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Patents and R&D personnel

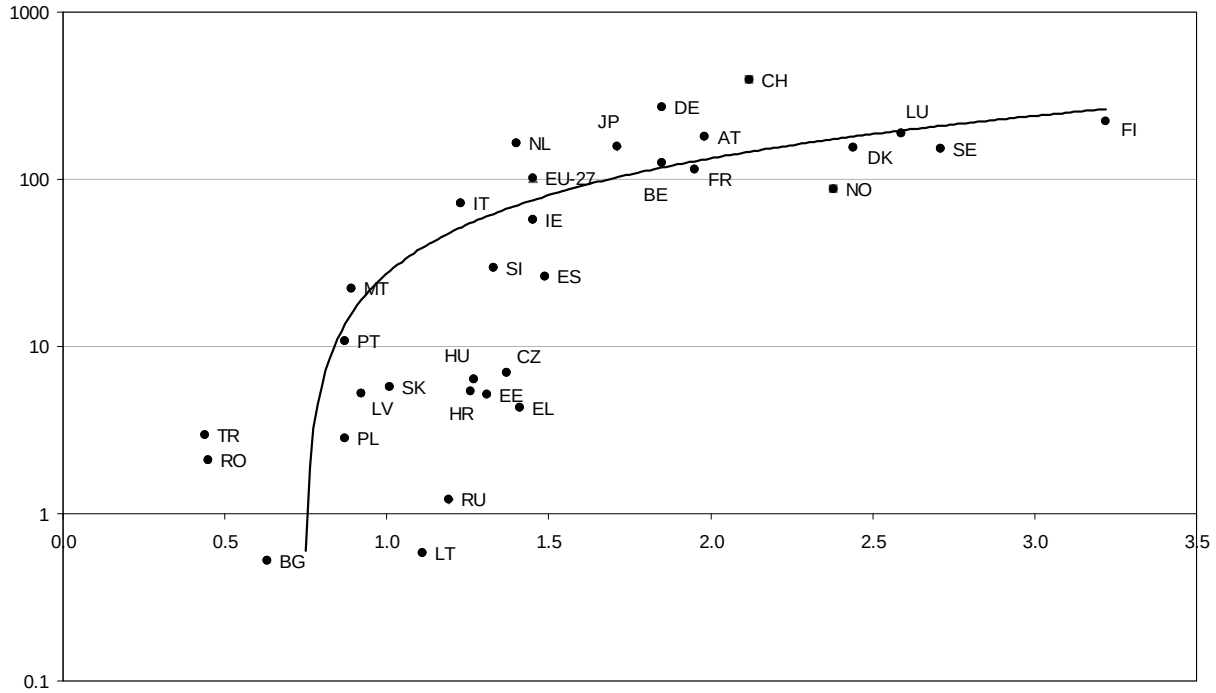
This publication aims to analyse the relationship between patent activity and R&D personnel.

Although many Member States fit the correlation, the relationship between patents and R&D personnel does not appear to be straightforward in all of them. Moreover, the evolution of patent activity does not necessarily follow that of R&D personnel. As the countries presented in this publication vary in terms of economic size and innovative structure, the analysis should accordingly take these aspects into consideration.

A breakdown by institutional sector reveals that patent activity is concentrated in the Business enterprise sector (BES), whereas similar shares of R&D personnel are employed in the BES and the Higher education sector. A significant number of R&D personnel are also employed in the Government sector.

The last part of the publication considers the role of researchers and compares those working in the BES to those employed in all economic sectors. This analysis reveals a number of interesting differences between countries.

Figure 1: Correlation of patent applications to the European Patent Office (EPO) per million inhabitants (log scale) and R&D personnel as share of total employment, selected countries, 2005



Source: Eurostat, patent and R&D statistics

2005 data for patent applications are estimates
Exception to reference year for R&D personnel data: 2004 AT, HR, CH
EU-27 Eurostat estimate, NL provisional estimate, MT provisional

Table 2: Patent applications to the EPO and R&D personnel, EU-27 and selected countries

	EPO patent applications			R&D personnel		
	Total number	per million inhabitants		Total number (Head Count-HC)	in % of total employment	
	2005	2000	2005	2005	2000	2005
EU-27	49 730	106.1	101.3	3 047 825 s	1.36 s	1.45 s
BE	1 302	125.8	124.6	78 509	:	1.85
BG	4	0.9	0.5	18 638	0.60	0.63
CZ	71	6.5	7.0	65 379	1.14	1.37
DK	842	175.5	155.6	67 267	2.07	2.44
DE	22 219	268.0	269.3	678 945	:	1.85
EE	7	4.1	5.2	7 955	1.14	1.31
IE	237	57.7	57.7	28 270	1.25	1.45
EL	48	5.0	4.3	61 454	:	1.41
ES	1 135	19.7	26.4	282 804	:	1.49
FR	7 201	119.8	115.2	488 949	1.64 i	1.95
IT	4 197	70.0	71.8	277 370	1.08	1.23
CY	0	10.4	0.0	2 470	0.55	0.71
LV	12	3.1	5.2	9 488	0.87	0.92
LT	2	1.3	0.6	16 323	1.04	1.11
LU	86	182.7	189.0	5 015	:	2.59
HU	64	11.8	6.3	49 723	1.18	1.27
MT	9	11.8	22.4	1 320 p	:	0.89 p
NL	2 695	215.5	165.3	113 606 e	:	1.40 e
AT	1 477	146.8	180.0	74 191	:	1.98
PL	108	1.1	2.8	123 431	0.86	0.87
PT	113	4.1	10.7	44 585	0.76 e	0.87
RO	45	0.3	2.1	41 035	0.35	0.45
SI	59	25.5	29.5	12 600	1.36	1.33
SK	31	2.1	5.8	22 294	1.06	1.01
FI	1 169	269.4	223.2	77 275	2.95	3.22
SE	1 370	256.1	152.0	117 714	:	2.71
UK	5 206	100.6	86.7	:	:	:
HR	24	3.3	5.4	19 739	:	1.26
TR	211	0.6	3.0	97 355	0.35	0.44
NO	401	88.2	87.1	54 341	:	2.38
CH	2 929	376.1	395.0	84 090	2.24	2.12
RU	175	1.6	1.2	813 207	1.37	1.19
US	29 538	108.0	99.6	:	:	:
JP	20 099	168.4	157.3	1 122 680	:	1.71

Source: Eurostat, patent and R&D statistics

2005 data for patent applications are estimates
Exception to reference year for R&D personnel data: 2004 AT, HR, CH

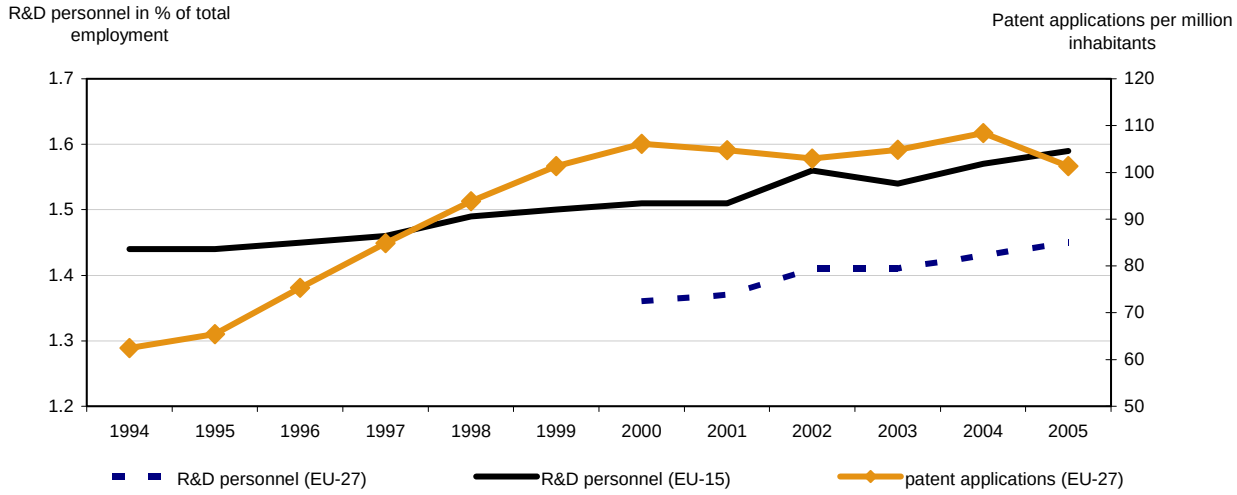
This publication aims to shed some light on the relationship between R&D personnel and patenting. The main question raised is: does a higher innovation input in form of more personnel lead to a higher innovation output in terms of patents?

This analysis takes into account that R&D personnel includes not only researchers and scientists, but also people providing direct services such as R&D managers, administrators and clerical staff. On the other hand, it should be noted that not all inventions necessarily lead to the submission of patent applications. There are other ways to protect intellectual property, such as copyrights, trademarks and industrial designs. Sometimes inventors prefer keeping their invention secret and do not apply for a patent. Other researchers prefer to place their invention in the public domain in order to freely share it with other users while preventing future patenting by third parties.

Taking a closer look at Figure 1, which shows EPO patent applications per million inhabitants on a logarithmic scale, reveals that for a majority of countries a correlation seems to exist between the indicators. Many countries such as Poland, Latvia, Portugal, Malta, Italy, Ireland, Belgium, France, Denmark, Luxembourg, Sweden and Finland are close to the logarithmic trend line.

In 2005, Switzerland, Germany, Finland, Luxembourg and Austria registered the highest numbers of EPO patent applications per million inhabitants, ranging from 395 to 180 patent applications per million inhabitants, much higher than the European average of 101.

Figure 3: R&D personnel as a share of total employment and patent applications per million inhabitants, EU-27, 1994-2005



2005 data for patent applications are estimates, EU aggregates for R&D personnel are Eurostat estimates

Finland and Sweden accounted for the highest shares of R&D personnel among total employment; Luxembourg, Denmark and Norway were also very active in patenting, with shares of R&D personnel well above the European average of 1.45%.

While countries with high shares of R&D personnel, such as Sweden and Denmark, also registered high patenting activity, this correlation was less evident for Norway.

Table 4: Patent applications to the EPO and by institutional sector as a percentage of all patent applications, selected countries, 2004

	Total number of patent applications	Total number per R&D expenditure (bn euro)	Business enterprise sector	Government sector	Higher education sector	Private non profit sector	Hospitals	Other
EU-27	52 968	273	79.6	1.2	1.5	1.6	0.1	16.0
BE	1 440	269	65.8	0.4	6.6	1.9	0.0	25.3
BG	17	169	55.4	1.6	0.8	:	:	42.2
CZ	107	97	77.0	0.1	0.4	0.7	:	21.9
DK	977	199	80.3	0.4	1.6	0.6	0.2	16.8
DE	22 328	404	89.2	0.1	0.9	1.9	0.1	7.9
IE	251	141	72.3	1.6	8.5	0.3	:	17.3
EL	64	62	55.6	1.2	1.4	0.4	2.1	39.3
ES	1 141	128	67.8	1.1	3.1	1.7	0.0	26.2
FR	8 088	228	43.7	5.2	1.4	1.5	0.1	48.1
IT	4 459	292	83.6	0.6	1.6	0.5	0.1	13.6
LT	14	101	79.9	:	0.7	:	:	19.4
LU	112	250	88.6	:	:	:	:	11.4
HU	146	202	57.1	0.1	1.5	0.3	0.7	40.3
NL	3 507	402	87.4	0.3	1.3	4.6	0.2	6.2
AT	1 391	265	81.3	0.1	0.8	0.3	0.0	17.5
PL	110	97	44.8	0.1	6.6	8.8	:	39.7
PT	55	50	55.3	:	19.0	6.6	0.3	18.9
RO	21	91	55.8	2.8	0.5	4.2	:	36.8
SI	108	284	62.6	:	:	0.9	:	36.4
SK	20	113	81.7	:	:	:	:	18.3
FI	1 322	252	95.3	0.0	0.1	1.3	:	3.3
SE	2 122	:	92.7	0.1	0.1	0.3	0.0	6.8
UK	5 141	172	85.4	2.2	3.2	0.3	0.2	8.8
HR	30	87	55.5	:	:	7.9	:	36.6
TR	122	:	31.2	:	:	1.1	:	67.7
NO	362	109	83.4	0.0	1.1	0.5	0.5	14.5
CH	2 903	342	87.9	0.1	1.8	1.1	0.0	9.1
RU	222	41	50.5	0.9	1.1	5.7	:	41.9
US	31 972	127	87.5	1.3	3.4	0.7	0.5	6.7
JP	21 566	:	96.1	0.6	0.9	0.5	0.0	1.9

Source: Eurostat, patent and R&D statistics

Cut-off: Countries with less than 10 patent applications are not shown: EE, CY, LV and MT
Other: regroups individual applicants and patent applications for which the sector could not specified

Figure 3 reveals that between 1998 and 2004 R&D personnel and patent applications followed a similar upward trend. In the first four years of the observation period, the number of patent applications per million inhabitants grew much faster than the share of R&D personnel in total employment.

For the last year shown, a downward trend was noted for patent applications. This may partly be explained by the fact that data for 2005 are still estimates (see box on page 6) and the actual value may prove to be higher. As applying for a patent is a lengthy procedure, it takes several years before final data for 2005 are available and higher values may be registered for 2005. However, this continuing growth of patent applications may decelerate in the future as the EPO plans to apply stricter quality criteria in order to avoid granting patents for applications filed only for reasons other than those that lead normally an inventor to request protection for his invention.

Table 4 presents the number of patent applications in relation to R&D expenditure and shows the breakdown of patent applications by institutional sector.

It should be mentioned that the decision to classify an applicant in an institutional sector is not always straightforward. Many patent applications are made in collaboration between institutions in two or more sectors. For instance, a scientific project can be financed by the business enterprise sector but executed by a state-owned University.

In 2004, Germany and the Netherlands were the only EU Member States that applied for more than 400 patents for every EUR billion invested in R&D. With 342 Switzerland ranked third, which is also much higher than the EU-27 average of 273 patent applications for every EUR billion invested in R&D.

Turning to the institutional breakdown, it is obvious that the business enterprise sector (BES) was the most active in terms of patent application to the EPO. Although the European average hides discrepancies at national level, the BES confirmed its predominance in patent applications, with a share of close to 80%.

Table 5: R&D personnel, all sectors in head count (HC) and by sector of performance, selected countries, 2005

	R&P personnel	in % of all sectors			
	All sectors	Business enterprise sector	Government sector	Higher education sector	Private non-profit sector
EU-27	3 047 825 s	42.9 s	13.1 s	42.8 s	1.1 s
BE	78 509	48.9	5.1	45.2	0.7
BG	18 638	12.4	58.4	27.0	2.2
CZ	65 379	42.4	20.6	36.7	0.3
DK	67 267	58.6	7.2	33.3	0.9
DE	678 945	50.3	12.9	36.8	:
EE	7 955	28.3	12.5	57.7	1.6
IE	28 270	48.2	4.4	47.4	:
EL	61 454	21.0	12.8	65.9	0.3
ES	282 804	34.9	15.5	49.4	0.2
FR	432 602 i	48.1	13.0 i	37.1	1.8
IT	277 370	31.2	16.4	49.3 b	3.1
CY	2 470	25.7	29.3	35.8	9.2
LV	9 488	21.6	20.6	57.7	0.0
LT	16 323	9.6	20.0	70.5	:
LU	5 015	82.9	12.8	4.3	:
HU	49 723	18.9	23.4	57.7	:
MT	1 320 p	30.8 p	2.9	66.4	0.0
NL	113 606 e	56.7	12.4 i	:	: i
AT	74 191	52.2	7.5	39.6	0.8
PL	123 431	14.5	17.8	67.6	0.1
PT	44 585	21.1	16.5	50.5	11.9
RO	41 035	40.6	25.0	33.8	0.6
SI	12 600	39.9	22.5	37.3	0.2
SK	22 294	21.6	19.1 i	59.2	0.1
FI	77 275	52.8	12.8	33.4	1.0
SE	117 714	55.6	4.8	39.2	0.3
HR	19 739	16.4	32.4	51.2	0.0
TR	97 355	19.0	11.7	69.3	:
NO	54 341	42.9	12.6	44.5	:
CH	84 090	45.0	1.9 i	53.1 e	:
RU	813 207 i	61.1 i	33.5 i	5.3 i	0.0 i
JP	1 122 680	60.9	6.5	31.1	1.6

Source: Eurostat, R&D statistics

Data not available for UK

In most countries the sectors of government, higher education, private non-profit and hospitals accounted for less than 10% of patent applications to the EPO. Exceptions are Portugal, where 19% of patent applications were submitted by the higher education sector (HES) and Poland, with 9% of patent applications submitted by the private non-profit sector.

Table 5 takes a closer look at R&D personnel and sectors in which they are employed. Whereas in many countries the BES and HES are the main sectors of performance of R&D personnel, the situation is considerably different in others. Luxembourg registered the highest shares of R&D personnel working in the BES, with close to 83%; this contrasts sharply with Lithuania, which registered less than 10% of R&D personnel in the BES. The opposite was the case in the HES, which accounted for only 4% of R&D personnel in Luxembourg, against more than 70% in Lithuania.

In most of the countries the share of R&D personnel in the Government sector stood between 10% and 20%. Bulgaria was the only exception with 58% of R&D personnel working in the Government sector. Shares over 30% were also found in countries outside the EU, such as Croatia and Russia.

Generally speaking, the share of R&D personnel was negligible in the private non-profit sector, although in Portugal R&D personnel exceeded 10% in this sector.

Table 6: Business enterprise sector (BES) key indicators, selected countries, 2005

	Patent applications in BES 2004	R&D personnel in BES HC 2005	BERD in BES Mio euro 2005	Employment C to K in thousands 2005	Value added at factor costs C to K excl. J Mio euro 2005
EU-27	42 188	1 308 691 s	105 035 s	134 758	5 360 088
BE	947	38 391	3 124	2 601	143 426
BG	9	2 305	23	2 012	9 845
CZ	82	27 708	738	3 421	:
DK	785	39 443	2 990	1 653	110 161
DE	19 917	341 832	35 585	24 331	1 080 980
EE	:	2 249	38	417	5 865
IE	181	13 621	1 145 i	1 307	91 635
EL	35	12 896	306	2 726	64 634
ES	774	98 564	4 385	13 068 b	494 607
FR	3 534	208 116	18 420	15 020	759 988
IT	3 726	86 609	6 032	15 672	592 147
CY	:	634	9	232	5 931
LV	:	2 054	18	624	6 819
LT	11	1 559	27	868	8 318
LU	99	4 157	374	114	13 057
HU	83	9 394	281	2 660	40 295
MT	:	406 p	14	103	:
NL	3 066	64 404	: i	4 790	237 469
AT	1 131	38 737	2 391 p	2 610	128 631
PL	49	17 875	365	8 373	121 985
PT	30	9 423	422	3 215	68 926
RO	12	16 647	93	4 662	28 188
SI	67	5 033	207	642	14 308
SK	16	4 821	66	1 542	15 109
FI	1 261	40 802	3 525	1 490	75 411
SE	1 967	65 491	7 218 b	2 564 b	149 768
UK	4 390	:	12 556	18 042	1 021 418
HR	17	3 233	98	960	:
TR	38	18 479	703	:	:
NO	302	23 310	1 602	1 330	148 086
CH	2 552	37 820	5 687	2 500	:
RU	112	496 706 i	1 661	:	:
US	27 971	:	163 969 ip	:	:
JP	20 720	683 705	91 567 i	:	:

Source: Eurostat, patent and R&D statistics, Labour force survey (LFS), Structural Business Statistics (SBS)

Exception to reference year for R&D data: 2004 AT, HR, CH

Table 6 provides key indicators to give an overview of the BES.

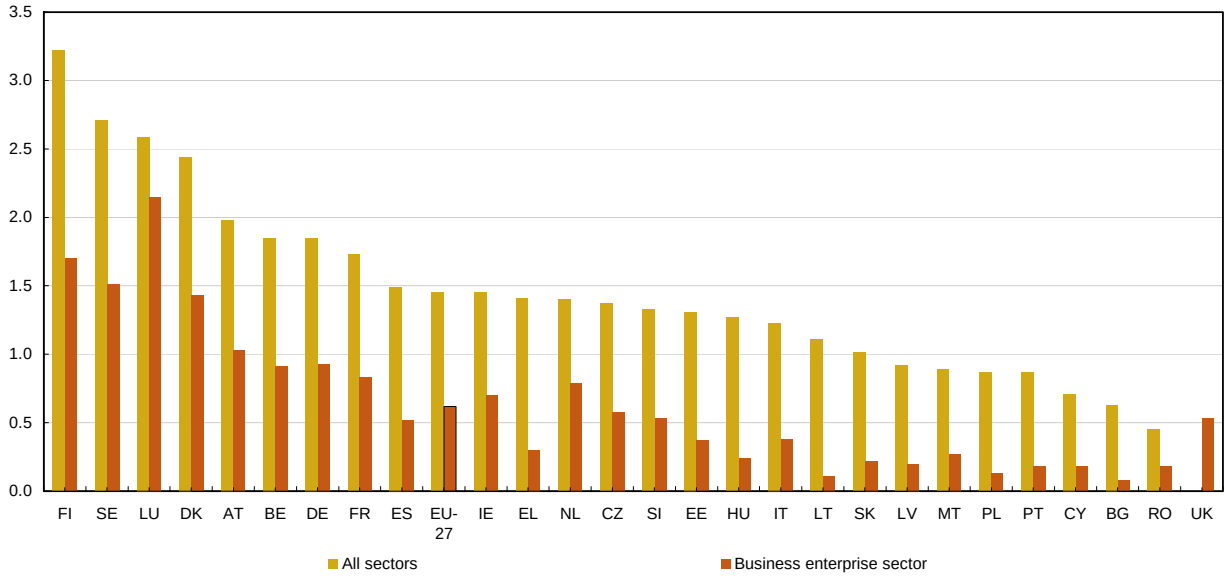
At a first glance, many of these indicators reflect the economic size of the countries shown. For example, as the largest European economy, Germany was ahead in all indicators and was mostly followed by the United Kingdom. However, a closer analysis reveals a number of differences.

In France, which ranked third in most indicators, the BES invested more on R&D than in the United Kingdom.

As the table is based on absolute numbers, only comparisons between countries with comparable economies are relevant.

In 2005 the Italian industry employed about 600 000 people more than the French, but the value added of the non-financial economy in France was about EUR 167 bn higher than in Italy. Whereas in France the shares of R&D personnel and expenditure were nearly three times higher than in Italy, patent activity in 2004 was slightly higher in Italy than in France. This example points out the structural differences between these countries.

Figure 7: Researchers in the BES and in the economy as a whole, as a share of total employment, EU Member States, 2005



Source: Eurostat, R&D statistics

Exception to reference year: 2004 AT

The main focus of Figure 7 is the share of researchers in the economy as a whole and in the BES. The bar chart shows substantial differences across EU Member States, not only in terms of shares but also in the role of researchers in the BES compared to the whole economy.

Finland led the way in terms of researchers employed in the economy as a whole (3.2%), followed by Sweden and Luxembourg (both above 2.5%). At the other end of the scale, Romania registered less than 0.5% of researchers employed in all sectors of the economy.

However, a number of changes in the ranking can be observed when considering the share of researchers working in the BES. Luxembourg, for instance, registered the highest share, with 2.2%, followed by Finland and Sweden with respectively 1.7% and 1.5%. Romania (0.2%) is no longer in last position, but is followed by Poland, Lithuania and Bulgaria with shares close to 0.1%.

These countries are far from the average EU share of researchers in the BES (0.6%) and the average share of researchers in the economy as a whole (1.5%).

Nowcasting method used for EPO data

For the EPO patent indicators only direct applications and PCT applications at the regional phase are taken into account (see methodological notes). The 'nowcasting' methodology is built on the assumption that the relation between direct applications and PCT applications at the regional phase can be estimated for 2005 by a linear regression of this relation for the period 2001 to 2004. For the calculation of the EPO data for 2005 a linear regression has been done in using the ratio of direct patent applications to the EPO to all patent applications to the EPO for the years 2001 to 2004. The estimate has been applied to the number of direct applications for 2005.

METHODOLOGICAL NOTES

Patents statistics

Following changes in the production of patent statistics at Eurostat in 2007, data shown on the Eurostat webpage are no longer fully comparable with data previously disseminated.

From 2007 onwards Eurostat's production of European Patent Office (EPO) and United States Patent and Trademark Office (USPTO) data has been based almost exclusively on the EPO Worldwide Statistical Patent Database. The worldwide statistical patent database, also known as "PATSTAT", was developed by the EPO in 2005, using their collection and knowledge of patent data.

EPO data

The new methodology for EPO data used for the calculation of indicators is very similar to the methodology of the OECD. For patent applications to the EPO all direct applications (EPO-direct) are taken into account, but among the PCT applications (applications following the procedure laid down by the Patent Cooperation Treaty – PCT) made to the EPO only those that have entered into the regional phase are counted. As PCT patent applications in the international phase designating the EPO will no longer be included in the calculation of patent applications to the EPO, the data shown are lower. Nevertheless, patent data produced by Eurostat and the OECD can still not be exactly the same. Differences may be explained by the fact that the data sources used and the date of extraction of the data could differ.

Reference year (or date)

All patent statistics from Eurostat are shown by priority date, i.e. the first date of filing of the patent application anywhere in the world. This date is the earliest and it is chosen in order to be the closest to the date of the invention as patent procedures always take several years.

Counting patents with multiple inventors from different countries

Eurostat has chosen fractional counting as the counting method. This means that when a patent was invented by several inventors from different countries, the respective contributions of each country are taken into account. This is done in order to eliminate multiple counting of such patents. For example, a patent co-invented by 1 French, 1 American and 2 German residents will be counted as ¼ of a patent for France, ¼ for the US and ½ a patent for Germany.

Research and experimental development (R&D)

Research and experimental development activities comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications.

Institutional classifications

Internal expenditure and R&D personnel are broken down with reference to the four institutional sectors in which the R&D takes place.

The business enterprise sector (BES)

With regard to R&D, the business enterprise sector includes: all firms, organizations and institutions whose primary activity is the market production of goods or services (other than higher education) for sale to the general public at an economically significant price and the private non-profit institutions mainly serving them — *Frascati Manual*, § 163.

The government sector (GOV)

In the field of R&D, the government sector includes: all departments, offices and other bodies which furnish but normally do not sell to the community those common services, other than higher education, which cannot otherwise be conveniently and economically provided, and administer the state and the economic and social policy of the community (public enterprises are included in the business enterprise sector) as well as PNPs controlled and mainly financed by government — *Frascati Manual*, § 184.

The higher education sector (HES)

This sector comprises: all universities, colleges of technology and other institutes of post-secondary education, whatever their source of finance or legal status. It also includes all research institutes, experimental stations and clinics operating under the direct control of or administered by or associated with higher education establishments — *Frascati Manual*, § 206.

The private non-profit sector (PNP)

This sector covers: non-market, private non-profit institutions serving households (i.e. the general public) and private individuals or households — *Frascati Manual*, § 194.

R&D indicators - R&D personnel

All persons employed directly on R&D should be counted, as well as those providing direct services such as R&D managers, administrators and clerical staff. Those providing indirect services, such as canteen and security staff, should be excluded — *Frascati Manual*, § 294-296.

- **Researchers (RSE)**

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

- **Personnel by number of individuals (by headcounts, HC)**

It represents the number of individuals who are employed mainly or partly on R&D — *Frascati Manual*, § 326-330.

- **R&D personnel and researchers as a percentage of employment**

The source for the employment statistics is the European Labour Force Survey (EU LFS).

The source for value added data is the Structural Business statistics.

General abbreviations

p	provisional value
e	estimated value
s	Eurostat estimate
b	break in series
:	not available
i	more information can be found in the country specific methodological notes in Eurostat's reference database NewCronos.

Reference manual

Standard method proposed for research and experimental development surveys — Frascati Manual, OECD, 2002.

For all further details, please see the Eurostat metadata on patent and R&D statistics posted on the webpage.

Further information

Data: Eurostat Website: http://ec.europa.eu/eurostat

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Patent statistics

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