# Key Figures on Science and Technology

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## 2006

Edited by

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Philippe Mustar and Laurence Esterle

**The Observatoire des Sciences et des Techniques (OST)** has for its principal objective the conception and production of indicators for use in describing and analysing scientific, technological, and innovation activities. For this purpose it maintains a data base comprising scientific publication data as well as data on patents, participation in European programmes, international mobility, R&D expenditure, and human resources (research personnel, students, university degrees, etc.). These data, which are obtained from recognised sources, are treated using nomenclature that has been adapted for international comparisons and for use in strategic decision-making.

In carrying out these tasks and through its publications, OST contributes to the ongoing discussion and debate on research and innovation policy. OST is formally established as a public interest organisation whose associated institutions include five government ministries (including the Ministry of Research) as well as France's main public research organisations. In this way, OST serves as a technical platform for its member institutions and, more broadly, for all actors in the French research and development system.

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# INTRODUCTION

A growing internationalisation of the activities of the French Observatory of Science and Technology (OST) and of the dissemination of its works has prompted us to publish the fifth edition of *Chiffres Clés de la Science et de la Technologie* - Key Figures on Science and Technology - in English. The goal in so doing is to contribute to a better awareness of the realm of research and innovation, a realm that is undergoing rapid and often baffling changes. R&D expenditure is growing strongly in some countries, while remaining level in other countries. The leadership positions of the European Union (EU), the United States and Japan in many areas are showing signs of slippage. The arrival on the international scene of new scientific powerhouses such as China, South Korea and India, and soon Brazil, is overturning the balance of scientific power inherited from the previous century. Within the European Union, the entry of ten new Member States is changing the landscape. Throughout the world of R&D, traditional lines are shifting; firms are outsourcing or delocalising large segments of their research activity; creative new initiatives are burgeoning at regional and European levels; firms and public research laboratories are finding new ways to cooperate; international collaboration is intensifying and start-ups in technological fields become world leaders in a few years. Understanding the scope and dynamics of these changes, and the forces that underlie them, requires robust quantitative indicators.

The goal of the present work is to bring together such indicators, in a concise and instructive format, in order to form an overall view of R&D activity in the world. This effort draws on work accomplished at OST, and especially its extensive biennial report providing a wealth of detailed indicators on science and technology. With each new edition of the OST report (seven to date), readers express a desire for a briefer, accompanying volume presenting a synthetic view of the principal data, particularly for non-specialists. It was in response to this demand from public and private sector deciders, regional research actors, laboratory directors, researchers, teachers and students, that OST began publishing the *Chiffres Clés de la Science et de la Technologie* (Key Figures on Science and Technology).

In this fifth edition, the S&T indicators show that the United States, the European Union and Japan - which contain one sixth of the world's population - are responsible for nearly three quarters of world R&D expenditure. They also shed light on deeper trends such as the huge Chinese movement towards investment in R&D, going from 0.83% of Gross Domestic Product (GDP) in 1999 to 1.22% in 2002. Although in these terms China is still well behind Japan with its 3.12% of GDP going towards R&D in 2002 or the United States (2.66%), it is drawing closer to Europe's 1.86% of GDP invested in R&D. While the Asian continent stakes out a position in world R&D, Africa for its part remains largely absent from the R&D picture, with the exception of South Africa.

The European Union devotes 202 billion dollars annually to R&D activities. Nearly two thirds of this amount is spent by three countries: Germany with 26.9% of the EU total, France (responsible for 18.8%) and the United Kingdom (15.4%). Among EU new Member States, Slovenia and the Czech Republic are first in R&D intensity, with 1.53% and 1.30% respectively of GDP spent on research and development.

It is estimated that in 2002 5,300,000 full-time equivalent (FTE) researchers were active in the world, and that 23.7% of this total worked in the United States (or more than 1,260,000 FTE researchers), while the EU accounted for 21.4%, China 15.2%, Japan 12.1%, and Russia 9.2%. It is worthy of note that China moved ahead of Japan in this category and has left countries such as India (1.8% of world R&D labour force) and Brazil (1.2%) well behind.

Alongside such input indicators, the present work furnishes numerous indicators of S&T production, focusing particularly on scientific publication. For 2003, the Web of Science of ISI-Thomson Scientific - the most complete bibliographic database for the sciences - recorded 750,000 scientific articles published worldwide, not counting Social Sciences and the Humanities. Of these, nearly 35.0% were produced by EU Member States, 27.5% by the United States, and nearly 9.0% by Japan. China is next in this ordering, with 4.5% of world publications, followed by Russia (2.6%), India (2.3%), South Korea (2.0%) and Israel (1.0%). Another facet of R&D production is represented by patents.

Patent statistics yield useful indicators for understanding the technological activity of a country. The European Patent Office files 140,000 patent applications each year, while the US Patent and Trademark Office grants 150,000 patents annually. Among EPO patent applications, the EU accounted for 40.0% of requests, followed by the US (31.7%), and Japan (16.2%). In the US patent system, American applicants account for nearly half of all filings (47.9%), followed by Japan (22.5%) and the European Union (17.6%). In the relevant chapters, these production figures are shown in relation to labour force, which changes greatly the rank ordering.

The indicators presented in the following pages have been developed directly by OST. The Observatory of Science and Technology conceives, produces, and disseminates research and technology indicators based on primary data received from a range of sources. These indicators enable users to identify the strengths and weaknesses of countries, regions, or economic sectors, from a look at macro-level data such as budget allocations, human resources, scientific publications, patents, and the like. In addition to conventional indicators on what economists call inputs - financial and human resources - and on the more difficult question of outputs - publications and patents, the present work proposes several indicators of mobility and international scientific cooperation. As it turns out, there is a general consensus in the literature on the innovation process concerning the absence of any linear connection between "inputs" and "outputs". Indicators on these two important aspects of R&D, as useful as they are, do not tell the whole story and in particular offer little insight into relations among actors and the flow of ideas and persons. Relational indicators therefore become important for understanding the contribution of research to a dynamic innovation process. Such indicators, however, are fewer and less amenable to international comparison, given their frequent specificity to a particular national context. To avoid over-ambition, the present work limits its efforts in this regard to a presentation of data on international scientific collaborations as seen through co-publications and student mobility.

Indicators are presented herein as responses to questions which are grouped together in five categories: R&D expenditure, human resources in R&D including doctoral students, scientific publications, international co-publications and patents. Each section is introduced by a short statement, followed by a series of questions. Generally a double page is devoted to each question, the page on the left containing a commentary on the data that is presented in tables and figures to the right. Remarks on methodology appear at the end of the book.

A word of caution on the limits of the use of this kind of quantitative data is appropriate in conclusion. These indicators are above all meant for descriptive purposes and for observing changes and trends. They are aids to the evaluation process, but they are not meant to replace that process. It is therefore necessary to take into account broad series of indicators making up a coherent whole if the intent is to build hypotheses or to draw conclusions. As for methodology, measurement problems in this area are numerous, and the curious reader is invited to consult the full OST reports, cited in the present bibliography, in order to know more about the limits and shortcomings of the aggregates presented in the present work. With all of this said, the important point remains the usefulness of these indicators for comparative and dynamic insight into S&T questions, insight which is the basis for the critical stance upon which analysis must rely.

# R&D budgets

The first chapter of this book shows the sums spent on civil and military R&D by governments, private companies, and external sources. The aim is to present a dynamic analysis, making comparisons at the EU and world level. This chapter demonstrates the weight of the EU programmes (Framework Programmes) in European R&D. Amounts are shown in dollars, but also as a percentage of the Gross Domestic Product (GDP) of a nation. The chief drawback to these indicators, which measure R&D budgets, is their lack of insight into the flows and interactions among research system actors, an activity which is known to account for much innovation. These indicators are nevertheless essential for comparing the importance that different countries or sectors give to R&D, and for tracking changes in countries' strategic decisions over time.

# I. R&D BUDGETS

**Where is research accomplished?**

In 2002, the United States accounted for 34.4% of world R&D expenditure, the European Union 25.0%, and Japan 13.2%. China was fourth in world ranking with 8.9% of world R&D expenditure.

Research activity does not represent the same relative weight inside each national economy. If research expenditure of each zone is examined by comparing Gross domestic Expenditure on R&D (GERD) to Gross Domestic Product (GDP), we find that Japan and the United States devote 3.12% and 2.66% respectively of their GDP to R&D as opposed to 1.86% for the European Union, and 1.22 % for China. The latter, however, has made remarkable strides, from 0.83% in 1999 to 1.0% in 2000, reaching 1.22% in 2002.

Israel is the country which spends the largest share of GDP on R&D, with 5.08%.

R&D is highly concentrated. The European Union, the United States and Japan represent not quite one sixth of the world's population but account for nearly three quarters of world research expenditure.



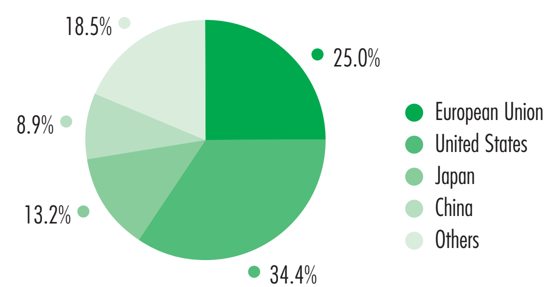


| | Population (2002) | Gross domestic expenditure on R&D (2002) | | | |
|---|---|---|---|---|---|
| | World share | Volume (Billion $) | | World share | GERD/GDP |
| Country/Zone | (%) | 2002 | Evolution 2002/1997 (%) | (%) | (%) |
| European Union (25) | 7.5 | 202 | +21 | 25.0 | 1.86 |
| United States | 4.7 | 277 | +20 | 34.4 | 2.66 |
| Japan | 2.1 | 107 | +12 | 13.2 | 3.12 |
| China | 21.1 | 72 | +160 | 8.9 | 1.22 |
| India* | 16.4 | 23 | na | 2.8 | 0.78 |
| South Korea | 0.8 | 23 | +25 | 2.8 | 2.53 |
| Russia | 2.4 | 15 | +54 | 1.8 | 1.25 |
| Israel | 0.1 | 7 | +82 | 0.8 | 5.08 |
| South Africa* | 0.7 | 4 | na | 0.5 | 0.77 |
| Brazil** | 2.9 | 14 | +11 | 1.7 | 1.04 |
| Others | 41.4 | 64 | - | 8.0 | 0.56 |
| **Total** | **100.0** | **807** | **-** | **100.0** | **1.66** |

*data OECD, Eurostat, Ined, OST estimations and computation* *Key Figures - 2006*

- ** 2001 data*
- *** 2000 data*
- *monetary values are expressed in dollars ppp and changes are calculated on the basis of national currencies expressed in year 2000 constant terms*
- *na: data not available*

**EU, US, Japan and China's world share of gross domestic expenditure on R&D (2002)**




*data OECD, Eurostat, Ined, OST estimations and computation* *Key Figures - 2006*

# I. R&D BUDGETS

**What sum of money does the European Union devote to research and development?**

In 2002, European Union Member States spent 202 billion dollars on R&D. Nearly two thirds of this sum was spent by three countries: Germany, which alone accounted for 26.9% of European R&D expenditure; France for 18.8%, and the United Kingdom for 15.4%.

When research spending is expressed in terms of each country's GDP, the gap between Germany and France is significant (2.53% compared to 2.26%). But the R&D effort by these two countries is markedly stronger than that of the United Kingdom (1.87%). Sweden, which devotes 4.27% of its GDP to R&D, is the leading European country when ranked by this indicator. At the other end of the ranking can be found Greece (0.65%), Poland (0.59%), Slovakia (0.58%), Latvia (0.42%) and Cyprus (0.31%). Among new Member States, the R&D efforts to be noted are those of the Czech Republic (1.30%) and most of all Slovenia (1.53%).

Change in R&D expenditure between 1997 and 2002, however, gives quite another picture. While overall, the European Union increased its spending by 21% over this period, some new member countries recorded increases two or more times greater than this average: Hungary (+75%), Portugal (+73%), Latvia (+60%), Cyprus (+59%), Estonia (+52%), Spain (+50%), Finland (+50%), Austria and Denmark (+44%), and lastly Greece (+43%).

In contrast, Slovakia, the Netherlands and Poland demonstrated a far less favourable tendency with changes over the period of, respectively, -38%, +2%, +2%.



## I.2. R&D EXPENDITURE IN EU MEMBER STATES (2002)

| | Gross domestic expenditure on R&D (2002) | | | |
|---|---|---|---|---|
| | Volume (Million $) | | EU (25) share | GERD/GDP |
| Country | 2002 | Evolution 2002/1997 (%) | (%) | (%) |
| Germany | 54,256 | +19 | 26.9 | 2.53 |
| France | 37,967 | +17 | 18.8 | 2.26 |
| United Kingdom | 31,163 | +19 | 15.4 | 1.87 |
| Italy* | 16,367 | +12 | 8.1 | 1.11 |
| Spain | 9,421 | +50 | 4.7 | 1.03 |
| Netherlands* | 8,693 | +2 | 4.3 | 1.88 |
| Greece* | 1,211 | +43 | 0.6 | 0.65 |
| Belgium | 6,427 | +33 | 3.2 | 2.24 |
| Portugal | 1,781 | +73 | 0.9 | 0.94 |
| Sweden* | 10,233 | +36 | 5.1 | 4.27 |
| Austria | 5,118 | +44 | 2.5 | 2.19 |
| Denmark | 3,977 | +44 | 2.0 | 2.52 |
| Finland | 4,779 | +50 | 2.4 | 3.46 |
| Ireland* | 1,304 | +18 | 0.6 | 1.13 |
| Luxembourg** | 364 | na | 0.2 | 1.71 |
| Poland | 2,439 | +2 | 1.2 | 0.59 |
| Czech Republic | 2,021 | +21 | 1.0 | 1.30 |
| Hungary | 1,451 | +75 | 0.7 | 1.02 |
| Slovakia | 382 | -38 | 0.2 | 0.58 |
| Lithuania | 239 | +39 | 0.1 | 0.67 |
| Latvia | 100 | +60 | 0.0 | 0.42 |
| Slovenia | 587 | +39 | 0.3 | 1.53 |
| Estonia | 134 | +52 | 0.1 | 0.75 |
| Cyprus | 44 | +59 | 0.0 | 0.31 |
| Malta | na | na | na | na |
| **European Union (25)** | **201,740** | **+21** | **100.0** | **1.86** |

*data OECD, Eurostat, OST estimations and computation* *Key Figures - 2006*

- ** 2001 data*
- *** 2000 data*
- *GERD: Gross domestic expenditure on R&D*
- *GDP: Gross domestic product*
- *monetary values are expressed in dollars ppp and changes are calculated on the basis of national currencies expressed in year 2000 constant terms*
- *na: data not available*

**Who supplies the bulk of a country's expenditure on R&D: private enterprises, the public sector, or foreign sources?**

In the three main geographic zones of the United States, the European Union and Japan, the share of private enterprises in R&D funding is greater than that of the public sector. Firm R&D expenditure represents two thirds of the overall research effort in the US (64.4%), nearly three quarters in Japan (73.9%) and more than half in the European Union (55.4%).

In the case of the European Union, funding from foreign sources covers both EC support (Framework Programmes) and funds from the European Space Agency (ESA) - whether they are allocated to public laboratories or those of firms. It also includes R&D budgets that transit from one branch of a multinational to another. Foreign funding is not a significant part for Japan or the United States, but does account for 7.6% of the total EU R&D effort.

Within the European Union, the three major funding sources vary considerably by country. Firms account for 65.5% of domestic R&D in Germany, 52.1% in France, and 46.7% in the United Kingdom. Funding from abroad differs greatly among these three countries, amounting to 20.5% in the case of the United Kingdom (due to the size and number of multinational subsidiaries in this country), 8.0% in France, and only 2.4% in Germany.
Lastly, the relatively weak level of public sector funding of R&D in Germany and Japan can be explained by the low-level effort made in direct funding of military R&D, compared to their competitors.

Only three new EU Member States demonstrate private firm contributions to R&D over 50% of total expenditure: Slovakia (53.6%), Czech Republic (53.7%) and Slovenia (60.0%). **See table A.3 in annex.**



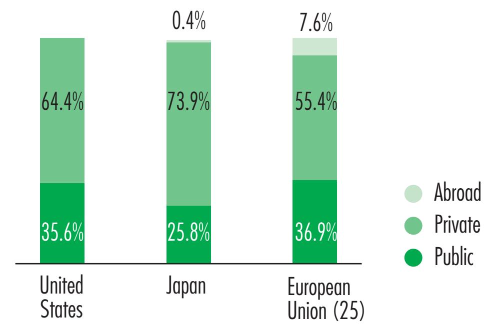
## I.3. R&D FUNDING SOURCES IN US, JAPAN AND EU MEMBER STATES (2002)

| Country/Zone | Funding sources of GERD (2002) Public (%) | Private (%) | Abroad (%) | Total (%) | Volume (Million $) |
|---|---|---|---|---|---|
| United States | 35.6 | 64.4 | na | 100.0 | 277,100 |
| Japan | 25.8 | 73.9 | 0.4 | 100.0 | 106,854 |
| European Union (25) | 36.9 | 55.4 | 7.6 | 100.0 | 201,740 |
| Germany | 32.1 | 65.5 | 2.4 | 100.0 | 54,256 |
| France | 39.9 | 52.1 | 8.0 | 100.0 | 37,967 |
| United Kingdom | 32.8 | 46.7 | 20.5 | 100.0 | 31,163 |

*data OECD, Eurostat, OST estimations and computation* *Key Figures - 2006*

- *GERD: Gross domestic expenditure on R&D*
- *monetary values are expressed in dollars ppp and changes are calculated on the basis of national currencies expressed in year 2000 constant terms*

**Distribution of funding sources of GERD in United States, Japan and European Union (2002)**




*data OECD, Eurostat, OST estimations and computation* *Key Figures - 2006*

## What part of public R&D budgets is devoted to military R&D?

The distribution between civil and military R&D of public R&D expenditure varies greatly among the three zones under analysis. In the US, 52.1% of public R&D budgets is used to fund military R&D. In Japan, this figure is only 4.1%, although comparison is difficult because a large part of the cost of research in Japan is included in the overall cost that is charged for military goods bought from private firms.

European Union Member States devote 12 billion dollars annually to military R&D expenditure, or 14.9% of total public spending on R&D. For Germany, military R&D takes up only 5.5% of the public R&D budget, while the United Kingdom, Spain and France are the top public spenders on military R&D with, respectively, 34.1%, 26.6% and 23.0% of public R&D budgets.

Between 1997 and 2002, the United States and European Union members boosted appreciably their budget for defence R&D (25% and 24%, respectively). But among EU members sharp differences in trends over this period are to be noted, ranging from Germany, which lowered defence R&D drastically by 43%, to Spain and Portugal which increased expenditure by 152% and 115% respectively. In the middle, France and the United Kingdom – after significant decreases in the preceding period – raised military R&D spending by 5%.



## I.4. PUBLIC EXPENDITURE ON CIVIL AND MILITARY R&D IN US, JAPAN AND EU MEMBER STATES (2002)

| | Government budget for R&D (2002) | | | | |
|---|---|---|---|---|---|
| Country/Zone | Civil budget (%) | Defence budget (%) | Total (%) | Volume (Million $) | Defence budget Evolution 2002/ 1997 (%) |
| United States | 47.9 | 52.1 | 100.0 | 103,057 | +25 |
| Japan | 96.0 | 4.1 | 100.0 | 24,314 | -13 |
| European Union (25) | 85.1 | 14.9 | 100.0 | 81,106 | +24 |
| Germany | 94.5 | 5.5 | 100.0 | 17,017 | -43 |
| France | 77.0 | 23.0 | 100.0 | 17,042 | +5 |
| United Kingdom | 65.9 | 34.1 | 100.0 | 12,795 | +5 |
| Italy* | 96.0 | 4.0 | 100.0 | 10,188 | +13 |
| Spain | 73.4 | 26.6 | 100.0 | 7,034 | +152 |
| Netherlands | 98.2 | 1.8 | 100.0 | 3,627 | -38 |
| Greece | 99.3 | 0.7 | 100.0 | 579 | -29 |
| Belgium | 99.7 | 0.3 | 100.0 | 1,775 | -29 |
| Portugal | 98.1 | 1.9 | 100.0 | 1,334 | +115 |
| Sweden | 81.8 | 18.2 | 100.0 | 2,118 | -15 |
| Austria | 100.0 | ns | 100.0 | 1,568 | na |
| Denmark* | 99.5 | 0.5 | 100.0 | 1,161 | +5 |
| Finland | 98.4 | 1.6 | 100.0 | 1,374 | +8 |
| Ireland | 100.0 | 0.0 | 100.0 | 387 | na |
| Luxembourg | na | na | 100.0 | 47 | na |
| Poland* | na | na | 100.0 | 1,610 | na |
| Czech Republic | 96.7 | 3.3 | 100.0 | 835 | na |
| Hungary | na | na | 100.0 | na | na |
| Slovakia | 90.8 | 9.2 | 100.0 | 210 | na |
| Lithuania | 100.0 | na | 100.0 | 98 | na |
| Latvia | na | na | 100.0 | 43 | na |
| Slovenia | 99.8 | 0.2 | 100.0 | 212 | +7 |
| Estonia | na | na | 100.0 | 52 | na |
| Cyprus | na | na | 100.0 | na | na |
| Malta | na | na | 100.0 | na | na |

*data OECD, Eurostat, OST estimations and computation* — *Key Figures - 2006*

- ** 2001 data*
- *monetary values are expressed in dollars ppp and changes are calculated on the basis of national currencies expressed in year 2000 constant terms*
- *na: data not available.*

### How has R&D expenditure in Europe evolved over the last twenty years?

In 2002, nearly two thirds of European R&D effort was carried out by the private sector (63.8%) and one third (36.2%) by the public sector.

Between 1997 and 2002, the share of European Union GERD carried out by the private sector rose by a point and a half. This growth in R&D spending share by private enterprises can be observed in some twenty Member States. In Italy, the Czech Republic, and Ireland, this same share dropped slightly, while in Hungary and Slovakia it dropped more sharply.

EU Member States can be grouped into three categories according to how their national R&D effort is distributed between the private sector and the public sector:
• Countries where R&D is chiefly carried out by the private sector. These countries are the closest to the EU average of one third of R&D performed by public research and two thirds by private research, and they include Germany, France, the United Kingdom, Denmark, Finland, Ireland, the Czech Republic, Slovakia and Slovenia;
• Countries which are close to a balanced distribution between public and private R&D, including Italy, Spain, the Netherlands, and Austria;
• Finally, the group of countries where R&D is primarily a public sector activity, with two thirds of all R&D effort being carried out by the public sector. These include Greece, Portugal, Hungary, Latvia, and Estonia, as well as the trio of Poland, Lithuania and Cyprus where the public sector share of R&D is 80% or more.



## I.5. R&D EXPENDITURE IN EU MEMBER STATES BY SECTOR (1997-2002)

| | GERD carried out by the public sector (%) | | GERD carried out by the private sector (%) | |
|---|---|---|---|---|
| Country | 1997 | 2002 | 1997 | 2002 |
| Germany | 32.5 | 30.8 | 67.5 | 69.2 |
| France | 37.5 | 36.7 | 62.5 | 63.3 |
| United Kingdom | 34.8 | 33.0 | 65.2 | 67.0 |
| Italy* | 50.2 | 50.7 | 49.8 | 49.3 |
| Spain | 51.2 | 45.4 | 48.8 | 54.6 |
| Netherlands | 45.4 | 44.7 | 54.6 | 55.3 |
| Greece | 74.4 | 66.0 | 25.6 | 34.0 |
| Belgium | 28.4 | 26.7 | 71.6 | 73.3 |
| Portugal | 77.5 | 65.6 | 22.5 | 34.4 |
| Sweden | 25.1 | 22.4 | 74.9 | 77.6 |
| Austria | na | 55.1 | na | 44.9 |
| Denmark* | 38.6 | 30.7 | 61.4 | 69.3 |
| Finland | 34.0 | 30.1 | 66.0 | 69.9 |
| Ireland | 29.0 | 29.5 | 71.0 | 70.5 |
| Luxembourg** | na | 9.7 | na | 90.3 |
| Poland* | 60.6 | 78.6 | 39.4 | 21.4 |
| Czech Republic | 37.2 | 38.9 | 62.8 | 61.1 |
| Hungary | 58.5 | 64.5 | 41.5 | 35.5 |
| Slovakia | 24.4 | 35.7 | 75.6 | 64.3 |
| Lithuania | 94.5 | 83.1 | 5.5 | 16.9 |
| Latvia | 76.2 | 59.1 | 23.8 | 40.9 |
| Slovenia | 47.0 | 40.3 | 53.0 | 59.7 |
| Estonia | na | 69.4 | na | 30.6 |
| Cyprus | na | 79.7 | na | 20.3 |
| Malta | na | na | na | na |
| **European Union (25)** | **37.7** | **36.2** | **62.3** | **63.8** |

*data OECD, Eurostat, OST estimations and computation* *Key Figures - 2006*

• * 2001 data
• ** 2000 data
• GERD: Gross domestic expenditure on R&D
• na: data not available

**How is European-level R&D funding shared among Member States?**

The principal R&D funding instrument at the European level is the Framework Programme (FP) for Research and Technological Development. Four EU members share close to half of the average annual expenditure by the Fifth FP (FP5): Germany with 14.2%, followed by France (13.1%), the United Kingdom (11.4%), and Italy (9.4%). Spain, the Netherlands, and Greece follow with smaller shares (8.5%, 5.6% and 4.8%, respectively).

Funding obtained through the FP5 represents 4.5% of all public civil research expenditure in EU member countries. The percentage it represents of each national budget, however, varies greatly by country. It is the highest for Greece, where FP5 funds represent over a quarter of public civil R&D expenditure (25.9%), and next highest for Ireland (more than 11%). FP5 funds account for only 3% of all public civil R&D in Germany, France, and Italy.

FP5 funds represent a higher share of national civil research budgets for new EU members than the EU average; FP funding amounted to 6.3% of the civil research expenditure of the Czech Republic, 8.5% in Slovenia, and 10.2% in Slovakia and Lithuania.

## I.6. FIFTH FRAMEWORK PROGRAMME FUNDING AS A SHARE OF NATIONAL PUBLIC R&D BUDGETS IN EU MEMBER STATES (2001)

| Country | Fifth Framework Programme: Participation share (%) | Fifth Framework Programme: Funding estimation (annual mean value): Volume (Million $) | Fifth Framework Programme: Funding estimation (annual mean value): Share (%) | Government budget of civil R&D (Million $) (2001) | Ratio of FP5 funding to government civil R&D budget (%) |
|---|---|---|---|---|---|
| Germany | 14.4 | 442 | 14.2 | 15,428 | 2.9 |
| France | 12.3 | 407 | 13.1 | 12,569 | 3.2 |
| United Kingdom | 13.0 | 354 | 11.4 | 7,457 | 4.7 |
| Italy | 9.1 | 294 | 9.4 | 9,778 | 3.2 |
| Spain | 8.2 | 263 | 8.5 | 3,724 | 7.1 |
| Netherlands | 6.0 | 174 | 5.6 | 3,564 | 4.9 |
| Greece | 3.8 | 149 | 4.8 | 583 | 25.9 |
| Belgium | 3.8 | 125 | 4.0 | 1,661 | 7.9 |
| Portugal | 2.0 | 67 | 2.2 | 1,143 | 5.9 |
| Sweden | 3.8 | 104 | 3.3 | 1,727 | 6.0 |
| Austria | 2.3 | 63 | 2.0 | 1,512 | 4.2 |
| Denmark | 2.7 | 65 | 2.1 | 1,175 | 5.7 |
| Finland | 2.6 | 63 | 2.0 | 1,347 | 4.7 |
| Ireland | 1.3 | 36 | 1.2 | 379 | 11.2 |
| Luxembourg | 0.2 | 5 | 0.1 | na | na |
| Poland | 1.4 | 66 | 2.1 | na | na |
| Czech Republic* | 1.0 | 51 | 1.6 | 808 | 6.3 |
| Hungary | 0.9 | 42 | 1.3 | na | na |
| Slovakia* | 0.4 | 20 | 0.6 | 191 | 10.2 |
| Lithuania | 0.2 | 10 | 0.3 | 97 | 10.2 |
| Latvia | 0.2 | 9 | 0.3 | na | na |
| Slovenia | 0.5 | 18 | 0.6 | 211 | 8.5 |
| Estonia | 0.3 | 17 | 0.5 | na | na |
| Cyprus | 0.2 | 8 | 0.3 | na | na |
| Malta | 0.1 | 2 | 0.1 | na | na |
| **European Union (25)** | **90.6** | **2,853** | **91.6** | **63,355** | **4.5** |
| **Total** | **100.0** | **-** | **100.0** | **-** | **-** |
| **Volume** | **70,438** | **-** | **3,114** | **-** | **-** |

*data CORDIS. OECD, Eurostat, OST estimations and computation* *Key Figures - 2006*

- ** 2002 data; unless otherwise noted the figures are based on 2001 data*
- *FP spending is shown as an average annual amount*
- *estimated values are calculated on the basis of 2001 exchange rates (from euros into national currency and national currency into dollars ppp)*
- *na: data not available*

# R&D human resources



The scientific and technical strength of a region or a nation is a reflection of the quality of its laboratories, and above all of the competences of the men and women who work in them. The following statistics refer to the “management” level of R&D, that is, research scientists, engineers, and teacher-researchers. The labels for these categories change from one institution or one country to another, but the nature of the work is essentially the same from place to place.

A laboratory staff can be represented in two ways: in number of full-time equivalents (FTE) or by a head count of staff members.

The distinction is important when university research is concerned, and the choice has been made in this second chapter to utilize FTE even though there are some drawbacks when comparing university research internationally.

Researchers are employed either in the public sector, that is, by universities or public research organisations, or in the private sector, composed of laboratories attached to firms. The allocation of human resources between these two sectors yields an idea of their relative strength.

One of the critical activities of any research laboratory is the training of doctoral researchers. Doctoral candidates are at once a production of and a resource for laboratories, where they work during four years (on average) preparing a thesis.

Several indicators concerning doctoral researchers and doctoral theses are presented in this second chapter, thus making possible some international comparisons.

Lastly, students in S&T disciplines are increasingly mobile during their education, and indicators of this mobility can shed light on the capacity of a country to attract young scientists.

# II. R&D HUMAN RESOURCES

**How many researchers are there in the world?**
**How are they distributed?**

There are about 5.3 million full-time-equivalent researchers in the world. One fourth of them work in the United States, constituting a scientific labour force of 1,260,000 researchers in US public and private laboratories. The European Union is the second largest world scientific area as measured by a researcher labour force that is 10% smaller than that of the US, and which is only 30% larger than that of China. The latter is now a world force in science and technology with 810,000 researchers and engineers. Japan is fourth worldwide in terms of scientific labour force, with 646,000 scientists. Lastly, Russia is still in possession of a significant scientific potential with nearly half of a million of researchers and engineers.

These five zones or countries represent more than 80% of total worldwide R&D labour force, composed of researchers and engineers.

When the number of scientists is expressed in ratio of the labour force of each zone or country, the list is shuffled. Japan's 9.7 researchers and engineers per thousand workers place it in front of the United States (8.6 per thousand), Russia (6.8 per thousand), and the European Union (5.4 per thousand). The density of researchers in China is far lower (not more than one researcher for a thousand members of the labour force), nearly nine times less than that of Japan.



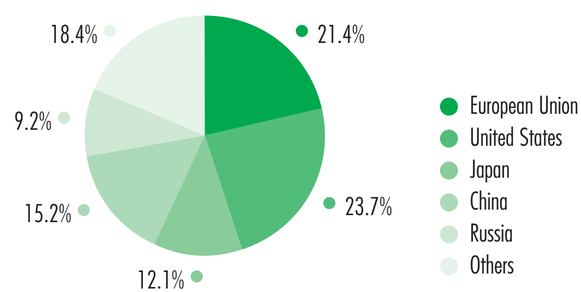
## II.1. RESEARCHERS WORLDWIDE (2002)

| Country/Zone | Researchers (2002) | | |
|---|---|---|---|
| | Number (in FTE) | Ratio per thousand labour force | World share (%) |
| European Union (25) | 1,139,885 | 5.39 | 21.4 |
| United States* | 1,261,227 | 8.62 | 23.7 |
| Japan | 646,547 | 9.67 | 12.1 |
| China | 810,525 | 1.09 | 15.2 |
| India** | 95,000 | 0.20 | 1.8 |
| South Korea | 141,917 | 6.20 | 2.7 |
| Russia | 491,944 | 6.80 | 9.2 |
| Israel | 48,432 | 19.02 | 0.9 |
| South Africa*** | 8,860 | 0.51 | 0.2 |
| Brazil*** | 64,361 | 0.74 | 1.2 |
| Others | 616,505 | 0.41 | 11.6 |
| **World** | **5,325,203** | **1.59** | **100.0** |

*data OECD, Eurostat, Ricyt and other sources, OST estimations and computation* *Key Figures - 2006*

- ** 1999 data*
- *** data estimated in1998*
- **** 2001 data*
- *FTE: Full-time equivalent in R&D*

**EU, US, Japan, China and Russia's world share of researchers (2002)**




*data OECD, Eurostat, Ricyt and other sources, OST estimations and computation* *Key Figures - 2006*

## How many researchers are there in each EU Member State?

In 2002 the research potential of the European Union amounted to 1,139,885 researchers (counted in full-time equivalents). Germany alone accounted for 23.3% of this total (or 265,812 scientists). France and the United Kingdom - with 186,420 and 173,747 researchers - accounted for 16.4% and 15.2% respectively of European Union's total scientific labour force. Taken together, Germany, France and the United Kingdom amount to more than half of the total European Union research potential as measured in human resources (54.9%).
Spain, Italy, and Poland are the other three countries possessing at least 5% of EU's scientists. Sweden, the Netherlands, Finland and Belgium account for around 4% to 3% each, and the total of these seven countries comes to one third of the full European potential.
The fifteen remaining countries of the European Union taken together account for only one eighth of the total number of scientists in the Union. This group of countries includes all of the new Member States except Poland.

When the number of scientists is expressed in ratio of the labour force, the list looks quite different. Finland, Sweden and Denmark are the countries showing the greatest density of researchers representing 14.7, 10.3, and 9.1 per thousand workers, respectively. Next come Belgium (7.4 per thousand), France (6.9‰), Germany (6.7‰), the United Kingdom (5.8‰), Luxembourg (5.6‰), and the Netherlands (5.5‰), all above the EU average of 5.4 per thousand labour force. Among new EU Member States, Slovenia and Estonia stand out with, respectively, 4.9 and 4.7 researchers per thousand workers. With a density of three researchers per thousand workers, Portugal and Greece are similar to most of the new Member States.





| Country | EU researchers (2002) | | |
|---|---|---|---|
| | Number (in FTE) | Ratio per thousand labour force | EU (25) share (%) |
| Germany | 265,812 | 6.71 | 23.3 |
| France | 186,420 | 6.90 | 16.4 |
| United Kingdom** | 173,747 | 5.80 | 15.2 |
| Italy* | 66,702 | 2.77 | 5.9 |
| Spain | 83,318 | 4.54 | 7.3 |
| Netherlands* | 45,328 | 5.47 | 4.0 |
| Greece* | 14,371 | 3.29 | 1.3 |
| Belgium | 32,856 | 7.39 | 2.9 |
| Portugal | 17,724 | 3.29 | 1.6 |
| Sweden* | 45,995 | 10.27 | 4.0 |
| Austria** | 18,715 | 4.76 | 1.6 |
| Denmark | 25,912 | 9.10 | 2.3 |
| Finland | 38,632 | 14.69 | 3.4 |
| Ireland* | 8,949 | 4.90 | 0.8 |
| Luxembourg** | 1,646 | 5.60 | 0.1 |
| Poland | 56,725 | 3.28 | 5.0 |
| Czech Republic | 14,974 | 2.89 | 1.3 |
| Hungary | 14,965 | 3.64 | 1.3 |
| Slovakia | 9,181 | 3.49 | 0.8 |
| Lithuania | 6,326 | 3.87 | 0.6 |
| Latvia | 3,451 | 3.06 | 0.3 |
| Slovenia | 4,642 | 4.86 | 0.4 |
| Estonia | 3,059 | 4.67 | 0.3 |
| Cyprus | 435 | 1.20 | 0.0 |
| Malta | na | na | na |
| **European Union (25)** | **1,139,885** | **5.39** | **100.0** |

*data OECD, Eurostat, OST estimations and computation* *Key Figures - 2006*

- ** 2001 data*
- *** UK: data estimated from national sources (SET); Austria: 1998 data; Luxembourg: 2000 data*
- *FTE: Full-time equivalent in R&D*
- *na: data not available*

### How are researchers distributed between public and private sectors?

The distribution of researchers between the private sector (mainly the laboratories of private firms and enterprises) and the public sector (that is, in laboratories funded by the State, institutions of higher education, and not-for-profit organisations) varies greatly from country to country.
Accordingly, in the United States, four out of five researchers work in the private sector, while in Europe this figure is one out of two. The United States in fact is the nation with the highest percentage of researchers working in the private sector (82.3%), followed by Israel (79.1%), South Korea (73.4%), and Japan (66.7%). China is moving closer to this group with now nearly 55% of its researchers working in for private firms (compared to 40% in the middle of the 1990's).

The European Union is characterised by a smaller proportion of researchers working in the private sector (less than 50%), although the picture varies by country within the Union. For example, in Sweden, the United Kingdom, and Germany, the percentage of researchers in private laboratories is near or exceeds 60% while it is 40% in Italy and 30% in Spain. Among the new EU Member States a similarly wide disparity can be found, ranging from Poland, with its large number of researchers, of whom only 8.3% work in the private sector to the Czech Republic, whose 41.3% of researchers in private firms approaches the EU average.



## II.3. RESEARCHERS WORLDWIDE BY PUBLIC AND PRIVATE SECTORS (2002)

| | Researchers by sector (2002) | | | |
|---|---|---|---|---|
| Country/Zone | Public (%) | Private (%) | Total (%) | Number (in FTE) |
| European Union (25) | 50.6 | 49.4 | 100.0 | 1,139,885 |
| Germany | 41.5 | 58.5 | 100.0 | 265,812 |
| France | 48.9 | 51.1 | 100.0 | 186,420 |
| United Kingdom** | 39.8 | 60.2 | 100.0 | 173,747 |
| Italy* | 60.2 | 39.8 | 100.0 | 66,702 |
| Spain | 70.4 | 29.6 | 100.0 | 83,318 |
| Netherlands* | 55.0 | 45.0 | 100.0 | 45,328 |
| Greece* | 72.0 | 28.0 | 100.0 | 14,371 |
| Belgium | 44.9 | 55.1 | 100.0 | 32,856 |
| Portugal | 84.6 | 15.4 | 100.0 | 17,724 |
| Sweden* | 39.4 | 60.6 | 100.0 | 45,995 |
| Austria | 37.4 | 62.6 | 100.0 | 18,715 |
| Denmark | 39.2 | 60.8 | 100.0 | 25,912 |
| Finland | 44.9 | 55.1 | 100.0 | 38,632 |
| Ireland* | 33.3 | 66.7 | 100.0 | 8,949 |
| Luxembourg | 15.0 | 85.0 | 100.0 | 1,646 |
| Poland | 91.7 | 8.3 | 100.0 | 56,725 |
| Czech Republic | 58.7 | 41.3 | 100.0 | 14,974 |
| Hungary | 71.0 | 29.0 | 100.0 | 14,965 |
| Slovakia | 76.4 | 23.6 | 100.0 | 9,181 |
| Lithuania | 95.8 | 4.2 | 100.0 | 6,326 |
| Latvia | 80.4 | 19.6 | 100.0 | 3,451 |
| Slovenia | 65.1 | 34.9 | 100.0 | 4,642 |
| Estonia | 84.8 | 15.2 | 100.0 | 3,059 |
| Cyprus | 73.1 | 26.9 | 100.0 | 435 |
| Malta | na | na | 100.0 | na |
| United States** | 17.7 | 82.3 | 100.0 | 1,261,227 |
| Japan | 33.3 | 66.7 | 100.0 | 646,547 |
| China | 45.3 | 54.7 | 100.0 | 810,525 |
| India** | 63.2 | 36.8 | 100.0 | 95,000 |
| South Korea | 26.6 | 73.4 | 100.0 | 141,917 |
| Israel | 20.9 | 79.1 | 100.0 | 48,432 |
| Russia | 44.0 | 56.0 | 100.0 | 491,944 |
| Brazil | 68.9 | 31.1 | 100.0 | 64,361 |

*data OECD, Eurostat, Ricyt and other sources, OST estimations and computation* — *Key Figures - 2006*

- * 2001 data
- ** UK: data estimated from national sources (SET), United States: 1999 data; India: estimated data from 1998
- FTE: Full-time equivalent in R&D
- na: data not available

### What place do women have in European research?

The proportion of women in research varies widely from country to country. Of the sixteen EU member countries for which data is available, Germany and Austria are the two countries where the share of women in research is the weakest, amounting to 16.1% of all researchers in Germany and 18.8% in Austria. At the other end of the spectrum, women have reached parity in Latvia (51.8%) and Lithuania (47.7%). In six countries women account for at least a third of all researchers: Estonia, Slovakia, Poland, Spain, Slovenia, and Hungary. In France, Denmark, and Belgium women do not make up more than one fourth of the scientific labour force.

All EU countries taken together, female representation in private sector research is significantly less than in the public sector (government or higher education).

Germany and Austria are also the two European countries where the proportion of women among researchers working in private firms is the smallest: 11.7% and 9.0%, respectively. Conversely, Latvia and Lithuania are the two countries where women account for the largest share of all private sector researchers: 48.2% and 32.7%, respectively.

It should be noted that for the public sector as for the private sector, the share of women is clearly larger in the new Member States than in the EU(15). Thoroughgoing data on women in research by discipline, by career level (researcher grade, level of university post), and by level of responsibility (laboratory director, lead investigator), across all European countries, is severely lacking.

With the exception of Lithuania and Latvia, women are underrepresented in research compared to all professions taken together. In Germany, for example, women are three times less represented in research than they are in the labour force overall.



## II.4. WOMEN RESEARCHERS IN EU MEMBER STATES (2002)

Share (%) of women among researchers (2002)

| Country | Business Enterprise sector (%) | Government sector (%) | Higher Education sector (%) | Total (%) | Number | Index of woman participation to R&D |
|---|---|---|---|---|---|---|
| Germany* | 11.7 | 22.9 | 22.4 | 16.1 | 42,588 | 0.36 |
| France | 20.9 | 31.9 | 33.0 | 27.7 | 64,253 | 0.60 |
| Spain | 24.8 | 42.4 | 37.0 | 35.2 | 52,850 | 0.88 |
| Belgium* | 16.8 | 29.9 | 37.2 | 25.6 | 8,254 | 0.59 |
| Austria* | 9.0 | 31.9 | 25.7 | 18.8 | 5,901 | 0.42 |
| Denmark | 21.3 | 33.8 | 32.0 | 26.2 | 9,943 | 0.56 |
| Finland | 18.4 | 40.7 | 44.2 | 29.9 | 15,025 | 0.62 |
| Poland* | 28.2 | 42.9 | 38.9 | 38.1 | 33,572 | 0.83 |
| Czech Republic | 19.7 | 32.9 | 34.9 | 29.5 | 9,024 | 0.66 |
| Hungary | 23.7 | 38.2 | 35.3 | 33.7 | 10,039 | 0.75 |
| Slovakia | 29.9 | 44.1 | 40.8 | 39.6 | 6,086 | 0.87 |
| Lithuania | 32.7 | 49.2 | 48.0 | 47.7 | 4,536 | 0.97 |
| Latvia | 48.2 | 54.8 | 52.2 | 51.8 | 3,159 | 1.07 |
| Slovenia | 28.7 | 43.3 | 34.3 | 35.1 | 2,466 | 0.76 |
| Estonia | 23.4 | 60.0 | 43.4 | 42.6 | 2,168 | 0.87 |
| Cyprus | 24.1 | 32.9 | 30.5 | 29.4 | 298 | 0.66 |

*data Eurostat, OST estimations and computation* — *Key Figures - 2006*

- *only countries for which data are available are shown*
- ** Germany and Belgium: 2001 data in FTE; Austria: year 1998; Poland: 2000 data*
- *the index of women participation to R&D is calculated by the ratio of the percentage of women among researchers to the percentage of women among the labour force*

## How many students earn a university degree?

The EU(25) turns out more university degree-holders than the United States (2,156,000 compared to 1,899,000). China occupies third place worldwide, followed by Russia and Japan.
When the number of degrees is expressed in ratio of the population, the rank order is nearly the reverse; Japan is in first place with 8.22 degrees per thousand inhabitants, followed by the United States (7.77‰), the European Union (6.36‰), and Russia (4.89‰). In the case of China, the same indicator reveals a very weak proportion of the population earning a university degree (0.80 degrees per thousand inhabitants).

Within the European Union, the United Kingdom dominates other members with 436,000 university degrees. When expressed in terms of number of inhabitants, Poland leads with 11.9 university degrees per one thousand inhabitants, followed by the United Kingdom (9.41‰), France (8.74‰), Spain (7.24‰), Finland (6.60‰), and Hungary (6.23‰). The other member countries all fall below the EU average of 6.36‰.

Doctorates or their equivalent take on a different meaning from the other types of degrees. The EU produces nearly twice as many doctorates as the United States (81,000 compared to 44,000). Russia remains a major actor in higher education, granting some 27,000 doctorates per year.

A rank ordering by number of doctorates per inhabitant finds Russia at the top of the list with 0.19 doctorates per thousand inhabitants, slightly ahead of the EU (0.18‰), followed by the United States (0.15‰) and Japan (0.11‰), with China much further behind with 0.01‰.



## II.5. GRADUATES AND DOCTORAL STUDENTS WORLDWIDE (2002)

| Country/Zone | Graduate students in higher education (2002) Number (in thousand) | Number per capita (‰) | Doctoral degree (in thousand) | Number per capita (‰) |
|---|---|---|---|---|
| European Union (25) | 2,156 | 6.36 | 81 | 0.18 |
| Germany | 200 | 3.57 | 24 | 0.29 |
| France | 383 | 8.74 | 10 | 0.17 |
| United Kingdom | 436 | 9.41 | 14 | 0.24 |
| Italy | 212 | 3.76 | 4 | 0.07 |
| Spain | 219 | 7.24 | 7 | 0.17 |
| Netherlands | 83 | 5.35 | 3 | 0.16 |
| Sweden | 42 | 4.67 | 4 | 0.40 |
| Finland | 34 | 6.60 | 1 | 0.26 |
| Poland | 265 | 11.90 | 4 | 0.11 |
| Czech Republic | 36 | 4.26 | 1 | 0.13 |
| Hungary | 60 | 6.23 | 1 | 0.10 |
| United States | 1,899 | 7.77 | 44 | 0.15 |
| Japan | 637 | 8.22 | 14 | 0.11 |
| China | 1,032 | 0.80 | 15 | 0.01 |
| Russia | 745 | 4.89 | 27 | 0.19 |

*data OECD, Eurostat, OST estimations and computation* *Key Figures - 2006*

*• only countries for which data are available are shown*

Among EU Member States, Sweden occupies first place well ahead of the others with 0.40 doctoral degrees per one thousand inhabitants, followed by Germany (0.29‰), Finland (0.26‰) and the United Kingdom (0.24‰). France, Spain, and the Netherlands are clustered around the EU mean value (0.18‰). Well back in the ranking is Italy (0.07‰).

**What are the principal patterns of student mobility worldwide?**

The European Union hosts more students from abroad than any other area in the world (584,000). Nearly half (48.5%) come from other countries on the European continent, while nearly a quarter (23.1%) of all foreign students come from Asia, a fifth (19.2%) from Africa and less than one out of ten are from the Americas (8.1%).
The United States receives an equivalent amount of students from abroad (581,000), but their geographical distribution is quite different; two thirds come from Asia (62.7%), nearly a sixth from elsewhere in the Americas (16.4%), or from the European continent (13.9%), and 6.5% from Africa.
Japan hosts only 70,000 students from abroad, most of whom come from Asia (92%), and only 3% of whom come from either Europe or the Americas.

Asia is the geographical zone that sends the most students abroad for their studies; 756,000 students go abroad, of which 48.2% study in the US, 17.8% in the European Union, and 8.5% in Japan.
European students are the next most numerous abroad (431,000), chiefly heading to EU Member States (65.7%) and the United States (18.7%).
From the Americas, 168,000 students go abroad to study, mainly to the United States (56.8%) and to the European Union (28.2%). Nearly as many Africans (165,000) also head to the United States and the EU for study, but in inverse proportions (22.8% and 67.8%, respectively).

World share (%) of foreign enrolled students in higher education (2002)

| Host country/Zone | Africa | Asia | Europe | Americas | Others | **Total** | Total students (in thousand) |
|---|---|---|---|---|---|---|---|
| European Union (25) | 19.2 | 23.1 | 48.5 | 8.1 | 1.1 | **100.0** | 584 |
| Japan | 1.1 | 91.8 | 3.1 | 3.4 | 0.6 | **100.0** | 70 |
| United States | 6.5 | 62.7 | 13.9 | 16.4 | 0.5 | **100.0** | 581 |
| Others | 4.3 | 68.6 | 10.8 | 10.0 | 6.3 | **100.0** | 333 |
| **Total** | **4.4** | **57.8** | **19.6** | **6.8** | **11.3** | **100.0** | **1,568** |
| **Total students abroad (in thousand)** | **165** | **756** | **431** | **168** | **48** | **1,568** | **-** |

*data OECD, Eurostat, OST estimations and computation* *Key Figures - 2006*

World share (%) of foreign enrolled students in higher education (2002)

| Host country/Zone | Africa | Asia | Europe | Americas | Others | **Total** | Total students (in thousand) |
|---|---|---|---|---|---|---|---|
| European Union (25) | 67.8 | 17.8 | 65.7 | 28.2 | 13.6 | **37.2** | 584 |
| Japan | 0.5 | 8.5 | 0.5 | 1.4 | 0.8 | **4.4** | 70 |
| United States | 22.8 | 48.2 | 18.7 | 56.8 | 6.6 | **37.1** | 581 |
| Others | 8.9 | 25.5 | 15.2 | 13.6 | 79.0 | **21.3** | 333 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **1,568** |
| **Total students abroad (in thousand)** | **165** | **756** | **431** | **168** | **48** | **1,568** | **-** |

*data OECD, Eurostat, OST estimations and computation* *Key Figures - 2006*

## CHAPTER THREE

# Scientific publication

Publishing an article in a scientific journal is one of the ways that the work of a research scientist is validated, and publication is one of the main products of research activity. By using the information contained in bibliographic databases that record all articles published in a selected set of scientific journals, it is possible to count articles by discipline, as well as by the country, region or institution of origin of the authors. OST has chosen to work with the most established of such bibliographic databases, the Web of Science of ISI-Thomson Scientific, which provides the best basis for international comparison. The Web of Science keeps track of more than 7,000 journals covering all disciplines. Furthermore, it boasts the particular features of giving, for a selected set of journals, the complete address of authors (laboratory, institution, and country). It therefore allows its users to know how many times an article has been cited, thus enabling the measurement of an article's "impact".

The indicators presented in this chapter are calculated on the basis of articles indexed from journals selected by ISI-Thomson Scientific for their quality. These indicators contain important information about the level of activity of a country or a group of countries in a given discipline, for every scientific discipline, with a degree of reliability that increases with the internationalisation of the discipline. It should be borne in mind that different scientific disciplines enjoy different degrees of internationalisation and that their characteristics of production and of impact differ also. Indicators for the social sciences and humanities have not been calculated due to insufficiently representative data on journals for this subject area in bibliographic data bases.

# III. SCIENTIFIC PUBLICATION

**Who produces the world's scientific knowledge?**

Nearly 35% of world publications in 2003 was produced by the European Union, 27.5% by the United States and nearly 9% by Japan. These three geographic zones together accounted for about three quarters of the 750,000 scientific articles included in ISI-Thomson Scientific's Web of Science database.

With 4.5% of world publications, China came in well ahead of Russia (2.6%), India (2.3%), and South Korea (2.0%). Brazil's scientific production reached a world share of 1.3% in 2003. South Africa, whose scientific production is the strongest on the African continent, showed a world share of 0.4%.

From 1998 to 2003 the number of scientific publications constantly increased, but the world share of publications of the two most dominant producers, the US and the EU, decreased by 3% and 9% respectively. In contrast, China's world share grew by an impressive 88%, echoed by South Korea's 56% growth rate, and Brazil's 53%.



## III.1. SCIENTIFIC PRODUCTION WORLDWIDE (1998-2003)

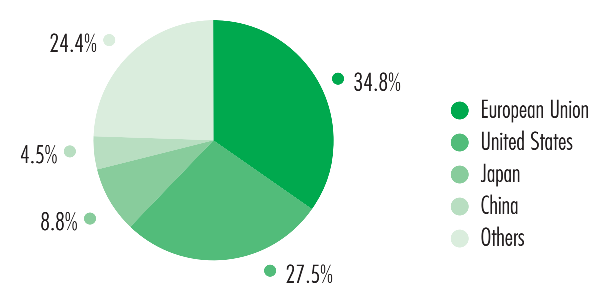
World share (%) of scientific publications

| Country/Zone | 1998 | 2001 | 2003 | Evolution 2003/1998 (%) |
|---|---|---|---|---|
| European Union (25) | 35.9 | 35.6 | 34.8 | -3 |
| United States | 30.1 | 28.1 | 27.5 | -9 |
| Japan | 8.7 | 9.0 | 8.8 | 0 |
| China | 2.4 | 3.6 | 4.5 | +88 |
| India | 2.1 | 2.1 | 2.3 | +6 |
| South Korea | 1.3 | 1.6 | 2.0 | +56 |
| Russia | 3.2 | 2.9 | 2.6 | -21 |
| Israel | 1.0 | 1.0 | 1.0 | 0 |
| South Africa | 0.4 | 0.4 | 0.4 | -12 |
| Brazil | 0.9 | 1.2 | 1.3 | +53 |
| Others | 14.0 | 14.5 | 15.0 | +7 |
| **World** | **100.0** | **100.0** | **100.0** | **0** |
| **Number of publications** | **710,513** | **743,455** | **748,893** | **+5** |

*data ISI-Thomson Scientific, OST computing* *Key Figures - 2006*

- *world publication share is determined using fractional count*
- *two ISI-Thomson Scientific databases with slightly different coverage were used: for 1998 the SCI expanded database, while for 2001 and 2003 a bibliometric version of the Web of Science. These differences may accentuate the changes in countries' world share from 1998 to 2003*

**World share in scientific publications of the top four producers (2003)**




*data ISI-Thomson Scientific, OST computing* *Key Figures - 2006*

## In which scientific disciplines do the European Union, the United States and Japan specialize?

When publication figures are shown by discipline, the relative strengths and weaknesses of the Europe Union, the United States and Japan appear.

Accordingly, the EU(25) enjoys a relatively strong position in Medical Research with 38.3% of world publications (compared to its overall world share of 34.8%). Contrastingly, its world shares of publications in Engineering Science, in Applied Biology-Ecology, and in Chemistry are all weaker than the overall average, even if they are still noticeably higher than US shares in these same fields.

The United States performs best in Fundamental Biology and Medical Research where their world share reaches 34.2% and 32.4 % respectively, but performs well under its average world publication share (27.5%) in Physics (19.7%) and in Chemistry (16.7 %).

Japan, by contrast, performs strongly in these last two disciplines with 11.7% of world publications in both Physics and Chemistry compared to its average world publication share of 8.8%. Japan's position in Astro-sciences and Earth Sciences is relatively weak (4.7%) as it is in Mathematics (4.9%).

Taken together, EU(25), US and Japan account for 71.1% of total world scientific production. In Medical Research this figure reaches 78.8% but only 60.6% in Chemistry.

In 2002 the US enjoyed a relative impact index well above the world average (which is 1) in every discipline and a relative impact index of 1.49 all disciplines combined. American science distinguishes itself not only by its world share but also by a high impact as expressed by its impact index.

The EU (0.97) and Japan (0.85) showed a relative impact index lower than world average all disciplines combined. The EU impact index is lower than the world average in two fields: Fundamental Biology and Medical Research.



## III.2. SCIENTIFIC PRODUCTION WORLDWIDE (2003) AND RELATIVE IMPACT INDEX BY DISCIPLINE (2002)

| | World share (%) of scientific publications (2003) | | |
|---|---|---|---|
| Discipline | European Union (25) | United States | Japan |
| Fundamental Biology | 35.2 | 34.2 | 8.9 |
| Medical Research | 38.3 | 32.4 | 8.1 |
| Applied Biology-Ecology | 32.0 | 27.2 | 6.8 |
| Chemistry | 32.2 | 16.7 | 11.7 |
| Physics | 33.7 | 19.7 | 11.7 |
| Astro-sciences and Earth Sciences | 34.9 | 28.9 | 4.7 |
| Engineering | 31.3 | 25.0 | 8.8 |
| Mathematics | 37.3 | 23.9 | 4.9 |
| **Total** | **34.8** | **27.5** | **8.8** |
| **Number of publications** | **260,334** | **205,726** | **65,716** |

*data ISI-Thomson Scientific, OST computing* — *Key Figures - 2006*

- *world publication share is determined by fractional count using the bibliometric version of the Web of Science*
- *classification by discipline follows the OST standard*

| | Relative impact index (2002) | | |
|---|---|---|---|
| Discipline | European Union (25) | United States | Japan |
| Fundamental Biology | 0.91 | 1.36 | 0.79 |
| Medical Research | 0.90 | 1.36 | 0.77 |
| Applied Biology-Ecology | 1.13 | 1.25 | 0.85 |
| Chemistry | 1.08 | 1.67 | 1.02 |
| Physics | 1.10 | 1.45 | 0.90 |
| Astro-sciences and Earth Sciences | 1.02 | 1.39 | 0.82 |
| Engineering | 1.04 | 1.23 | 1.01 |
| Mathematics | 1.06 | 1.29 | 0.81 |
| **Total** | **0.97** | **1.49** | **0.85** |

*data ISI-Thomson Scientific, OST computing* — *Key Figures - 2006*

- *the relative impact index corresponds to the average number of citations obtained over two years by a country's publications compared to the world average. In other words it is the ratio of a country's world share of citations over a country's world share of publications*
- *classification by discipline follows the OST standard*

## III.3. THE FIVE MOST SPECIALISED COUNTRIES BY DISCIPLINE (2003)

The five most specialised countries by discipline (2003)

| Fundamental Biology | | Medical Research | | Applied Biology-Ecology | | Chemistry | | Physics | | Astro-sciences & Earth Sciences | | Engineering | | Mathematics | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Index | Country | Index | Country | Index | Country | Index | Country | Index | Country | Index | Country | Index | Country | Index |
| United States | 1.25 | Turkey | 1.69 | South Africa | 2.92 | China | 2.28 | Russia | 2.50 | South Africa | 1.96 | South Korea | 2.01 | Hungary | 2.18 |
| Denmark | 1.24 | Austria | 1.40 | Slovakia | 2.51 | India | 1.92 | China | 1.67 | Russia | 1.60 | Slovenia | 1.86 | China | 1.66 |
| Sweden | 1.15 | Netherlands | 1.33 | Czech Republic | 1.83 | Russia | 1.91 | Poland | 1.61 | Denmark | 1.33 | Greece | 1.56 | Israel | 1.60 |
| Netherlands | 1.11 | United Kingdom | 1.31 | Brazil | 1.83 | Poland | 1.70 | South Korea | 1.45 | Greece | 1.28 | China | 1.42 | Russia | 1.58 |
| Finland | 1.07 | Sweden | 1.24 | Denmark | 1.52 | Czech Republic | 1.63 | Japan | 1.33 | Portugal | 1.20 | Portugal | 1.39 | Czech Republic | 1.58 |

*data ISI-Thomson Scientific, OST computing*

*Key Figures - 2006*

- *the specialisation index shows a country's world publication share in a particular discipline relative to its overall world publication share. The neutral value is 1*
- *classification by discipline follows the OST standard*

### Which countries are most specialised by discipline?

The discipline specialisation indexes of various countries can be used to draw a world map of science which differs from the one portrayed in the first two sections of this chapter. While the strongest specialisations in Fundamental Biology belong to scientifically strong countries like the US and certain European nations, in other disciplines the specialisation leaders are often countries like the new EU members, or China, India and Russia, not to mention South Africa, South Korea, or Japan. China is high on the list of countries specialised in Chemistry, Physics, Engineering and Mathematics.

European leaders like the UK, Germany and France, are virtually absent from the lists of most specialised countries by discipline (apart from the presence of UK among the most specialised countries in Medical Research). These findings are an indication that these countries are present more evenly across all disciplines than are other countries.

By the same token the European countries of low scientific output, such as the new Member States, Greece and Portugal, are in the front rank in this category. Hungary is the country the most specialised in mathematics, Greece is highly specialised in Engineering and Astro-sciences and Earth Sciences. Poland shows up twice in the specialisation rankings, for Chemistry and for Physics.

**What is the distribution of world scientific production, by Member State?**

The European Union still produces over one third of world scientific publication, but its share decreased from 35.6% to 34.8% between 2001 and 2003.

The EU's scientific output is concentrated in a small number of Member States; Germany, France, and the United Kingdom account for over half of EU scientific production. Adding Italy, Spain, and the Netherlands encompasses more than three quarters of EU production.

The United Kingdom is the EU member country with the largest world publication share at 6.9%, followed closely by Germany with a 6.7% world share. France's share is noticeably smaller at 4.8%. Italy (3.6%) and Spain (2.6%) follow.

Between 2001 and 2003 world share for the United Kingdom, Germany and France all dropped significantly (decreasing by 5% to 7%), while both Italy and Spain showed world share increases (by 3% to 4%).

Among the new EU Member States, Poland's place and growth rate stand out, with its 1.1% world share and 10% increase.



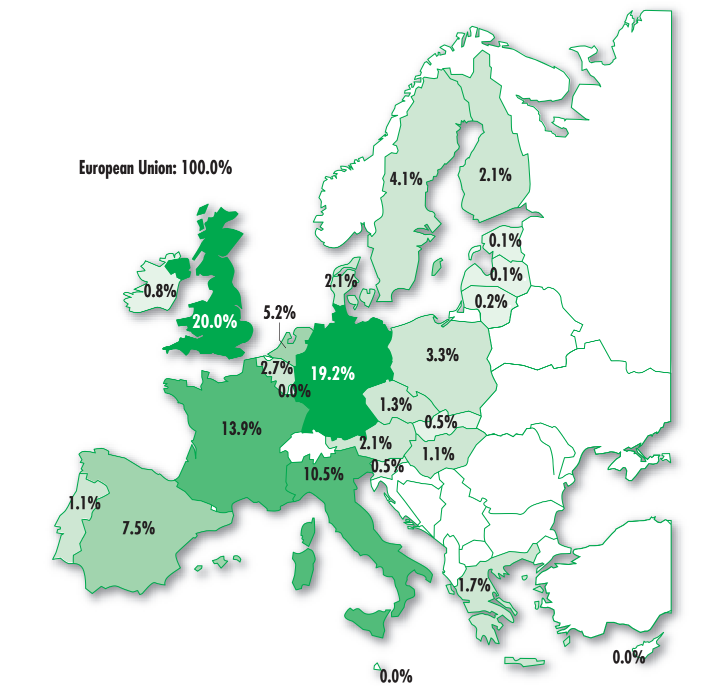
## III.4. EU MEMBER STATES' WORLD SHARE OF SCIENTIFIC PRODUCTION (2001-2003)

| | World share (%) of scientific publications (2003) | | |
|---|---|---|---|
| Country | 2001 | 2003 | Evolution 2003/2001 (%) |
| Germany | 7.0 | 6.7 | -5 |
| France | 5.1 | 4.8 | -6 |
| United Kingdom | 7.4 | 6.9 | -7 |
| Italy | 3.5 | 3.6 | +3 |
| Spain | 2.5 | 2.6 | +4 |
| Netherlands | 1.8 | 1.8 | -1 |
| Greece | 0.5 | 0.6 | +14 |
| Belgium | 0.9 | 0.9 | +1 |
| Portugal | 0.3 | 0.4 | +16 |
| Sweden | 1.5 | 1.4 | -4 |
| Austria | 0.7 | 0.7 | +2 |
| Denmark | 0.7 | 0.7 | -2 |
| Finland | 0.7 | 0.7 | -1 |
| Ireland | 0.3 | 0.3 | +3 |
| Luxembourg | 0.0 | 0.0 | ns |
| Poland | 1.0 | 1.1 | +10 |
| Czech Republic | 0.4 | 0.4 | +6 |
| Hungary | 0.4 | 0.4 | -1 |
| Slovakia | 0.2 | 0.2 | -9 |
| Lithuania | 0.0 | 0.1 | ns |
| Latvia | 0.0 | 0.0 | ns |
| Slovenia | 0.2 | 0.2 | +4 |
| Estonia | 0.1 | 0.0 | ns |
| Cyprus | 0.0 | 0.0 | ns |
| Malta | 0.0 | 0.0 | ns |
| **European Union (25)** | **35,6** | **34,8** | **-2** |

*data ISI-Thomson Scientific, OST computing* — *Key Figures - 2006*

- *world publication share is determined using fractional count based on the bibliometric version of the Web of Science*
- *ns: data not significant*

Distribution of EU share of scientific publications by Member State (2003)




*data ISI-Thomson Scientific, OST computing* *Key Figures - 2006*

## What is the distribution of European Union scientific production, by Member State?

The United Kingdom and Germany hold commanding positions as they account for 20.0% and 19.2% of total EU production, respectively. France and Italy are well back with 13.9% and 10.5% of European publications, respectively. A third group, ranging from 7.5% to 3.0% European share, is composed of Spain, the Netherlands, Sweden and Poland. A fourth group includes Belgium, Austria, Denmark, Finland, Greece, the Czech Republic, Portugal, and Hungary, whose European shares are found between 3% and 1%. All other Member States produce less than 1% of total EU output **(See Table A.4 in annex)**.



## III.5. EU MEMBER STATES' RELATIVE SCIENTIFIC DENSITY (2003)

| Country | Scientific production (2003) EU share (%) | Scientific density per labour force |
|---|---|---|
| Germany | 19.2 | 102 |
| France | 13.9 | 109 |
| United Kingdom | 20.0 | 141 |
| Italy | 10.5 | 92 |
| Spain | 7.5 | 85 |
| Netherlands | 5.2 | 132 |
| Sweden | 4.1 | 192 |
| Denmark | 2.1 | 154 |
| Poland | 3.3 | 42 |
| Czech Republic | 1.3 | 53 |
| Hungary | 1.1 | 57 |
| **European Union (25)** | **100.0** | **100** |

*data ISI-Thomson Scientific, OST computing* *Key Figures - 2006*

- *European publication share is determined using fractional count based on the bibliometric version of the Web of Science*
- *relative scientific density is calculated as the ratio of the quantity of a nation's publications to the size of its labour force, normalised to 100 for the European Union*

These figures make clear the fact that the EU is composed of countries that vary widely by size and R&D potential. An indicator of scientific density, which relates the number of scientific publications to the size of the labour force, is a usual way of countering the effect of country size.

In 2003, ten nations showed a scientific density noticeably higher than the EU average (which has been normalised at 100). The top group is composed of Sweden - whose density at 192 is nearly double the European average, Finland (173), and Denmark (154). A second group includes the UK (141), the Netherlands (132) and Belgium (131). A third set of countries is made up by those that are just above the EU average, including Austria (114), France (109), Germany (102), and Slovenia (102).

The latter's performance is particularly noteworthy as representing the only new Member State to surpass the EU average, coming in well ahead of Hungary (57) and Poland (42).

## III.6. EU MEMBER STATES' SCIENTIFIC PRODUCTION BY DISCIPLINE (2003)

World share (%) of scientific publications (2003)

| Country | Total Sciences | Fundamental Biology | Medical Research | Applied Biology-Ecology | Chemistry | Physics | Astro-sciences & Earth Sciences | Engineering | Mathematics |
|---|---|---|---|---|---|---|---|---|---|
| Germany | **6.7** | 6.6 | 7.2 | 5.0 | 6.7 | 8.0 | 5.9 | 5.5 | 6.2 |
| France | **4.8** | 5.0 | 4.7 | 3.9 | 4.8 | 5.5 | 5.1 | 4.3 | 7.6 |
| United Kingdom | **6.9** | 7.4 | 9.1 | 6.0 | 4.9 | 4.6 | 7.4 | 6.3 | 4.7 |
| Italy | **3.6** | 3.5 | 4.2 | 2.2 | 3.0 | 4.1 | 3.9 | 3.4 | 4.4 |
| Spain | **2.6** | 2.6 | 2.4 | 3.3 | 3.1 | 2.1 | 2.6 | 2.3 | 3.7 |
| Netherlands | **1.8** | 2.0 | 2.4 | 1.7 | 1.2 | 1.3 | 1.9 | 1.6 | 1.3 |
| Sweden | **1.4** | 1.6 | 1.8 | 1.5 | 1.1 | 1.2 | 1.4 | 1.1 | 0.8 |
| Denmark | **0.7** | 0.9 | 0.9 | 1.1 | 0.4 | 0.5 | 1.0 | 0.5 | 0.5 |
| Poland | **1.1** | 0.9 | 0.6 | 1.3 | 2.0 | 1.8 | 1.0 | 1.2 | 1.7 |
| Czech Republic | **0.4** | 0.4 | 0.2 | 0.8 | 0.7 | 0.5 | 0.4 | 0.3 | 0.7 |
| Hungary | **0.4** | 0.4 | 0.3 | 0.5 | 0.6 | 0.4 | 0.2 | 0.3 | 0.8 |
| **European Union (25)** | **34.8** | **35.2** | **38.3** | **32.0** | **32.2** | **33.7** | **34.9** | **31.3** | **37.3** |
| **Number of publications EU(25)** | **260,334** | **40,546** | **86,828** | **16,132** | **34,823** | **29,092** | **16,620** | **25,567** | **8,632** |

*data ISI-Thomson Scientific, OST computing* *Key Figures - 2006*

- *world publication share is determined by fractional count using the bibliometric version of the Web of Science*
- *classification by discipline follows the OST standard*

### What is the profile of European Union scientific production, by discipline?

In 2003 the European Union's world publication share across all disciplines was 34.8%, with highest shares in Medical Research (38.3%) and Mathematics (37.3%). Europe's strength in the former is due in large part to the performance of the UK and Germany, which account for 9.1% and 7.2% of world Medical Research publications, respectively. Medical Research is the strongest field for both countries (their world share all disciplines together is 6.9% and 6.7%, respectively). France dominates in Mathematics, with a world share of 7.6% (compared to a 4.8% share overall).

It is important to point out that disciplines are not equally represented in the ISI databases, where of 260,334 articles attributed to the EU in 2003, nearly 87,000 were in Medical Research while barely 9,000 were in Mathematics.

These two disciplines are also Italy's strongest fields. Medical Research is the discipline of choice for a number of other EU Members (the Netherlands, Sweden, Austria, Finland, and others). Several new Member States show areas of particular strength: Poland in Chemistry, the Czech Republic and Slovakia in Applied Biology-Ecology, and Hungary and Lithuania in Mathematics, to name a few) **(see Table A.5 in annex)**.

Only four countries show Engineering research results higher than their national average for all disciplines: Greece, Poland, Portugal, and Slovenia. This confirms the under-representation of this discipline in the EU (whose world share is 31.3% of Engineering publications).

## III.7. EU MEMBER STATES' RELATIVE IMPACT INDEX BY DISCIPLINE (2002)

| Country | Relative impact index (2002): Total Sciences | Fundamental Biology | Medical Research | Applied Biology-Ecology | Chemistry | Physics | Astro-sciences & Earth Sciences | Engineering | Mathematics |
|---|---|---|---|---|---|---|---|---|---|
| Germany | **1.08** | 1.07 | 0.89 | 1.31 | 1.25 | 1.24 | 1.17 | 1.08 | 1.11 |
| France | **0.92** | 0.93 | 0.82 | 1.11 | 1.03 | 0.98 | 0.95 | 1.03 | 1.06 |
| United Kingdom | **1.12** | 1.14 | 0.95 | 1.58 | 1.24 | 1.21 | 1.21 | 1.05 | 1.28 |
| Italy | **0.89** | 0.67 | 0.93 | 0.77 | 1.02 | 1.12 | 1.07 | 1.01 | 0.93 |
| Spain | **0.75** | 0.64 | 0.65 | 0.86 | 1.04 | 1.10 | 0.80 | 1.04 | 0.98 |
| Netherlands | **1.21** | 0.96 | 1.20 | 1.44 | 1.54 | 1.24 | 1.28 | 1.31 | 1.17 |
| Sweden | **1.05** | 0.90 | 1.04 | 1.32 | 1.20 | 1.03 | 0.87 | 1.16 | 1.27 |
| Denmark | **1.16** | 0.92 | 1.13 | 1.19 | 1.59 | 1.44 | 1.02 | 1.55 | 1.36 |
| Poland | **0.48** | 0.35 | 0.46 | 0.45 | 0.60 | 0.70 | 0.68 | 0.74 | 0.69 |
| Czech Republic | **0.56** | 0.42 | 0.57 | 0.53 | 0.79 | 0.72 | 0.60 | 0.79 | 0.99 |
| Hungary | **0.62** | 0.57 | 0.56 | 0.49 | 0.70 | 0.89 | 0.74 | 0.99 | 0.69 |
| **European Union (25)** | **0.97** | **0.91** | **0.90** | **1.13** | **1.08** | **1.10** | **1.02** | **1.04** | **1.06** |

*data ISI-Thomson Scientific, OST computing*

*Key Figures - 2006*

- *the relative impact index corresponds to the average number of citations obtained over two years by a country's publications compared to the world average. In other words it is the ratio of a country's world share of citations over a country's world share of publications*
- *classification by discipline follows the OST standard*

### What are the discipline-specific impact indexes for EU Member States?

In 2002, five EU Member States enjoyed a relative impact index higher than 1, all disciplines taken together: the Netherlands (1.21), Denmark (1.16), the United Kingdom (1.12), Germany (1.08), and Sweden (1.05). The Netherlands, Denmark, and Finland all had a relative impact index greater than 1 in all disciplines except Fundamental Biology. Similarly, Germany and the UK showed an impact index greater than 1 in all disciplines except Medical Research **(See Table A.6 in annex)**.

A second group is formed of four EU members who all showed an impact index between 1 and 0.9: Finland, Austria, France, and Belgium. These four countries all showed impact indexes less than 1 in Fundamental Biology and - except Finland - in Medical Research.



The relative impact index of France is greater than 1 in only four disciplines: Applied Biology-Ecology (1.11), Mathematics (1.06), Chemistry (1.03), and Engineering (1.03). Belgium shows the distinction of a very high index for Mathematics (1.38) as does Denmark (1.36).

The impact indexes of Italy, Ireland, Spain, Portugal and Hungary all fall between 0.9 and 0.6, while Greece and all of the rest of the new Member States show an impact index less than 0.6. Ireland, however, does boast an impact index well above 1 in Chemistry (1.15).

The impact index of the new Member States is less than 1 in all disciplines, except for Hungary in Engineering and the Czech Republic in Mathematics, both of which record an impact index of around 1.

CHAPTER FOUR

# International scientific co-publications

The scientific community is highly interconnected across national borders. Research networks form as various specialists come together around a common research project or programme. Scientific collaboration is also a means for scientists from emerging scientific countries to find their place in the international scientific community. A reliable indicator of levels and patterns of scientific cooperation can be derived from data on co-signed scientific articles, as the latter constitute a trace of cooperative activity. The relational indicators presented in this chapter make it possible to measure the amount of a country's scientific output that is produced in collaboration with the rest of the world (international co-publication). They also serve to identify the preferred scientific partners of a particular country or zone vis-a-vis a set of countries or all countries. As in the indicators for scientific production, indicators for the social sciences and humanities have not been calculated due to insufficiently representative data on journals for this subject area in bibliographic databases.

# IV. INTERNATIONAL SCIENTIFIC CO-PUBLICATIONS

**What percentage of scientific publication derives from international collaboration?**

International cooperation has been a part of science since its beginnings. Co-signed articles (known as co-publications) can serve as an indicator to reveal features of this cooperation as it takes place among researchers from various countries. The table IV.1 shows that on average one quarter of all scientific publications in large scientific countries or zones are international co-publications.

In 2003, for instance, 24.4% of scientific publications produced by the United States resulted from an international collaboration. The European Union, according to this indicator, is slightly less involved internationally, with 22.9% of its publications stemming from such collaboration.
Two countries in 2003 stood out for their high level of international collaboration: Israel and South Africa, both of which produced 40% of their total publications in collaboration with international partners.

Also in 2003, nearly one third of publications produced by Russia and Brazil was the result of international scientific cooperation. Similarly, nearly one fourth of Chinese and South Korean scientific production sprang from collaboration with another country. Finally, Japan and India demonstrated a weaker level of international co-signatures, with 19.3% and 17.5% respectively.



## IV.1. INTERNATIONAL SCIENTIFIC CO-PUBLICATIONS WORLDWIDE (2001-2003)

| | International co-publication share (%) of total publications | | |
|---|---|---|---|
| Country/Zone | 2001 | 2003 | Evolution 2003/2001 (%) |
| European Union (25) | 20.9 | 22.9 | +9 |
| United States | 22.2 | 24.4 | +10 |
| Japan | 17.4 | 19.3 | +11 |
| China | 22.1 | 22.8 | +3 |
| India | 15.4 | 17.5 | +13 |
| South Korea | 22.7 | 24.5 | +8 |
| Russia | 31.5 | 35.3 | +12 |
| Israel | 38.9 | 40.1 | +3 |
| South Africa | 34.8 | 40.4 | +16 |
| Brazil | 32.8 | 32.4 | -1 |

*data ISI-Thomson Scientific, OST computing* *Key Figures - 2006*

• *international co-publication indicators are calculated on the basis of integer counts using the bibliometric version of the Web of Science*

Between 2001 and 2003, international co-publications as a share of total publications rose significantly in most countries, with the exception of Israel, China, and Brazil. In the case of Israel, the international co-publication share in 2001 is already near 40%, which may represent a level above which it is difficult to go. The other two countries serve as proof that world share of publications can be driven up without any increase in international cooperation. Table III.1 indeed shows that between 1998 and 2003 both China and Brazil increased their world publication share by 88% and 53%, respectively.

## IV.2. INTERNATIONAL SCIENTIFIC CO-PUBLICATIONS AMONG COUNTRIES (2003)

| | Share (%) of international co-publications (2003) of: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| With | European Union (25) | United States | Japan | China | India | South Korea | Russia | Israel | South Africa | Brazil |
| European Union (25) | - | 52.4 | 33.8 | 31.9 | 43.9 | 18.7 | 66.9 | 45.4 | 57.1 | 49.7 |
| United States | 44.7 | - | 40.2 | 35.3 | 34.3 | 53.7 | 24.4 | 51.6 | 31.5 | 37.5 |
| Japan | 7.1 | 9.9 | - | 16.8 | 11.4 | 22.3 | 8.2 | 4.4 | 2.9 | 3.8 |
| China | 4.2 | 5.4 | 10.6 | - | 5.1 | 8.2 | 2.7 | 2.2 | 1.8 | 2.2 |
| India | 2.1 | 2.0 | 2.7 | 1.9 | - | 3.1 | 1.2 | 1.0 | 2.0 | 1.7 |
| South Korea | 1.2 | 3.9 | 6.7 | 3.9 | 4.0 | - | 2.8 | 1.1 | 0.7 | 1.0 |
| Russia | 8.4 | 3.6 | 4.9 | 2.6 | 3.0 | 5.6 | - | 4.9 | 1.9 | 3.7 |
| Israel | 2.5 | 3.3 | 1.2 | 0.9 | 1.2 | 0.9 | 2.1 | - | 2.2 | 1.3 |
| South Africa | 1.2 | 0.8 | 0.3 | 0.3 | 0.9 | 0.2 | 0.3 | 0.8 | - | 0.7 |
| Brazil | 2.9 | 2.5 | 1.1 | 1.0 | 2.0 | 0.9 | 1.7 | 1.3 | 1.8 | - |

*data ISI-Thomson Scientific, OST computing* *Key Figures - 2006*

• *international co-publication indicators are calculated on the basis of integer counts using the bibliometric version of the Web of Science*

### Which countries co-publish with what other countries, and to what degree?

In 2003, 44.7% of EU international co-publications were carried out with the United States and 7.1% with Japan. EU countries co-publish more with Russia (8.4%) than with Japan. US scientists chose European partners for 52.4% of their international co-publications and Japanese partners for 9.9%. They co-publish more with China (5.4% of US international co-publications) than do EU researchers (4.2 % with China). Japan preferred US partners (40.2% of international co-publications) over the EU (33.8%).

Brazil, South Africa, Russia, and especially Israel co-published very little with countries other than EU members or the United States (12.8%, 11.4%, 8.7% and 3.0%, respectively, of international co-publications outside of EU or US). Inversely, China, South Korea, Japan, and India showed themselves to be particularly open to non-EU, non-US scientific partners (32.8%, 27.6%, 26.0% and 21.8%, respectively). South Korea and China, for instance, co-published 22.3% and 16.8%, respectively, of their international collaborative output with Japan. Conversely, 10.6% of Japan's co-publications were authored with Chinese partners.

# IV. INTERNATIONAL SCIENTIFIC CO-PUBLICATIONS

**In what fields do the United States, Japan and the European Union tend to co-publish?**

If the share of US publication resulting from international co-publication is higher than for the European Union (22.9%) or Japan (19.3%), it is no less true that all three zones demonstrate a strong commitment to international collaboration. This commitment varies in strength by scientific field.

All fields taken together, 24.4% of total US scientific publications results from collaborations with scientists from other countries. Variations by discipline, however, are very great. In Physics, international co-publication represents 36.6%, in Astro-sciences and Earth Sciences 34.3%, and in Mathematics 34.4%. By contrast, only 18.8% of US Medical Research output is due to international collaboration. It is in this same field that the EU and Japan also show the weakest tendencies for international collaboration (16.1% and 14.8%, respectively, of total publication).

Japan's international co-publication represents a lesser share of its total publication than in the US or the EU for every field except Astro-sciences and Earth Sciences. The EU shows a distinctly lower propensity for international co-publication in Mathematics than does the US.



## IV.3. INTERNATIONAL SCIENTIFIC CO-PUBLICATIONS OF EU, US AND JAPAN BY DISCIPLINE (2003)

| | International co-publication share (%) of total publications (2003) | | |
|---|---|---|---|
| Discipline | European Union (25) | United States | Japan |
| Fundamental Biology | 24.1 | 24.5 | 22.0 |
| Medical Research | 16.1 | 18.8 | 14.8 |
| Applied Biology-Ecology | 22.9 | 22.6 | 18.6 |
| Chemistry | 21.5 | 23.9 | 15.7 |
| Physics | 33.3 | 36.6 | 24.1 |
| Astro-sciences and Earth Sciences | 33.6 | 34.3 | 39.2 |
| Engineering | 20.8 | 23.9 | 17.9 |
| Mathematics | 27.0 | 34.4 | 25.1 |
| **Total** | **22.9** | **24.4** | **19.3** |

*data ISI-Thomson Scientific, OST computing* — *Key Figures - 2006*

- *international co-publication indicators are calculated on the basis of integer counts using the bibliometric version of the Web of Science*
- *classification by discipline follows the OST standard*

On the whole, the European Union, the United States, and Japan co-publish predominantly in Physics, Astro-sciences and Earth Sciences, and Mathematics. Differences in co-publication shares appear to be due more to disciplinary than geographical factors.

# IV. INTERNATIONAL SCIENTIFIC CO-PUBLICATIONS

**What share of EU Member States' production stems from international collaboration?**

Within the European Union the share of a nation's publication that can be attributed to international collaboration varies widely from member to member. In 2003, a number of countries were around the EU-wide average of 22.9%, including Germany (21.0%), France (23.2%), Italy (22.7%), and Spain (21.8%). The United Kingdom showed the least proclivity for international collaboration of all EU(15) nations, with an 18.9% share. At the other extreme, the rest of the EU(15) nations and most of the new Member States showed a higher than average share of international co-publication, in many cases as much as a third of their total output.

With the exception of Greece and Portugal, all EU(15) members increased their European co-publication as a share of total publication between 2001 and 2003.

Among newly admitted States to the Union, Slovenia, Latvia and Slovakia all achieved marked increases in their European co-publication shares, ranging from 5% to 10% increase.



## IV.4. INTERNATIONAL SCIENTIFIC CO-PUBLICATIONS OF EU MEMBER STATES (2001-2003)

| | International co-publication share (%) of total publications | | |
|---|---|---|---|
| Country | 2001 | 2003 | Evolution 2003/2001 (%) |
| Germany | 19.0 | 21.0 | +11 |
| France | 21.1 | 23.2 | +10 |
| United Kingdom | 16.9 | 18.9 | +12 |
| Italy | 21.9 | 22.7 | +4 |
| Spain | 20.4 | 21.8 | +7 |
| Netherlands | 27.8 | 29.9 | +7 |
| Greece | 25.4 | 24.4 | -4 |
| Belgium | 35.3 | 37.1 | +5 |
| Portugal | 36.8 | 36.5 | -1 |
| Sweden | 26.5 | 28.7 | +8 |
| Austria | 32.0 | 34.2 | +7 |
| Denmark | 31.1 | 32.3 | +4 |
| Finland | 27.2 | 28.7 | +5 |
| Ireland | 30.0 | 32.3 | +8 |
| Luxembourg | 61.5 | 67.1 | ns |
| Poland | 25.4 | 25.2 | -1 |
| Czech Republic | 33.5 | 33.9 | +1 |
| Hungary | 33.6 | 34.7 | +3 |
| Slovakia | 37.2 | 41.0 | +10 |
| Lithuania | 43.3 | 38.3 | -12 |
| Latvia | 43.9 | 46.4 | +6 |
| Slovenia | 25.0 | 26.3 | +5 |
| Estonia | 43.8 | 43.6 | 0 |
| Cyprus | 53.3 | 48.9 | ns |
| Malta | 30.3 | 32.4 | ns |

*data ISI-Thomson Scientific, OST computing* *Key Figures - 2006*

- *international co-publication indicators are calculated on the basis of integer counts using the bibliometric version of the Web of Science*
- *ns: data not significant*

## IV.5. INTERNATIONAL SCIENTIFIC CO-PUBLICATIONS OF EU(15) MEMBER STATES WITH EU COUNTRIES (2003)

| | Share (%) of international co-publications (2003) of: | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| With | DEU | FRA | GBR | ITA | ESP | NLD | GRC | BEL | PRT | SWE | AUT | DNK | FIN | IRL | LUX |
| Germany (DEU) | - | 15.2 | 14.2 | 16.7 | 14.2 | 20.8 | 18.8 | 16.8 | 12.7 | 15.4 | 34.4 | 17.5 | 16.3 | 13.2 | 30.0 |
| France (FRA) | 11.3 | - | 11.2 | 17.5 | 17.5 | 12.2 | 16.4 | 22.8 | 17.9 | 9.9 | 10.4 | 10.7 | 9.3 | 10.2 | 35.8 |
| United Kingdom (GBR) | 13.0 | 13.8 | - | 17.2 | 16.9 | 20.1 | 23.9 | 16.6 | 22.0 | 16.1 | 11.0 | 18.7 | 16.4 | 40.1 | 14.0 |
| Italy (ITA) | 7.9 | 11.1 | 8.9 | - | 13.2 | 10.0 | 12.8 | 9.7 | 9.5 | 7.4 | 9.8 | 8.0 | 7.7 | 8.4 | 10.7 |
| Spain (ESP) | 4.6 | 7.6 | 5.9 | 8.9 | - | 6.0 | 7.3 | 6.9 | 16.2 | 4.7 | 5.4 | 6.0 | 5.4 | 5.9 | 6.6 |
| Netherlands (NLD) | 6.6 | 5.2 | 7.0 | 6.7 | 6.0 | - | 6.8 | 15.2 | 6.8 | 6.4 | 5.8 | 8.3 | 8.3 | 7.4 | 11.1 |
| Greece (GRC) | 1.5 | 1.7 | 2.0 | 2.1 | 1.8 | 1.6 | - | 2.2 | 2.4 | 1.5 | 1.7 | 1.8 | 1.5 | 1.5 | 3.7 |
| Belgium (BEL) | 3.4 | 6.3 | 3.7 | 4.2 | 4.4 | 9.7 | 5.7 | - | 4.9 | 3.9 | 3.7 | 4.3 | 4.1 | 4.9 | 33.3 |
| Portugal (PRT) | 0.9 | 1.7 | 1.7 | 1.4 | 3.6 | 1.5 | 2.3 | 1.7 | - | 1.5 | 1.5 | 1.4 | 1.7 | 2.4 | 4.9 |
| Sweden (SWE) | 4.1 | 3.5 | 4.7 | 4.1 | 3.8 | 5.3 | 5.0 | 5.0 | 5.5 | - | 4.1 | 15.5 | 19.0 | 5.5 | 5.8 |
| Austria (AUT) | 4.8 | 1.9 | 1.7 | 2.9 | 2.3 | 2.5 | 3.1 | 2.5 | 3.0 | 2.2 | - | 2.6 | 3.1 | 1.9 | 4.9 |
| Denmark (DNK) | 2.5 | 2.1 | 3.0 | 2.5 | 2.7 | 3.8 | 3.5 | 3.1 | 2.9 | 8.5 | 2.7 | - | 6.7 | 3.4 | 4.9 |
| Finland (FIN) | 1.9 | 1.5 | 2.1 | 1.9 | 2.0 | 3.1 | 2.4 | 2.4 | 2.8 | 8.6 | 2.7 | 5.5 | - | 3.8 | 4.1 |
| Ireland (IRL) | 0.6 | 0.6 | 2.0 | 0.8 | 0.9 | 1.1 | 0.9 | 1.1 | 1.5 | 1.0 | 0.6 | 1.1 | 1.5 | - | 4.5 |
| Luxembourg (LUX) | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.5 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 | - |
| Poland (POL) | 3.9 | 3.5 | 1.9 | 3.0 | 2.4 | 2.5 | 3.8 | 3.2 | 2.6 | 3.4 | 4.2 | 3.1 | 3.2 | 1.3 | 2.9 |
| Czech Republic (CZE) | 2.0 | 1.7 | 1.1 | 1.5 | 1.3 | 1.5 | 2.7 | 1.7 | 2.0 | 1.5 | 3.3 | 0.9 | 1.6 | 1.1 | 1.2 |
| Hungary (HUN) | 1.9 | 1.4 | 1.1 | 1.5 | 1.1 | 1.4 | 1.9 | 2.3 | 1.8 | 1.5 | 2.8 | 1.5 | 2.6 | 1.6 | 2.5 |
| Slovakia (SVK) | 0.7 | 0.5 | 0.5 | 0.6 | 0.5 | 0.4 | 1.7 | 0.8 | 0.6 | 0.7 | 3.0 | 0.5 | 1.1 | 0.5 | 0.4 |
| Lithuania (LTU) | 0.2 | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.6 | 0.1 | 0.5 | 0.6 | 0.1 | 0.4 |
| Latvia (LVA) | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.0 | 0.2 | 0.5 | 0.2 | 0.2 | 0.4 | 0.1 | 0.0 |
| Slovenia (SVN) | 0.5 | 0.4 | 0.3 | 0.6 | 0.4 | 0.5 | 1.4 | 0.6 | 1.1 | 0.6 | 2.0 | 0.5 | 0.9 | 0.2 | 0.0 |
| Estonia (EST) | 0.2 | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 1.1 | 0.1 | 0.3 | 2.1 | 0.2 | 0.0 |
| Cyprus (CYP) | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 1.2 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 |
| Malta (MLT) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

*data ISI-Thomson Scientific, OST computing* *Key Figures - 2006*

- *international co-publication indicators are calculated on the basis of integer counts using the bibliometric version of the Web of Science*

### EU(15) Member States co-publish with which other EU members and in what proportion?

Germany is the leading scientific partner for four members of EU(15) (France, the United Kingdom, the Netherlands, and Austria). France is also the preferred partner for four other members (Italy, Spain, Belgium, and Luxembourg). The United Kingdom according to this same indicator is preferred by seven member nations (Germany, Greece, Portugal, Sweden, Denmark, Finland, and Ireland). Of all EU countries, Spain co-publishes the most with Italy (13.2% of its co-publications). Geographical and cultural proximities (such as Belgium with the Netherlands, Germany with Austria, or Denmark with Sweden) promote scientific cooperation.

Among new Member States, Poland is the preferred partner of all EU(15) nations except Ireland (whose leading partner is Hungary). Poland accounted for 1.9% of all United Kingdom co-publications and ranged up to 4.2% of Austrian co-publications. The second new-member partner for EU(15) States is either the Czech Republic or Hungary.

## IV.6. INTERNATIONAL SCIENTIFIC CO-PUBLICATIONS OF NEW EU MEMBER STATES WITH EU COUNTRIES (2003)

| | Share (%) of international co-publications (2003) of: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| With | POL | CZE | HUN | SVK | LTU | LVA | SVN | EST | CYP | MLT |
| Germany (DEU) | 23.4 | 24.3 | 23.1 | 21.2 | 16.8 | 30.1 | 21.0 | 19.5 | 20.2 | 6.8 |
| France (FRA) | 15.5 | 15.7 | 12.4 | 10.8 | 12.5 | 8.6 | 11.0 | 7.2 | 18.4 | 8.5 |
| United Kingdom (GBR) | 10.4 | 11.7 | 11.9 | 12.4 | 11.5 | 7.1 | 11.5 | 9.0 | 24.6 | 52.5 |
| Italy (ITA) | 8.5 | 8.9 | 8.9 | 8.7 | 7.5 | 4.3 | 12.4 | 6.5 | 21.1 | 13.6 |
| Spain (ESP) | 4.6 | 4.9 | 4.5 | 4.2 | 3.5 | 2.6 | 4.9 | 2.8 | 15.1 | 5.1 |
| Netherlands (NLD) | 4.7 | 5.9 | 5.6 | 4.0 | 2.7 | 3.7 | 6.7 | 5.0 | 15.4 | 1.7 |
| Greece (GRC) | 1.8 | 2.6 | 1.8 | 3.7 | 1.0 | 1.9 | 4.6 | 0.6 | 21.7 | 3.4 |
| Belgium (BEL) | 3.9 | 4.2 | 5.9 | 4.7 | 3.6 | 1.5 | 4.9 | 1.1 | 1.2 | 3.4 |
| Portugal (PRT) | 1.1 | 1.8 | 1.6 | 1.2 | 0.7 | 1.9 | 3.5 | 0.5 | 1.8 | 0.0 |
| Sweden (SWE) | 5.4 | 4.8 | 4.8 | 5.2 | 15.6 | 18.5 | 6.2 | 27.2 | 0.9 | 1.7 |
| Austria (AUT) | 3.5 | 5.7 | 4.8 | 11.8 | 1.7 | 3.7 | 11.7 | 1.6 | 0.6 | 0.0 |
| Denmark (DNK) | 2.6 | 1.7 | 2.6 | 2.0 | 6.7 | 4.5 | 3.0 | 3.6 | 0.3 | 0.0 |
| Finland (FIN) | 2.2 | 2.3 | 3.8 | 3.6 | 6.7 | 6.5 | 4.5 | 22.4 | 0.6 | 3.4 |
| Ireland (IRL) | 0.3 | 0.6 | 0.9 | 0.7 | 0.2 | 0.9 | 0.4 | 0.9 | 5.0 | 1.7 |
| Luxembourg (LUX) | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Poland (POL) | - | 6.9 | 4.2 | 10.0 | 8.0 | 5.0 | 9.2 | 4.4 | 1.8 | 0.0 |
| Czech Republic (CZE) | 3.4 | - | 2.9 | 19.2 | 3.7 | 2.1 | 5.8 | 3.0 | 0.0 | 0.0 |
| Hungary (HUN) | 2.0 | 2.8 | - | 3.4 | 1.7 | 3.2 | 3.3 | 1.7 | 13.1 | 0.0 |
| Slovakia (SVK) | 2.1 | 8.2 | 1.5 | - | 1.2 | 1.5 | 3.1 | 0.5 | 0.6 | 0.0 |
| Lithuania (LTU) | 0.5 | 0.5 | 0.2 | 0.4 | - | 5.2 | 0.5 | 3.1 | 0.3 | 0.0 |
| Latvia (LVA) | 0.2 | 0.2 | 0.3 | 0.3 | 3.2 | - | 0.6 | 3.9 | 0.0 | 0.0 |
| Slovenia (SVN) | 1.3 | 1.7 | 0.9 | 2.1 | 1.2 | 2.2 | - | 0.6 | 0.9 | 0.0 |
| Estonia (EST) | 0.3 | 0.4 | 0.2 | 0.1 | 3.1 | 6.4 | 0.3 | - | 0.3 | 0.0 |
| Cyprus (CYP) | 0.0 | 0.0 | 0.7 | 0.1 | 0.1 | 0.0 | 0.2 | 0.1 | - | 0.0 |
| Malta (MLT) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | - |

***data ISI-Thomson Scientific, OST computing*** ***Key Figures - 2006***

• *international co-publication indicators are calculated on the basis of integer counts using the bibliometric version of the Web of Science*

**Newly admitted Member States tend to co-publish with which established members and in what proportion?**

Germany is by far the preferred scientific partner of the eight new Member States from central Europe. The rate of co-publication varies from Latvia's 30.1% of international co-publication with Germany to Lithuania's 16.8%. Well back in second place is either France (preferred by five nations) or United Kingdom (three nations). As for Cyprus and Malta, their clear involvement is with the United Kingdom. Among all ten new Member States, Poland appears most often as the preferred partner of other new members (four nations), followed by the Czech Republic (two nations, including Slovakia). An interesting development to observe will be the changes these networks undergo as the effects of EU expansion take hold.

# Patent applications

Patent data is by far the best available basis for indicators of the technological activity of a country or set of countries. Nevertheless patent indicators have their limits; not all inventions are subject to patents and not all patent applications are of the same importance. Furthermore, some firms are in the practice of filing decoy applications, while others avoid patenting legitimate innovations for reasons of secrecy. When data are gathered on a sufficiently large scale, however, the disparities due to individual firm behaviour disappear without prejudice to the quality of the analysis based on patent data.

In order to protect an invention in one or more European countries, it has been possible since 1978 to file for a single European patent, granted by the European Patent Office (EPO). In addition to this single-filing procedure, there is another way of requesting patent protection in more than one country: the Patent Cooperation Treaty (PCT) procedure. The latter provides the opportunity to any patent applicant in any country to request an international patent. The applicant must specify in which countries the patent is to be valid. In the European patent system, patent requests are published after eighteen months. Under the American system, only successful applications are published, after a variable waiting period.

Currently, the combined annual number of EPO applications and PCT requests for European countries is nearly 140,000, while more than 150,000 patents are granted by the US Patent and Trademark Office. It will be made clear in this chapter that the significant share of patents originating outside of the European and US systems is a reliable reflection of increasingly globalized competition.

# V. PATENT APPLICATIONS

## What nationalities file for European and US patents?

From 1998 to 2003, the number of European applications rose by 57%, from 88,570 to 138,968. Nearly nine out of ten applications originated from within the European Union, the United States or Japan. Nevertheless the share of European patent applications of this triad decreased somewhat over this period, from 91.6% to 88.1%.

In the European patent system, EU Member States patent share dominates, unsurprisingly, accounting for 40% of all applications, but this share has decreased by 6% since 1998. The United States accounts for somewhat less than one third of European patent applications, and its share is decreasing as well. Japan's requests, representing about one sixth of all patent applications, grew slightly over the period 1998-2003 (+3%).

The loss of share by the US and by EU members has been to the benefit of the rest of the world, and especially China, India and South Korea, whose share rose by a factor of 3 or 4.

An analysis of patents filed with the US Patent and Trademark Office (USPTO) shows the same sharp increase in number of filings, which grew by 41% over the period 1998-2003. The same hegemonic triad appears; the US, Japan and the EU account for nearly nine of every ten filings, although the same slippage can be observed as for European applications, as the 'Big Three' share dropped from 90.3% to 88.0%.

Where the situation differs is in relative share of US patents among these three zones. The US dominates with nearly half of all applications (but slipping from 49.2% to 47.9%). Japan is next with a share that dropped from 23.5% to 22.5%, and the EU share remained stable at 17.6%.

China and India, whose shares in 1998 were identical between the two large patent systems, increased their European application share more sharply. South Korea's share of US patents showed very weak growth in the American system.



## V.1. EUROPEAN APPLICATIONS AND US PATENTS WORLDWIDE (1998-2003)

| Country/Zone | World share (%) of European patent applications 1998 | 2003 | Evolution 2003/1998 (%) |
|---|---|---|---|
| European Union (25) | 43.0 | 40.2 | -6 |
| United States | 32.9 | 31.7 | -4 |
| Japan | 15.7 | 16.2 | +3 |
| China | 0.2 | 0.9 | ns |
| India | 0.1 | 0.3 | ns |
| South Korea | 0.6 | 1.8 | +192 |
| Russia | 0.3 | 0.4 | +17 |
| Israel | 0.7 | 1.0 | +54 |
| South Africa | 0.1 | 0.3 | ns |
| Brazil | 0.1 | 0.1 | ns |
| **World** | **100.0** | **100.0** | **0** |
| **Number of European applications** | **88,570** | **138,968** | **+57** |

*data INPI and EPO, OST computing* *Key Figures - 2006*

- *world patent share is determined using a fractional count based on the country named in inventor's address*
- *European patent applications are those filed with the EPO as well as those filed internationally via the PCT procedure and designating European countries*
- *ns: data not significant*

| Country/Zone | World share (%) of US patents 1998 | 2003 | Evolution 2003/1998 (%) |
|---|---|---|---|
| European Union (25) | 17.6 | 17.6 | 0 |
| United States | 49.2 | 47.9 | -3 |
| Japan | 23.5 | 22.5 | -5 |
| China | 0.2 | 0.4 | ns |
| India | 0.1 | 0.2 | ns |
| South Korea | 2.0 | 2.4 | +20 |
| Russia | 0.2 | 0.2 | ns |
| Israel | 0.5 | 0.7 | +29 |
| South Africa | 0.1 | 0.1 | ns |
| Brazil | 0.1 | 0.1 | ns |
| **World** | **100.0** | **100.0** | **0** |
| **Number of US patents** | **108,851** | **153,198** | **+41** |

*data USPTO, OST and CHI-Research computing* *Key Figures - 2006*

# V. PATENT APPLICATIONS

**What are the technological strengths and weaknesses of the European Union, the United States and Japan as seen in shares of European and US patents?**

When European patent applications are sorted by technological field, differences among the triad appear.
In Electronics-Electricity, European Union's 33.9% share of European patents is virtually equal to the US' 34.7% share. But US patent inventors hold a predominant share of European patents in Pharmaceuticals-Biotechnologies (41.8% compared to 32.9%). In contrast, European Union applications dominate the field of Machines-Mechanics-Transportation by 54.5% compared to the United States share of 19.2%, as well as the field of Consumer Goods and Construction (53.5% compared to 21.6%). Japan meanwhile accounts for nearly one fifth of European patent applications in Electronics-Electricity and in Materials-Chemistry. Compared to its world share all fields taken together of 16.2%, Japan is a relatively smaller player in European applications in the fields of Consumer Goods and Construction (7.4%) and Pharmaceuticals-Biotechnologies (10.1%).

In the US patent system, EU and Japanese shares are quite equal in Industrial Processes, Machines-Mechanics-Transportation and Materials-Chemistry. Japan is well ahead of the EU in Instrumentation, with a 24.3% share compared to 15.6%, and especially in Electronics-Electricity (27.0% compared to 11.1%).
In US as opposed to European patent applications, the European Union is specialised in Pharmaceuticals-Biotechnologies. EU world share of US patents in this field is clearly stronger than its share in all fields taken together (23.0% as compared to 17.6%). But in this field, the United States largely dominates with a world share of 58.5%.



## V.2. EUROPEAN UNION, UNITED STATES AND JAPAN' SHARES OF EUROPEAN APPLICATIONS AND US PATENTS BY TECHNOLOGICAL FIELD (2003)

| | World share (%) of European patent applications (2003) | | |
|---|---|---|---|
| Field | European Union (25) | United States | Japan |
| Electronics-Electricity | 33.9 | 34.7 | 20.3 |
| Instrumentation | 34.5 | 38.2 | 15.3 |
| Materials-Chemistry | 38.3 | 32.4 | 19.3 |
| Pharmaceuticals-Biotechnologies | 32.9 | 41.8 | 10.1 |
| Industrial Processes | 47.7 | 25.6 | 15.6 |
| Machines-Mechanics-Transportation | 54.5 | 19.2 | 15.9 |
| Consumer Goods-Construction | 53.5 | 21.6 | 7.4 |
| **World** | **40.2** | **31.7** | **16.2** |
| **Number of European applications** | **55,813** | **44,028** | **22,549** |

*data INPI and EPO, OST computing* *Key Figures - 2006*

- *world patent share is determined using a fractional count based on the country named in inventor's address*
- *European patent applications are those filed with the EPO as well as those filed internationally via the PCT procedure and designating European countries*
- *classification by technological field follows the OST standard*

| | World share (%) of US patents (2003) | | |
|---|---|---|---|
| Field | European Union (25) | United States | Japan |
| Electronics-Electricity | 11.1 | 49.0 | 27.0 |
| Instrumentation | 15.6 | 50.1 | 24.3 |
| Materials-Chemistry | 24.1 | 45.5 | 21.6 |
| Pharmaceuticals-Biotechnologies | 23.0 | 58.5 | 8.3 |
| Industrial Processes | 23.7 | 43.7 | 20.9 |
| Machines-Mechanics-Transportation | 24.9 | 42.0 | 21.6 |
| Consumer Goods-Construction | 18.7 | 48.1 | 10.5 |
| **World** | **17.6** | **47.9** | **22.5** |
| **Number of US patents** | **27,006** | **73,336** | **34,411** |

*data USPTO, OST and CHI-Research computing* *Key Figures - 2006*

- *world patent share is determined using a fractional count based on the country named in inventor's address*
- *classification by technological field follows the OST standard*

## V.3. THE FIVE MOST SPECIALISED COUNTRIES BY TECHNOLOGICAL FIELD AS SEEN IN EUROPEAN APPLICATIONS (2003)

The five most specialised countries by technological field in European patent applications (2003)

| Electronics-Electricity | | Instrumentation | | Materials-Chemistry | | Pharmaceuticals-Biotechnologies | | Industrial Processes | | Machines-Mechanics-Transportation | | Consumer Goods-Construction | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Index | Country | Index | Country | Index | Country | Index | Country | Index | Country | Index | Country | Index |
| Singapore | 1.88 | Israel | 1.67 | India | 2.84 | China | 3.54 | Italy | 1.85 | Germany | 1.69 | Taiwan | 3.01 |
| Finland | 1.70 | Ireland | 1.43 | Belgium | 1.90 | India | 3.14 | Switzerland | 1.49 | Italy | 1.57 | South Africa | 2.69 |
| South Korea | 1.49 | Russia | 1.37 | Russia | 1.43 | Denmark | 1.82 | Spain | 1.46 | Norway | 1.52 | Spain | 2.39 |
| Netherlands | 1.45 | Switzerland | 1.29 | Japan | 1.19 | New Zeeland | 1.57 | Finland | 1.46 | Austria | 1.46 | Norway | 2.36 |
| Israel | 1.34 | United States | 1.20 | Germany | 1.08 | Canada | 1.48 | South Africa | 1.43 | Spain | 1.38 | Austria | 2.35 |

*data INPI and EPO, OST computing* *Key Figures - 2006*

- *the specialisation index shows a country's world patent share in a particular domain relative to its overall patent share. The neutral value is 1*
- *classification by technological field follows the OST standard*

**What are the most specialised countries by technological field as seen in shares of European applications?**

As was seen with specialisation in scientific production, the map of technological specialisation by country is completely different than that of volume of output (patent applications).

Accordingly, the two largest technological producers, France and the United Kingdom, do not figure among the most specialised EU member countries, as determined by applications filed in the European patent system, and Germany figures in only two fields: Machines-Mechanics-Transportation and Materials-Chemistry. China and India are particularly specialised in Pharmaceuticals-Biotechnologies (while India is also among the most specialised countries in Materials-Chemistry).

Among countries most specialised in Electronics-Electricity, Finland follows just behind Singapore, and precedes the Netherlands and South Korea. Israel is on this list while also the most highly specialised country in Instrumentation. In the latter field, Ireland and Russia also are relatively highly specialised along with Switzerland and the United States. Interestingly, Instrumentation is the only technological field where the US shows a high degree of specialisation, as seen in European patent applications.

No new Member States of the European Union appears in the list.

Except for Instrumentation, the United States does not demonstrate a high degree of specialisation, nor does Japan except in Materials-Chemistry.

## V.4. THE FIVE MOST SPECIALISED COUNTRIES BY TECHNOLOGICAL FIELD AS SEEN IN US PATENTS (2003)

The five most specialised countries by technological field in US patents (2003)

| Electronics-Electricity | | Instrumentation | | Materials-Chemistry | | Pharmaceuticals-Biotechnologies | | Industrial Processes | | Machines-Mechanics-Transportation | | Consumer Goods-Construction | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Index | Country | Index | Country | Index | Country | Index | Country | Index | Country | Index | Country | Index |
| Singapore | 1.84 | Isreal | 1.79 | India | 3.38 | India | 4.20 | Spain | 2.55 | Germany | 1.85 | China | 3.38 |
| South Korea | 1.62 | Russia | 1.23 | Belgium | 2.64 | Denmark | 4.11 | Australia | 2.14 | Austria | 1.63 | Taiwan | 2.82 |
| Taiwan | 1.35 | Switzerland | 1.15 | Switzerland | 1.64 | France | 2.00 | Finland | 1.95 | Norway | 1.50 | Canada | 2.28 |
| Ireland | 1.24 | Japan | 1.08 | Germany | 1.50 | United Kingdom | 1.85 | Italy | 1.81 | Sweden | 1.38 | Austria | 2.10 |
| Finland | 1.22 | Sweden | 1.08 | Austria | 1.42 | Belgium | 1.84 | Switzerland | 1.70 | Spain | 1.37 | Australia | 2.10 |

*data USPTO, OST and CHI-Research computing* *Key Figures - 2006*

- *the specialisation index shows a country's world patent share in a particular domain relative to its overall patent share. The neutral value is 1*
- *classification by technological field follows the OST standard*

### What are the most specialised countries by technological field as seen in shares of US patents?

When US patents are analysed, EU countries figure among the most specialised countries in four technological fields: Materials-Chemistry, Pharmaceuticals-Biotechnologies, Industrial Processes and Machines-Mechanics-Transportation. The Asian countries of Singapore, South Korea, and Taiwan are well ahead of Ireland and Finland in their degree of specialisation in Electronics-Electricity.

India can be found leading two fields in terms of degree of specialisation as seen in US patents: Materials-Chemistry and Pharmaceuticals-Biotechnologies. China meanwhile is the most specialised country in Consumer Goods and Construction, in the US patent system.

Russia is highly specialised in the US system in Instrumentation, similar to its profile in the European system.

The United States, as seen in its own patent system, is not particularly specialised in any field.

# V. PATENT APPLICATIONS

**How do the world's technological leaders rank in the fields of Telecommunications and Biotechnologies as seen in European patent applications?**

In the European patent system, the EU continues to lead the United States in Telecommunications patents with a 40.6% world share of European patent applications in this field compared to 33.3% for the US. In contrast, the EU's position in Biotechnologies on its own territory is noticeably weak in comparison to the United States, which files one and a half times as many applications for European patents in Biotechnologies as does the EU. Japan meanwhile is stronger in Telecommunications (14.3 % world share of European applications) than in Biotechnologies (8.6%).

From 1998 to 2003 China and South Korea both made clear inroads into the European system, as the latter reached 2.8% world share of European Telecommunications patents in 2003 and China accounted for 5.1% of European patents in Biotechnologies. India on the other hand registered more modest growth in world share of European applications over the same period. The European Union managed to maintain its position despite Asian progress, while both the United States and Japan world share of European applications in these two key fields declined.



## V.5. WORLD SHARE OF EUROPEAN APPLICATIONS IN TELECOMMUNICATIONS AND BIOTECHNOLOGIES (1998-2003)

| | World share (%) of European patent applications | | | |
|---|---|---|---|---|
| | Telecommunications | | Biotechnologies | |
| Country/Zone | 1998 | 2003 | 1998 | 2003 |
| European Union (25) | 40.3 | 40.6 | 28.1 | 28.0 |
| United States | 37.6 | 33.3 | 52.2 | 47.6 |
| Japan | 15.6 | 14.3 | 10.6 | 8.6 |
| China | 0.1 | 0.9 | 0.1 | 5.1 |
| India | 0.0 | 0.2 | 0.1 | 0.4 |
| South Korea | 0.5 | 2.8 | 0.5 | 1.7 |
| Russia | 0.1 | 0.2 | 0.2 | 0.2 |
| Israel | 0.9 | 1.8 | 0.9 | 1.1 |
| South Africa | 0.1 | 0.1 | 0.0 | 0.1 |
| Brazil | 0.0 | 0.0 | 0.1 | 0.1 |
| **World** | **100.0** | **100.0** | **100.0** | **100.0** |
| **Number of European applications** | **5,639** | **12,034** | **3,240** | **6,522** |

*data INPI and EPO, OST computing* *Key Figures - 2006*

- *world patent share is determined using a fractional count based on the country named in inventor's address*
- *European patent applications are those filed with the EPO as well as those filed internationally via the PCT procedure and designating European countries*
- *classification by technological field follows the OST standard*

# V. PATENT APPLICATIONS

**How do the world's technological leaders rank in the fields of Telecommunications and Biotechnologies as seen in US patents?**

In the US patent system, the United States holds a very strong position in Telecommunications (accounting for 53.6% of patents in this field) and an even more dominant position in Biotechnologies (63.4%). Japan still outpaces the EU in Telecommunications with 19.3% share of US patents compared to the EU's 16.5%, but these figures represent a shrinkage of 17% for Japan while the EU has registered an 11% gain over the same period.

In Biotechnologies, the EU accounts for nearly one fifth of US patents (19.0%) and Japan less than a tenth (7.9%).

If the growth of Asian countries' world share is less impressive in US patents than it is in European patents, it is nonetheless strong, especially in Biotechnologies. China and India have each tripled their share of US patents.

Although Russia's share of US patents is only 0.1% in Telecommunications and 0.3% in Biotechnologies, its US patent filings in this latter area has increased between 1998 and 2003.



## V.6. WORLD SHARE OF US PATENTS IN TELECOMMUNICATIONS AND BIOTECHNOLOGIES (1998-2003)

| | World share (%) of US patents | | | |
|---|---|---|---|---|
| | Telecommunications | | Biotechnologies | |
| Country/Zone | 1998 | 2003 | 1998 | 2003 |
| European Union (25) | 14.9 | 16.5 | 17.2 | 19.0 |
| United States | 53.4 | 53.6 | 65.9 | 63.4 |
| Japan | 23.3 | 19.3 | 9.8 | 7.9 |
| China | 0.1 | 0.1 | 0.1 | 0.3 |
| India | 0.1 | 0.2 | 0.2 | 0.6 |
| South Korea | 2.7 | 3.6 | 0.5 | 0.9 |
| Russia | 0.1 | 0.1 | 0.2 | 0.3 |
| Israel | 0.8 | 1.1 | 0.8 | 0.9 |
| South Africa | 0.0 | 0.0 | 0.0 | 0.0 |
| Brazil | 0.0 | 0.0 | 0.0 | 0.1 |
| **World** | **100.0** | **100.0** | **100.0** | **100.0** |
| **Number of US patents** | **6,694** | **11,056** | **3,185** | **3,761** |

*data USPTO, OST and CHI-Research computing* *Key Figures - 2006*

- *world patent share is determined using a fractional count based on the country named in inventor's address*
- *classification by technological field follows the OST standard*

## What are EU Member States' world shares of European patent applications?

In 2003, the United Kingdom led all Member States in world share of scientific production, with a world share of 6.9%, ahead of Germany (6.7%) and France (4.8%), as shown in chapter III. The ranking of these countries looks quite different when their world shares of patent applications are considered, demonstrating that there is no automatic relationship between scientific output and technological capacity. When the latter is analysed, it is Germany that finishes in first place among EU countries, with nearly three times more European patent applications than France or the United Kingdom (16.7%, compared to 5.6% and 5.0%, respectively). Between 1998 and 2003 the position of all three leaders slipped, with France and the United Kingdom losing more share than Germany.

Italy, the Netherlands and Sweden make up a second group of EU countries accounting for 3.0%, 2.6% and 2.0% of European applications, respectively. Further back in the pack are those EU countries that file relatively few patent applications: Finland (1.2%), Belgium (1.0%), Austria (0.9%), Denmark (0.7%), and Spain (0.7%). Lastly there are those countries with very low shares like Ireland (0.2%) and Greece (0.1%). Some of the EU's new Member States have reached the threshold of 0.1%, such as Poland, Hungary, or the Czech Republic.

Ireland and Poland showed a markedly high rate of growth in European patent share from 1998 to 2003, with 55% and 87%, respectively, while Sweden and France are the two countries showing the greatest share loss, -17% and -16%, respectively.



## V.7. EU MEMBER STATES' WORLD SHARE OF EUROPEAN APPLICATIONS (1998-2003)

| | World share (%) of European patent applications | | |
|---|---|---|---|
| Country | 1998 | 2003 | Evolution 2003/1998 (%) |
| Germany | 17.7 | 16.7 | -6 |
| France | 6.6 | 5.6 | -16 |
| United Kingdom | 5.5 | 5.0 | -10 |
| Italy | 3.3 | 3.0 | -7 |
| Spain | 0.6 | 0.7 | +11 |
| Netherlands | 2.4 | 2.6 | +9 |
| Greece | 0.1 | 0.1 | ns |
| Belgium | 1.1 | 1.0 | -9 |
| Portugal | 0.0 | 0.0 | ns |
| Sweden | 2.4 | 2.0 | -17 |
| Austria | 0.9 | 0.9 | -2 |
| Denmark | 0.8 | 0.7 | -4 |
| Finland | 1.1 | 1.2 | +7 |
| Ireland | 0.1 | 0.2 | +55 |
| Luxembourg | 0.0 | 0.1 | ns |
| Poland | 0.0 | 0.1 | +87 |
| Czech Republic | 0.1 | 0.1 | +24 |
| Hungary | 0.1 | 0.1 | +8 |
| Slovakia | 0.0 | 0.0 | ns |
| Lithuania | 0.0 | 0.0 | ns |
| Latvia | 0.0 | 0.0 | ns |
| Slovenia | 0.0 | 0.0 | ns |
| Estonia | 0.0 | 0.0 | ns |
| Cyprus | 0.0 | 0.0 | ns |
| Malta | 0.0 | 0.0 | ns |
| **European Union (25)** | **43.0** | **40.2** | **-6** |

*data INPI and EPO, OST computing* *Key Figures - 2006*

- *world patent share is determined using a fractional count based on the country named in inventor's address*
- *European patent applications are those filed with the EPO as well as those filed internationally via the PCT procedure and designating European countries*
- *ns: data not significant*

## What are EU Member States' world shares of US patents?

In the US patent system, as in the European one, Germany largely dominates its EU partners, with a world share of 7.4%, which is nearly three times that of France or the United Kingdom. The next group is composed of three countries that each accounts for about 1% of patents granted by the US Patent and Trademark Office: Italy, Sweden, and the Netherlands. A third group of six countries is composed of those that are responsible for between 0.5% and 0.1% of US patents: (in descending order) Belgium, Finland, Austria, Denmark, Spain, and Ireland. New EU Member States as well as Greece and Portugal are virtually absent from the US patent system.

Between 1998 and 2003, the most dynamic growth in world share of US patents was recorded by Ireland, Sweden, and Finland with growth rates of 34%, 19%, and 15%, respectively. In the other direction, Belgium and France showed the most slippage, as their world shares dropped -13% and -10%, respectively.



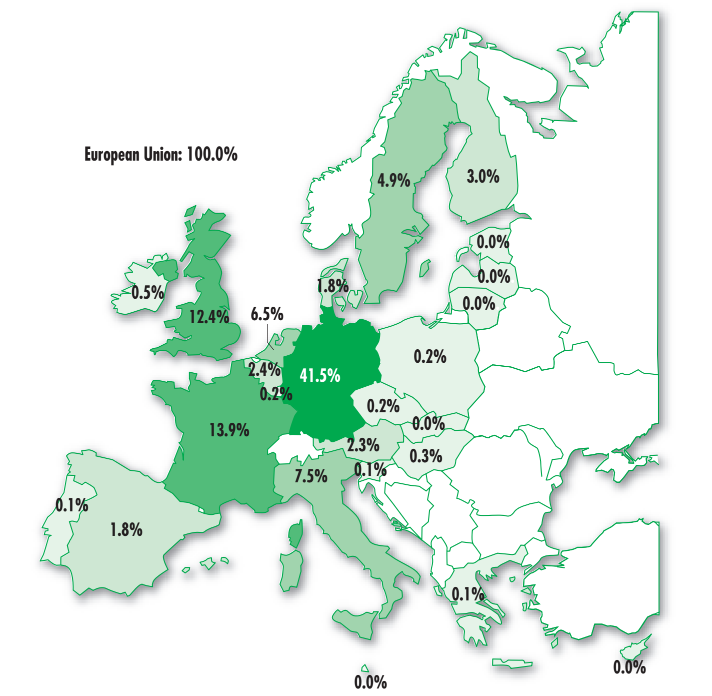
## V.8. EU MEMBER STATES' WORLD SHARE OF US PATENTS (1998-2003)

| Country | World share (%) of US patents 1998 | 2003 | Evolution 2003/1998 (%) |
|---|---|---|---|
| Germany | 7,0 | 7,4 | +5 |
| France | 2,9 | 2,6 | -10 |
| United Kingdom | 2,7 | 2,5 | -6 |
| Italy | 1,2 | 1,1 | -9 |
| Spain | 0,2 | 0,2 | +10 |
| Netherlands | 0,9 | 0,9 | 0 |
| Greece | 0,0 | 0,0 | ns |
| Belgium | 0,5 | 0,5 | -13 |
| Portugal | 0,0 | 0,0 | ns |
| Sweden | 0,9 | 1,1 | +19 |
| Austria | 0,3 | 0,4 | +8 |
| Denmark | 0,3 | 0,3 | +6 |
| Finland | 0,5 | 0,5 | +15 |
| Ireland | 0,1 | 0,1 | +34 |
| Luxembourg | 0,0 | 0,0 | ns |
| Poland | 0,0 | 0,0 | ns |
| Czech Republic | 0,0 | 0,0 | ns |
| Hungary | 0,0 | 0,0 | ns |
| **European Union (25)** | **35,9** | **34,8** | **-3** |

*data USPTO, OST and CHI-Research computing* *Key Figures - 2006*

- *world patent share is determined using a fractional count based on the country named in inventor's address*
- *only countries for which data are available are shown*
- *ns: data not significant*

EU shares of European patent applications (2003)




*data INPI and EPO, OST computing* *Key Figures - 2006*

**How many European patent applications are filed by EU Member States compared to the size of their labour force?**

When the technological density - that is, the number of European patent applications by a nation compared to its labour force - is calculated for EU Member States, it is quickly seen that Finland with 244, Sweden 230 and Germany at 222 are all more than twice as technologically dense as the normalised European average of 100. Following these leaders are Luxembourg (179), the Netherlands (164), Denmark (136) and Austria (124). Densities of France (110) and the United Kingdom (87) are close to the EU average.



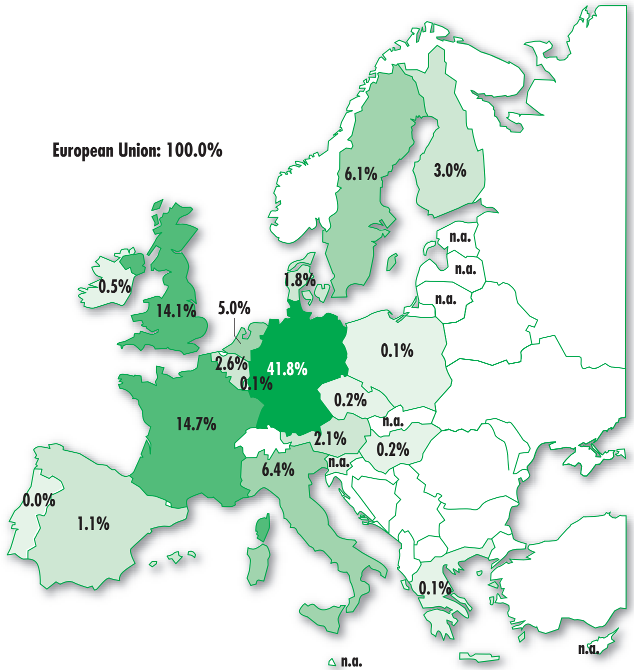
## V.9. TECHNOLOGICAL DENSITY OF EU MEMBER STATES IN EUROPEAN APPLICATIONS (2003)

| Country | European patent applications (2003) EU shares (%) | Technological density per labour force |
|---|---|---|
| Germany | 41.5 | 222 |
| France | 13.9 | 110 |
| United Kingdom | 12.4 | 87 |
| Italy | 7.5 | 67 |
| Spain | 1.8 | 20 |
| Netherlands | 6.5 | 164 |
| Greece | 0.1 | 6 |
| Belgium | 2.4 | 117 |
| Portugal | 0.1 | 3 |
| Sweden | 4.9 | 230 |
| Austria | 2.3 | 124 |
| Denmark | 1.8 | 136 |
| Finland | 3.0 | 244 |
| Ireland | 0.5 | 57 |
| Luxembourg | 0.2 | 179 |
| Poland | 0.2 | 2 |
| Czech Republic | 0.2 | 8 |
| Hungary | 0.3 | 16 |
| Slovakia | 0.0 | 2 |
| Lithuania | 0.0 | 2 |
| Latvia | 0.0 | 4 |
| Slovenia | 0.1 | 21 |
| Estonia | 0.0 | 7 |
| Cyprus | 0.0 | 10 |
| Malta | 0.0 | 16 |
| **European Union (25)** | **100.0** | **100** |

*data INPI, EPO and Eurostat, OST computing* *Key Figures - 2006*

- *European patent share is determined using a fractional count based on the country named in inventor's address*
- *European patent applications are those filed with the EPO as well as those filed internationally via the PCT procedure and designating European countries*
- *technological density is calculated as the ratio of the quantity of a nation's patents to the size of its labour force, normalised to 100 for the European Union*

EU shares of US patents (2003)




*data USPTO, OST and CHI-Research computing* — *Key Figures - 2006*

## How many US patents are filed by EU Member States compared to the size of their labour force?

When the technological densities are calculated using data from the US patent system, the results are slightly different from the European system. Sweden comes in first at 282, followed by Finland (245) and Germany (222). Further back still is Luxembourg (151), Denmark (134), the Netherlands (126), and Belgium (124). Austria at 115 does less well in this ranking than in the European patent system.

The United Kingdom performs better in the US system, with a density of 100.

## V.10. TECHNOLOGICAL DENSITY OF EU MEMBER STATES IN US PATENTS (2003)

| Country | US patents (2003) EU share (%) | US patents (2003) Technological density per labour force |
|---|---|---|
| Germany | 41.8 | 224 |
| France | 14.7 | 116 |
| United Kingdom | 14.1 | 100 |
| Italy | 6.4 | 56 |
| Spain | 1.1 | 13 |
| Netherlands | 5.0 | 126 |
| Greece | 0.1 | 4 |
| Belgium | 2.6 | 124 |
| Portugal | 0.0 | 2 |
| Sweden | 6.1 | 282 |
| Austria | 2.1 | 115 |
| Denmark | 1.8 | 134 |
| Finland | 3.0 | 245 |
| Ireland | 0.5 | 60 |
| Luxembourg | 0.1 | 151 |
| Poland | 0.1 | 1 |
| Czech Republic | 0.2 | 7 |
| Hungary | 0.2 | 12 |
| **European Union (25)** | **100.0** | **100** |

*data USPTO and Eurostat, OST and CHI-Research computing* — *Key Figures - 2006*

- *European patent share is determined using a fractional count based on the country named in inventor's address*
- *technological density is calculated as the ratio of the quantity of a nation's patents to the size of its labour force, normalised to 100 for the European Union*

## V.11. EUROPEAN APPLICATIONS OF EU MEMBER STATES BY TECHNOLOGICAL FIELD (2003)

| Country | World share (%) of European patent applications (2003) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Total Fields** | Electronics-Electricity | Instrumentation | Materials-Chemistry | Pharmaceuticals-Biotechnologies | Industrial Processes | Machines-Mechanics-Transportation | Consumer Goods-Construction |
| Germany | **16.7** | 12.2 | 14.1 | 18.1 | 10.8 | 20.6 | 28.3 | 19.7 |
| France | **5.6** | 5.1 | 4.5 | 4.9 | 5.9 | 5.8 | 7.2 | 7.3 |
| United Kingdom | **5.0** | 4.6 | 5.5 | 4.5 | 5.8 | 4.6 | 4.2 | 7.1 |
| Italy | **3.0** | 1.5 | 2.2 | 2.5 | 1.9 | 5.6 | 4.8 | 6.8 |
| Spain | **0.7** | 0.4 | 0.5 | 0.6 | 0.8 | 1.0 | 1.0 | 1.7 |
| Netherlands | **2.6** | 3.8 | 2.1 | 2.2 | 2.1 | 2.1 | 1.9 | 2.4 |
| Greece | **0.1** | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 |
| Belgium | **1.0** | 0.5 | 0.7 | 1.9 | 1.2 | 1.4 | 0.9 | 1.2 |
| Portugal | **0.0** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| Sweden | **2.0** | 2.2 | 2.0 | 1.0 | 1.4 | 2.1 | 2.6 | 2.0 |
| Austria | **0.9** | 0.6 | 0.7 | 0.8 | 0.5 | 1.2 | 1.3 | 2.1 |
| Denmark | **0.7** | 0.5 | 0.8 | 0.6 | 1.3 | 0.8 | 0.8 | 1.0 |
| Finland | **1.2** | 2.0 | 0.8 | 0.5 | 0.4 | 1.7 | 0.8 | 0.8 |
| Ireland | **0.2** | 0.2 | 0.3 | 0.1 | 0.2 | 0.2 | 0.1 | 0.2 |
| Luxembourg | **0.1** | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 |
| Poland | **0.1** | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 |
| Czech Republic | **0.1** | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 |
| Hungary | **0.1** | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 |
| **European Union (25)** | **40.2** | **33.9** | **34.5** | **38.3** | **32.9** | **47.7** | **54.5** | **53.5** |
| **Number of applications** | **55,813** | **14,257** | **7,649** | **5,814** | **5,069** | **6,929** | **10,805** | **5,290** |

*data INPI and EPO, OST computing*

*Key Figures - 2006*

- *world patent share is determined using a fractional count based on the country named in inventor's address*
- *European patent applications are those filed with the EPO as well as those filed internationally via the PCT procedure and designating European countries*
- *classification by technological field follows the OST standard*

### What are the technological strengths and weaknesses of EU Member States, as seen in the European patent system?

In the European patent system, Germany's world share is the highest of any EU country in all seven technological fields, with share values which nonetheless vary widely from 28.3% in Machines-Mechanics-Transportation to 10.8% in Pharmaceuticals-Biotechnologies. France arrives in second place in six fields and third in one, while showing a narrower range of world share (from 7.3% in Consumer Goods and Construction to 4.5% in Instrumentation). The United Kingdom is in second place in one field (Instrumentation) and third or fourth in the other six, ranging from 7.1% in Consumer Goods and Construction to 4.2% in Machines-Mechanics-Transportation.

Several countries show a high degree of specialisation in certain fields when compared to their world share in all fields taken together. Accordingly, Italy, Austria, and Spain each show a world share of European patents in Consumer Goods and Construction that is twice as high as the country's overall average. The Netherlands meanwhile are specialised in Electronics-Electricity, with a world share of 3.8% compared to an overall average of 2.6%.

## V.12. US PATENTS OF EU MEMBER STATES BY TECHNOLOGICAL FIELD (2003)

| | World share (%) of US patents (2003) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Country | **Total Fields** | Electronics-Electricity | Instrumentation | Materials-Chemistry | Pharmaceuticals-Biotechnologies | Industrial Processes | Machines-Mechanics-Transportation | Consumer Goods-Construction |
| Germany | **7.4** | 3.9 | 6.7 | 11.1 | 6.0 | 10.2 | 13.6 | 6.5 |
| France | **2.6** | 1.8 | 2.0 | 3.5 | 5.2 | 3.2 | 3.1 | 2.7 |
| United Kingdom | **2.5** | 1.8 | 2.5 | 3.1 | 4.6 | 2.4 | 2.5 | 3.7 |
| Italy | **1.1** | 0.7 | 0.8 | 1.4 | 1.2 | 2.0 | 1.5 | 1.6 |
| Spain | **0.2** | 0.1 | 0.1 | 0.3 | 0.3 | 0.5 | 0.3 | 0.4 |
| Netherlands | **0.9** | 0.8 | 0.9 | 1.2 | 1.2 | 1.1 | 0.7 | 0.8 |
| Greece | **0.0** | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Belgium | **0.5** | 0.2 | 0.4 | 1.2 | 0.8 | 0.7 | 0.3 | 0.3 |
| Portugal | **0.0** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Sweden | **1.1** | 0.9 | 1.2 | 0.8 | 1.2 | 1.4 | 1.5 | 1.0 |
| Austria | **0.4** | 0.2 | 0.2 | 0.5 | 0.4 | 0.6 | 0.6 | 0.8 |
| Denmark | **0.3** | 0.1 | 0.3 | 0.4 | 1.3 | 0.4 | 0.3 | 0.3 |
| Finland | **0.5** | 0.6 | 0.3 | 0.4 | 0.3 | 1.0 | 0.4 | 0.4 |
| Ireland | **0.1** | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Luxembourg | **0.0** | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 |
| Poland | **0.0** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Czech Republic | **0.0** | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Hungary | **0.0** | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| **European Union (25)** | **17.6** | **11.1** | **15.6** | **24.1** | **23.0** | **23.7** | **24.9** | **18.7** |
| **Number of patents** | **27,006** | **6,244** | **3,990** | **4,170** | **2,220** | **3,486** | **5,172** | **1,724** |

***data USPTO, OST and CHI-Research computing*** ***Key Figures - 2006***

*• world patent share is determined using a fractional count based on the country named in inventor's address*

*• classification by technological field follows the OST standard*

### What are the technological strengths and weaknesses of EU Member States, as seen in the US patent system?

In the US patent system, France and the United Kingdom appear highly specialised in Pharmaceuticals-Biotechnologies; France's world share of US patents in this field (5.2%) is twice its world share of US patents in all fields taken together. Germany nevertheless maintains its EU leadership in this field with 6.0% world share. Denmark is fourth in the Pharmaceuticals-Biotechnologies field with a world share of 1.3% of US patents.

In the US system, Germany is highly specialised in Machines-Mechanics-Transportation (world share of 13.6%), but is not specialised in Consumer Goods and Construction as it is in the European system (world share of only 6.5%).

The Netherlands, which appears specialised in Electronics-Electricity in the European patent system, shows a world share of US patents in this field that is lower than its world share of all fields (0.8% compared to 0.9%).

In the final analysis, these data show not only a country's specialisation tendencies but also its territorial strategies as applied to intellectual property and specific technological fields.

## A.1. WORLD POPULATION, LABOUR FORCE AND GDP IN VOLUME AND WORLD SHARE (2002)

| Country/Zone | Population (2002) Number (Million) | Population (2002) World share (%) | Labour force (2002) Number (Million) | Labour force (2002) World share (%) | GDP (2002) Volume (Billion $) | GDP (2002) World share (%) |
|---|---|---|---|---|---|---|
| European Union (25) | 455 | 7.5 | 212 | 6.3 | 10,863 | 22.2 |
| United States | 288 | 4.7 | 146 | 4.4 | 10,429 | 21.3 |
| Japan | 127 | 2.1 | 67 | 2.0 | 3,422 | 7.0 |
| China | 1,285 | 21.1 | 745 | 22.2 | 5,882 | 12.0 |
| India* | 998 | 16.4 | 470 | 14.0 | 2,930 | 6.0 |
| South Korea | 48 | 0.8 | 23 | 0.7 | 898 | 1.8 |
| Russia | 144 | 2.4 | 72 | 2.2 | 1,191 | 2.4 |
| Israel | 7 | 0.1 | 3 | 0.1 | 134 | 0.3 |
| South Africa* | 42 | 0.7 | 17 | 0.5 | 488 | 1.0 |
| Brazil** | 175 | 2.9 | 88 | 2.6 | 1,188 | 2.4 |
| Others | 2,515 | 41.4 | 1,510 | 45.0 | 11,445 | 23.4 |
| **World** | **6,083** | **100.0** | **3,353** | **100.0** | **48,870** | **100.0** |

*data OECD, Eurostat, Ricyt and other sources, OST estimations and computation* *Key Figures - 2006*

- ** 2001 data*
- *** 2000 data*
- *GDP: Gross domestic product*
- *monetary values are expressed in dollars ppp and changes are calculated on the basis of national currencies expressed in year 2000 constant terms*

## A.2. EU MEMBER STATES' POPULATION, LABOUR FORCE AND GDP IN VOLUME AND EU SHARE (2002)

| Country/Zone | Population (2002) Number (Million) | Population (2002) EU share (%) | Labour force (2002) Number (Million) | Labour force (2002) EU share (%) | GDP (2002) Volume (Billion $) | GDP (2002) EU share (%) |
|---|---|---|---|---|---|---|
| Germany | 82 | 18.1 | 40 | 18.7 | 2,143 | 19.7 |
| France | 61 | 13.5 | 27 | 12.8 | 1,679 | 15.5 |
| United Kingdom | 60 | 13.1 | 0 | 14.1 | 1,663 | 15.3 |
| Italy* | 58 | 12.7 | 24 | 11.4 | 1,492 | 13.7 |
| Spain | 40 | 8.9 | 18 | 8.7 | 912 | 8.4 |
| Netherlands* | 16 | 3.5 | 8 | 3.9 | 471 | 4.3 |
| Greece* | 11 | 2.4 | 4 | 2.1 | 203 | 1.9 |
| Belgium | 10 | 2.3 | 4 | 2.1 | 287 | 2.6 |
| Portugal | 10 | 2.2 | 5 | 2.5 | 190 | 1.8 |
| Sweden* | 9 | 2.0 | 4 | 2.1 | 244 | 2.2 |
| Austria | 8 | 1.8 | 4 | 1.9 | 233 | 2.1 |
| Denmark | 5 | 1.2 | 3 | 1.3 | 158 | 1.5 |
| Finland | 5 | 1.1 | 3 | 1.2 | 138 | 1.3 |
| Ireland* | 4 | 0.8 | 2 | 0.9 | 127 | 1.2 |
| Luxembourg** | 0 | 0.1 | 0 | 0.1 | 22 | 0.2 |
| Poland | 39 | 8.5 | 17 | 8.2 | 416 | 3.8 |
| Czech Republic | 10 | 2.3 | 5 | 2.4 | 156 | 1.4 |
| Hungary | 10 | 2.2 | 4 | 1.9 | 142 | 1.3 |
| Slovakia | 5 | 1.2 | 3 | 1.2 | 66 | 0.6 |
| Lithuania | 4 | 0.8 | 2 | 0.8 | 36 | 0.3 |
| Latvia | 2 | 0.5 | 1 | 0.5 | 24 | 0.2 |
| Slovenia | 2 | 0.4 | 1 | 0.5 | 38 | 0.4 |
| Estonia | 1 | 0.3 | 1 | 0.3 | 18 | 0.2 |
| Cyprus | 1 | 0.2 | 0 | 0.2 | 15 | 0.1 |
| Malta | 0 | 0.1 | na | na | na | na |
| **European Union (25)** | **455** | **100.0** | **212** | **100.0** | **10,863** | **100.0** |

*data OECD, Eurostat, OST estimations and computation* *Key Figures - 2006*

- ** 2001 data*
- *** 2000 data*
- *GDP: Gross domestic product*
- *monetary values are expressed in dollars ppp and changes are calculated on the basis of national currencies expressed in year 2000 constant terms*
- *na: data not available*

## A.3. FUNDING SOURCES OF EU MEMBER STATES' GERD BY SECTOR (2002)

**(COMMENTS IN CHAPTER I.3)**

| Country/Zone | Funding sources of GERD (2002) Public (%) | Private (%) | Abroad (%) | **Total (%)** | Volume (Million $) |
|---|---|---|---|---|---|
| Germany | 32.1 | 65.5 | 2.4 | **100.0** | 54,256 |
| France | 39.9 | 52.1 | 8.0 | **100.0** | 37,967 |
| United Kingdom | 32.8 | 46.7 | 20.5 | **100.0** | 31,163 |
| Italy* | 50.8 | 43.0 | 6.2 | **100.0** | 16,367 |
| Spain | 44.3 | 48.9 | 6.8 | **100.0** | 9,421 |
| Netherlands** | 37.2 | 51.8 | 11.0 | **100.0** | 8,693 |
| Greece* | 48.6 | 33.1 | 18.4 | **100.0** | 1,211 |
| Belgium | 23.9 | 64.3 | 11.8 | **100.0** | 6,427 |
| Portugal** | 63.4 | 31.5 | 5.1 | **100.0** | 1,781 |
| Sweden** | 24.8 | 71.9 | 3.4 | **100.0** | 10,233 |
| Austria | 36.5 | 41.8 | 21.7 | **100.0** | 5,118 |
| Denmark | 30.7 | 61.5 | 7.8 | **100.0** | 3,977 |
| Finland | 27.3 | 69.5 | 3.1 | **100.0** | 4,779 |
| Ireland* | 26.9 | 67.2 | 6.0 | **100.0** | 1,304 |
| Luxembourg*** | 90.7 | 7.7 | 1.7 | **100.0** | 364 |
| Poland | 64.3 | 31.0 | 4.8 | **100.0** | 2 439 |
| Czech Republic | 43.6 | 53.7 | 2.7 | **100.0** | 2 021 |
| Hungary**** | 58.8 | 29.7 | 10.4 | **100.0** | 1 451 |
| Slovakia | 44.4 | 53.6 | 2.1 | **100.0** | 382 |
| Lithuania | 65.1 | 27.9 | 7.1 | **100.0** | 239 |
| Latvia | 42.7 | 21.7 | 35.6 | **100.0** | 100 |
| Slovenia | 36.3 | 60.0 | 3.7 | **100.0** | 587 |
| Estonia | 56.5 | 29.2 | 14.4 | **100.0** | 134 |
| Cyprus | 67.5 | 17.4 | 15.1 | **100.0** | 44 |
| Malta | na | na | na | **na** | na |
| **European Union (25)** | **36.9** | **55.4** | **7.6** | 100.0 | **201,740** |

*data OECD, Eurostat, OST estimations and computation* — *Key Figures - 2006*

- ** 1996 data*
- *** 2001 data*
- **** 2000 data*
- ***** incomplete breakdown*
- *GERD: Gross domestic expenditure on R&D*
- *monetary values are expressed in dollars ppp and changes are calculated on the basis of national currencies expressed in year 2000 constant terms*
- *na: data not available*

## A.4. EU MEMBER STATES' SCIENTIFIC PRODUCTION IN EU SHARE AND RELATIVE DENSITY PER LABOUR FORCE (2003)

**(COMMENTS IN CHAPTER III.5)**

| Country | Scientific production (2003) EU share (%) | Scientific density per labour force |
|---|---|---|
| Germany | 19.2 | 102 |
| France | 13.9 | 109 |
| United Kingdom | 20.0 | 141 |
| Italy | 10.5 | 92 |
| Spain | 7.5 | 85 |
| Netherlands | 5.2 | 132 |
| Greece | 1.7 | 77 |
| Belgium | 2.7 | 131 |
| Portugal | 1.1 | 41 |
| Sweden | 4.1 | 192 |
| Austria | 2.1 | 114 |
| Denmark | 2.1 | 154 |
| Finland | 2.1 | 173 |
| Ireland | 0.8 | 87 |
| Luxembourg | 0.0 | 22 |
| Poland | 3.3 | 42 |
| Czech Republic | 1.3 | 53 |
| Hungary | 1.1 | 57 |
| Slovakia | 0.5 | 38 |
| Lithuania | 0.2 | 20 |
| Latvia | 0.1 | 15 |
| Slovenia | 0.5 | 102 |
| Estonia | 0.1 | 46 |
| Cyprus | 0.0 | 23 |
| Malta | 0.0 | 18 |
| **European Union (25)** | **100.0** | **100** |

*data ISI-Thomson Scientific, OST computing* — *Key Figures - 2006*

- *European publication share is determined using fractional count based on the bibliometric version of the Web of Science*
- *relative scientific density is calculated as the ratio of the quantity of a nation's publications to the size of its labour force, normalised to 100 for the European Union*

## A.5. WORLD SHARE OF SCIENTIFIC PRODUCTION OF EU MEMBER STATES BY DISCIPLINE (2003)

**(COMMENTS IN CHAPTER III.6)**

| | World share (%) of scientific publications (2003) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Country | **Total Sciences** | Fundamental Biology | Medical Research | Applied Biology-Ecology | Chemistry | Physics | Astro-sciences & Earth Sciences | Engineering | Mathematics |
| Germany | **6.7** | 6.6 | 7.2 | 5.0 | 6.7 | 8.0 | 5.9 | 5.5 | 6.2 |
| France | **4.8** | 5.0 | 4.7 | 3.9 | 4.8 | 5.5 | 5.1 | 4.3 | 7.6 |
| United Kingdom | **6.9** | 7.4 | 9.1 | 6.0 | 4.9 | 4.6 | 7.4 | 6.3 | 4.7 |
| Italy | **3.6** | 3.5 | 4.2 | 2.2 | 3.0 | 4.1 | 3.9 | 3.4 | 4.4 |
| Spain | **2.6** | 2.6 | 2.4 | 3.3 | 3.1 | 2.1 | 2.6 | 2.3 | 3.7 |
| Netherlands | **1.8** | 2.0 | 2.4 | 1.7 | 1.2 | 1.3 | 1.9 | 1.6 | 1.3 |
| Greece | **0.6** | 0.4 | 0.7 | 0.6 | 0.5 | 0.5 | 0.8 | 0.9 | 0.8 |
| Belgium | **0.9** | 1.0 | 1.1 | 0.9 | 0.8 | 0.9 | 0.8 | 0.9 | 1.0 |
| Portugal | **0.4** | 0.3 | 0.2 | 0.5 | 0.6 | 0.4 | 0.4 | 0.5 | 0.6 |
| Sweden | **1.4** | 1.6 | 1.8 | 1.5 | 1.1 | 1.2 | 1.4 | 1.1 | 0.8 |
| Austria | **0.7** | 0.7 | 1.0 | 0.6 | 0.5 | 0.6 | 0.6 | 0.6 | 0.8 |
| Denmark | **0.7** | 0.9 | 0.9 | 1.1 | 0.4 | 0.5 | 1.0 | 0.5 | 0.5 |
| Finland | **0.7** | 0.8 | 0.9 | 1.1 | 0.5 | 0.5 | 0.8 | 0.7 | 0.5 |
| Ireland | **0.3** | 0.3 | 0.3 | 0.4 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 |
| Poland | **1.1** | 0.9 | 0.6 | 1.3 | 2.0 | 1.8 | 1.0 | 1.2 | 1.7 |
| Czech Republic | **0.4** | 0.4 | 0.2 | 0.8 | 0.7 | 0.5 | 0.4 | 0.3 | 0.7 |
| Hungary | **0.4** | 0.4 | 0.3 | 0.5 | 0.6 | 0.4 | 0.2 | 0.3 | 0.8 |
| Slovakia | **0.2** | 0.2 | 0.1 | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 | 0.2 |
| Lithuania | **0.1** | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 |
| Slovenia | **0.2** | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.3 | 0.3 |
| **European Union (25)** | **34.8** | **35.2** | **38.3** | **32.0** | **32.2** | **33.7** | **34.9** | **31.3** | **37.3** |
| **Number of publications EU(25)** | **260,334** | **40,546** | **86,828** | **16,132** | **34,823** | **29,092** | **16,620** | **25,567** | **8,632** |

*data ISI-Thomson Scientific, OST computing*

*Key Figures - 2006*

- *world publication share is determined by fractional count using the bibliometric version of the Web of Science*
- *especially for countries with a small scientific output, as it is the case for several new Member States, the figures are particularly sensitive to the database coverage (national journals) and should be carefully interpreted*
- *only countries for which data are significant are shown*
- *classification by discipline follows the OST standard*

## A.6. EU MEMBER STATES' RELATIVE IMPACT INDEX BY DISCIPLINE (2002)

**(COMMENTS IN CHAPTER III.7)**

| Country | Relative impact index (2002) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Total Sciences** | Fundamental Biology | Medical Research | Applied Biology-Ecology | Chemistry | Physics | Astro-sciences & Earth Sciences | Engineering | Mathematics |
| Germany | **1.08** | 1.07 | 0.89 | 1.31 | 1.25 | 1.24 | 1.17 | 1.08 | 1.11 |
| France | **0.92** | 0.93 | 0.82 | 1.11 | 1.03 | 0.98 | 0.95 | 1.03 | 1.06 |
| United Kingdom | **1.12** | 1.14 | 0.95 | 1.58 | 1.24 | 1.21 | 1.21 | 1.05 | 1.28 |
| Italy | **0.89** | 0.67 | 0.93 | 0.77 | 1.02 | 1.12 | 1.07 | 1.01 | 0.93 |
| Spain | **0.75** | 0.64 | 0.65 | 0.86 | 1.04 | 1.10 | 0.80 | 1.04 | 0.98 |
| Netherlands | **1.21** | 0.96 | 1.20 | 1.44 | 1.54 | 1.24 | 1.28 | 1.31 | 1.17 |
| Greece | **0.53** | 0.48 | 0.54 | 0.59 | 0.79 | 0.84 | 0.54 | 0.82 | 0.71 |
| Belgium | **0.96** | 0.88 | 0.98 | 1.16 | 1.00 | 0.98 | 0.86 | 1.14 | 1.38 |
| Portugal | **0.64** | 0.56 | 0.72 | 0.73 | 0.74 | 1.04 | 0.59 | 0.82 | 1.10 |
| Sweden | **1.05** | 0.90 | 1.04 | 1.32 | 1.20 | 1.03 | 0.87 | 1.16 | 1.27 |
| Austria | **0.96** | 0.96 | 0.84 | 1.08 | 1.19 | 1.23 | 0.73 | 0.94 | 1.29 |
| Denmark | **1.16** | 0.92 | 1.13 | 1.19 | 1.59 | 1.44 | 1.02 | 1.55 | 1.36 |
| Finland | **1.00** | 0.89 | 1.12 | 1.11 | 0.87 | 1.14 | 0.79 | 1.14 | 1.07 |
| Ireland | **0.84** | 0.84 | 0.79 | 0.98 | 1.15 | 0.96 | ns | 1.00 | ns |
| Poland | **0.48** | 0.35 | 0.46 | 0.45 | 0.60 | 0.70 | 0.68 | 0.74 | 0.69 |
| Czech Republic | **0.56** | 0.42 | 0.57 | 0.53 | 0.79 | 0.72 | 0.60 | 0.79 | 0.99 |
| Hungary | **0.62** | 0.57 | 0.56 | 0.49 | 0.70 | 0.89 | 0.74 | 0.99 | 0.69 |
| Slovakia | **0.39** | 0.30 | 0.34 | 0.30 | 0.52 | 0.70 | ns | 0.67 | ns |
| Lithuania | **ns** | ns | ns | ns | 0.52 | ns | ns | ns | ns |
| Slovenia | **0.46** | 0.33 | 0.46 | ns | 0.65 | 0.91 | ns | 0.69 | ns |
| **European Union (25)** | **0.97** | **0.91** | **0.90** | **1.13** | **1.08** | **1.10** | **1.02** | **1.04** | **1.06** |

***data ISI-Thomson Scientific, OST computing*** ***Key Figures - 2006***

- *the relative impact index corresponds to the average number of citations obtained over two years by a country's publications compared to the world average. In other words it is the ratio of a country's world share of citations over a country's world share of publications*
- *only countries for which data are significant are shown*
- *especially for countries with a small scientific output, as it is the case for several new Member States, the figures are particularly sensitive to the database coverage (national journals) and should be carefully interpreted*
- *classification by discipline follows the OST standard*
- *ns: data not significant*

# NOTES ON METHODOLOGY

## Financial and Human Resources

• Indicators concerning financial and human resources devoted to R&D as well as indicators on graduate students and graduate degrees are based on OECD and Eurostat data, which makes possible comparisons of normalised data among countries. Student data are sorted according to standard OECD nomenclature.

• Expenditures are shown in either millions (M$) or billions (G$) of dollars.

• For international comparisons, expenditures are generally given in terms of purchasing power parity (ppp). Changes in expenditure are given in constant terms unless otherwise indicated.

• A choice has been made to show expenditures in dollars in light of the international nature of the work and the use of dollar denominated sums by the OECD in its database.

• Research personnel are counted as full-time equivalents (FTE), while head counts are used for students.

## Publication

• Indicators of scientific production have been constructed from the *Web of Science* database of *ISI-Thomson Scientific* (WoS), a standard reference for bibliometrics. The WoS is a very selective database, oriented toward academic research and considered to be an accurate representation of those disciplines that are highly internationalised. It is less representative of applied or field-oriented disciplines, of disciplines with strong national traditions, and of disciplines such as computer science where information often circulates by other means besides journal articles. The WoS should not be considered as a sampling of world scientific production but rather as a well-conceived survey of the best internationalised journals.
The field categories used in this work are the eight standard categories used by OST, which represent an aggregation of WoS specialised fields ("subject category codes") as defined at the journal level.

• The omission of social sciences and humanities (SSH) from Chapters III and IV of this work is due to the absence (for this subject area) of sufficiently representative publication databases for calculating meaningful indicators of international scientific activity.

## Patent applications

• Indicators of technological production have been constructed from data from the European patent system (EPO) as well as the American one (USPTO). The total number of European patents is calculated as the sum of the patents filed with the EPO plus the number of PCT filings that designate European countries, while avoiding double counting. Indicators are based on the date the patent application is filed, in the case of the EPO, or the date the patent is granted, for patents in the American system. The technological field classification used in this work is OST's standard classification, derived from the International Patent Classification codes (IPC). This system divides patentable technologies into seven fields and thirty sub-fields. Among the latter, two in particular are singled out for analysis is this work: Telecommunications and Biotechnologies.

• European and US patent counts are established on the basis of the address of the inventor, which is considered to be a good approximation of the address where the research was carried out, and not the address of the institution or company responsible for the actual filing of the patent application.

## Patent and publication counting

• World share of publications and patents are calculated in fractional count. For a single-author article by, say, a French author, one point is attributed to France, whereas if an article is co-signed by two authors from different countries, a half-point is attributed to each country. This approach is based on the idea of "contribution" to scientific or technological activity, where each country's contribution is considered to be the prorated contribution of its scientists among scientists from other countries. Fractional counting can be consolidated at all levels.

• Bibliometric data (in science and technology) has been made more robust by showing each year as an average of three years. Accordingly, the data for the year 2003 for example is in fact the average of the years 2001, 2002, and 2003.

• The indicators for publication and relative impact index (page 47) do not refer to the same year, in order to provide a period of 2 years for the calculation of the relative impact.

## Co-publications

• Integer counts are used for calculating co-publications since a co-signed article is presumed to be the result of ties between institutions regardless of the total number of co-signers. By this method, any author of a co-signed article is credited with a full unit of participation. When integer counts are used, totals and percentages cannot be consolidated among various research actors.

## Note

• The sum of the figures presented in tables may differ slightly from the totals presented, since the numbers have been rounded.



# DATA SOURCES

- *Eurostat* for S&T data on European countries (http://epp.eurostat.cec.eu.int )
- *OECD* for S&T and Education data on OECD countries (www.oecd.org)
- *Ricyt* Network on Science and Technology Indicators for data on Ibero-American and Inter-American S&T activities (www.ricyt.edu.ar)
- *ISI-Thomson Scientific* for data on scientific publication (www.isinet.com)
- *Cordis* for data on EU Framework-Programme (www.cordis.lu)
- *World Intellectual Property Organization* for data on PCT applications (www.wipo.int)
- *European Patent Office* for data on European patents (http://www.european-patent-office.org)
- *CHI-Research (ipIQ)* for computing US patent data from US Patent and Trademark Office (www.ipiq.com)

# GLOSSARY

| | |
|---|---|
| CORDIS | Community Research & Development Information Service |
| EC | European Communities |
| EPO | European Patent Office |
| ESA | European Space Agency |
| EU | European Union |
| EUROSTAT | Statistical Office of the European Communities |
| FP5 | Fifth Framework Programme of the EC |
| FTE | Full-time equivalent (on R&D) |
| GDP | Gross Domestic Product |
| GERD | Gross Domestic Expenditure on R&D |
| INED | Institut national des études démographiques |
| INPI | Institut national de la propriété industrielle |
| ISI | Institute for Scientific Information |
| OECD | Organisation for Economic Co-operation & Development |
| OST | Observatoire des Sciences et des Techniques |
| PCT | Patent Cooperation Treaty |
| PNP | Private Non-Profit Institutions |
| PPP | Purchasing Power Parity |
| R&D | Research & Development |
| Ricyt | Network on Science & Technology Indicators on Ibero-American and Inter-American S&T Activities |
| SSH | Social Sciences and Humanities |
| USPTO | US Patent and Trademark Office |
| IPC | International Patent Classification |
| WoS | Web of Science (of ISI-Thomson Scientific) |



OST Observatoire des Sciences et des Techniques

# SELECTED BIBLIOGRAPHY

## S&T Indicators

European Commission (http://europa.eu.int)
- *Key Figures 2005*
- *Third European Report on Science and Technology Indicators, 2003 (http://www.cordis.lu/indicators)*
- *Towards a European Research Area - Key Figures 2003-2004*
- *She Figures 2003 - Women and Science Statistics and Indicators (http://europa.eu.int/comm/research/science-society/women-science/women-science_en.html)*

French Ministry in charge of Higher Education and Research (www.education.gouv.fr/stateval/rers/2005.htm)
- *Statistics on French Research*

National Science Foundation (http://www.nsf.gov)
- *Science & Engineering Indicators, 2004*

OECD (http://www.oecd.org)
- *Main Science and Technological Indicators (MSTI), 2005*
- *Science, Technology and Industry Scoreboard, 2005*
- *Education at a glance, 2005*

OST - Observatoire des sciences et des techniques (www.obs-ost.fr)
- *Les chiffres clés de la science et de la technologie, Edition 2003, Economica*
- *Indicateurs de Sciences et de Technologies, Edition 2004, Economica*

## Methodology

CWTS - Centre for Science and Technology Studies
- *Handbook of Quantitative Science and Technology Research: the Use of Publication and Patent Statistics in Studies of S&T Systems, Kluwer Academic Publishers, 2004*

OECD (www.oecd.org)
- *Frascati Manual: The Measurement of Science and Technological Activities, 2004*
- *Canberra Manual: The Measurement of Human Resources Devoted to S&T, 1995*
- *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, 2005*