

High-technology and knowledge-intensity leading to more Value added, Innovation and Patents

Statistics in focus

SCIENCE AND TECHNOLOGY

8/2004

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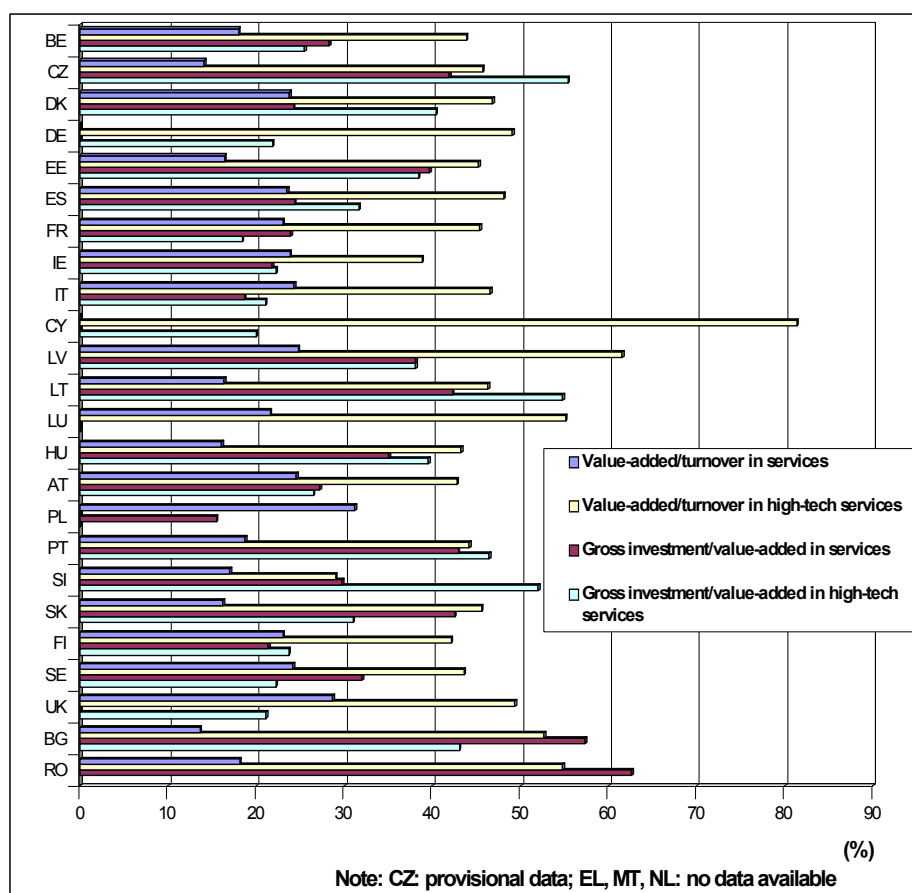
Contents

High-technology manufacturing did not necessarily add more value than broad manufacturing in 2001 2

Innovation activities are much more widespread in sectors with higher technological intensity 3

Finland has the highest number of high-technology patent applications to the EPO per million inhabitants 5

Figure 1: Value added as a percentage of turnover and gross investment in tangible goods as a percentage of value added in services (NACE G, H, I and K) vs. high-tech services (NACE 64, 72 and 73)



- ◆ Value added as a percentage of turnover was between 1.6 and 3.2 times higher in the Knowledge-intensive high-technology services than in the broad services industry in the EU in 2001.
- ◆ High-tech manufacturing at EU-wide level had a value added to turnover ratio of 28% in 2001, only slightly ahead of that of the total manufacturing sector, with 27%.
- ◆ Innovation activities are decidedly more widespread in sectors with higher technological intensity than in the ones requiring less of it.
- ◆ EU high-technology patent applications to the EPO have been rising at an annual average rate of 22% between 1996 and 2001.
- ◆ Communication technology and computer and automated business equipment made up more than three quarters of the EU's high-tech patent applications to the EPO in 2001.



Value added as a percentage of turnover in 2001 was between 1.6 and 3.2 times higher in the Knowledge-intensive high-technology (KISHT) services than in the whole of the services sector (NACE G to K, excluding J 'Financial Services') in all the current EU Member States. In that year, KISHT services yielded over 40% of value added to turnover in a majority of EU countries, Cyprus recording as high a ratio as 81%. This ratio was 53% and 55% respectively in candidate countries Bulgaria and Romania.

KISHT services encompass post and telecommunications, computer and related activities as well as research and development (NACE 64, 72 and 73 respectively). These services are categorised as high-technology due to their high technological intensity and their fostering of innovation. High technology services provide services to consumers, and input to the innovative activities of other firms in all sectors of the economy. This in turn increases productivity throughout the economy by supporting the diffusion of innovation.

This may explain part of the high value-adding properties of the KISHT sector.

The higher technological content of KISHT services also translates into high investment ratios. The fact that data in graph 1 only cover gross investment in tangible goods (as opposed to intangible assets, of even higher importance to the 'knowledge economy') and that investment is highly cyclical, needs to be heeded when looking at them. A number of countries clearly show higher gross investment in tangible goods to value added ratios in the KISHT services sectors than in the broad services industry, such as Denmark and Slovenia. But overall, the bar chart reveals no dramatic difference in the proportion of investment to value added between services as a whole and KISHT services, at least for the year 2001. Most Central European Member States had higher ratios of gross investment in tangible assets to value added than the EU-15 Member States.

High-technology manufacturing did not necessarily add more value than broad manufacturing in 2001

On the whole, high-tech manufacturing at the EU level was only slightly more value-adding than total manufacturing when looking at the ratio to turnover in 2001 (27% for the total manufacturing sector against 28% for high-tech manufacturing). At Member State level the picture is even more mixed. The Belgian high-tech manufacturing sector's value added to turnover ratio, for instance, was 1.6 times higher than the country's whole manufacturing sector in 2001. In the case of Malta however, high-tech manufacturing was only half as value-adding as the island's broad manufacturing sector. In the majority of European countries whose high-tech manufacturing sector achieved more than 30% value added to turnover in 2001 (namely Belgium, Denmark, Germany, Estonia, Italy, Cyprus, Slovenia, Norway and Romania), it exceeded the overall manufacturing sector's value added to turnover ratio at national level. Most of these countries' high-tech manufacturing sectors also had a significantly higher value added to turnover ratio than the EU-25's average. Technological intensity might be one factor explaining the higher value-adding property of the high-tech sector in these countries. However, other factors such as the size of the various sectors, the size of the enterprises in these sectors, the size of their markets, competition, concentration, extent of automation, etc. also need to be taken into consideration.

Denmark, Ireland, Cyprus, Latvia, Malta, Austria and

Finland displayed the highest value added to turnover ratios in the EU's medium high-technology sector in 2001 (over 30%). Interestingly, in Ireland and Malta the medium high-tech manufacturing sector registered more than twice as much value added as percentage of turnover than high-tech manufacturing in the same year. Belgium, the Czech Republic, Denmark, Ireland, Cyprus, Latvia, Lithuania, Malta and Finland all saw their medium-high technology manufacturing sectors generate average value added to turnover ratios higher than for the total manufacturing industry. This was also the case in Bulgaria, Romania and Norway. These countries' examples contrast with the fact that at EU level, the medium high-technology manufacturing sector achieved a slightly lower added-value to turnover ratio than the overall manufacturing sector in 2001 (26% against 27%). The EU's aggregated medium low-technology manufacturing industry was likewise less value-adding than the whole manufacturing sector in the same year (also yielding 26% of value added to turnover).

The EU-25 countries' manufacturing industries displayed ratios of gross investment in tangible goods to turnover of about 20% on average in 2001. Just as for services (see above paragraph on services), no really conclusive pattern can be observed based on technological intensity alone. The new Member States seemed to invest more in tangible goods than did the 'older' ones as compared to their value added.

Table 1: Value added as a percentage of turnover and gross investment as a percentage of value added in the manufacturing industry, 2001

	Total manufacturing		High-tech manufacturing		Medium high-tech manufacturing		Medium low-tech manufacturing	
	Value-added as % of turnover	Gross investment as % of value-added	Value-added as % of turnover	Gross investment as % of value-added	Value-added as % of turnover	Gross investment as % of value-added	Value-added as % of turnover	Gross investment as % of value-added
EU-25	27	:	28	:	26	:	26	:
BE	23	19	38	12	26	17	21	21
CZ	23	32	22	28	24	37	25	34
DK	33	15	42	15	36	13	:	:
DE	28	14	30	20	28	14	28	13
EE	26	29	30	23	26	21	0	0
EL	:	:	:	:	:	:	:	:
ES	26	19	28	17	23	24	27	19
FR	22	16	23	14	20	19	23	15
IE	32	12	21	24	46	8	:	:
IT	25	19	32	25	24	16	24	20
CY	31	22	41	15	34	15	28	20
LV	45	23	:	:	46	19	:	:
LT	21	31	29	54	25	28	:	:
LU	28	:	:	:	:	:	28	:
HU	22	27	18	30	19	40	:	:
MT	29	19	16	28	43	10	0	0
NL	23	13	:	:	23	:	24	12
AT	32	17	31	25	31	14	:	:
PL	36	14	:	:	:	:	:	:
PT	26	29	23	21	24	27	25	35
SI	24	26	32	26	20	30	:	:
SK	22	44	23	22	20	54	:	:
FI	29	:	28	:	30	:	28	:
SE	28	18	18	25	27	15	34	17
UK	31	13	30	16	28	15	31	12
NO	29	13	32	8	30	13	28	12
BG	17	46	:	26	25	28	0	0
RO	29	50	39	32	35	40	24	56

notes: 1.CZ: provisional data; 2.Some ratios were calculated using only NACE 2-digit aggregates whenever more figures at the more detailed NACE 3 level were not available, allowing to obtain estimates nevertheless for the high-tech aggregates considered (see also methodology on page 7); 3.'.' either stands for 'not available' or 'confidential'.

Innovation activities are much more widespread in sectors with higher technological intensity

Technological innovation has the purpose of creating new products and/or processes. Achieving this involves a variety of scientific and technological inputs. High-technology enterprises in manufacturing and services not only rely on investment in tangible goods to bring forth higher technological intensity, but also on technological innovation enhancing their products and/or processes. The third round of the Community Innovation Survey (CIS3) provides data on innovation activities in the EEA countries. Some of its results can be used to further our knowledge about specificities of the high- technology manufacturing and services sector. Data presented in this issue refer to 2000 except for the

Czech Republic, Latvia, Lithuania, Slovakia and Norway, whose data refer to 2001.

In most EU countries, high-technology manufacturing SMEs with innovation activities were much more likely to innovate in-house than the rest of their manufacturing peers (as shown in table 2). This probability declines with the technological intensity of the industries concerned. In services, this incidence is even higher than in manufacturing. Except for Denmark, in those countries whose data are shown in table 2, innovative high-technology services SMEs are at least 1.4 times as likely to have in-house innovation than the service industry's average.

Table 2: Percentage of SMEs with innovation activities that are innovating in-house in EEA countries, 2000

	Total manufacturing	High-tech manufacturing	Medium high-tech manufacturing	Medium low-tech manufacturing	Low-tech manufacturing	Total services	High-tech services
BE	46	78	56	47	41	32	69
CZ*	26	39	38	24	21	23	53
DK	17	8	21	10	20	15	15
DE	55	70	67	51	47	44	:
EE	39	64	55	36	37	33	81
EL	17	40	29	21	12	21	54
ES	29	46	40	:	:	17	39
FR	34	56	:	31	:	24	:
IT	35	67	40	39	28	20	:
LV*	19	40	34	23	16	11	31
LT*	26	42	32	24	25	15	44
LU	39	:	49	22	:	40	66
NL	43	:	1	0	:	28	:
AT	36	12	45	41	31	36	73
PT	36	:	:	40	32	38	69
SI	22	35	37	17	16	13	31
SK*	14	33	15	13	13	10	25
FI	41	57	46	39	38	35	65
SE	35	59	43	31	31	36	51
UK	25	39	34	23	20	:	:
IS	45	39	52	37	46	48	90
NO*	32	:	36	:	28	26	:

notes: 1. * = 2001; 2. ':' either stands for 'not available' or 'confidential'; 3. 'Total services': sections G, I, J and K of NACE.

Lithuanian high-technology service SMEs are almost 3 times as likely to have in-house innovation than other innovating SMEs in the services industry. Hence, in-house innovation seems more important in high-technology manufacturing and services than in other sectors. High and medium high-technology manufacturing SMEs with innovation activities have a higher propensity to be involved in joint R&D or

innovation projects with other enterprises or non-commercial entities than is generally the case in the broader manufacturing or services sector. For instance, only 3% of Spanish manufacturing SMEs participated in joint innovation projects, but in the high-technology and medium high-technology manufacturing sectors, their number is respectively more than three times and more than twice as high.

Table 3: Number of SMEs with innovation activities involved in innovation co-operation in EEA countries in 2000.

	Total manufacturing	High-tech manufacturing	Medium high-tech manufacturing	Medium low-tech manufacturing	Low-tech manufacturing	Total services	High-tech services
BE	:	34	19	:	:	8	19
CZ*	6	9	10	5	4	5	16
DK	:	16	25	:	:	13	28
DE	11	26	17	10	4	8	:
EE	12	27	20	10	11	12	28
EL	:	35	9	:	:	12	25
ES	3	11	7	:	:	2	10
FR	12	26	:	12	:	5	:
IT	3	11	4	3	1	4	:
LV*	4	14	10	4	3	4	9
LT*	12	21	12	22	9	13	30
LU	:	:	24	13	13	:	32
NL	11	:	15	10	:	8	:
AT	7	60	7	9	4	10	9
PT	6	:	:	6	4	9	29
SI	8	12	14	6	7	4	13
SK*	4	14	6	4	3	2	11
FI	22	43	28	20	18	18	36
SE	:	37	21	:	:	13	26
UK	10	16	18	8	6	:	:
IS	11	39	20	11	9	:	29
NO*	13	:	16	:	9	12	:

notes: 1. * = 2001; 2. ':' either stands for 'not available' or 'confidential'; 3. 'Total services': sections G, I, J and K of NACE.

In Finland, where almost 22% of the innovating manufacturing SMEs are co-operating with other companies or institutions on innovation projects, this number rises to 43% when only high-technology manufacturing SMEs are taken into account. Again, as for the in-house innovation incidence, innovation co-operation tends to decrease with the degree of

technology of each industry. In most countries listed in table 3, innovation co-operation is 2 to 7 times more likely in high-technology services than in services at large. In conclusion, innovation co-operation activities are more widespread in sectors with higher technological intensity than in the ones requiring less of it.

Finland has the highest number of high-technology patent applications to the EPO per million inhabitants

Successful innovation activities also create new intangible assets such as patents, meant to protect and reward the innovation effort for a defined period of time and within a certain geographical area. Patents that are considered 'High-technology' relate to the aviation, communication technology, computer and automated business equipment, laser, micro-organism and genetic engineering and semiconductors sectors.

Table 4 presents the number of high-tech patent applications to the European Patent Office (EPO) in 1996 and 2001 by inventor's place of residence. About two thirds of the European Union's high-tech patent applications in 2001 originated from Germany, France and the United Kingdom. In terms of number of patents per million inhabitants, the picture is different. Finland registered more than 130 high-technology patent applications per million inhabitants in that year, especially concentrated in communication technology and computer and automated business equipment. Sweden came second in 2001, with around 100 high-tech patent applications per million inhabitants, while the Netherlands came third, with about 70 high-tech patent applications per million inhabitants. About 40% of Finnish patent applications and 36% of Irish ones were in high-tech fields in 2001, the highest ratios within the EU. The same ratio was around 28-29% for Lithuania, Sweden and the Netherlands, making them rank third in the EU as countries with the highest share of high-tech patents out of total patents. Denmark, Ireland, the Netherlands, Finland and Sweden together with the big patent-generators Germany, France and the UK are the countries that produced more high-tech patents per million inhabitants than the EU-25's average. The Union's average high-tech patents per million inhabitants stood at 26 in 2001. The US had about 57 patent applications per million inhabitants that year, Japan 45.

Some EU countries starting from a smaller base in 1996, such as Greece, Ireland, Luxembourg, Hungary, Poland, Portugal and Slovenia, have seen strong rises of more than 36% on average annual basis between 1996 and 2001 in their high-tech patents applications to the EPO. In terms of non-EU countries, China's high-tech patent applications to the EPO have increased 85% annually on average in the five years to 2001, albeit also starting from a smaller base. Among the non-exhaustive selection of third countries displayed in table 4, Malaysia, Singapore and Israel also experienced strong average annual growth of more than 30% in EPO high-tech patents filings between 1996 and 2001. The number of EU high-technology patent applications at the EPO has been rising at an annual average **rate of 22%** between 1996 and 2001, while the US and Japan's progression in these years has been 20% and 15% respectively. In 2001, more than a quarter of Japanese patent applications to the EPO and more than a third of the US's were high-tech. For the EU, this share was around 20%. Globally, the EPO's share of high-tech patent applications to the total number of patent applications has been rising steadily in the five years to 2001.

Communication technology is the biggest generator of patents among the six high-tech patent subclasses in the EU. Together with computer and automated business equipment, it made up a little more than three quarters of the high-tech patent applications by EU countries in 2001. These two patent subclasses are slightly less predominant for Japan and the US. Japanese applications to the EPO of semiconductors patents represented more than 15% of this country's total high-tech patent applications. Proportionally as well as in absolute numbers, the US applied for many more micro-organisms and genetic engineering patents to the EPO than the EU and Japan.

Table 4: High-technology patent applications to the EPO in 1996 and 2001.

	High-tech patent applications:						Aviation		Communi- cation technology		Computer and automated business equipment		Laser		Micro- organism and genetic engineering		Semi- conductors	
	Total number		as % of all patent applications		AAGR 1996- 2001	per million in- habitants	Total number		Total number		Total number		Total number		Total number		Total number	
	2001	1996	2001	1996			2001	1996	2001	1996	2001	1996	2001	1996	2001	1996	2001	1996
EU-25	12017	4385	20	12	22	26	148	73	5656	2117	3426	947	163	100	1560	679	1062	469
BE	240	124	15	13	14	23	1	0	83	59	64	22	3	-	50	29	39	13
CZ	7	4	6	9	9	1	1	-	1	2	3	1	-	-	2	2	-	-
DK	225	68	20	10	27	42	1	1	76	18	60	3	2	-	82	45	4	1
DE	4017	1338	16	9	25	49	66	29	1713	584	987	296	67	38	607	178	576	214
EE	2	1	13	8	31	1	-	-	-	-	1	-	-	-	1	1	-	-
EL	22	3	27	6	50	2	1	-	6	2	10	1	-	-	2	1	3	-
ES	143	36	15	7	31	4	3	2	55	12	43	8	-	1	36	12	6	2
FR	1791	716	21	12	20	30	41	24	824	305	563	180	25	29	212	106	126	71
IE	117	25	36	18	36	31	1	-	53	12	49	7	2	-	10	4	3	2
IT	374	269	9	9	7	6	2	3	162	74	112	113	9	2	49	26	40	51
CY	2	-	18	-	-	3	-	-	1	-	1	-	-	-	-	-	-	-
LV	1	1	6	13	0	0	1	-	-	-	-	1	-	-	-	-	-	-
LT	3	-	29	-	-	1	-	-	-	-	-	-	-	-	3	-	-	-
LU	5	1	5	2	49	11	0	-	2	-	3	1	-	-	0	-	-	-
HU	43	8	23	7	40	4	-	-	24	5	15	1	-	-	3	2	1	1
MT**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL	1100	357	28	17	25	69	2	-	581	178	294	63	1	8	102	65	119	43
AT	152	61	11	8	20	19	2	3	60	24	39	18	3	1	26	10	23	5
PL	8	1	8	2	72	0	1	-	3	-	2	1	-	-	2	-	-	-
PT	7	1	12	4	65	1	-	-	1	-	2	1	-	-	3	0	1	-
SI	17	1	21	4	63	9	-	-	10	-	4	-	-	-	3	1	-	-
SK	6	2	18	9	19	1	-	-	3	-	1	-	-	-	1	2	1	1
FI	705	250	40	28	23	136	-	-	568	214	108	13	1	-	24	17	6	6
SE	896	319	28	17	23	101	8	2	542	234	241	38	11	2	62	24	32	19
UK	2134	799	27	17	22	36	19	10	890	394	823	181	40	20	279	155	83	38
BG	3	2	18	8	15	0	-	1	-	-	2	-	-	-	1	1	-	-
RO	3	1	18	6	25	0	2	-	-	-	-	-	-	-	-	1	1	-
TR	17	1	24	8	63	9	-	-	6	1	5	-	-	-	1	0	-	-
IS	9	1	26	6	77	31	-	1	3	-	2	-	-	-	3	-	1	-
NO	223	22	17	6	59	50	3	2	96	5	87	10	4	-	32	5	2	0
JP	5707	2787	26	22	15	45	16	5	2177	1004	1995	968	132	57	481	248	908	506
US	15839	6252	34	22	20	57	125	99	4881	2065	6572	2156	240	90	2697	1119	1324	722
Canada	804	239	32	20	27	26	6	5	371	130	277	43	9	2	123	54	19	6
Russian Fed.	79	49	17	12	10	1	2	9	22	11	30	12	8	2	14	9	3	7
China***	77	4	29	6	85	0	2	0	44	2	19	0	0	0	11	2	3	0
India***	26	8	19	18	27	:	0	0	9	1	5	2	0	0	12	4	0	1
Taiwan***	65	24	20	19	22	3	0	0	23	5	23	8	0	0	4	2	14	9
Singapore***	66	16	54	30	33	16	0	0	19	8	16	3	2	0	7	3	23	2
South Korea***	442	131	37	30	28	9	0	0	254	73	109	33	11	1	45	11	23	13
Malaysia***	8	2	25	20	39	:	0	0	0	1	3	0	0	0	1	0	3	1
Israel***	323	74	38	21	34	50	1	1	149	35	145	23	4	1	22	11	3	3
Brazil***	5	2	5	3	24	:	0	0	0	1	2	0	0	0	2	0	0	0
South Africa***	16	8	13	10	15	:	0	1	3	3	10	1	0	0	2	3	1	0

** no EPO patent applications for high-tech in 1996 nor 2001; ***: OECD data

notes: Eurostat data for 2001 are all provisional, except for IT, LU, PT and UK; 2001 number of patent applications per million inhabitants estimated and provisional for EU-25, EL, HU, TR, JP, US, CA, RU;

➤ ESSENTIAL INFORMATION – METHODOLOGICAL NOTES

• SOURCES

Data in this present Statistics in Focus (SIF) are based on the **Structural Business Statistics** for the part on value added and investment in manufacturing and services; the **third Community Innovation Survey (CIS3)** for innovation, and **NewCronos's Theme9/patents** and the **OECD** for patents. A high-technology dedicated domain will soon become available within Eurostat's NewCronos Theme9 'Science and Technology'.

Statistical abbreviations and symbols

AAGR: Annual average growth rate;

p provisional data;

: not available/confidential;

- not applicable;

0 less than 50 % of the indicated unit

• DEFINITIONS

Structural Business Statistics (SBS): collected within the framework of Council regulation on structural business statistics. This Regulation governs the transmission of data to Eurostat from the reference year 1995 onwards. It covers all market activities in section C to K and M to O of the NACE Rev.1. However, the available data are confined to sections C to K, excluding section J (financial services). For further methodological notes, please refer to Eurostat's reference database NewCronos-Theme 4, Domain SBS, Collection 'enterpr'.

NACE The data in this publication are based on the statistical classification of economic activities in the European Community, NACE Rev.1.1.

Turnover the value of everything that was sold by the unit during the reference year. It includes goods sold from stocks and goods bought for resale (enterprise, local unit, etc.)

Value added at factor cost is the gross income from operating activities after adjusting for operating subsidies and indirect taxes.

Gross investment in tangible goods Investments in all tangible goods during the reference period. This variable can vary widely year on year. Investments in tangible goods can be broken down into several types of investments.

CIS 3- Third Community Innovation Survey

SMEs: small and medium-sized enterprises (10 to 249 persons employed)

Enterprises with innovation activity

Enterprises that have had any kind of innovation activity during the survey period, i.e. have introduced or implemented new products and/or processes and/or have had ongoing and/or abandoned innovation activity.

High-tech patents

High-tech patents are counted following the criteria established by the Trilateral Statistical Report, where the following technical fields are defined as high-technology: Computer and automated business equipment; micro-organism and genetic engineering; aviation; communications technology; semiconductors; lasers. Data are gathered according to the International Patents Classification sub-classes corresponding to the aforementioned high-tech fields. European Patent Organisation (EPO) data in this issue were extracted according to patent applications by year of application and by country of inventor. Population data from both Eurostat (for the EU-25 estimate) and the OECD (for third countries with ***) were used to complete data on the number of patents per million inhabitants.

• HIGH-TECH CLASSIFICATION OF MANUFACTURING INDUSTRIES

Eurostat and the OECD use the following breakdown of the manufacturing industry according to global technological intensity, and based on NACE rev. 1.1 at 3-digit level (Please note that in table 1, due to restrictions of the data source, a different but related classification based on NACE at 2-digit level was also used):

High-technology	Aerospace (35.3); Pharmaceuticals (24.4); Computers, office machinery (30); Electronics-communications (32); Scientific instruments (33)
Medium-high-technology	Electrical machinery (31); Motor vehicles (34); Chemicals - excl. pharmaceuticals (24 excl. 24.4); Other transport equipment (35.2+35.4+35.5); Non-electrical machinery (29)
Medium-low-technology	Coke, refined petroleum products and nuclear fuel (23); Rubber and plastic products (25); Non metallic mineral products (26); Shipbuilding (35.1); Basic metals (27); fabricated metal products (28)
Low-technology	Other manufacturing and recycling (36+37); Wood, pulp, paper products, printing and publishing (20+21+22); Food, beverages and tobacco (15+16); Textile and clothing (17+18+19)

• KNOWLEDGE-INTENSIVE HIGH-TECH SERVICES (KIS) CLASSIFICATION

Eurostat defines the following sector as knowledge-intensive high-tech services (KISHT):

Knowledge-intensive high-tech services	Post and Telecommunications (64); Computer and related activities (72); Research and development (73)
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Further information:

➤ Databases

NewCronos, Theme 9

To obtain information or to order publications, databases and special sets of data, please contact the **Data Shop** network:

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This document has been produced in collaboration with Vincent Van Gompel.

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