	Southern and Eastern	158	Border, Midlands and Western	71.1
	Border, Midlands and Western	78	Southern and Eastern	52.5
EL	Attiki	50	Attiki	12.5
	Kentriki Makedonia	10	Thessalia	7.5
	Thessalia	6	Kriti	7.4
ES	Cataluña	481	Comunidad Foral de Navarra	97.0
	Comunidad de Madrid	229	Cataluña	70.9
	País Vasco	127	País Vasco	60.2
FR	Île de France	2 979	Île de France	261.4
	Rhône-Alpes	1 390	Rhône-Alpes	233.2
	Provence-Alpes-Côte d'Azur	491	Alsace	181.5
IT	Lombardia	1 381	Emilia-Romagna	180.4
	Emilia-Romagna	749	Lombardia	147.1
	Veneto	619	Piemonte	138.5
CY	Cyprus	16	Cyprus	21.4
LV	Latvia	18	Latvia	8.0
LT	Lithuania	9	Lithuania	2.6
LU	Luxembourg	95	Luxembourg	206.4
HU	Kozep-Magyarorszag	95	Kozep-Magyarorszag	33.3
	Eszak-Alfold	13	Eszak-Alfold	8.2
	Del-Alfold	10	Del-Alfold	7.1
MT	Malta	11	Malta	27.9
NL	Noord-Brabant	1 671	Noord-Brabant	693.1
	Zuid-Holland	466	Limburg (NL)	185.7
	Gelderland	279	Utrecht	159.9
AT	Wien	298	Vorarlberg	474.7
	Oberösterreich	298	Oberösterreich	213.1
	Niederösterreich	236	Wien	183.4
PL	Mazowieckie	19	Zachodniopomorskie	8.1
	Podkarpackie	11	Podkarpackie	5.1
	Zachodniopomorskie	8	Mazowieckie	3.7
PT	Lisboa	40	Lisboa	14.5
	Centro (P)	24	Centro (P)	10.1
	Norte	20	Norte	5.4
RO	Bucuresti - Ilfov	12	Bucuresti - Ilfov	5.3
	Centru	4	Centru	1.6
	Nord-Vest	2	Nord-Vest	0.6
SI	Zahodna Slovenija	48	Zahodna Slovenija	52.2
	Vzhodna Slovenija	45	Vzhodna Slovenija	41.8
SK	Zapadne Slovensko	10	Bratislavsky kraj	14.1
	Bratislavsky kraj	8	Zapadne Slovensko	5.5
	Vychodne Slovensko	3	Vychodne Slovensko	2.0
FI	Etelä-Suomi	787	Etelä-Suomi	305.0
	Länsi-Suomi	338	Länsi-Suomi	253.9
	Pohjois-Suomi	118	Pohjois-Suomi	186.7
SE	Stockholm	645	Stockholm	344.4
	Västsverige	523	Sydsverige	323.0
	Sydsverige	424	Västsverige	289.5
UK	East Anglia	450	East Anglia	199.6
	Berkshire, Buckinghamshire and Oxfordshire	422	Berkshire, Buckinghamshire and Oxfordshire	197.7
	Surrey, East and West Sussex	410	Cheshire	165.3

Note:
DK regional population data for 2005 missing.

Source: Eurostat (pat_ep_rtot)

Table 6.24 presents, for individual countries, the three leading regions in terms of patent applications to the EPO. The leading regions may vary depending on the measurement criterion chosen (total number or per million inhabitants). However, regional data are not available for all EU-27 countries, as smaller countries are considered as regions (at NUTS 2 level). This is the case for Estonia, Cyprus, Latvia, Lithuania, Luxembourg and Malta.

Patenting activity varies not only between countries, but also between regions. In 2005, Île de France (FR) was the foremost EU region in total number of patent applications (2 979), while Noord-Brabant (NL) was in the lead in terms of patent applications per million inhabitants (693).

Figure 6.25 presents regional disparities by country. Significant disparities were observed in Germany 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. In contrast, discrepancies between regions were much lower in Finland and Sweden.

Noord-Brabant

"The people of Noord-Brabant are among the most productive of the Netherlands. Figures prove this: the share of the gross national product, employment levels, the number of companies, the number of patents in relation to inventions. The province can boast that it is the third best technological region at the European level with Eindhoven at the centre.

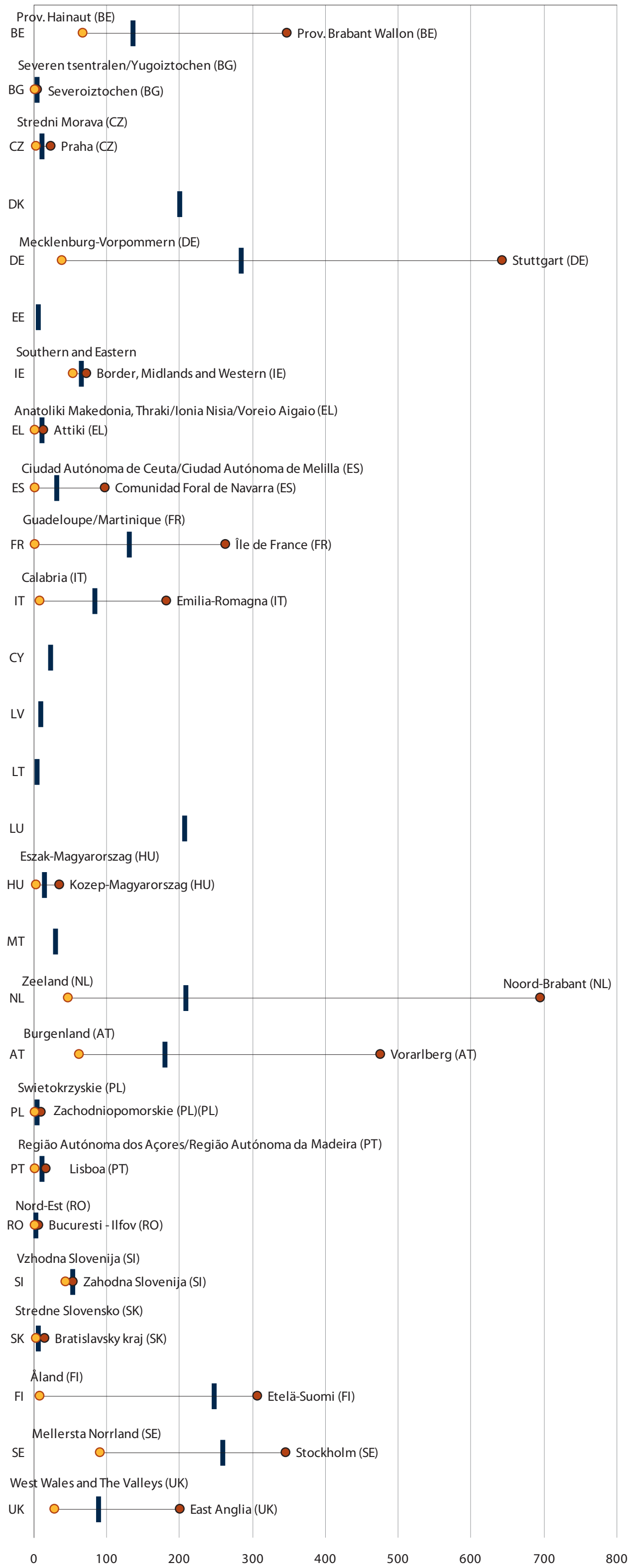
Traditional agriculture has been transformed into a high-tech food industry around Veghel/Uden/Oss. The pharmaceutical sector and biomedical technology, that is, the new 'human health' sector, has developed mainly around Oss.

European military aviation maintenance is organised in the triangle between Vlissingen, Venlo and Woensdrecht. Industrial and chemical companies add value to the goods that find their way to over 300 million consumers in Western and Central Europe. Most of these goods are shipped from the nearby ports of Rotterdam and Antwerp.

The province has around 1 000 international companies with foreign or Dutch managers fronting them. Apparently, the approach practised in Noord-Brabant more than suits what the international business world is attempting to achieve."

Source: http://www.brabant.nl/english/describing-the-people-from-brabant.aspx

Figure 6.25: Patent applications to the EPO per million inhabitants, regional disparities (best- and worst-performing region) and national average by country (NUTS 2) — 2005



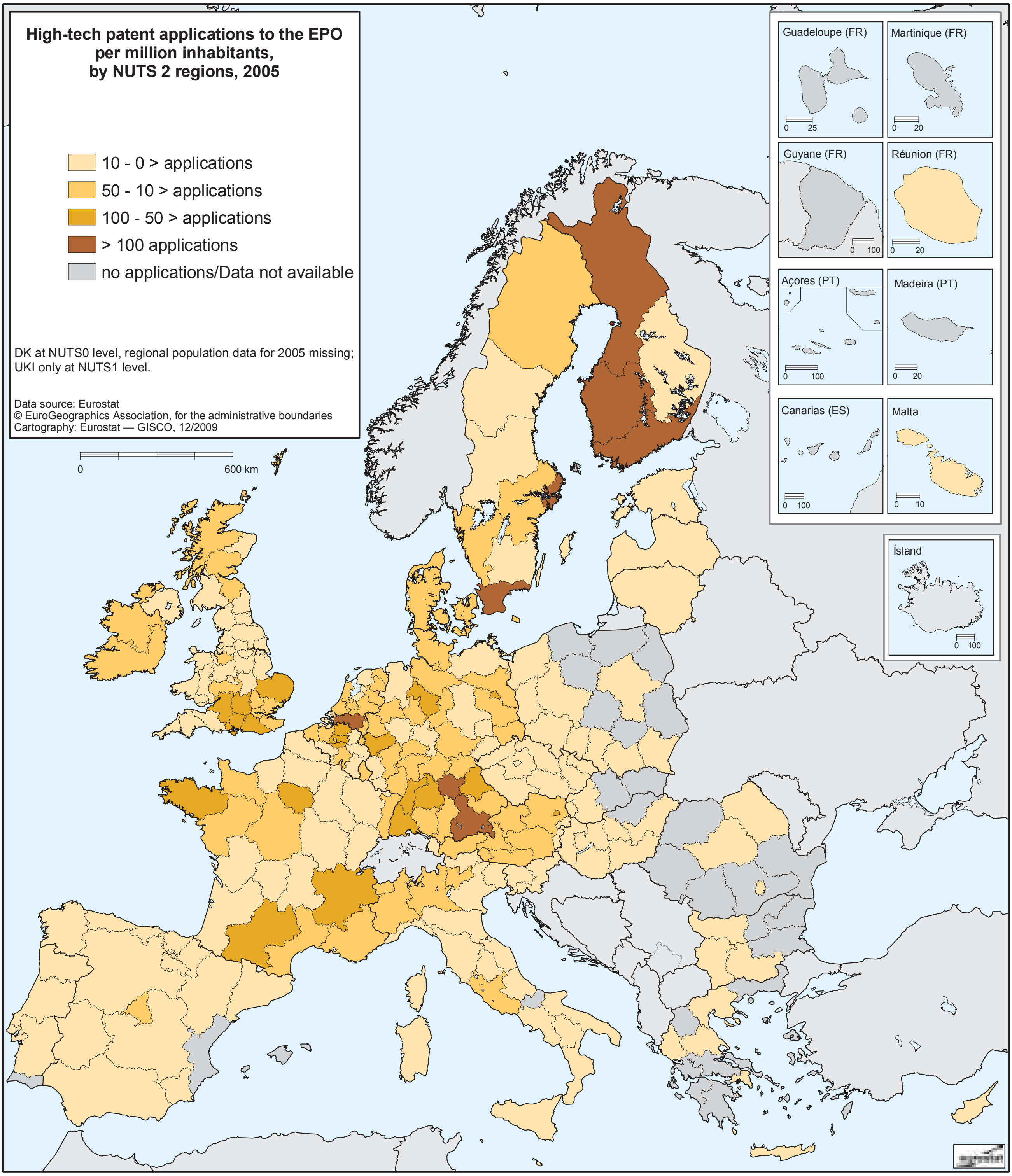
Note:
DK regional population data for 2005 missing.

Source: Eurostat (pat_ep_rtot)

Map 6.26 provides an overview of regional performance in high-tech patent applications.

Only very few regions recorded more than 100 high-tech patent applications per million inhabitants to the EPO.

Map 6.26: High-tech patent applications to the EPO per million inhabitants by EU-27 region (NUTS 2) — 2005



Source: Eurostat (pat_ep_rtec)

Table 6.27: High-tech patent applications to the EPO in the leading EU-27 regions (NUTS 2), total number and by high-tech group, as a percentage of the total — 2005

Leading high-tech region (or country)		Total high tech	Computer and automated business equipment	Micro-organism and genetic engineering	Aviation	Communication technology	Semi-conductors	Laser
BE	Prov. Antwerpen	92	50.8	3.1	0.5	41.1	8.8	0.8
BG	Yugozapaden	3	31.1	37.5	:	31.1	:	:
CZ	Praha	6	50.8	11.0	:	38.1	:	:
DK	Hovedstaden	159	14.5	45.5	1.4	37.1	1.0	1.5
DE	Oberbayern	607	27.9	9.7	1.9	52.7	11.6	0.5
EE	Estonia	5	20.5	28.1	:	30.8	20.5	:
IE	Southern and Eastern	40	46.8	18.2	:	25.5	9.6	2.5
EL	Attiki	10	23.9	9.3	9.6	57.3	:	:
ES	Comunidad de Madrid	82	5.9	36.9	15.5	36.7	5.1	:
FR	Île de France	768	25.3	9.3	2.4	58.9	5.5	2.8
IT	Lombardia	164	28.7	19.3	1.6	37.0	15.5	1.4
CY	Cyprus	0	28.3	:	:	:	71.7	:
LV	Latvia	2	12.5	:	:	87.5	:	:
LT	Lithuania	2	:	27.8	27.8	44.4	:	:
LU	Luxembourg (Grand-Duché)	7	43.9	7.3	:	58.6	4.8	:
HU	Közép-Magyarország	17	34.2	5.8	:	64.5	:	:
MT	Malta	1	:	100.0	:	:	:	:
NL	Noord-Brabant	608	41.0	2.1	0.2	42.5	18.7	0.5
AT	Wien	117	31.9	14.0	1.7	56.4	0.2	0.9
PL	Mazowieckie	3	6.2	57.3	:	36.5	:	:
PT	Lisboa	24	8.3	10.5	:	81.2	:	:
RO	Bucuresti - Ilfov	2	86.4	:	:	13.6	:	:
SI	Zahodna Slovenija	3	:	31.5	:	68.5	:	:
SK	Bratislavský kraj	3	:	7.9	:	92.1	:	:
FI	Etelä-Suomi	387	19.6	5.4	:	78.6	2.8	0.8
SE	Stockholm	241	12.3	6.7	:	83.9	1.0	0.8
UK	East Anglia	179	34.8	12.8	2.8	43.1	9.0	1.4

Source: Eurostat (pat_ep_rtec)

Table 6.27 provides another perspective on regional patenting. On the one hand, the table shows the leading region in terms of number of high-tech patent applications at NUTS level for each Member State. Several small countries are considered as one single NUTS 2 region (Estonia, Cyprus, Latvia, Lithuania, Luxembourg and Malta).

Looking at these leading regions, Île de France (FR, 768) was ranked first, followed by Noord-Brabant (NL, 608) and Oberbayern (DE, 607). Etelä-Suomi (FI, 387) and Stockholm (SE, 241) came next with more than 200 high-tech patent applications per region.

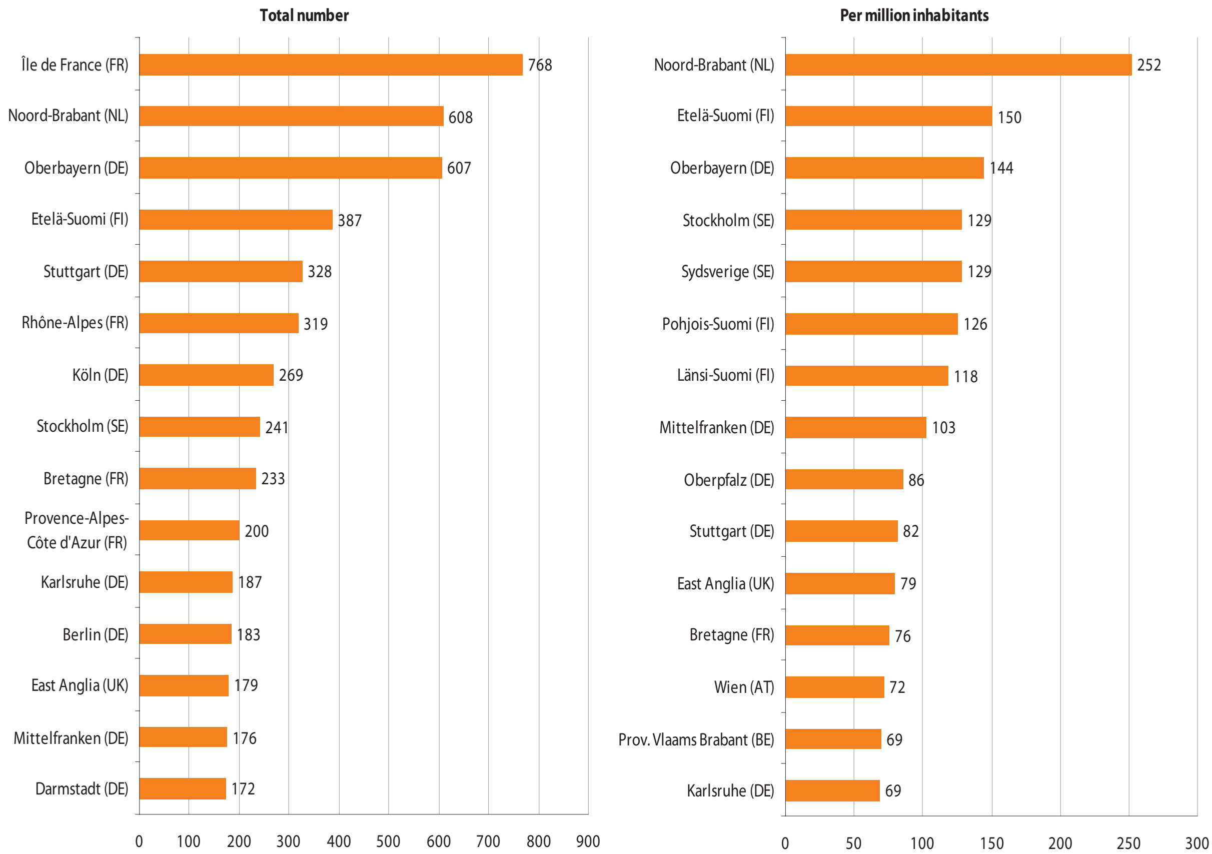
On the other hand, the table provides a breakdown by high-tech group. Six groups can be identified:

- Computer and automated business equipment
- Micro-organism and genetic engineering
- Aviation
- Communication technology
- Semiconductors
- Laser

Countries with very few high-tech patent applications did not record patenting activity in all the groups.

The breakdown reveals a specialisation of Stockholm (SE) and Etelä-Suomi (FI), and to a lesser extent Île de France (FR) and Oberbayern (DE), in 'Communication technology' patent applications. Hovedstaden, the leading Danish region in high-tech patenting, specialised in the field of 'Micro-organism and genetic engineering'.

Figure 6.28: Top 15 EU-27 regions in terms of high-tech patent applications to the EPO, total number and per million inhabitants — 2005



Source: Eurostat (pat_ep_rtec)

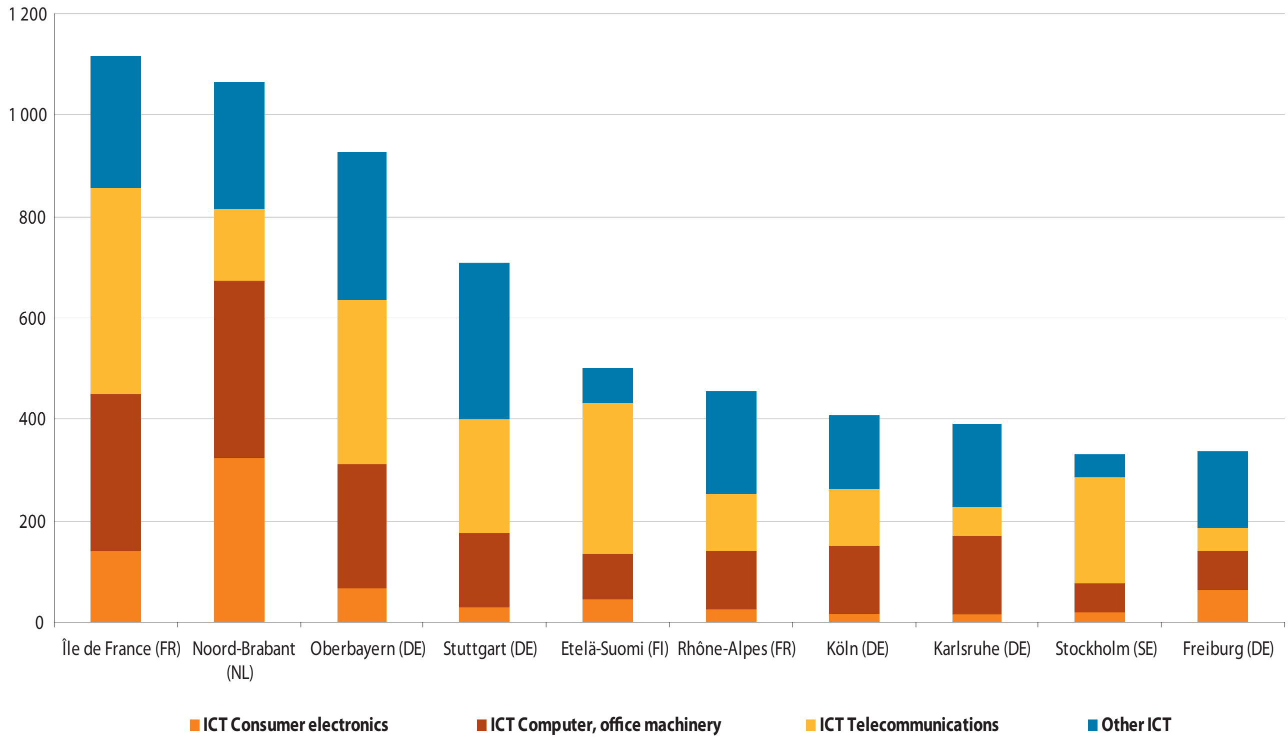
Figure 6.28 compares the top 15 EU regions in high-tech patent applications in terms of total number and per million inhabitants.

The top 15 regions by total number of patent applications included seven regions in Germany, four in France, and one region respectively in the Netherlands, Finland, Sweden and the United Kingdom. In contrast, the top 15 regions by patent applications per million inhabitants included five regions in Germany, three in Finland, two in Sweden and one region in the Netherlands, the United Kingdom, France, Austria and Belgium respectively.

In 2005, Île de France (FR, 786) reported the highest number of high-tech patent applications, followed by Noord-Brabant (NL, 608) and Oberbayern (DE, 607).

Noord-Brabant was the undisputed leader in terms of high-tech patent applications per million inhabitants (252). The Finnish region of Etelä-Suomi ranked second, with 150 high-tech patent applications per million inhabitants, and Oberbayern (DE, 144) again ranked third.

Figure 6.29: Top 10 EU-27 regions (NUTS 2) in terms of ICT patent applications to the EPO, total number and breakdown by subcategory — 2005



Source: Eurostat (pat_ep_rict)

Figure 6.29 presents the top 10 regions in terms of ICT patent applications to the EPO broken down into four subcategories:

- Telecommunications
- Other ICT
- Computers, office machinery
- Consumer electronics

Île de France (FR) was in the lead regarding the total number of ICT patent applications, followed by Noord-Brabant (NL) and Oberbayern (DE). Each of the above regions counted more than 800 ICT patent applications to the EPO. The other regions submitted 700 or fewer ICT patent applications to the EPO.

The breakdown by subcategory varies substantially according to the region considered. While 33 % of all ICT patent applications from Noord-Brabant (NL) were submitted in the field of 'Consumer electronics', 'Telecommunications' accounted for respectively 39 % and 38 % of ICT patent applications in Île de France (FR) and Oberbayern (DE). Stockholm, the Swedish capital region, and the Finnish region of Etelä-Suomi were most active in the subcategory of 'Telecommunications', accounting for respectively 68 % and 69 % of ICT patent applications in each region.

In the region of Karlsruhe (DE), 43 % of all ICT patent applications were devoted to 'Computers and office machinery', whereas close to half of all ICT patent applications from Stuttgart (DE), Rhône-Alpes (FR) and Freiburg (DE) were filed under the subcategory 'Other ICT'.

Table 6.30: Leading EU-27 regions (NUTS 2) in terms of ICT patent applications to the EPO — 2005

Leading ICT region (or country)		Total number of ICT patent applications per region	Region's share of all ICT patent applications	Per million inhabitants	Per million labour force
BE	Prov. Antwerpen	108	29.1	64.1	143.2
BG	Yugozapaden	3	50.8	1.4	3.0
CZ	Praha	9	38.9	7.3	13.5
DK	Hovedstaden	131	61.0	:	:
DE	Oberbayern	859	16.1	204.1	389.7
EE	Estonia	5	100.0	3.3	6.8
IE	Southern and Eastern	62	75.3	20.6	40.9
EL	Attiki	14	63.6	3.5	7.7
ES	Comunidad de Madrid	66	32.4	11.4	21.6
FR	Île de France	1031	41.3	90.5	187.5
IT	Lombardia	226	27.2	24.0	51.6
CY	Cyprus	1	100.0	1.9	4.0
LV	Latvia	6	100.0	2.4	5.0
LT	Lithuania	3	100.0	0.8	1.7
LU	Luxembourg (Grand-Duché)	15	100.0	33.4	76.1
HU	Közép-Magyarország	21	78.9	7.3	15.8
MT	Malta	:	:	:	:
NL	Noord-Brabant	983	75.5	407.6	776.4
AT	Wien	136	40.8	83.8	171.3
PL	Podkarpackie	10	32.8	4.8	11.1
PT	Lisboa	22	65.0	7.8	15.3
RO	Bucuresti - Ilfov	4	51.0	1.6	3.5
SI	Zahodna Slovenija	6	64.8	7.0	:
SK	Bratislavský kraj	3	83.7	5.5	10.1
FI	Etelä-Suomi	435	59.2	168.7	320.4
SE	Stockholm	307	37.8	163.8	297.1
UK	East Anglia	223	12.5	99.0	197.8

Note:
Regional population (DK) and labour force (DK, SI) data for 2005 missing.

Source: Eurostat (pat_ep_rict)

Table 6.30 provides more detailed information on ICT patent applications. Besides the number of ICT patent applications in the leading region of each country, the table also presents the share of each leading region relative to the country. This share amounts to 100 % in Member States which are counted at NUTS 2 level. In the remaining countries this percentage may be used as a proxy to measure the concentration of ICT patent activity in the country.

With more than two thirds of all ICT patent applications, it appears that ICT patent activity in the Netherlands was concentrated in only one region: Noord-Brabant.

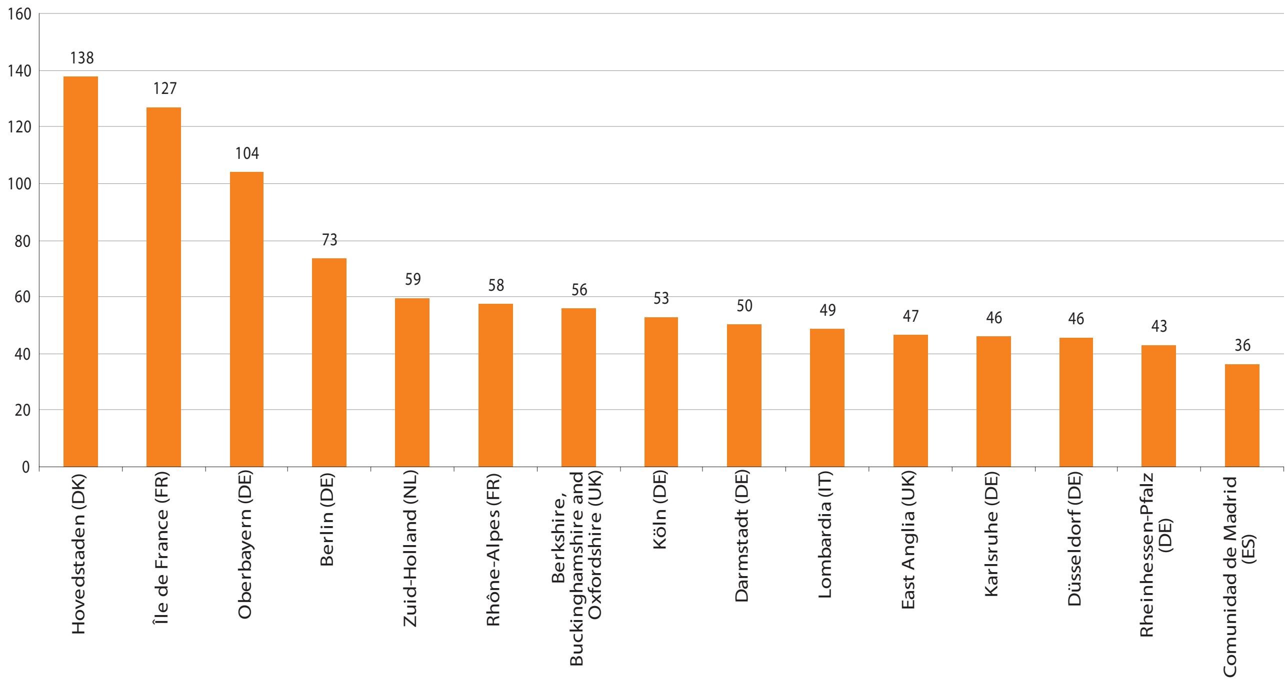
As shown in the following examples, patenting activity is not always concentrated in the leading region. Only 16 % of all German ICT patent applications were filed in Oberbayern and only 13 % of all British ICT patent applications were filed in East Anglia.

Biotechnology patenting can also be measured at regional level. Among the top 15 regions in biotech patenting in the EU, seven were in Germany, two were in France, two were in the United Kingdom, and one was in the Netherlands, Denmark, Italy and Spain respectively.

Ten of the top 15 regions in biotechnology were also among the top regions in terms of overall patenting (see Table 6.24).

However, the German region of Stuttgart and the Dutch region of Noord-Brabant, which were strongly represented in the previous analysis, were not among the top 15 regions specialised in biotechnology patent applications to the EPO.

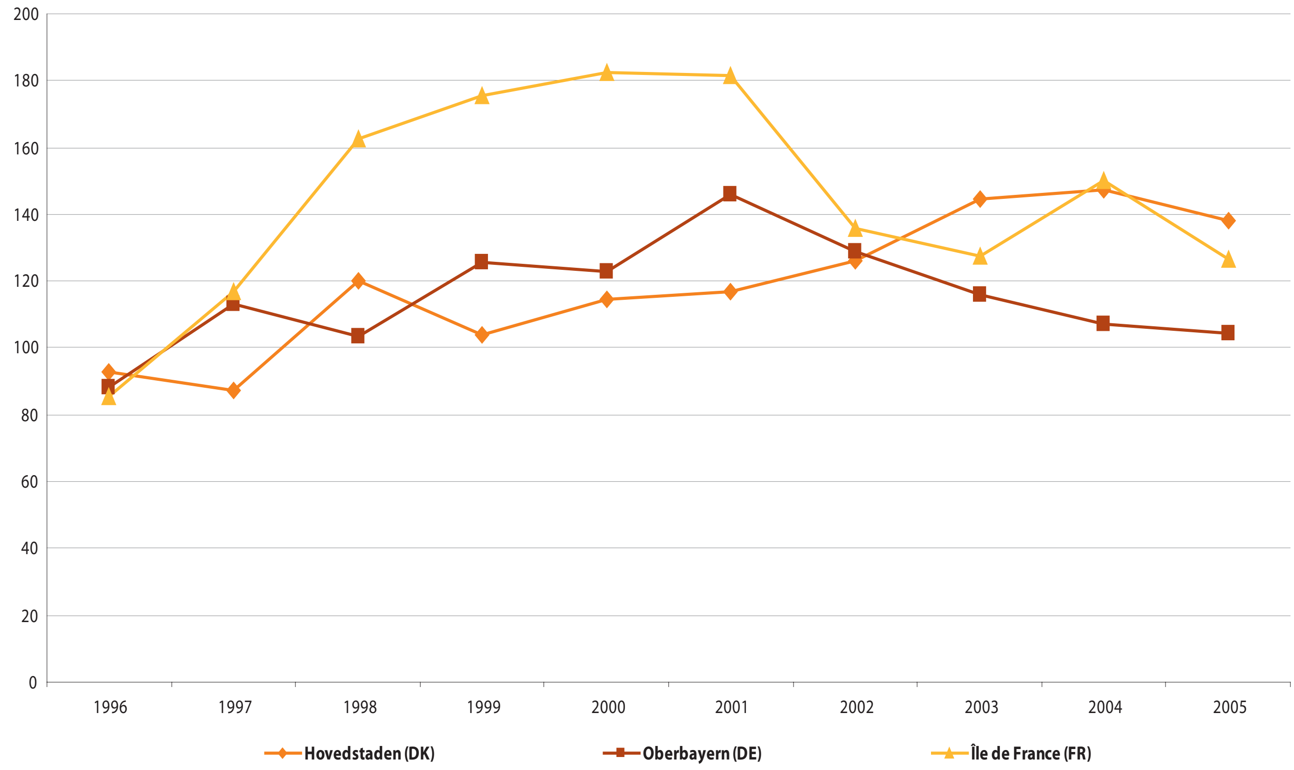
Figure 6.31: Top 15 EU-27 regions (NUTS 2) in terms of biotechnology patent applications to the EPO, total number — 2005



Source: Eurostat (pat_ep_rbio)

As presented in Figure 6.32, the trends over 10 years for the top three EU-27 regions in terms of biotechnology patent applications are quite different. Whereas Île de France registered a sharp increase in the number of patent applications in biotechnology between 1996 and 1998, nearly doubling its score (1996: 85, 1998: 163), the other two regions progressed at a slower pace. In 2002, all three regions were almost at the same level again, reaching 130 biotechnology patent applications. An upward trend was recorded in the Danish region of Hovedstaden between 1999 and 2004. In Île de France (FR), biotechnology patenting activity picked up only in 2004 after plummeting in 2001; however, this recovery was not maintained in 2005. By contrast, the number of biotechnology patent applications from Oberbayern (DE) has decreased continuously since 2001 from 146 to 104 in 2005.

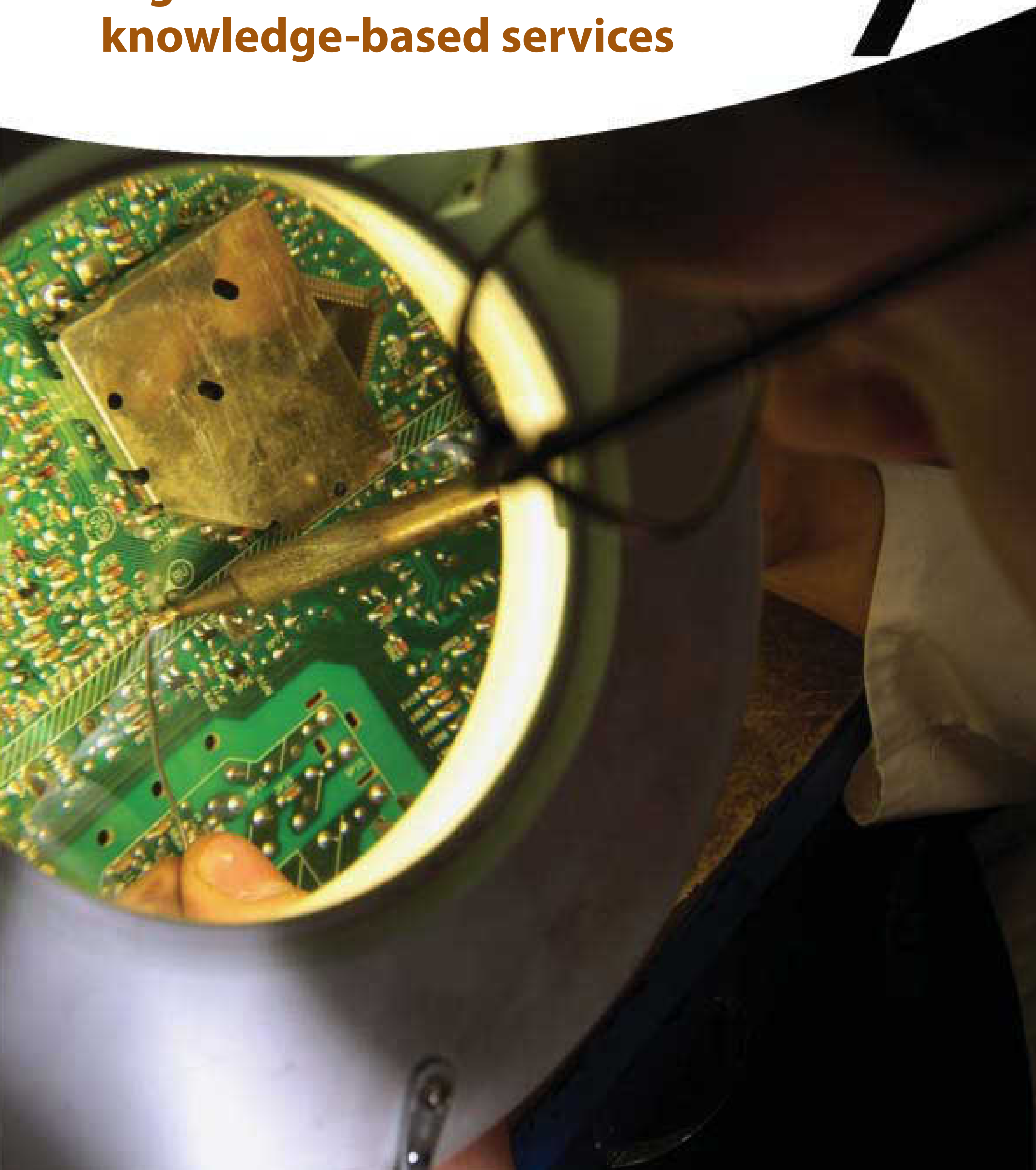
Figure 6.32: Top three EU-27 regions (NUTS 2) in terms of biotechnology patent applications to the EPO, total number — 1996 to 2005



Source: Eurostat (pat_ep_rbio)

High-tech industries and knowledge-based services

7



7.1 Introduction

Creating new technologies, finding applications for them and putting them on the market have become essential in the global race for competitiveness. High-technology sectors are key drivers of economic growth, productivity and welfare and are generally a source of high value added and well-paid jobs.

Technology-intensive enterprises are commonly referred to as high-technology (or 'high-tech') companies. They are vital to the competitive position of a country because:

- They are associated with innovation and, hence, tend to gain larger market shares, create new markets for products and services and use resources more efficiently. Environmental aspects are playing an increasingly important role in this context.
- They are linked to high value-added production and success on foreign markets, which help to yield higher returns on the workers they employ.
- The industrial R&D they perform has spill-over effects which benefit other lines of business by generating new products and processes, often leading to productivity gains and business expansion and creating highly paid jobs.

This chapter provides insight into the performance of high-technology industries and knowledge-intensive services in Europe by looking into various aspects of the statistics on enterprises (value added, production value, etc.), venture capital investment, high-tech trade and employment in high-tech sectors.

Section 7.2 examines structural statistics on enterprises to analyse the performance of high-tech industries and high-tech knowledge-intensive services (KIS).

Section 7.3 presents statistics on venture capital investment (VCI) at the early stage, at the expansion and replacement stage and at the buyout stage.

Section 7.4 analyses the patterns of international high-tech trade, which makes up a considerable proportion of total trade in many advanced economies.

Finally, Section 7.5 takes a look at the employment situation in high-tech manufacturing and high-tech knowledge-intensive services, at both national and regional levels. In this context, regional data are analysed at NUTS 2 level.

The Knowledge-Intensive Services Innovation Platform

"The KIS-IP is a **European initiative** funded under Europe INNOVA, with the aim to accelerate the take-up of services innovations in Europe. The initiative focuses on developing and testing new or better innovation support mechanisms for innovative small and medium-sized enterprises (SMEs), in particular in technological and industrial fields.

The KIS-IP brings together **public and private partners** from different countries willing to cooperate in developing new forms of support for innovation, taking into account the specific needs of service companies as well as the potential role of services innovation in support of societal needs. This includes not only designing and testing new service packages, but also experimenting with new forms of service delivery that are specifically tailored to the strong market orientation of service companies. The KIS-IP will thus contribute to overcoming the traditional bias of innovation support mechanisms towards technological innovation in manufacturing.

The KIS-IP is **open for cooperation with other initiatives** in support of services innovation and will make maximum efforts to develop and test a set of new innovation support services that can ultimately be integrated into regional and national innovation support programmes. Specific attention will be paid to leveraging proven and tested solutions into the Enterprise Europe Network that offers great potential to strengthen the impact of new service concepts developed under Europe INNOVA.

Seven **sectoral partnerships** will act as laboratories searching for 'better practice' in support of innovative services companies. These partnerships are expected to become the driving forces of the KIS-IP. Each partnership will address a number of specific challenges related to responding better to the specific needs of potential high-growth companies active in knowledge-intensive services. For example:

'**ACHIEVE MORE**' aims to address barriers to the development of KIS ventures in the ICT sector (software),

'**KIS PIMS**' will support innovation in services that cover the whole life of new technologies for renewable energy,

'**KIS4SAT**' will establish an innovation support platform to stimulate the launch and development of potentially high-growth knowledge-intensive services ventures in the field of satellite downstream services."

Source: based on http://www.europe-innova.eu/

7.2 Enterprises in high-tech industries and knowledge-intensive services

Table 7.1: Economic statistics on high-tech sectors, EU-27 — 2006

	High-tech manufacturing					High-tech knowledge-intensive services (KIS)				
	Number of enterprises	Turnover in EUR million	Production value in EUR million	Value added in EUR million	Gross investment in tangible goods	Number of enterprises	Turnover in EUR million	Production value in EUR million	Value added in EUR million	Gross investment in tangible goods
BE	1 917	16 699	18 376	7 411	781	16 828	29 466	29 058	12 990	1 709
BG	1 208	587	557	190	: c	4 243	2 253	2 125	1 078	379
CZ	9 364	11 380	10 939	1 841	: c	23 886	10 002	9 234	4 793	723
DK	1 106	10 809	10 998	4 529	555	9 684	18 463	17 027	8 598	942
DE	20 060	172 003	150 331	55 337	6 467	65 713	164 568	142 663	85 427	9 794
EE	256	: c	: c	: c	: c	1 350	939	893	416	99
IE	273	37 927	36 980	10 066	1 283	6 166	24 713	13 795	6 378	1 648
EL	: c	: c	: c	: c	: c	9 518	11 444	9 645	5 044	1 009
ES	8 233	28 349	25 810	7 498	1 077	39 933	64 565	51 217	30 894	4 516
FR	15 982	127 432	114 303	37 035	3 930	66 866	133 241	129 567	65 634	7 175
IT	31 055	67 376	63 917	20 133	2 675	107 484	106 308	101 605	49 469	6 567
CY	88	163	158	55	6	318	628	621	473	137
LV	272	: c	: c	: c	: c	1 756	1 155	1 070	569	154
LT	430	433	414	106	23	1 987	1 277	1 147	529	124
LU	68	: c	: c	: c	: c	1 200	: c	: c	: c	: c
HU	5 732	18 996	17 394	3 214	549	28 630	9 209	5 927	3 420	699
MT	:	:	:	:	:	684	314	312	230	67
NL	3 135	: c	: c	: c	: c	27 430	45 352	44 116	21 570	2 642
AT	1 983	11 881	10 925	4 986	471	14 475	16 544	12 014	7 743	1 153
PL	13 811	10 287	9 416	2 805	600	34 907	17 427	15 516	8 609	1 776
PT	1 666	: c	: c	: c	: c	15 485	11 455	10 826	4 851	1 113
RO	2 028	1 963	1 811	499	346	15 884	6 563	5 801	3 093	2 337
SI	909	2 305	1 998	938	: c	3 913	2 496	2 162	1 093	260
SK	: c	: c	: c	: c	: c	1 904	2 960	2 659	1 456	380
FI	1 275	40 254	22 468	7 298	447	6 118	13 840	13 408	5 905	622
SE	3 697	28 064	29 303	11 735	650	36 081	: c	: c	: c	: c
UK	11 163	87 350	82 764	35 685	3 011	122 658	214 226	201 866	107 820	17 326
NO	812	5 088	5 084	1 993	231	11 467	16 958	16 478	7 987	957

Note:
Exceptions to the reference year: 2005: High-tech KIS in CY;
2002: High-tech KIS in MT.

Source: Eurostat (htec_eco_sbs)

In 2006, Italy had the most high-tech manufacturers in the EU-27 in absolute terms (over 31 000), followed by Germany (20 060), France (15 982) and Poland (13 811). Together, these four countries accounted for more than 60 % of Europe's high-tech manufacturers.

However, the ranking was different for turnover in high-tech manufacturing. Germany led with total turnover of EUR 172 billion, followed by France (EUR 127 billion) and the United Kingdom (EUR 87 billion). Although Italy had more high-tech manufacturers, its high-tech manufacturing sector was smaller than in the other leading European countries when measured by other indicators (number of persons employed, turnover, etc.).

Germany, France and the United Kingdom were in the lead in terms of total production value in high-tech manufacturing. In France a large proportion of the total production value can be attributed to the 'aerospace' and 'pharmaceuticals' sectors, as can be seen in Figure 7.13.

In terms of value added by high-tech manufacturers, Germany was well ahead, on EUR 55 billion.

In 2006, the European Union had 665 132 enterprises in high-tech knowledge-intensive services, 34 % of which were registered in the United Kingdom and Italy, with 122 658 and 107 484 respectively.

However, it is striking that turnover, production value and value-added figures were practically twice as high in the United Kingdom as in Italy.

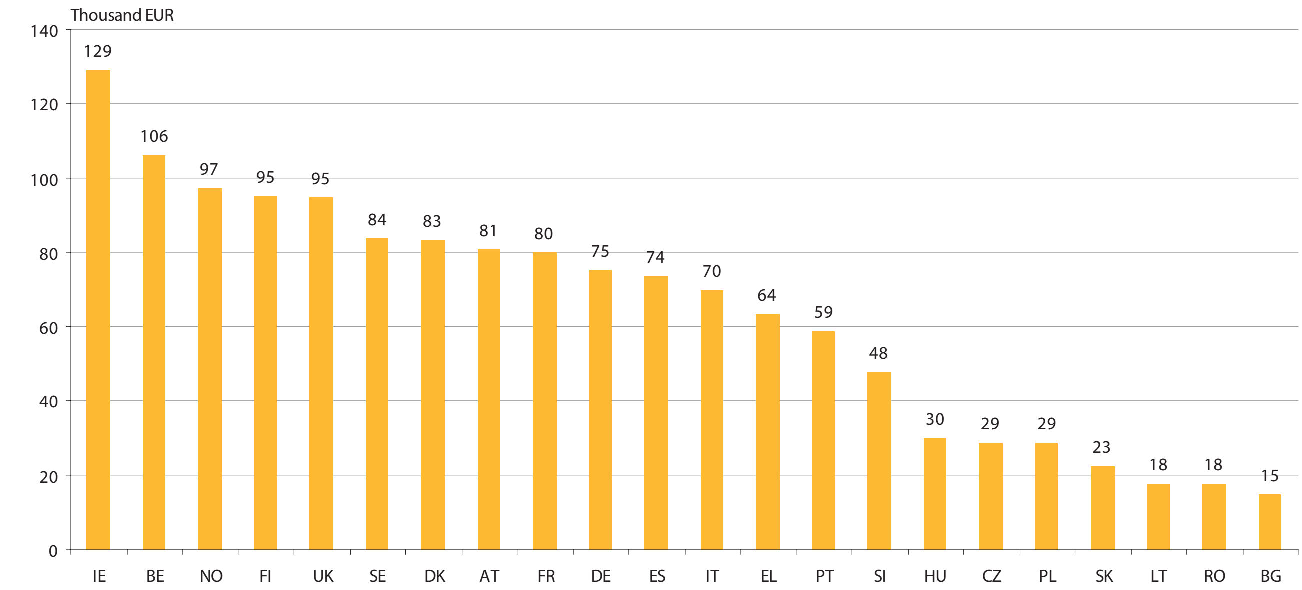
In high-tech KIS, turnover and production value were also higher in Germany and France than in Italy.

The labour productivity of EU enterprises per person employed in all high-tech sectors (high-tech manufacturing and high-tech KIS) varied considerably from one Member State to another.

Ireland recorded the highest average production value per person employed, at EUR 129 000. Belgium was ranked second, with an average labour productivity of EUR 106 000. Finland, the United Kingdom, Sweden, Denmark, Austria, France, Germany and Spain also recorded labour productivity above the EU-27 average.

Lithuania, Romania and Bulgaria were ranked at the lower end of the scale, with labour productivity of less than EUR 20 000 per person employed.

Figure 7.2: Labour productivity (value added at factor cost per person employed) in thousand EUR, high-tech sectors[1], EU 27 — 2006



Note:
Exceptions to the reference year: 2005: EL, PT and SK; 2004: SE.
EU-27: Eurostat estimate.
[1] High-tech sectors = high-tech manufacturing plus high-tech KIS.

Source: Eurostat (htec_eco_sbs)

Structural labour productivity growth in the EU is lower than in the US

"The annual average EU-15 growth rate of real GDP was around 0.8 % lower than in the US over the period 1995-2006. A macroeconomic growth accounting exercise for this group reveals the strong and weak points in that period:

- EU strengths: The EU-15 has made relative improvements compared to the US in the field of labour market participation. Moreover, the initial education of labour has also improved more in the EU-15.
- EU weaknesses: The lower growth rate in the EU-15 was mainly due to less favourable demographic developments and lower growth of labour productivity, the latter being caused mainly by underperforming total factor productivity developments and, to a lesser extent, less capital deepening.

The slower growth of labour productivity and in particular of total factor productivity may relate to the EU's lower level of innovation performance, which is a key long-term driver of productivity. Although measures of innovation performance show the EU is catching up with the US, the rate of this convergence appears to have slowed down."

Source: Communication from the Commission on the European Competitiveness Report 2008: http://ec.europa.eu/enterprise/enterprise_policy/competitiveness/1_eucompetrep/eu_compet_reports.htm

7.3 Venture capital investment

Venture capital investment (VCI) is defined as private equity to help launch and develop new companies.

Venture capital investment is generally used to finance start-ups and fast-growing enterprises. These investments are often risky, but when successful they can yield substantial returns. For small and medium-sized enterprises, access to venture capital investment is crucial for growth and employment.

Venture capital data are broken down into investment at two different stages: the early stage and the expansion and replacement stage. Buyout data are also considered in parallel with these two stages.

Early-stage venture capital is raised at the seed and start-up stages (i.e. when or before the business is launched). Venture capital investment at the expansion and replacement stage supports enterprises at a later stage of their development and VCI at the buyout stage provides funds to enable an enterprise to acquire a product line or another business.

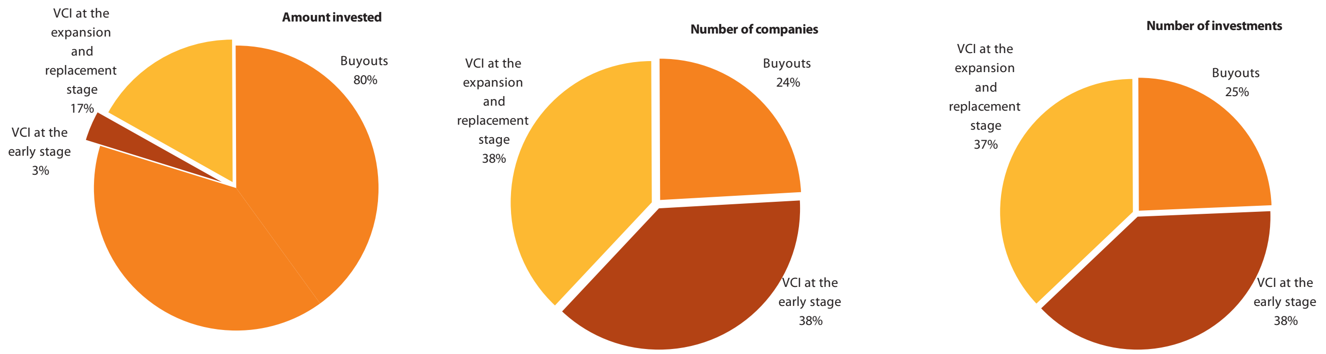
Expansion capital helps to fund the growth of a company, which may or may not break even or trade profitably, while replacement capital is used to purchase existing shares in a company from another private equity investment organisation or from other shareholders.

In 2007, although venture capital investment was more common at the early stage or at the expansion and replacement stage when considering the number of investments made and the number of beneficiary companies, in net terms the vast majority of the amounts invested were for buyouts (80 %). In the EU15, venture capital investment in buyouts added up to slightly over EUR 56 billion, 28 times the amount invested at the early stage (EUR 2 billion) and more than four times the amount invested at the expansion and replacement stage (EUR 12 billion).

On the other hand, only 1 293 companies benefited from VCI in buyouts, whereas 2 019 received VCI at the early stage and 2 044 at the expansion and replacement stage. This is an indication that venture capital investment is generally higher at the buyout stage than at other stages.

A higher proportion of venture capital investments were made at the early stage (38 %) than at the expansion and replacement (37 %) or buyout (25 %) stages.

Figure 7.3: Share of investments by stage of development in terms of amounts invested, number of investments and number of companies, EU-15 — 2007



Source: Eurostat (htec_vci_ear, htec_vci_exre, htec_vci_buyout)

Early-Stage Venture Capital in Europe

"Early-stage venture capital in Europe has historically yielded sporadic and scattered results. Although it is hard to make straightforward comparisons with the US, in the medium term European early-stage venture capital has consistently produced lower returns than in the US.

There are a number of well-known reasons for this. For one, European VCs have typically focused on the same areas as their US counterparts, namely technology plays. However, there are few areas of European technology excellence. European VCs are always competing with US VCs, which are better-funded and closer to key customers and R&D centres. In addition, buyers are still mainly US-based and generally prefer buying US companies — or at least look at US targets first. The European public markets are also much less keen to attract fast-growing tech businesses and, despite the promises of euro integration, remain very fragmented.

Listed tech companies generally suffer from this lack of liquidity. In addition, given the fact that there was never a prolonged growth period for European tech start-ups, the overall infrastructure did not fully mature: the boom times of 1999-2000 were too short to produce enough serial entrepreneurs."

Source: www.net-partners.com

The EU-15 spent more than EUR 70 727 million on venture capital investment in 2007.

The United Kingdom was far ahead for VCI at all stages in terms of amounts invested, with EUR 620 million at the early stage, EUR 6 260 million at the expansion and replacement stage and EUR 27 292 million at the buyout stage. It was followed by France and Germany. On the other hand, more companies in Germany than in the UK benefited from VCI, especially at the expansion and replacement stage. In the EU-15, more than half of all the companies that received venture capital investment were from the UK, Germany or France.

Companies in the Czech Republic and Hungary are gradually beginning to turn to venture capital as a source of financing.

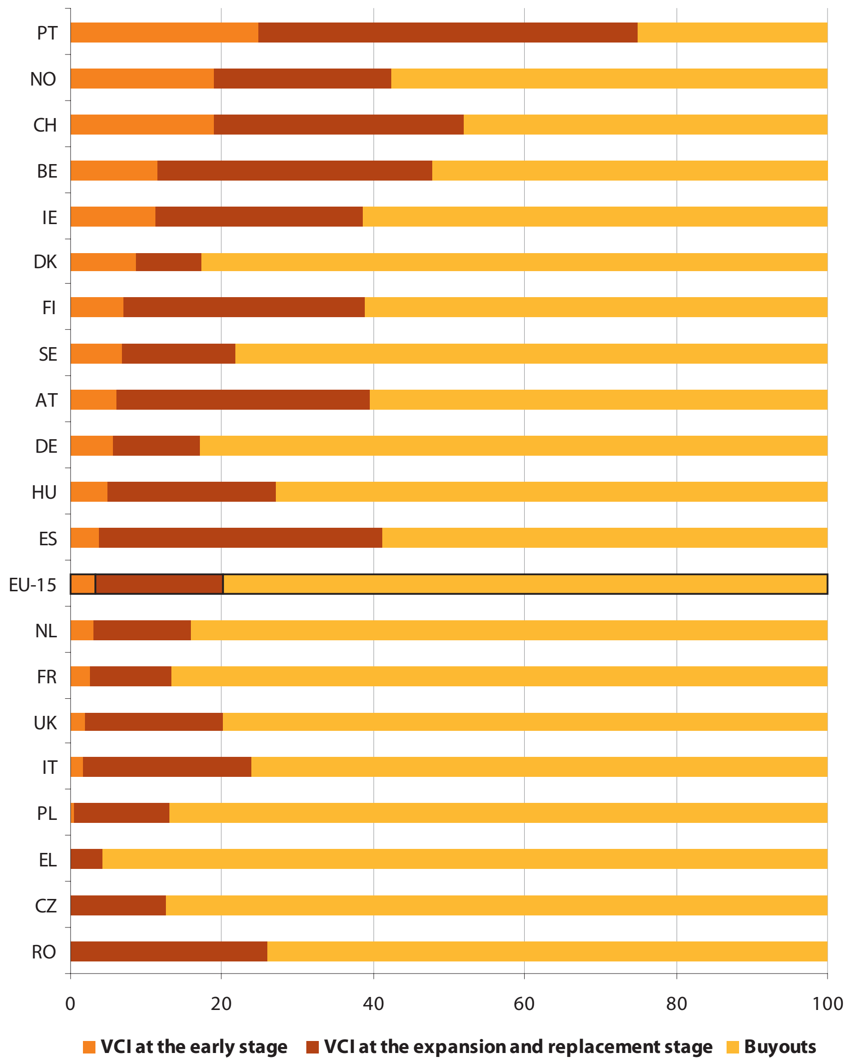
Germany recorded the highest number of venture capital investments at the early stage (815), followed by Sweden (487), the United Kingdom (384) and France (367). The United Kingdom recorded the most investments at the expansion and replacement stage, followed by Germany, France and Sweden. Together with the Netherlands, these countries were also in the forefront when considering the number of investments at the buyout stage.

Table 7.4: Venture capital investment (VCI) at the early stage, the expansion and replacement stage and the buyout stage, EU-15 and selected countries — 2007

	VCI at the early stage			VCI at the expansion and replacement stage			Buyouts		
	Amount invested in EUR million	Number of companies	Number of investments	Amount invested in EUR million	Number of companies	Number of investments	Amount invested in EUR million	Number of companies	Number of investments
EU-15	2 279.4 i	2 019 i	2 974 i	12 026.9 i	2 044 i	2 873 i	56 421.3 i	1 293 i	1 900 i
BE	108.7	75	90	338.4	84	109	490.8	36	40
CZ	0.0	1	1	16.4	6	7	113.4	10	10
DK	106.2	69	78	104.5	54	58	1 001.3	26	26
DE	426.5	483	815	851.3	540	670	6 172.5	157	210
IE	32.3	49	56	77.7	31	36	175.2	7	7
EL	0.3	1	1	18.8	3	3	435.8	7	7
ES	111.9	126	134	1 144.4	91	111	1 795.1	65	91
FR	319.9	153	367	1 298.2	286	518	10 600.6	303	503
IT	22.6	12	15	327.0	29	34	1 109.3	51	64
HU	2.1	6	6	9.2	9	9	30.4	3	3
NL	120.8	193	202	505.3	131	155	3 287.0	99	144
AT	15.5	44	51	85.8	18	24	154.9	6	6
PL	2.4	4	4	72.4	19	27	495.4	26	30
PT	38.8	38	39	77.9	23	29	39.1	11	12
RO	0.0	0	0	76.1	8	10	216.9	8	9
FI	70.8	169	255	314.9	60	79	606.6	49	66
SE	285.0	338	487	622.2	198	269	3 260.8	77	112
UK	620.2	269	384	6 260.6	496	778	27 292.3	399	612
NO	183.5	173	215	225.9	67	82	554.2	26	27
CH	171.1	69	75	299.5	43	51	434.2	13	16
US	4 630.1	:	1 410	16 826.1	:	2 403	:	:	:

Source: Eurostat (htec_vci_ear, htec_vci_exre, htec_vci_buyout)

Figure 7.5: Amounts allocated to VCI by stage of development, EU-15 and selected countries — 2007



Source: Eurostat (htec_vci_ear, htec_vci_exre, htec_vci_buyout)

Figure 7.5 shows the national disparities in the distribution of venture capital investment by stage of development. In the EU-15 almost 80 % of venture capital was allocated to buyouts, followed by 17 % to the expansion and replacement stage and 3 % to early-stage development. Conversely, in Portugal half of the total amount was invested at the expansion and replacement stage. The remaining 50 % were divided equally between VCI at the early stage and at the buyout stage.

In some countries, such as Poland, Greece, the Czech Republic and Romania, VCI at the early stage fell short of 1 %.

Table 7.6: Venture capital investment as a share of GDP by stage of development, EU-15 and selected countries — 2002 and 2007

	VCI as a percentage of GDP					
	2002			2007		
	VCI at the early stage	VCI at the expansion and replacement stage	Buyouts	VCI at the early stage	VCI at the expansion and replacement stage	Buyouts
EU-15	0.028 i	0.079 i	0.179 i	0.02 i	0.105 i	0.493 i
BE	0.041	0.046	0.048	0.033	0.102	0.148
CZ	0.001	0.036	0.08	0	0.013	0.089
DK	0.074	0.052	0.004	0.047	0.046	0.44
DE	0.026	0.037	0.053	0.018	0.035	0.255
IE	0.021	0.060	0	0.017	0.042	0.094
EL	0.008	0.021	0	0	0.008	0.19
ES	0.015	0.086	0.033	0.011	0.109	0.171
FR	0.026	0.056	0.29	0.017	0.069	0.56
IT	0.005	0.078	0.12	0.001	0.021	0.072
HU	0.003	0.021	0	0.002	0.009	0.03
NL	0.043	0.159	0.168	0.022	0.09	0.587
AT	0.013	0.046	0.009	0.006	0.032	0.057
PL	0.005	0.042	0.009	0.001	0.024	0.161
PT	0.008	0.038	0.005	0.024	0.048	0.024
RO	0.005	0.030	0	0	0.063	0.179
SK	0.003	0.008	0	:	:	:
FI	0.069	0.135	0.114	0.039	0.175	0.337
SE	0.094	0.161	0.301	0.086	0.187	0.982
UK	0.036	0.135	0.448	0.031	0.310	1.352
NO	0.036	0.058	0.005	0.065	0.080	0.195
CH	0.044	0.049	0.012	0.055	0.097	0.140
US	0.042	0.180	:	0.033	0.122	:

Source: Eurostat (htec_vci_ear, htec_vci_exre, htec_vci_buyout)

At EU-15 level, the percentage of GDP allocated to VCI at the early stage decreased between 2002 and 2007, while the opposite was observed for VCI at the expansion and replacement and the buyout stages. This trend was seen in Belgium, the Czech Republic, Spain, France, Romania, Slovakia, Finland, Sweden and the United Kingdom.

In the remaining countries only VCI at the buyout stage increased in terms of GDP. Italy was the only country to record an overall decrease in VCI as a share of GDP at every stage. By contrast, nonEU countries, such as Norway and Switzerland, recorded a marked increase in GDP allocated to VCI at every stage of development.

7.4 Trade in high-tech products

SITC Rev. 3 v SITC Rev. 4

'High-tech trade' means exports and imports of products classified as high-tech in the SITC.

The SITC is the Standard International Trade Classification developed by the United Nations Statistical Commission to classify data on trade in products. The list of high-tech products was compiled by the OECD based on R&D intensity (R&D expenditure/total sales). Products with high R&D intensity are classified as high-tech.

Until 2006, high-tech products were defined on the basis of SITC Rev. 3. A new version (SITC Rev. 4) was introduced in March 2006 and accepted by the United Nations Statistical Commission at its thirty-seventh session (March 2006).

As the SITC has been revised, the definition of high-tech products had to be re-defined as well. The new definition, which is seen as transitional for the time being, was based on correlation tables between SITC Rev. 3 and SITC Rev. 4. Due to the revision, there is a break in the series in 2007. As a result, a new data series for high-tech products based on SITC Rev. 4 had to be built from 2007 onwards. This publication presents the first results for trade in high-tech products based on SITC Rev. 4.

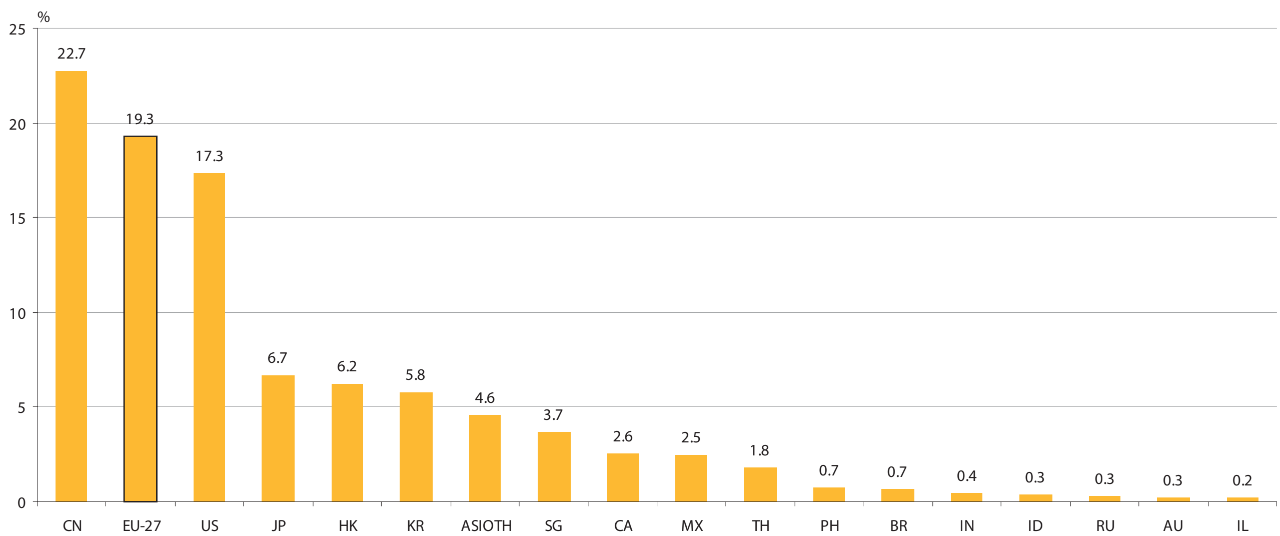
Figure 7.7 shows the world market shares of high-tech exports in 2007 for the EU27 and 17 other leading economies. During the reference year, the world market share of high-tech exports exceeded 15 % in only three of the 18 leading economies: China (22.7 %), the EU-27 (19.3 %) and the United States (17.3 %).

They were followed by a second group of countries with world market shares ranging from 6.7 % to 5.8 %: Japan, Hong Kong and South Korea.

The remaining countries each had world market shares of less than 5 %. The Philippines, Brazil, India, Indonesia, Norway, Russia, Australia and Israel all took less than 1 % of the world market.

In 2007, the 20 largest exporters listed below accounted for 96 % of global exports of high-tech products.

Figure 7.7: World market share of high-tech exports, leading high-tech trading countries — 2007



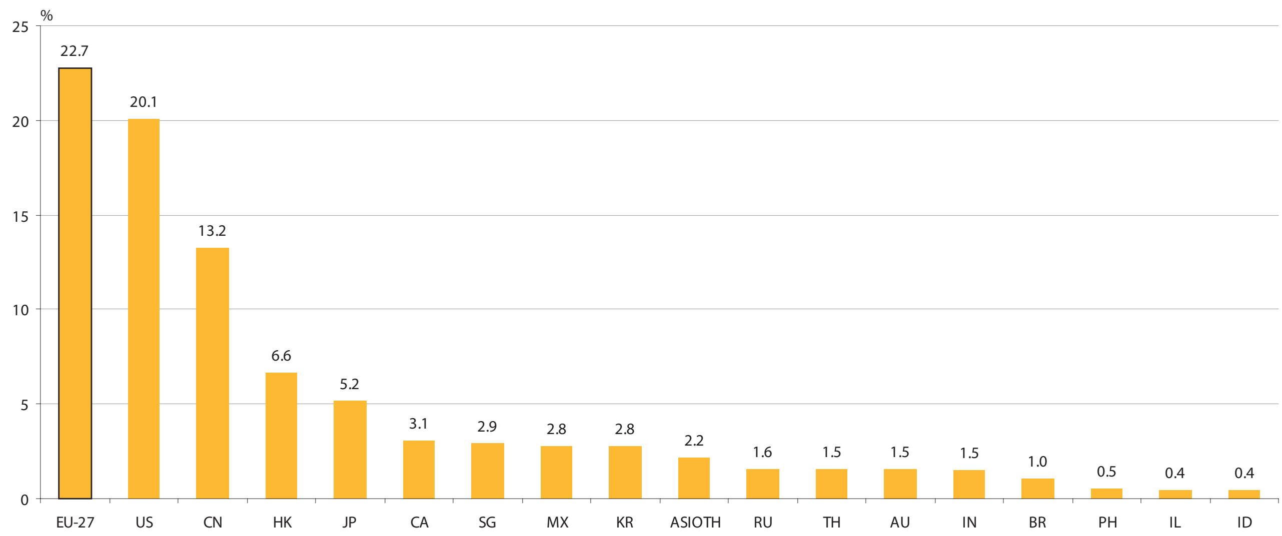
Note:
EU-27 excluding intra-EU trade.
CN excluding HK.

Source: Eurostat (htec_trd_weu4)

Figure 7.8 shows the shares of the leading economies in the world market in high-tech imports. In 2007, the EU-27 was the largest high-tech importer worldwide, with a share of 22.7 %, followed by the United States (20.1 %) and China (13.2 %). In other words, the same three economies were in the lead for both high-tech exports and imports, but in different order.

Hong Kong held fourth place (6.6 %), ahead of Japan (5.2 %) and Canada (3.1 %). Singapore, Mexico, South Korea and 'other Asian countries' (see methodological notes) each accounted for more than 2 % of global high-tech imports, followed by Switzerland (1.7 %), Russia (1.6 %), Thailand (1.5 %), Australia (1.5 %) and India (1.5 %). Brazil accounted for 1 % of global high-tech imports, followed by the Philippines, Israel and Indonesia.

Figure 7.8: World market share of high-tech imports, leading high-tech trading countries — 2007



Note:
EU-27 excluding intra-EU trade.
CN excluding HK.

Source: Eurostat (htec_trd_weu4)

Table 7.9 provides an overview of the high-tech trade figures in EUR million broken down for the EU-27 and for the leading world economies.

In 2007, Germany was the only Member State with high-tech exports and imports exceeding EUR 100 billion. The Netherlands exported and imported more than EUR 60 billion worth of high-tech products. In the United Kingdom and France high-tech exports and imports added up to more than EUR 50 billion. The sizeable share observed in the Netherlands can be partly explained by the Rotterdam effect, as goods arriving at this port on their way to the rest of Europe are recorded as Dutch imports.

The EU-27 recorded a high-tech trade deficit of EUR 33 796 million in 2007. Note that the EU aggregates (imports, exports and trade balance) do not equal the sum of the individual Member States because they exclude intra-EU trade. Most EU Member States reported a negative high-tech trade balance, while ten, namely Denmark, Germany, Ireland, France, Hungary, Malta, the Netherlands, Austria, Finland and Sweden, were net exporters of high-tech goods. Germany recorded a high-tech trade surplus of more than EUR 16 billion, whereas Spain, the United Kingdom and Italy posted deficits of more than EUR 10 billion.

In Luxembourg, high-tech imports accounted for 27.5 % of total imports in 2007, followed by Malta (26.9 %) and Ireland (25.1 %). These three countries were also high in the rankings for high-tech exports as a share of total exports, with Malta in first place (47.8 %), followed by Luxembourg (32.4 %) and Ireland (25.7 %).

Worldwide, China recorded the largest high-tech trade surplus, at EUR 98 514 million, followed by South Korea (EUR 31 107 million), 'other Asian countries' (EUR 24 385 million) and Japan (EUR 16 261 million).

The EU 27, counted as a single entity, recorded the largest high-tech trade deficit worldwide (EUR 33 796 million), followed by the United States (EUR 26 728 million), but the EU aggregate excludes intra-EU trade.

The United States was the only economy to record high-tech import levels in excess of EUR 200 billion. By contrast, high-tech imports to highly populated countries like India, Indonesia and Russia fell short of EUR 20 billion.

Table 7.9: High-tech trade, in EUR million, as a percentage of total, EU-27 and selected countries — 2007

	Import		Balance	Ratio	Export	
	EUR million	as a % of total imports	EUR million	Import/Export	EUR million	as a % of total exports
EU-27	231 894 i	16.2 i	-33 796 i	1.2	198 098 i	16.0 i
BE	21 669	7.2	-906	1.0	20 762	6.6
BG	1 446	6.6	-974	3.1	472	3.5
CZ	13 348	15.5	-720	1.1	12 628	14.1
DK	8 252	11.5	443	0.9	8 695	11.6
DE	108 277	14.1	16 933	0.9	125 210	13.0
EE	929	8.1	-302	1.5	628	7.8
IE	15 363	25.1	7 457	0.7	22 820	25.7
EL	4 558	8.2	-3 743	5.6	815	4.7
ES	26 820	9.4	-18 988	3.4	7 832	4.2
FR	54 443	12.0	8 250	0.9	62 693	15.6
IT	32 412	8.7	-10 521	1.5	21 890	6.0
CY	448	7.1	-299	3.0	149	14.6
LV	791	7.1	-511	2.8	280	4.6
LT	1 201	6.7	-283	1.3	918	7.3
LU	5 531	27.5	-232	1.0	5 300	32.4
HU	13 283	19.0	1 584	0.9	14 867	21.4
MT	935	26.9	139	0.9	1 074	47.8
NL	66 431	18.5	7 023	0.9	73 455	18.3
AT	12 832	10.8	434	1.0	13 267	11.1
PL	11 234	9.3	-8 125	3.6	3 108	3.0
PT	5 856	10.3	-3 404	2.4	2 452	6.5
RO	4 332	8.4	-3 297	4.2	1 035	3.5
SI	1 628	7.1	-613	1.6	1 015	4.6
SK	4 545	10.3	-2 642	2.4	1 903	4.5
FI	8 968	15.0	2 540	0.8	11 508	17.5
SE	14 911	13.4	2 148	0.9	17 059	13.8
UK	65 102	14.3	-13 284	1.3	51 818	16.2
IS	627	12.8	-61	1.1	565	16.2
NO	5 798	9.9	-2 621	1.8	3 177	3.2
CH	17 091	14.5	7 772	0.7	24 863	19.8
HR	1 548	8.3	-963	2.6	585	6.6
MK	232	6.1	-215	13.7	17	0.7
TR	10 647	8.6	-9 291	7.8	1 356	1.7
ASIOTH	22 456	14.0	24 385	0.5	46 841	26.0
AU	15 737	13.9	-13 115	6.0	2 622	2.6
BR	10 416	11.8	-3 647	1.5	6 769	5.8
CA	31 266	11.3	-5 006	1.2	26 260	8.6
CN	135 007	19.4	98 514	0.6	233 521	26.3
HK	67 599	25.0	-3 748	1.1	63 851	25.0
ID	4 448	8.2	-870	1.2	3 578	4.3
IL	4 491	10.9	-2 208	2.0	2 283	5.8
IN	15 070	9.4	-10 819	3.5	4 252	4.0
JP	52 610	11.6	16 261	0.8	68 871	13.2
KR	28 193	10.8	31 107	0.5	59 300	21.9
MX	28 445	13.8	-3 032	1.1	25 413	12.8
PH	5 459	12.9	2 016	0.7	7 475	20.3
RU	16 194	11.1	-13 159	5.3	3 035	1.2
SG	29 594	15.4	8 185	0.8	37 778	17.3
TH	15 791	15.1	2 341	0.9	18 132	16.2
US	204 577	13.9	-26 728	1.2	177 848	21.0

Note:
(i) EU-27 does not include intra-EU trade and therefore does not equal the sum of the Member States.
CN excluding HK.

Source: Eurostat (htec_trd_tot4)

EU steel industry: Further towards high-tech products
September 25, 2009

"The past ten years have witnessed considerable structural shifts on the EU steel market, and these are likely to continue. The process of concentration in the steel industry will probably persist as companies look to improve their cost structure and increase their market power through acquisitions.

But the trend is not confined to the European Union alone. In China, the scale of concentration in the steel industry is still comparatively low. However, according to the guidelines on Chinese steel policy the government plans to consolidate China's several hundred steelmakers into ten larger units in the coastal region to the north of the People's Republic. By 2010 these are targeted to encompass around half of crude steel output and by 2020 fully 70 %.

Moreover, high-tech steel is accounting for a larger part of European manufacturers' product ranges. In general, European companies are working together much more closely. ArcelorMittal, Tata Corus und ThyssenKrupp are collaborating, for example, on energy-saving technologies in blast furnace systems and underground storage of carbon dioxide to enhance their technology lead in this field.

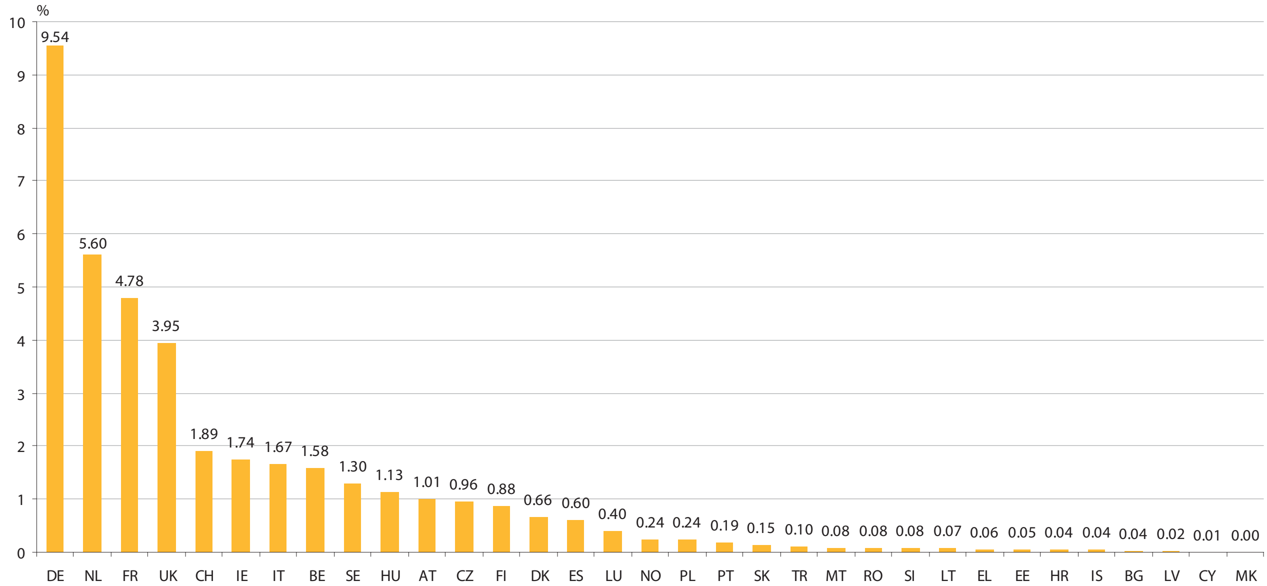
By international standards, growth in European crude steel output — having declined by 9 % p.a. in the period 2007/2010 — will be below average up to 2020, edging up by just 0.5 % p.a. This will widen the gap further between the major steel-producing regions, especially between Asia and the EU. We must, however, consider that steel consumption of around 370 kg per head in Europe is the highest in the world.

Even if the European steel industry's share of the world market does shrink appreciably, Europe will remain an important steel-producing region as manufacturing networks with important local customers continue to deliver essential advantages. The most notable ties in this context exist between the steel industry, carmakers, mechanical engineering and electrical engineering.

Within the EU the western Member States will still play a more important role than the CEEC countries, although progressive modernisation in Eastern Europe should further boost its share of continuous casting. At present it still lags behind the EU-15 level by around 5 percentage points."

Source: http://www.dbresearch.com/PROD/DBR_INTERNET_EN-PROD/PROD0000000000248298.pdf

Figure 7.10: World market share of high-tech exports, EU-27 and selected countries — 2007



Source: Eurostat (htec_trd_wms4)

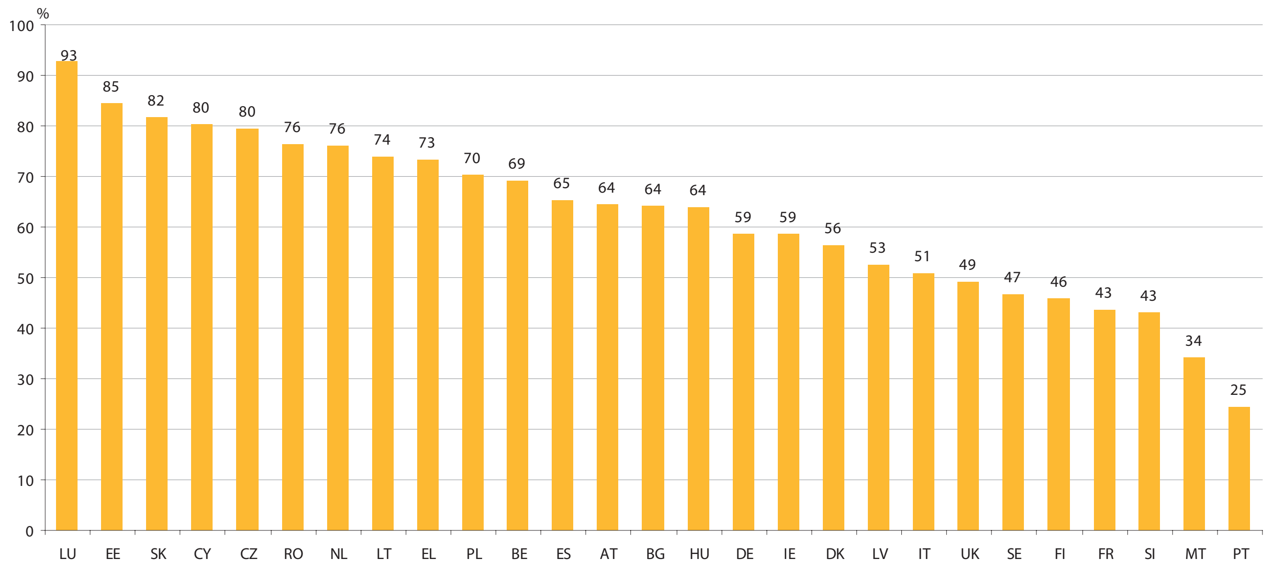
In 2007, ten EU Member States plus Switzerland each accounted for more than 1 % of high-tech exports at global level.

In the EU-27, Germany held the highest share of high-tech exports (9.54 %), well ahead of the Netherlands (5.60 %), France (4.78 %) and the United Kingdom (3.95 %).

Switzerland, Ireland, Italy, Belgium, Sweden, Hungary and Austria accounted for between 1 % and 2 % of global high-tech exports. Hungary was the only new Member State with a share above 1 % (1.13 %).

The remaining EU Member States each accounted for less than 1 % of high-tech exports worldwide.

Figure 7.11: Share of intra-EU exports of high-tech products in total exports, EU-27 Member States —2007



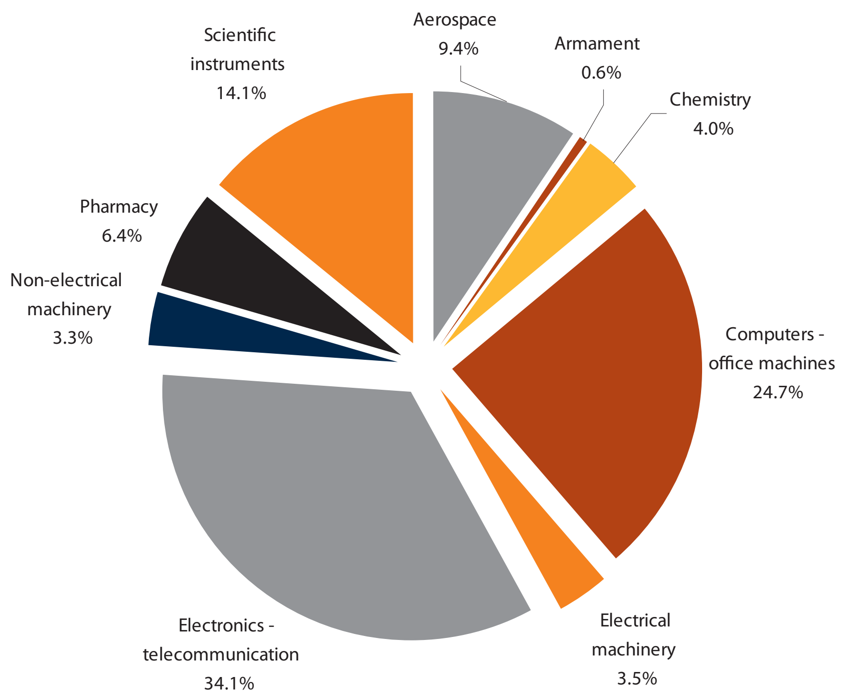
Source: Eurostat (htec_trd_tot4)

In 2007, intra-EU trade accounted for over 60 % of high-tech exports in 15 Member States. In Luxembourg, Estonia, Slovakia, Cyprus and the Czech Republic 80 % or more of high-tech exports were bound for the EU market.

By contrast, more than half of high-tech exports from the United Kingdom, Sweden, Finland, France, Slovenia, Malta and Portugal went to non-EU countries.

Figure 7.12 shows the breakdown of global high-tech exports by group of products. In 2007, 'electronics - telecommunication' accounted for the largest share of high-tech exports (34.1 %), followed by 'computers - office machines' (24.7 %). These two groups added up to nearly 60 % of high-tech exports worldwide. Taken together, 'scientific instruments', 'aerospace' and 'pharmacy' accounted for a third of global high-tech exports. By contrast, 'chemistry', 'non-electrical machinery', 'electrical machinery' and 'armament' each accounted for less than 4 %.

Figure 7.12: Breakdown of world high-tech exports by high-tech group of products — 2007



Source: Eurostat (htec_trd_tot4)

Figure 7.13 provides an overview of high-tech exports and imports in the EU-27 and selected countries, broken down by product group.

In 2007, 'electronics - telecommunication' accounted for the largest share of high-tech exports from 17 EU Member States and also from Croatia and the former Yugoslav Republic of Macedonia. This was also the leading group of products in high-tech exports from Australia, Hong Kong, Indonesia, Mexico, Japan, South Korea, Singapore and 'other Asian countries' (see methodological notes).

In France, the third-largest EU exporter of high-tech products (see Figure 7.10), the 'aerospace' sector accounted for the largest share of high-tech exports (39.7 %). It also accounted for the vast majority of high-tech exports from Iceland (90.4 %) and a sizeable share from Brazil (53.3 %), Turkey (35.3 %), Canada (32.9 %), the United States (30.9 %) and Russia (25.7 %).

'Computers - office machines' made up more than half of high-tech exports from Luxembourg, the Philippines and Thailand. This group of products also took a high share of high-tech exports from the Czech Republic and Ireland with 48.0 % and 48.9 % respectively. 'Pharmacy' products were the top high-tech exports from Belgium, Denmark, Slovenia, Switzerland and India.

Norway and Israel were big exporters of 'scientific instruments'. This group of products also took a significant share of total high-tech exports from Bulgaria, Cyprus, Switzerland, 'other Asian countries', Japan and South Korea.

The breakdown by group of products was less diversified for high-tech imports than for exports. In the EU-27, 'electronics - telecommunication' accounted for the largest share of high-tech imports. This was also the case in most EU Member States, except the Czech Republic, Ireland, Luxembourg and the Netherlands, and also in Norway, Iceland and Switzerland. With the exceptions of Australia, Brazil, China and the Philippines, 'electronics - telecommunication' accounted for the largest shares of high-tech imports to the selected non-European countries surveyed.

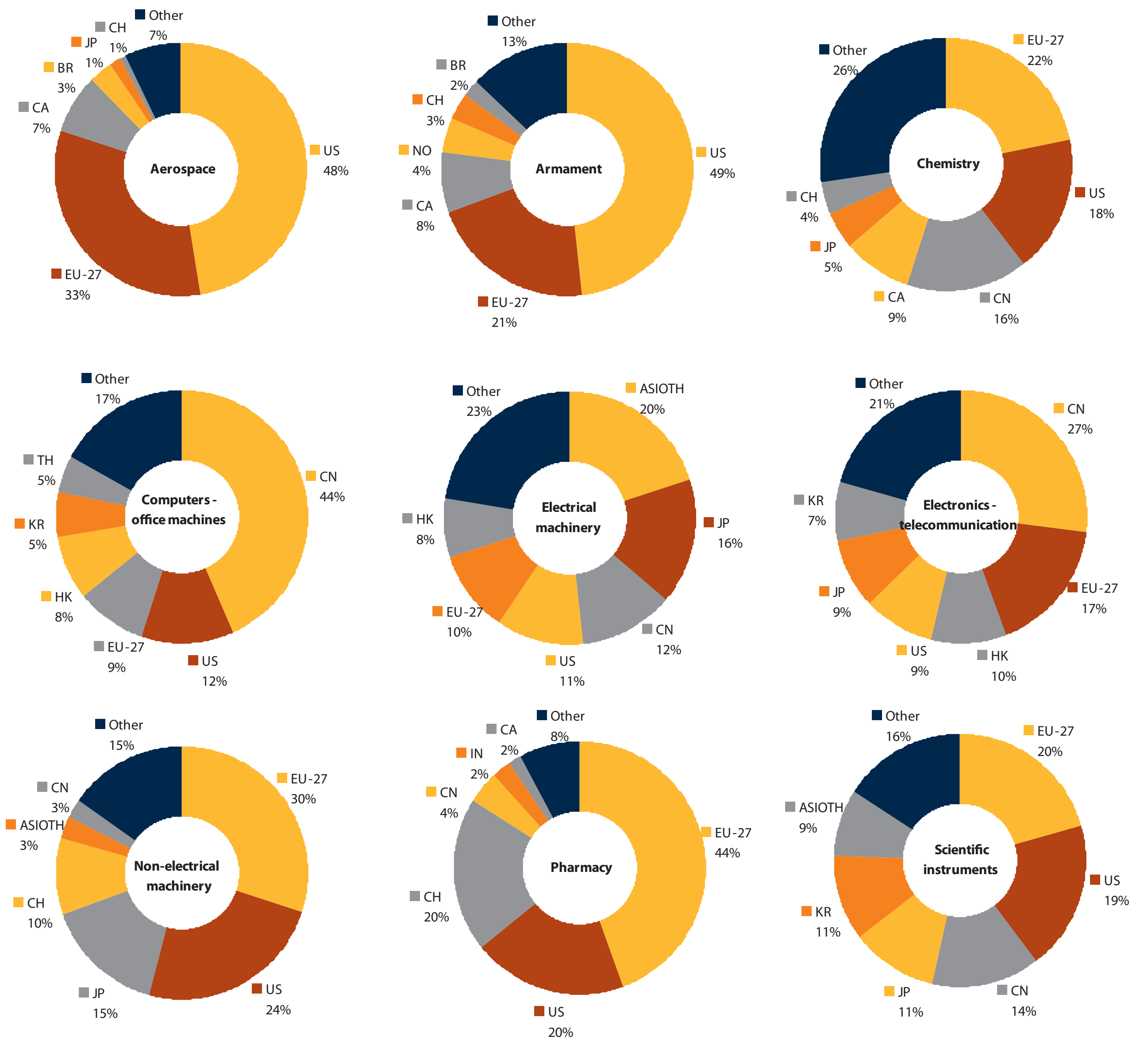
'Computers - office machinery' formed the core of high-tech imports to the Czech Republic, Ireland, Luxembourg, the Netherlands, Norway and the Philippines. 'Aerospace' accounted for the majority of high-tech imports to Iceland, while 'scientific instruments' were the main high-tech imports to China and Brazil. Switzerland was the only country where 'pharmacy' took the largest share of high-tech imports (32.3 %), although this group was also significant in Belgium (23.7 %).

Figure 7.13: High-tech trade by high-tech group of products, EU-27 and selected countries — 2007

Note:
EU-27 does not include intra-EU trade and therefore does not equal the sum of the Member States.
'Other' includes 'electrical machinery', 'chemistry', 'non-electrical machinery' and 'armament'.
CN excluding HK.

Source: Eurostat (htec_trd_group4)

Figure 7.14: World shares of high-tech exports by high-tech product group, EU-27 and main exporters — 2007



Note:
EU-27 excluding intra-EU trade.
CN excluding HK.

Source: Eurostat (htec_trd_weu4)

Figure 7.14 provides a breakdown of global high-tech exports by the main exporting countries for each high-tech product group.

Only the EU-27 and the United States were consistently among the top five exporters in every high-tech product group.

In 2007, the United States was the top exporter in the 'aerospace' and 'armament' groups, while the EU27 took the largest shares of high-tech exports in the cases of 'chemistry, 'non-electrical machinery', 'pharmacy' and 'scientific Instruments'. China was the leading exporter by far of 'computers - office machines' and also, to a lesser extent, for 'electronics - telecommunication'.

7.5 Employment in high-tech industries and in knowledge-intensive services

7.5.1 Performance at national level in Europe

In 2007, 40 million people were employed in manufacturing in the EU-27, equal to 18.3 % of total employment in the EU. Germany reported the largest number employed in manufacturing (more than 8 million), followed by Italy and France (more than 4 million), the United Kingdom, Poland and Spain (more than 3 million).

In the EU-27, women accounted for 30.6 % of employment in manufacturing. Bulgaria was the only country where the proportion of women employed in manufacturing was above 50 %, although Estonia, Latvia, Lithuania, Portugal and Romania all came fairly close to an even gender balance (46.1 %, 42.6 %, 48.3 %, 42.2 % and 46.7 % respectively).

Of these 40 million workers, more than 12 million were employed in medium high-tech manufacturing and 2.4 million in high-tech manufacturing.

Women's share of the jobs was lower in medium high-tech manufacturing than in high-tech manufacturing (23.6 % and 36.1 % respectively). In the high-tech sector women outnumbered men only in Bulgaria and Slovakia.

In the EU-27, employment in total manufacturing decreased slightly between 2002 and 2007 (by 0.3 % a year). Employment in high-tech manufacturing also decreased. However, the number of jobs in medium high-tech manufacturing increased over the same period.

Employment in the manufacturing sector as a whole increased in eleven Member States, especially in Poland, which also reported the highest increases in employment in high-tech and medium high-tech manufacturing.

Conversely, in the Netherlands employment in high-tech manufacturing fell by more than 10 % a year between 2002 and 2007.

Table 7.15: Employment in manufacturing, EU-27 and selected countries — 2007 (selected sectors, in thousands, percentage of women and AAGR 2002-2007)

	High-tech manufacturing				Medium high-tech manufacturing				Total manufacturing			
	1000s	as a % of total employment	% of women	AAGR 2002-2007	1000s	as a % of total employment	% of women	AAGR 2002-2007	1000s	as a % of total employment	% of women	AAGR 2002-2007
EU-27	2 416 s	1.1	36.1	-0.2 i	12 149	5.6	23.6	0.3 i	39 854	18.3	30.6	-0.3 i
BE	34	0.8	33.3	-0.4	241	5.5	21.7	0.7	724	16.6	24.7	-0.3
BG	18	0.6	53.6 u	5.7	149	4.6	33.3	1.9	766	23.6	50.8	2.8
CZ	91	1.9	48.1	6.5	443	9.0	33.7	4.4	1 405	28.6	36.3	1.2
DK	30 b	1.1 b	38.2 b	0.2	139 b	5.0 b	28.1 b	-0.6	435 b	15.5 b	31.7 b	-0.4
DE	663	1.7	36.3	-1.2	3 426	9.0	20.6	0.1	8 600	22.6	28.2	0.2
EE	7 u	1.1 u	:	:	19	2.9	:	2.0	135	20.6	46.1	1.1
IE	52	2.5	38.8	-1.0	58	2.8	32.3	-2.4	267	12.8	29.6	-1.3
EL	12	0.3	22.9 u	0.5	95	2.1	20.8	3.4	560	12.4	27.6	-0.7
ES	86	0.4	29.9	2.2	824	4.1	21.1	0.6	3 145	15.5	24.8	0.8
FR	329	1.3	32.3	0.9	1 295	5.1	24.9	-0.3	4 065	15.9	28.8	-0.9
IT	297	1.3	33.0	5.2	1 463	6.3	22.0	1.3	4 864	21.0	28.3	-0.3
CY	:	:	:	:	3	0.8	35.6 u	-3.3	37	9.9	31.8	-0.7
LV	:	:	:	:	18	1.6	36.4 u	0.3	165	14.7	42.6	0.0
LT	7 u	0.5 u	:	-5.8	31	2.0	30.3 u	1.5	268	17.5	48.3	1.1
LU	1 u	0.4 u	:	1.7	1 u	0.7 u	:	-2.1	16	7.9	19.9	-3.8
HU	101	2.6	47.7	0.0	245	6.2	33.1	1.6	874	22.3	38.6	-1.9
MT	4	2.7	48.5 u	-5.2	5	3.5	:	-4.2	26	16.5	24.2	-4.2
NL	52	0.6	25.3	-10.2	211	2.5	16.4	-2.8	1 059	12.7	22.8	0.5
AT	54	1.4	31.1	-3.6	213	5.3	20.1	3.9	730	18.2	25.7	0.4
PL	103	0.7	49.4	13.9	733	4.8	26.5	6.6	3 149	20.7	34.1	4.0
PT	22	0.4	42.0	2.8	154	3.0	28.2	0.5	950	18.7	42.2	-2.0
RO	37	0.4	39.6	2.1	492	5.3	33.7	-0.5	1 974	21.1	46.7	-1.2
SI	12	1.2	42.0	7.6	77	7.9	32.9	0.1	269	27.5	34.7	-1.2
SK	42	1.8	56.7	5.3	191	8.1	32.1	6.3	634	26.9	36.4	2.2
FI	53	2.1	30.5	2.2	122	4.9	18.4	-1.2	452	18.1	27.7	-0.9
SE	39	0.9	34.5	-9.2	243	5.3	22.8	-0.8	657	14.5	25.3	-1.9
UK	265	0.9	29.6	-6.0	1 260	4.5	21.2	-2.9	3 629	12.9	25.4	-3.1
IS	:	:	:	:	3	1.7	:	-2.5	20	11.9	30.3	-2.5
NO	11	0.5	30.5 u	-5.1	91	3.8	12.7	0.1	280	11.5	23.9	-0.7
CH	97	2.4	36.7	2.5	197	4.8	21.2	-1.2	616	15.0	26.3	-0.4
HR	8	0.5	44.4	5.6	74	4.7	22.6	1.2	302	19.2	36.2	-0.7
TR	56	0.3	22.6	:	705	3.3	10.9	:	3 947	18.7	19.7	:

Note:
i: AAGR for the EU-27 based on the estimated value for 2002.
Exceptions to the reference year: 2006: HR and IS.
Exceptions to the reference period: 2002-2006: HR and IS.

Source: Eurostat (htec_emp_nat)

In 2007, the services sector provided more than 144 million jobs in the EU-27, almost half of which were in knowledge-intensive services (KIS). Germany was ranked first in this sector, with 25 million employed in services, followed by the United Kingdom. The top two were the same for both the KIS and the high-tech KIS sectors: Germany followed by the United Kingdom.

Women made up more than half (54 %) of the total workforce in services in the EU-27. In knowledge-intensive services women's share of employment (60.4 %) was even higher than in total services. Malta and Turkey were the only countries where women did not outnumber men in knowledge-intensive services.

By contrast, in the EU-27 a lower rate of female employment was observed in high-tech KIS (33.1 %). Lithuania and Latvia were the only countries where female employment exceeded 50 %.

Between 2002 and 2007, employment in total services increased not only in the EU-27 but also in each Member State. In this respect, the biggest increase was observed in Spain (5.3 % a year), followed by Cyprus (4.1 %), Poland and Ireland (both 4.0 % a year).

Like total services, employment in KIS increased in every Member State in the period under review.

Employment in high-tech KIS also grew in the EU-27, albeit less vigorously than in total services. Denmark, France, Austria, Romania, Iceland and Norway all recorded a decline in employment in high-tech KIS between 2002 and 2007. However, growth in high-tech KIS varied widely, decreasing in some countries, whereas others, like Luxembourg and Poland, recorded average annual growth rates of around 10 %.

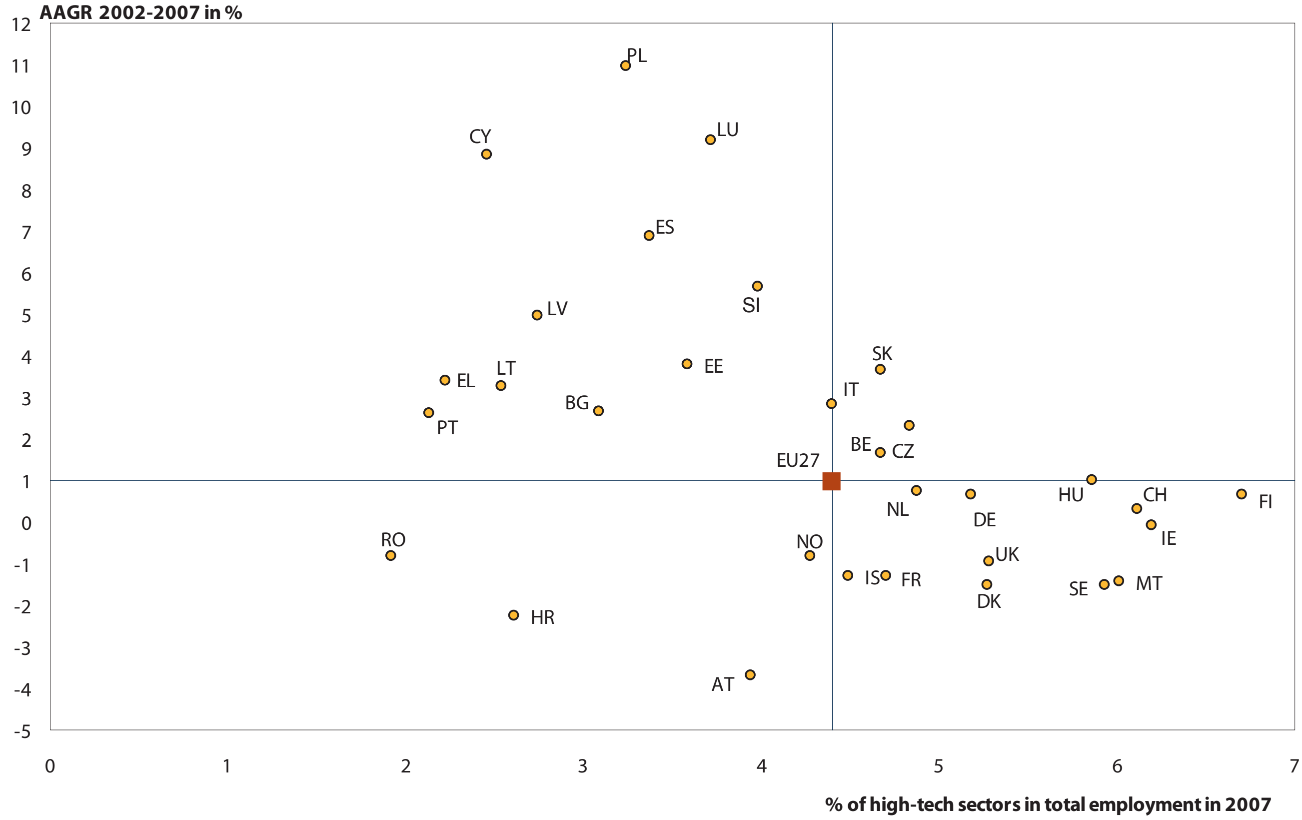
Table 7.16: Employment in services, EU-27 and selected countries — 2007 selected sectors, in thousands, percentage of women and AAGR 2002-2007)

	High-tech KIS				Knowledge-intensive services (KIS)				Total services			
	1000s	as a % of total employment	% of women	AAGR 2002-2007	1000s	as a % of total employment	% of women	AAGR 2002-2007	1000s	as a % of total employment	% of women	AAGR 2002-2007
EU-27	7 162	3.3	33.1	1.4 i	71 719	32.9	60.4	2.6 i	144 695	66.5	54.0	2.1 i
BE	170	3.9	28.7	2.1	1 672	38.2	59.6	1.7	3 221	73.7	52.6	1.7
BG	82	2.5	45.3	2.1	703	21.7	64.4	2.5	1 851	57.0	54.1	3.2
CZ	147	3.0	42.5	0.1	1 261	25.7	63.3	2.3	2 760	56.2	54.1	1.3
DK	118 b	4.2 b	32.5 b	-1.9	1 220 b	43.5 b	61.9 b	0.2	2 067 b	73.7 b	54.5 b	0.6
DE	1 313	3.4	32.8	1.7	13 270	34.8	60.5	2.9	25 766	67.6	55.7	1.8
EE	17	2.6	47.4 u	0.0	182	27.8	69.7	0.3	393	60.0	61.9	1.6
IE	77	3.7	30.0	0.6	741	35.5	62.6	4.7	1 399	67.0	56.4	4.0
EL	88	2.0	32.5	3.8	1 128	25.1	53.0	3.5	2 972	66.0	45.8	2.8
ES	600	3.0	34.7	7.7	5 734	28.2	57.1	6.4	13 492	66.3	53.1	5.3
FR	875	3.4	38.4	-2.1	9 426	36.8	61.9	2.1	18 700	73.1	55.5	2.1
IT	722	3.1	34.5	2.0	7 108	30.7	55.4	3.6	15 262	65.9	48.3	2.1
CY	9	2.3	29.5	8.0	110	29.2	59.5	5.9	275	73.1	53.7	4.1
LV	28	2.5	52.3	4.4	276	24.7	68.9	2.4	688	61.5	60.8	3.3
LT	32	2.1	52.6 u	6.0	398	26.0	72.5	2.5	903	59.0	60.6	3.3
LU	7	3.4	30.9	10.2	87	43.0	55.4	4.0	165	81.2	50.5	2.4
HU	129	3.3	41.2	1.8	1 107	28.2	64.5	1.6	2 463	62.7	55.4	1.3
MT	5	3.3	:	2.5	51	32.7	48.1	3.7	112	72.0	39.3	2.6
NL	356	4.3	22.3	3.2	3 566	42.7	58.9	2.4	6 098	73.1	53.2	1.6
AT	104	2.6	29.8	-3.8	1 204	30.0	59.4	1.8	2 693	67.1	54.8	2.4
PL	390	2.6	36.2	9.8	3 772	24.8	65.1	4.1	8 252	54.3	56.0	4.0
PT	86	1.7	28.3	2.6	1 193	23.5	64.2	3.5	2 979	58.7	55.3	1.4
RO	142	1.5	43.0	-1.5	1 347	14.4	63.0	1.5	3 654	39.1	51.4	2.7
SI	27	2.8	27.9	4.9	257	26.3	63.5	4.1	534	54.6	55.0	2.5
SK	68	2.9	44.8	2.7	583	24.7	66.4	2.8	1 329	56.4	57.2	2.6
FI	114	4.6	37.7	0.0	1 015	40.7	66.3	1.5	1 722	69.1	59.6	1.3
SE	230	5.1	31.0	0.3	2 172	47.8	62.4	1.2	3 443	75.8	56.0	1.3
UK	1 227	4.3	26.1	0.4	12 135	43.0	59.9	1.6	21 503	76.1	54.6	1.0
IS	7	4.1	42.3	-2.0	71	42.5	63.9	2.1	121	72.0	55.6	2.5
NO	93	3.8	32.1	-0.2	1 119	46.0	62.1	2.0	1 847	75.9	56.6	1.6
CH	154	3.8	32.1	-0.9	1 729	42.2	55.6	2.7	2 993	73.0	53.3	1.2
HR	33	2.1	41.3	-3.7	363	23.0	62.2	2.5	893	56.7	54.0	1.8
TR	176	0.8	20.2	:	2 728	12.9	36.0	:	10 173	48.2	20.6	:

Note:
i: AAGR for the EU-27 based on the estimated value for 2002.
Exceptions to the reference year: 2006: HR and IS.
Exceptions to the reference period: 2002-2006: HR and IS

Source: Eurostat (htec_emp_nat)

Figure 7.17: Employment in high-tech sectors as a percentage of total employment and AAGR of employment in high-tech sectors, EU-27 and selected countries — 2002–2007



Note:
High-tech sectors = high-tech manufacturing plus high-tech KIS.
AAGR for the EU-27 based on the estimated value for 2002.
Exceptions to the reference period: 2002-2006: IS and HR;
2004-2007: PL.

Source: Eurostat (htec_emp_nat)

Figure 7.17 shows employment in high-tech sectors as a share of total employment and the average annual growth rate of employment in high-tech sectors between 2002 and 2007.

In 2007, high-tech sectors accounted for 4.4 % of total employment in the EU-27, with high-tech employment growing by an average of 1 % per year between 2002 and 2007. This overall increase was essentially due to growing shares of employment in knowledge-intensive services. In fact, employment in high-tech manufacturing decreased slightly between 2002 and 2007.

Three main groups of countries can be distinguished in Figure 7.17. The first has shares of employment in high-tech sectors that are well above or close to the EU-27 average and consists of Finland, Switzerland, Hungary, Germany, the Netherlands, the Czech Republic, Slovakia, Belgium and Italy. Apart from shares of high-tech sectors in total employment above the EU-27 average, this group also had moderate but nonetheless positive growth ranging from 0.3 % in Switzerland to 3.6 % in Slovakia. Thanks to this, the countries in this group are either maintaining their leading positions or drawing closer to the leaders.

In the second group, made up of Ireland, Malta, Sweden, the United Kingdom, Denmark and France plus Iceland and Norway, high-tech sectors also took average to high shares of total employment, but employment in the high-tech sectors decreased over the period covered.

The third group includes several new Member States — Poland, Cyprus, Slovenia, Latvia, Estonia, Lithuania and Bulgaria — alongside Luxembourg, Greece, Spain and Portugal. In this group the share of high-tech sectors in total employment was below the EU average but, by contrast, this group recorded moderate to very high growth rates in high-tech employment and is closing the gap with the leading countries. For instance, Luxembourg, Poland, Cyprus and Spain recorded remarkably high growth rates between 2002 and 2007.

In Romania and Croatia, both high-tech employment indicators were quite a bit below the EU-27 average. Austria recorded the biggest decrease in high-tech employment (3.7 %), although the share of this sector in total employment there was nevertheless close to the European average.

In the high-tech sectors the share of employees with tertiary education is above average. Figure 7.18 shows the share of employees with tertiary education in high-tech sectors (manufacturing plus KIS) compared with all other sectors of the economy.

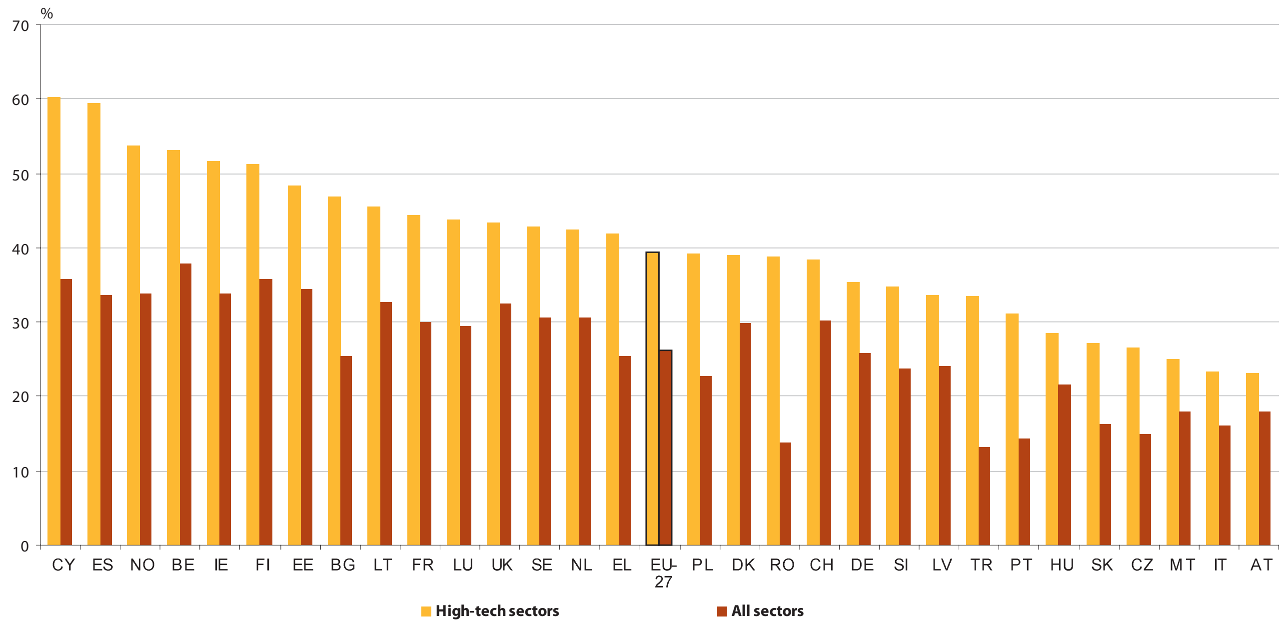
On average, 39.5 % of employees in high-tech sectors in the EU in 2007 had tertiary education, compared with only a quarter of the population in all sectors of the economy. Among the countries covered, the share of workers with tertiary education was consistently higher in high-tech sectors than in the economy as a whole. The widest gaps were found in Cyprus, Romania and Spain, where 60.2 %, 38.8 % and 59.4 % of high-tech workers had completed tertiary education respectively, compared with 35.8 %, 13.8 % and 33.7 % respectively for the economy as a whole.

In Cyprus, Spain, Belgium, Norway, Ireland and Finland more than half of all high-tech workers had tertiary education. Nine other countries were above the EU average (39.5 %) for this indicator.

At the other end of the scale, less than a quarter of persons employed in high-tech sectors in Austria and Italy had tertiary education.

A different picture emerges when considering the economy as a whole, with Belgium reporting the highest share of tertiary-educated workers in the entire economy (37.9 %), followed by Cyprus, Finland and Estonia.

Figure 7.18: Share of tertiary-educated persons in all sectors and in high-tech sectors, EU-27 and selected countries — 2007



Note:
High-tech sectors = high-technology manufacturing plus high-tech KIS.
Data for EE, LT and MT lack reliability due to the sample size but are still publishable.

Source: Eurostat (htec_emp_nisced)

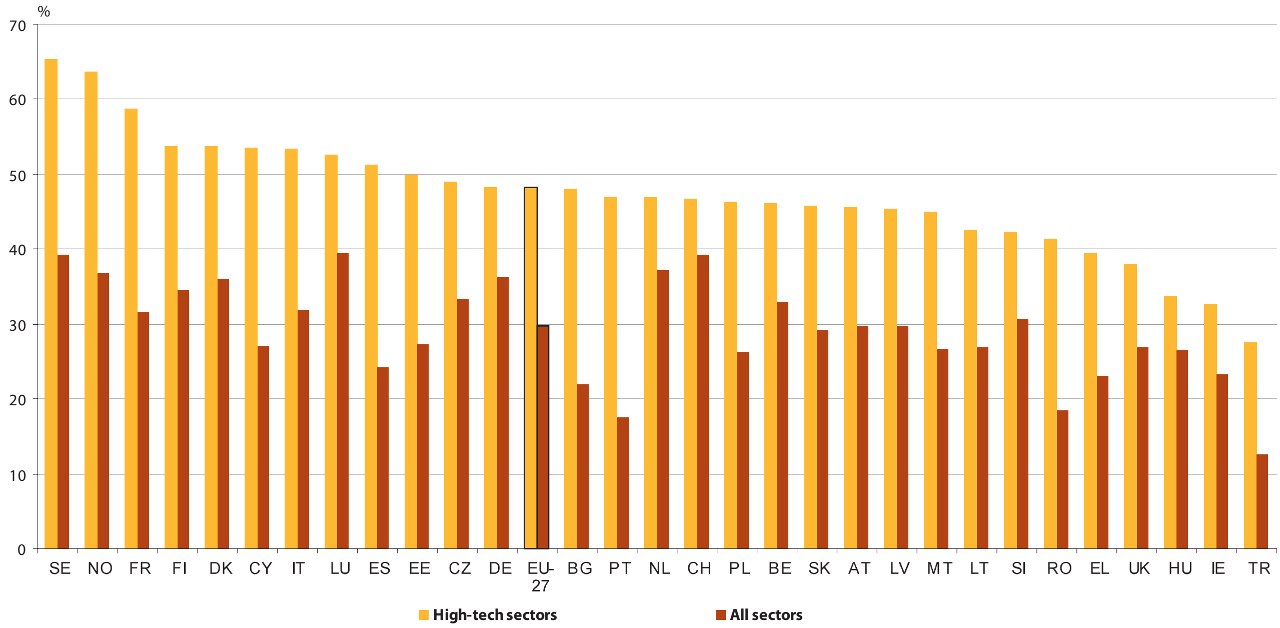
Figure 7.19 shows the share of technicians and professionals in high-tech sectors and in all sectors of the economy.

In 2007, technicians and professionals accounted for 48.3 % of persons employed in high-tech sectors in the EU-27. They also made up more than half of the workforce in high-tech sectors in nine EU Member States plus Norway and even over 60 % in Sweden and Norway.

Technicians and professionals accounted for less than 40 % of high-tech employment in Greece, the United Kingdom, Hungary, Ireland and Turkey.

The number of technicians and professionals in high-tech sectors is at least twice the average for all sectors in Denmark, Spain, Bulgaria, Portugal, Romania and Turkey.

Figure 7.19: Share of technicians and professionals in high-tech sectors and in all sectors, EU-27 and selected countries — 2007



Note:
High-tech sectors = high-technology manufacturing plus high-tech KIS.
Data for EE and LT lack reliability but are still publishable.

Source: Eurostat (htec_emp_nisco)

7.5.2 Performance at regional level in Europe

Figure 7.20: Regional disparities in employment in high-tech sectors as a share of total employment, NUTS 2 level — 2007

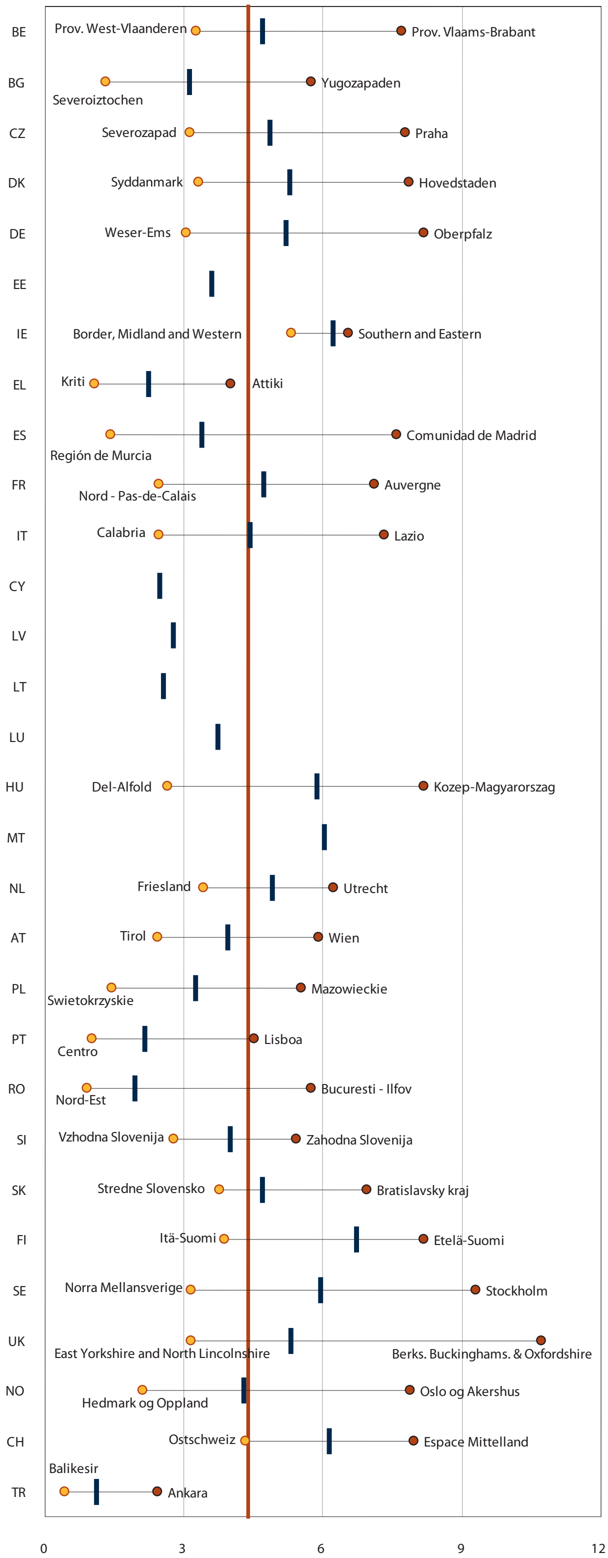


Figure 7.20 shows the regional disparities in employment in high-tech sectors as a share of total employment. It indicates the national average for each country along with the regions with the lowest and highest shares of employment in high-tech sectors.

In 2007, employment in high-tech sectors ranged from 0.4 % of total employment in Balikesir (TR) to 10.7 % in Berkshire, Buckinghamshire and Oxfordshire (UK). With the exception of Greece, all Member States not classified as a region at NUTS 2 level had at least one region where the rate of employment in high-tech sectors was above the EU-27 average (4.4 %).

Ireland was the only Member State (not classified as a region at NUTS 2 level) where every region reported shares above the EU average.

In every country, apart from Belgium, the Netherlands, Germany, France and the United Kingdom, the leading region was the capital region.

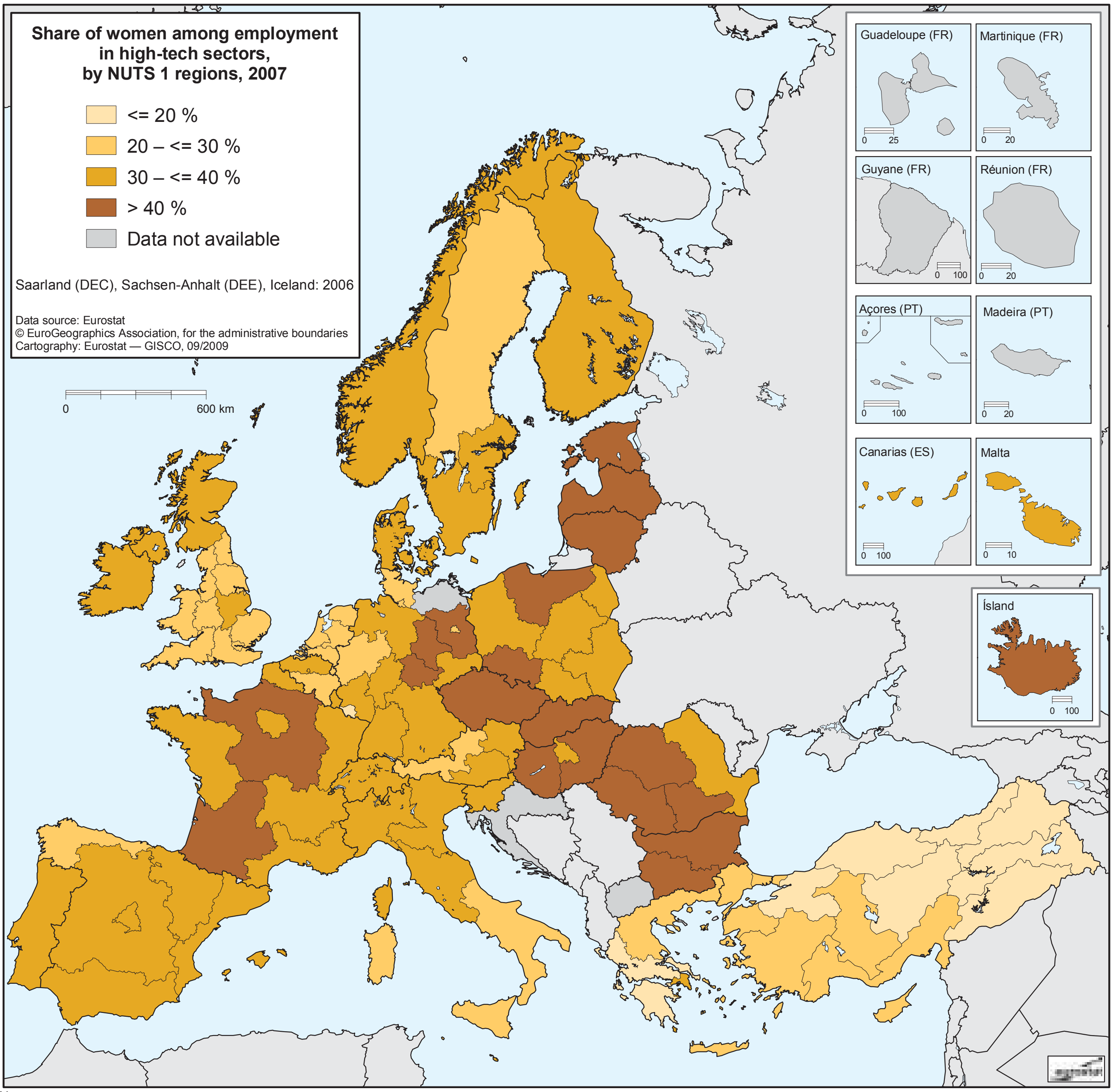
At national level, in the three big economies — Germany, France and the United Kingdom — high-tech shares of employment were above the EU average. This was also the case in many northern European countries. By contrast, the national average was below the EU average in many new Member States and in a majority of southern Member States.

In Ireland, Greece, the Netherlands, Slovenia, Slovakia, Switzerland and Turkey regional disparities in high-tech employment were less than 4 %.

Note:
High-tech sectors = high-technology manufacturing plus high-tech KIS.
Data lack reliability due to small sample size in the region with the smallest share in BG, EL, PL and NO.
Due to small sample size, data for the following regions cannot be published: Brandenburg-Nordost (DE), Bremen (DE), Kassel (DE), Koblenz (DE), Trier (DE), Sachsen-Anhalt (DE), Dytiki Makedonia (EL), Thessalia (EL), Ipeiros (EL), Ionia Nisia (EL), Sterea Ellada (EL), Voreio Aigaio (EL), Notio Aigaio (EL), Ciudad Autónoma de Ceuta (ES), Ciudad Autónoma de Melilla (ES), Corse (FR), Valle d'Aosta/Vallée d'Aoste (IT), Molise (IT), Zeeland (NL), Burgenland (AT), Algarve (PT), Lisboa (PT), Alentejo (PT), Região Autónoma dos Açores (PT), Região Autónoma da Madeira (PT), Åland (FI), Cumbria (UK), Lincolnshire (UK), Cornwall and Isles of Scilly (UK), North Eastern Scotland (UK) and Kirikkale (TR).

Source: Eurostat (htec_emp_nisco)

Map 7.21: Female employment in high-tech sectors, EU-27 and selected countries at NUTS 1 level — 2007



Note:
High-tech sectors = high-technology manufacturing plus high-tech KIS.

Source: Eurostat (htec_emp_reg)

Map 7.21 provides an overview of the share of female workers in high-tech sectors in 2007 at NUTS 1 level. Note that at NUTS 1 level, many smaller countries are counted as regions.

As a rule, women were under-represented in the high-tech sectors in the EU. The highest shares of women employed in high-tech sectors were found mainly in eastern European regions in Lithuania, Bulgaria, Hungary, Poland, Slovakia, Latvia, Romania, the Czech Republic and Estonia, most of which recorded more than 40 %. Only five other EU regions (two in France and three in Germany) recorded female high-tech employment rates of above 40 %. Iceland, at country level, also had a share of more than 40 %.

By contrast, women were significantly under-represented in high-tech sectors in most regions of the United Kingdom and the Netherlands (accounting for under 30 % of persons employed in high-tech). Low shares (below 30 %) were also recorded in a few regions in Austria, Sweden, Italy, Denmark and Spain. Turkey and Greece were the only countries with regions where women took less than 20 % of high-tech employment.

Methodology

This part presents, in some detail, the methodology used for the data set out in this publication. After some general information, specific explanations 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.

1. General information

1.1 Currency

Series in current euro have been calculated using the annual average euro-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 PPS (Purchasing Power Standards)

The Purchasing power standard, abbreviated as PPS, is an artificial currency unit. PPS is the technical term chosen by Eurostat for the common currency in which National Accounts aggregates are expressed when they are adjusted for price level differences using purchasing power parities (PPPs). Thus, PPPs can be interpreted as the exchange rate of the PPS against the euro.

One PPS can buy the same amount of goods and services in each country, whereas, due to different price levels in the countries, different numbers of national currency units are necessary to buy the same amount of goods and services. An economic aggregate of a given country, expressed in national currency, should be divided by the respective Purchasing power parity (PPP) in order to obtain an internationally comparable figure expressed in PPS. PPPs are scaled so that the sum of the gross domestic product (GDP) for all EU Member States is the same in both euro and PPS.

The Purchasing power standard at constant year 2000 prices, abbreviated as PPS_KP00, is based on the GDP price deflator with base year 2000 and the PPPs for the year 2000. The reason for calculating this measure is to arrive at figures that are adjusted to accommodate price differences between countries and over time. The reader should however be aware that this unit is based on the relation of price levels for a fixed base year. Therefore, the further away from the base year the comparison is made, the less accurate the price adjustment for the various countries becomes. For a price adjusted comparison between countries in any given year the simple PPS is the more accurate measure.

1.4 Population

The population on 1 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 (Human Resources in Science and Technology) indicators, calculations for population totals are based on the Labour Force Survey (LFS) data, the same source being used for numerators and denominators. Population totals derived from the LFS may differ from the population totals from demographic statistics used in other chapters, mainly because the reference dates are different and some institutionalised persons are excluded.

1.5 Employment

Employed persons are persons aged 15 and over who performed work during the reference week — even for just one hour per week — for pay, profit or family gain, or who were not at work but had a job or business from which they were temporarily absent because of illness, holidays, industrial dispute, education/training, etc.

1.6 Labour force

The labour force is 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 did any work for pay or profit during the reference week, 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 had found a job to start later, i.e. within a period of three months at most.

1.7 Average annual growth rate

Average annual 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

1.8 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 is composed of: all departments, offices and other bodies which provide, but normally do not sell to the community, those common services, other than higher education, which cannot otherwise be conveniently and economically provided, as well as those that 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, irrespective of their source of finance or legal status. It also includes all research institutes, experimental stations and clinics operating under the direct control of, 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.

1.9 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
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 organisations and bodies	99

[1] NACE is derived from the French 'Nomenclature statistique des Activités économiques dans la Communauté Européenne' (Statistical Classification of Economic Activities in the European Community).

1.9.1 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.

Please note that, given the limitations of the data sources used, in a few cases (R&D, employment in high tech and HRST), aggregations are made on a NACE 2-digit level only. 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.

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.

1.9.2 Aggregations of services based on NACE Rev. 1.1

Following an approach similar to the one adopted 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 organisation n.e.c. **93** Other service activities **95 to 97** Activities of households **99** Extra-territorial organisations 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

1.10 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, 2006 version. The NUTS was established by the Statistical Office of the European Communities (Eurostat), in cooperation 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 number of NUTS 1 regions, each of which is subdivided in turn into a 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 2006 version. The exceptions have been indicated in the tables or figures.

For six countries (Estonia, Cyprus, Latvia, Lithuania, Luxembourg and Malta) the national level coincides with the NUTS 2 level, which is why they may be found among 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 of the data is presented at NUTS 1 level. For eleven countries (Czech Republic, Denmark, Estonia, Ireland, Cyprus, Latvia, Lithuania, Luxembourg, Malta, Slovenia and Slovakia) the national level coincides with the NUTS 1 level, which is why they may be found among the regional rankings in this publication.

For Bulgaria, Romania and Croatia, the NUTS level 2 has been revised and one-to-one correspondence is not possible between the previous and the new NUTS level 2. This could explain the lack of data for these countries at NUTS level 2 in some of the figures in this Statistical Book.

2. Methodological notes by domain

2.1 Government budget appropriations or outlays on R&D — GBAORD

2.1.1 Concepts and definitions

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 carried out 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 for R&D activities, in other words, how much priority governments place on the public funding of R&D.

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).

2.1.2 Sources

The basic data are forwarded to Eurostat by the national administrations of Member States and other countries. Data for South Korea, Japan and the United States come from the OECD — Main Science and Technology Indicators (MSTI).

2.1.3 Statistical data compilation

Until 2003, data on GBAORD were collected under a gentlemen's agreement. From the reference year 2004 onwards, data collection is based on Commission Regulation (EC) No 753/2004 as regards statistics on science and technology, (OJ L 118, 23.4.2004, p. 23).

2.1.4 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.

NABS 2007

The latest version of the nomenclature (NABS 2007) is applicable since reference year 2007. Before that an earlier version (NABS 1992) was used.

The NABS 2007 chapter level covers:

- Chapter 1 — Exploration and exploitation of the earth
- Chapter 2 — Environment
- Chapter 3 — Exploration and exploitation of space
- Chapter 4 — Transport, telecommunications and other infrastructures
- Chapter 5 — Energy
- Chapter 6 — Industrial production and technology
- Chapter 7 — Health
- Chapter 8 — Agriculture
- Chapter 9 — Education
- Chapter 10 — Culture, recreation, religion and mass media
- Chapter 11 — Political and social systems, structures and processes
- Chapter 12 — General advancement of knowledge: R&D financed from general university funds (GUF)
- Chapter 13 — General advancement of knowledge: R&D financed from sources other than GUF
- Chapter 14 — Defence

Not all countries collect the data directly by NABS. Some follow other compatible classifications (OECD, Nordforsk), which are then converted into data compiled according to the NABS classification (see Table 8.2 of the *Frascati Manual*).

2.1.5 Exceptions

No GBAORD data exist for Bulgaria or Luxembourg before 2000. EU aggregates therefore exclude them before that year.

No GBAORD data exist for Cyprus or Malta before 2004. EU aggregates therefore exclude Cyprus and Malta before that year.

No GBAORD data exist for Hungary before 2005,. EU aggregates therefore exclude Hungary before that year.

2.1.6 Time series

The analysis in this Statistical Book covers the period 1997 to 2007.

2.2 R&D expenditure and personnel

2.2.1 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 detailed in chapters 6 and 5 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.

2.2.2 Sources

The basic data are forwarded to Eurostat by the national administrations of Member States and other countries. Data for China, South Korea, Japan and the United States come from the OECD — Main Science and Technology Indicators (MSTI).

2.2.3 Statistical data compilation

Until 2003, data on R&D were collected under a gentlemen's agreement. From the reference year 2003 onwards, data collection is based on Commission Regulation (EC) No 753/2004 as regards statistics on science and technology, (OJ L 118, 23.4.2004, p. 23).

2.2.4 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 funding (*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 national level (EEA countries), GDP from national accounts is used as the reference data. At regional level, GDP data are taken from the regional accounts. Both data series were extracted from Eurostat's reference database.

R&D activity

Data on R&D expenditure may be broken down by three types of R&D activity: basic research, applied research and experimental development (*Frascati Manual*, § 239 et seq.).

2.2.5 R&D personnel

Data on R&D personnel measure the resources going directly to R&D activities. Total R&D personnel is defined as follows:

All persons employed directly in 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 the purposes of comparison between different regions and periods, this indicator is often used in conjunction with employment or population variables.

R&D personnel intensity

R&D personnel intensity is R&D personnel (in HC) expressed as a percentage of total employment.

Both data series were extracted from Eurostat's reference database.

2.2.6 Classifications

Institutional classification

Intramural 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 the definition of institutional sectors, please refer to 'General information'.

Source of funds

R&D expenditure is subdivided into five funding sources: business enterprise, government, higher education, PNP and abroad — *Frascati Manual*, § 389 et seq. Since the amounts from the higher education and PNP sectors are small, they have been combined as 'other national sources'.

Field of science

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 economic 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 Information').

For this publication the breakdown used is:

- Manufacturing (Section D)
- Services (Sections G to Q)
- Other business activities (Sections A, B, C, E, F)

Size class of enterprise

Business enterprise R&D expenditure may be broken down by the following size classes of enterprises:

- 0 employees
- 1 to 9 employees
- 10 to 49 employees
- 50 to 249 employees
- 250 to 499 employees
- 500 and more employees

For this publication the size classes used are:

- 0 to 49 employees
- 50 to 249 employees
- 250 to 499 employees
- 500 and more employees

Type of cost

R&D expenditures include both current and capital expenditures.

- Current costs are composed of labour costs and other current costs. Labour 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 carried out 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 in which they took place and should not be registered as an element of depreciation.

Occupation

- Researchers: 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: 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 support staff: include 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 usually only four are collected:

- ISCED level 6: holders of university degrees at Doctorate level
- ISCED level 5A: holders of basic university degrees below 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.

2.2.7 Geographical coverage

These data are available at the national level for EU-27 Member States, Croatia, Turkey, Iceland, Norway, Switzerland, China, South Korea, Russia, Japan, and the United States and at the regional level NUTS level 2 for European countries (see General information).

2.2.8 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 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-27 and EU-15 aggregates are estimated values.

2.2.9 Time series

Data are presented for the period 2001–2007. However, data series in Eurostat's reference database 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 in Eurostat's reference database.

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 serve to show the needs and the current situation of the labour force, and the latter indicate 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, 5 b 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).

Note that 'science' in the broad sense of the term means knowledge and it is used with this meaning in the Canberra Manual. Hence 'S&T fields of study' includes all fields of study. The conditions of the above educational or occupational requirements are considered in the light of 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.

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

2.3.1 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 the second quarter of any given year.

HRST stock data and their derived indicators are extracted and built up using data from the EU Labour Force Survey, which 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 are 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 (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).

Sub-categories of HRST	People belonging to HRST that have/are
HRSTO : Human resources in science and technology — occupation	• employed in an 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 (ISCED '97 version levels 5a, 5b or 6).
HRSTC : Human resources in science and technology — core	• successfully completed education at the third level (ISCED '97 version levels 5a, 5b or 6 **and** • employed in an S&T occupation (ISCO '88 COM codes 2 or 3).
SE : 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 (ISCED '97 version levels 5a, 5b or 6) **and** are unemployed.
NHRSTU : Unemployed non-HRST	• no education at the third level **and** are unemployed.

Note that according to 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.

2.3.2 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 who go on to fulfil 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, which builds on the UNESCO/OECD/Eurostat questionnaire on education, based in turn on the International Standard Classification of Education — ISCED. The user should note that European education systems differ from one country to another and that for some countries there might be duplications of degrees.

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 all 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 that the following should also be considered as HRST: production and operations managers, other specialist managers, managers of small enterprises (ISCO 122, 123 and 131) who may work in the S&T field. However, they are not included in the term HRST as used here (although 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, because of variations in the way countries treat and classify managers.

2.3.3 Doctoral 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 exclusively on coursework. They usually require 3–5 years of research and coursework, generally after a Master's degree. Indicators of the number of doctoral students therefore provide an idea of the extent to which countries will have researchers at the highest level of education.

2.3.4 Foreign students

A foreign student is defined as someone not having the citizenship of the country in which he/she is educated. The number of non-national students may be overestimated in some countries where a significant group of students are permanently resident second-generation migrants of foreign nationality.

2.3.5 Mobility

Data on job-to-job mobility can be defined as the movement of employed HRST from one job to another during the previous 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.

2.3.6 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.

2.3.7 Breakdown by nationality

HRST data by nationality are based on the citizenship of the person. This 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 with citizenship of the country of residence.
– Non-nationals: persons whose citizenship is different from the country of residence.

2.3.8 Time series

In many countries data are available from 1994 onwards, but there are discrepancies and certain years are missing. Users should note that the existence of data in the HRST domain depends on their degree of 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 flagged either as not available or as unreliable.

Readers should note that when, HRST results were updated in Eurostat's reference database in mid-2007 a slightly different methodology was used. This new methodology takes into account the changes in the EU LFS data collection process. In addition, the reference population is based on the age group 15–74 years old and not the entire population as was the case previously.

2.3.9 Sources

Additional information on the methodology used may be found in Eurostat's reference database under 'Science and Technology/Human Resources in Science & Technology'.

2.4 Innovation

2.4.1 Community Innovation Survey

At European level, the **Community Innovation Survey** (CIS) data provide the main source of information for studying innovation drivers and company behaviour towards innovation.

The CIS is a survey on innovation activity in enterprises covering EU Member States, candidate countries, Iceland and Norway.

The data have been collected on a two-yearly basis (from 2004 onwards). The latest survey (CIS 2006) was carried out in 2007 (based on the reference year 2006) in the 27 Member States, candidate countries and Norway,

In order to ensure comparability across countries, Eurostat, in close cooperation with the EU Member States, developed standard core questionnaires for CIS 2006, accompanied by a set of definitions and methodological recommendations.

CIS 2006 is still based on the *Oslo Manual* (2nd edition, 1997), which gives methodological guidelines and defines the concept of innovation, and on Commission Regulation (EC) No 1450/2004.

2.4.2 Statistical units

The main statistical unit for CIS 2006 was the **enterprise**.

The target population for CIS 2006 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).

2.4.3 Type of survey

Most Member States and other countries carried out CIS 2006 by means of a stratified sample survey. Some 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 2006 data in the Eurostat reference database are organised more or less according to the same structure as the questionnaire.

2.4.4 Reference period

CIS 2006 covered the observation period 2004–2006 inclusive, i.e. the three-year period from the beginning of 2004 to the end of 2006. The reference period for CIS 2006 was 2006.

2.4.5 Definitions

***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 ongoing and/or abandoned innovation activities.

Product innovation is the 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 the 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 the 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 the 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: the acquisition of advanced machinery, equipment and computer hardware or software to produce new or significantly improved products and processes.

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

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 a country or regions.

A patent is assumed to represent a codification of inventive activity commensurate with the novelty, utility and creativity 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.

As from 2005, Eurostat produced patent statistics using data relating to the priority year of the application rather than to the year of filing, as was previously the case. However, data values were similar. Generally speaking, these data were less extensive than the data released by Eurostat before 2005. This is because Eurostat took into consideration all PCT applications filed with the EPO (i.e. applications made in accordance with the Patent Cooperation Treaty procedure), unlike the OECD data sets, which did so only partially. The data produced provided a better indication of the innovation and R&D performance of an economy.

Since 2007 Eurostat's production of EPO and USPTO data is based almost exclusively on the **EPO Worldwide Statistical Patent Database**. This database, also known as 'PATSTAT', was created by the EPO in 2005, using their collection and knowledge of patent data, and further developed in cooperation with the World Intellectual Property Organisation (WIPO), the OECD and Eurostat. PATSTAT aims to fulfil the user needs of the various international organisations which use this raw database for production. Designed to be sustainable over time, PATSTAT concentrates on raw data, leaving the 'production' of indicators mainly to PATSTAT users, such as the OECD, Eurostat and others.

In 2007 Eurostat also decided to revise its methodology for the calculation of indicators based on EPO patent applications by priority year. For patent applications to the EPO all direct applications (EPO-direct) are taken into account. In the case of PCT applications (applications following the procedure laid down by the Patent Cooperation Treaty) made to the EPO, only those that have entered the regional phase are counted. As PCT patent applications in the international phase designating the EPO will no longer be included in the calculation of patent applications to the EPO, the data shown are lower. A similar methodology is also applied by the OECD. Nevertheless, patent data produced by Eurostat and the OECD may not be exactly the same. These differences may be due to discrepancies between the data sources used and the date of extraction of the data.

For all further details, please refer to the Eurostat metadata on patent statistics posted on the webpage http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/en/pat_esms.htm .

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, it is not advisable to make cross-comparisons between the EPO, USPTO and patent family data. Methodological issues specific to each type of data are explained below.

2.5.1 Patent applications to the EPO by priority year

The data in Eurostat's EPO database refer to patent applications to the EPO by priority year and include both applications filed directly under the European Patent Convention (EPC) and applications filed under the Patent Cooperation Treaty (PCT) designating the EPO (Euro-PCT) for protection. The regional (national) distribution of patent applications is based on 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 double counting is avoided.

EPO data are shown from 1995 to 2005. Although longer time series are available, the more recent data are not comparable, as they are incomplete mainly due to the length of patenting procedure.

For further information on definitions and explanatory notes concerning EPO patent data, please refer to Eurostat's reference database under Science and Technology/Patent statistics/Patent applications to EPO by priority year.

2.5.2 Patents granted by the USPTO by priority year

Data on patents granted by the USPTO refer to patents actually granted and not to applications, as is the case for data from the EPO. The data in these two collections are therefore not comparable.

USPTO data are available from 1992 to 2002. Although longer time series are available, the more recent data are not comparable, as they are incomplete mainly due to the length of patenting procedure.

For further information on definitions and explanatory notes concerning USPTO patent data, please refer to Eurostat's reference database under Science and Technology/Patent statistics/Patents granted by the USPTO by priority year.

2.5.3 Triadic patent families by priority year

A patent family is defined as a set of patents taken out in various countries to protect the same invention, i.e. related patents are grouped together in a single record to form 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 both the European Patent Office (EPO) and the Japanese Patent Office (JPO) and has been granted by the US Patent and Trademark Office (USPTO). Patent families, as opposed to patents, are intended to improve international comparability (home advantage removed; patents 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 as regards timeliness. Thus, the latest available data refer to 2002 only.

For further methodological notes please refer to: OECD triadic patent families, OECD, 2004.

Metadata are available in Eurostat's reference database under Science and Technology Patent statistics/Triadic patent families by earliest priority year.

2.5.4 Reference year (or date)

All patent statistics from Eurostat are shown by priority date, i.e. the first date of filing of the patent application anywhere in the world. This date is the earliest and has been chosen in order to be the closest to the date of the invention as patent procedures always take several years. In many cases, patent applications will claim the right of priority of the date of filing of previous applications.

2.5.5 Patent Cooperation Treaty

Under the Patent Cooperation Treaty (PCT) patent rights can be sought in a large number of countries by filing a single international application with a single patent office, and this option 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'. Since 2007, Eurostat includes only PCT applications that have reached the 'national/regional phase'.

2.5.6 European Patent Convention

The European Patent Convention (EPC) is the convention governing 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.epo.org/patents/law/legal-texts/html/epc/1973/e/ar14.html#A14) and translations are governed by Article 65 of the EPC *Translation of the specification of the European patent* (see http://www.epo.org/patents/law/legal-texts/html/epc/1973/e/ar65.html#A65).

2.5.7 Foreign ownership

Data on foreign ownership measure the number of patents invented within a given country or applied for by that country) involving at least one foreign applicant (or a foreign inventor).

To clarify this definition take the example of 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). A combination of the resident countries of inventors and applicants gives six partnerships, of which four are foreign (because they involve two different countries of residence), and two are national.

2.5.8 Counting patents with multiple inventors from different countries

Eurostat has chosen fractional counting as the counting method. In other words, where a patent is invented by several inventors from different countries, the respective contributions of each country are taken into account. The aim is to eliminate multiple counting of such patents. For example, a patent co-invented by an inventor from France, an inventor from the United States and two from Germany will be counted as ¼ of a patent for France and ¼ for the US, and ½ a patent for Germany.

2.5.9 International Patent Classification (8th edition, 2006)

Patents are classified according to the *International Patent Classification* (IPC). Data in the EPO and USPTO collections are available at IPC section and class level. However, data by IPC subclass may also be obtained by requesting an ad hoc extraction.

The *International Patent Classification* is based on an international multilateral treaty administered by the World Intellectual Property Organisation (WIPO), i.e. the Strasbourg Agreement concerning the International Patent Classification.

According to the IPC classification, an invention is assigned to an IPC-class by its function or intrinsic nature, or by its field of application. The IPC is therefore a combined function-application classification system in which the function takes precedence. 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
B 22	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

2.5.10 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 please refer to Eurostat's reference database under Science and Technology/Patent statistics.

The easiest way to explain the link between the two classifications is to give an example. 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.).

2.5.11 NACE-ISIC correspondence

Table 6.6 in Chapter 6 of this 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 world-wide level, whereas the NACE codes are used at 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
		D 33	Manufacture of medical, precision and optical instruments, watches and clocks
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

2.5.12 Technological fields

For the aggregation of technological fields of patent applications/patents granted since the summer of 2008 all IPC codes mentioned on an application are taken into account and not just the main IPC code, as was the case in previous publications and the calculation of other patent indicators.

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).

The patent applications/patents granted with the IPC codes (8th edition, 2006) listed below are aggregated to calculate the indicator 'biotechnology patent applications/patents granted':

A01:1/00, A01:4/00, A61K38/00, A61K39/00, A61K48/00,
C02F3/34, C40B10/00, C40B40/00-50/18, C40B 70/00-80/00
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 (8th edition, 2006), 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, G06Q10/00, G06Q30-99/00, 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 [C40B40/00-50/18];
6. Semi-conductors — SMC [H01L].

3. Information and Communication Technologies (ICT): The IPC codes (8th edition, 2006) listed behind each ICT sub-category are added up for the aggregation of each ICT-sub-category.

1. Telecommunications [G01C11/36, 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, C40B60/00-60/14, G02F, G03G, G05F, G07, G09G, G10L, G11C, H03K, H03L];
4. Other ICT [B01J20/281-20/292, G01B, G01C, G01D, G01F, G01G, G01H, G01J, G01K, G01L, G01M, G01N, G01P, G01R, G01S17/78, 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].

4. Nanotechnology:

Unlike the data of the other technological fields shown above, nanotechnology patent applications are not directly based on an aggregation of patent applications with the same IPC codes. The EPO introduced 'Y01N' tags to label nanotechnology in their databases because the interdisciplinary nature of the field made it too difficult to retrieve these specific patent data from the available databases. The Y01N code is not static, but is constantly updated and improved as new aspects of this young technology emerge. Y01N is divided into six main groups (from Y01N2 to Y01N12), with each group collecting nanotechnology patents of similar technological backgrounds.

The six subgroups are:

- Nano-biotechnology (Y01N2)
- Nanotechnology for information processing, storage and transmission (Y01N4)
- Nanotechnology for materials and surface science (Y01N6)
- Nanotechnology for interacting, sensing or actuating (Y01N8)
- Nano-optics (Y01N10)
- Nanomagnetics (Y01N12)

2.5.13 Co-patenting

Data on co-patenting for patent applications to the EPO and patents granted by the USPTO are available at national level according to both the inventor's and the applicant's country of residence as follows:

- Total patents in the declaring country
- Single inventors/applicants
- Co-patents involving inventors/applicants from the declaring country
- Co-patents involving inventors/applicants from the declaring country and one or more EU Member States
- Co-patents involving inventors/applicants from the declaring country, one or more EU Member States and one or more non EU countries
- Co-patents involving inventors/applicants from the declaring country and one or more non EU countries
- Share of co-patenting between a EU Member State and non-EU countries in the total of each EU Member State patents
- Share of co-patenting between a EU Member State and another EU Member State(s) in the total of each EU Member State patents
- Share of patents with EU inventor and non-EU applicant in the total of EU's domestic inventions
- Share of patents with non-EU inventor and EU applicant in the total of EU's domestic inventions

Apart from co-patenting according to the inventor's and applicant's country of residence, co-patenting data are available for patent applications to the EPO involving cooperation among applicants and inventors. Those data are:

- Share of co-patenting between EU Member States and non-EU countries in the total of all EU patents
- Share of co-patenting between EU Member States in the total of all EU patents
- Share of co-patenting between EU Member States and non-EU countries in the total of all international patents.

The national distribution of patent applications is assigned according to the inventor's country of residence and also according to the applicant's country of residence. If one application has more than one inventor, the application is divided equally among all of them and subsequently among their countries of residence, thus avoiding double counting. The same applies in the case of the indicators which are produced according to the applicant's country of residence.

2.5.14 Patent citations

The total number of publications cited in patents is equal to the number of patent publications to which the identified citation corresponds in patents to the EPO.

Share of EU: for the identified patent publications, EU corresponds to cases of patent publications in which at least one author comes from an EU-27 country.

EU Patents: patent applications to the EPO that have only EU inventors (applicants).

Number of citations referring to non-EU patent publications: In patent applications to the EPO that have only EU inventors (applicants), both the citations and the corresponding patent publications for those citations are identified. For the patent publications cited, those with at least one EU inventor (applicant) are specified, as are those with only non-EU inventors (applicants).

2.6 High-tech industries and knowledge based services

2.6.1 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 at national level for EU-27 Member States, candidate countries, Norway and Switzerland. 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 on the basis of 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 in company accounts as financial or extraordinary are 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. This includes 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.

2.6.2 Venture capital investment

Venture Capital Investment (VCI) is defined as private equity raised for investment in companies. Buyout provides funds to enable an enterprise to acquire another enterprise, another product line or business.

Data are broken down into two investment stages:

- Early stage (seed + start-up) and
- Expansion and replacement (expansion and replacement capital).

Buyout data are also considered in parallel with these two stages and include management buyout, management buy-in, leverage buyout and venture purchase of quoted shares.

Venture capital is expressed as a percentage of GDP (Gross domestic product at market prices), which is defined in accordance with the **E**uropean **S**ystem of National and Regional **A**ccounts 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.

Buyout is defined as the purchase of a company or a controlling interest of a corporation's shares or product line or some business.

2.6.3 High-tech trade

Indicators on high-tech trade are extracted and aggregated on the basis of the Standard International Trade Classification (SITC Rev. 4) using data from COMEXT and from COMTRADE databases.

Until 2006, high-tech products were defined according to SITC Rev. 3. A new version of SITC (SITC Rev. 4) was developed and introduced in March 2006. SITC Rev. 4 was accepted by the United Nations Statistical Commission at its thirty-seventh session (March 2006).

With the revision of the SITC, the definition of high-tech products had to be re-defined as well. The new definition, which is seen as transitional for the time being, is based on correspondence tables between SITC Rev. 3 and SITC Rev. 4. As a result of the revision there was a break in series in 2007, which meant that a new data series had to be built from 2007 onwards for the high-tech products according to SITC Rev. 4. This publication presents the first results for the trade of high-tech products according to SITC Rev. 4.

These data are available for EU-27 Member States, candidate countries, Iceland, Norway, Switzerland, China, Japan and the United States. EU aggregates exclude intra-EU trade.

High-technology groups of products are defined according to the R&D intensity of products following the concepts developed by the OECD — R&D expenditure/total sales covering six countries. Nine SITC Rev. 4 groups of products are considered as high-tech. They are:

- Aerospace
- Computers-Office machines
- Electronics-Telecommunications
- Pharmacy
- Scientific instruments
- Electrical machinery
- Chemistry
- Non-electrical machinery, and
- Armament

The EU totals reported include only extra-EU trade (i.e. they exclude intra-EU trade). This makes it possible to consider the EU as an entity and compare it with other countries. Nevertheless, figures for the individual EU Member States include intra-EU trade.

It should also be noted that these high-tech exports include re-exported imports. This means that a country might show high figures because a large number of goods pass through that country and are counted as both imports and exports.

The indicator 'exports/imports of high-tech products as a percentage of total' is calculated as the share of exports/imports of high-technology products from a country (entity) in total exports/imports from that country (entity).

The world market share is a ratio in which the nominator is the sum of the total exports/imports of high-tech products from countries (entities). The denominator is calculated as the sum of high-tech exports from all countries/entities in the world. This means that, when the EU is counted as an entity, the denominator for world market shares is lower, as it excludes intra-EU trade. As the data originate from two different sources with partly differing methodologies, analysis should be carried out with caution.

2.6.4 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 EU Labour Force Survey — EU LFS.

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).

Employed people are defined as persons aged 15 years and over who performed work during the reference week, even for just one hour in that 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 illness, holidays, industrial dispute, education/training, etc.. In this context, for data quality reasons, anyone below the age of 15 or over the age of 74 is excluded from the figures.

European Commission

Science, technology and innovation in Europe

Luxembourg: Publications Office of the European Union

2010 — 269 pp. — 21 x 29,7 cm

ISBN 978-92-79-14618-3
doi: 10.2785/39823

KS-EM-10-001-EN-N

Publications Office

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