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The technological profile and specialization pattern of countries

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The technological profile and specialization pattern of countries

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Contents

1. INTRODUCTION

The objective of this report is to provide an analysis of the patterns of technological specialization at the level of broad geographical areas and countries, using patent data as the main indicator of inventive performance. The strengths and weaknesses of patent data as indicators of technological performance are well known and will not be further discussed here (see Griliches (1990) for a survey). The report uses patent data coming from four different sources:

1. European Patent Office (EPO)
2. United States Patent and Trademark Office (USPTO)
3. World Intellectual Property Organization (WIPO)
4. Triadic patents

The OECD Patent Statistics Manual 2009 provides a detailed overview of the different patent systems and procedures. In particular:

a) WIPO patent data refer to the patent applications filed at the World Intellectual Property Organizations under the Patent Co-operation Treaty (PCT). The PCT procedure allows seeking protection in a large number of countries by filing a single international application (similarly to the EPO).
b) Triadic patents refer instead to a particular type of patent *families*, namely the subset of patent *applications* filed at the EPO and the JPO, and *granted* by the USPTO, sharing one or more priority applications.

In particular, for this study we used data on patent applications *and* patents granted for the EPO and the WIPO, whereas we restricted attention to patents granted for the USPTO. The October 2012 release of the EPO-PATSTAT database has been used to collect data. The coverage of the patent data set built for this analysis goes from 2000 to 2012. In this respect, it is important to stress that patent procedures imply a time lag between the filing of a patent application and its publication. This implies that for the most recent years data tend to be incomplete because applications have not yet been published. This problem is further compounded by the fact that the procedures differ across patent systems and that inventors may take different

routes for obtaining protection in a given jurisdiction. Once again, the reader may refer to the OECD Patent Manual for details about this issue.

As far as the dating of patents is concerned, we used the *priority date*, i.e. the date of the first application filed worldwide (in any patent office). The rationale for using this date, instead of the application or publication dates, is that this date is closer to the actual date of the invention.

Figure 1 - Number of patent applications by priority year

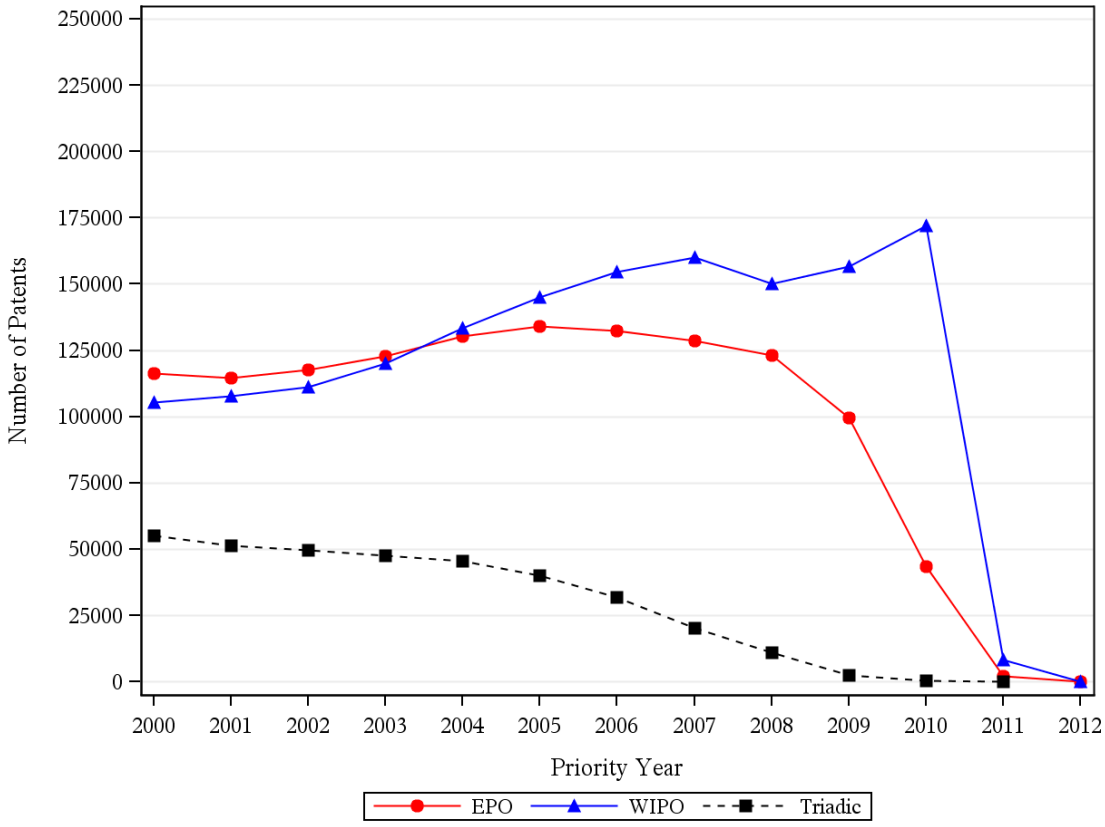


Figure 1 reports the yearly number of patent applications at EPO and WIPO and the total number of triadic patents. The yearly number of patent applications at the EPO slightly increases from 2000 up to 2005 and it drops quite dramatically after 2008. The number of patent applications at the WIPO displays a different trend. The growth in the first half of the decade looks similar to that at the EPO, but the trend in the second half does not show the drop in the number of patents observable for the EPO until 2010. It is worth

noting that the sudden decline in the number of patent applications at both offices is a consequence of the time lags mentioned above.

Figure 2 - Number of patents granted by priority year

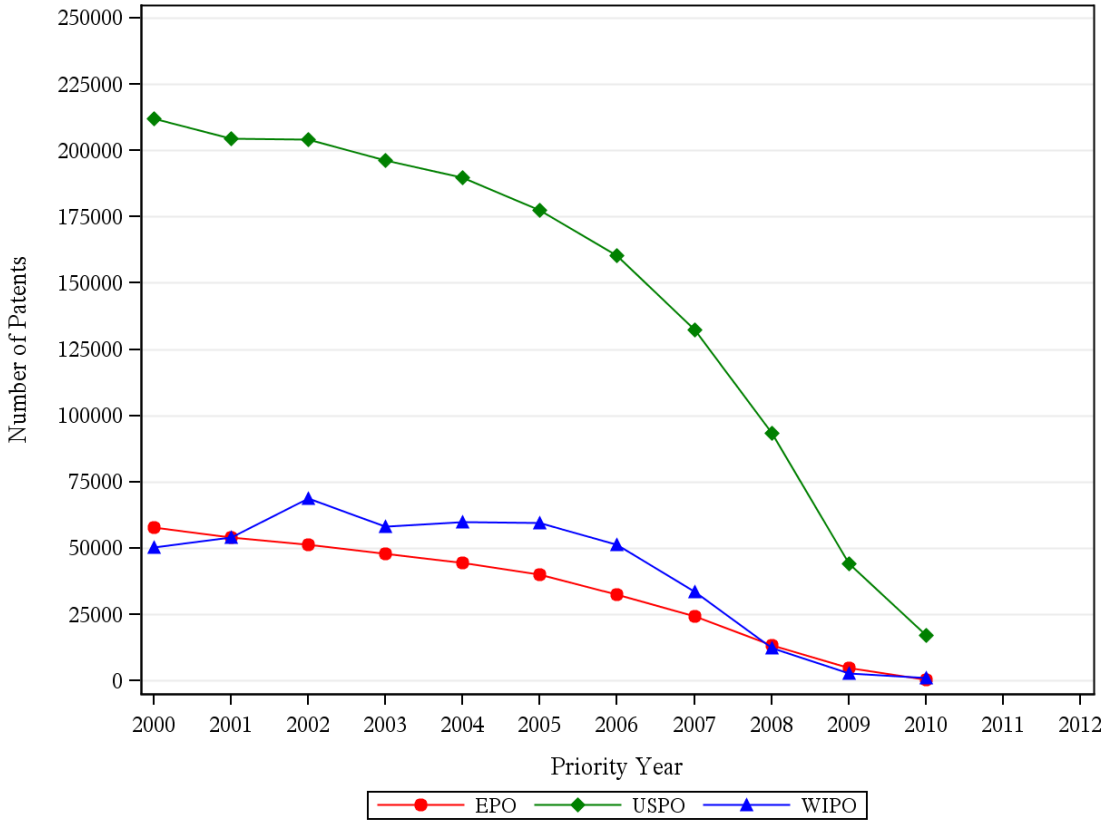


Figure 2 reports the total number of patens granted at the WIPO, the EPO and the USPTO. Not surprisingly, these numbers are constantly declining throughout the period under examination. The time lag between filing and grant of a patent may be quite long, ranging between two and eight years, with significant differences across patent offices. The problem is particularly acute in the case of the USPTO. As the number of patent applications has dramatically increased over the last three decades, the length of time it takes for an invention to go through the examination process at the USPTO has also considerably increased (Popp, Juhl and Johnson 2004). Thus, for example, whereas of all USPTO patents with priority year 2000, which will be eventually granted, the vast majority have been already granted in 2010, a very small fraction of all USPTO patents with priority year 2005, which will be eventually granted, have been already granted in 2010.

The declining trend in Triadic patents observed in Figure 1 is driven by the trend in USPTO patents. Since, triadic patents are defined as those patent applications filed at the EPO and the JPO, and *granted* by the USPTO, sharing one or more priority applications, the decrease in the number of USPTO patents granted has obviously an impact on the trend of Triadic patents.

As mentioned above, the report aims at examining the profiles of technological specialization of broad geographical areas and countries. Regarding the geographical location of patents, we have used information on the address of inventors and applicants as reported on the patent document. In this respect, it has to be observed that the two criteria used to locate patents in geographical space respond to different logics. On the one hand, locating patents according to the address of the inventor tends to identify the area or region in which the research leading to the invention is carried out. This is because one can quite safely presume that the address of the inventor corresponds most of the times to her residence. On the other hand, the address of the patent applicant responds to the logic of ownership and it captures the location where the rents, if any, deriving from the exploitation of the patented invention are most likely to accrue. Following the criteria described above, patents are geo-located at two different levels of increasing spatial aggregation, namely countries and broad geographical areas. Regarding the level of countries, even though our data set covers all countries whose inventors and/or applicants appear on patent documents at the four patent systems described above, we focus our attention on the most important 42 countries in terms of patenting activities. Finally, country data are aggregated at the level of broad geographical areas. This level of aggregation comprises EU27, EFTA, ERA, and Asia. Table 1 illustrates the classification of countries by area[1].

[1] See http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/introduction, for fuller details. Please note that at the time of writing this report, Croatia just became a member state of the European Union.

Table 1 - Classification of the 42 countries by area

Country	Area	ERA
Austria	EU27	Yes
Belgium	EU27	Yes
Bulgaria	EU27	Yes
Brazil		
Switzerland	EFTA	Yes
China (Peoples Republic)	ASIA	
Cyprus	EU27	Yes
Czech Republic	EU27	Yes
Germany	EU27	Yes
Denmark	EU27	Yes
Estonia	EU27	Yes
Greece	EU27	Yes
Spain	EU27	Yes
Finland	EU27	Yes
France	EU27	Yes
Croatia	CANDIDATE	Yes
Hungary	EU27	Yes
Ireland	EU27	Yes
Israel		Yes
India	ASIA	
Iceland	CANDIDATE	Yes
Italy	EU27	Yes
Japan	ASIA	
South Korea	ASIA	
Liechtenstein	EFTA	Yes
Lithuania	EU27	Yes
Luxembourg	EU27	Yes
Latvia	EU27	Yes
Former Yugoslav Republic of Macedonia	CANDIDATE	Yes
Malta	EU27	Yes
Netherlands	EU27	Yes
Norway	EFTA	Yes
Poland	EU27	Yes
Portugal	EU27	Yes
Romania	EU27	Yes
Russian Federation		
Sweden	EU27	Yes
Slovenia	EU27	Yes
Slovakia	EU27	Yes
Turkey	CANDIDATE	Yes
United Kingdom	EU27	Yes
United States of America		

Note: EU-15 area countries are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom.

Since the vast majority of patents contain two or more inventors, not necessarily residing in the same location, and a not negligible fraction of all

patents are co-assigned to two or more applicants[2], an important methodological choice regards the way in which patents have to be *counted*. To this purpose, we opted for a *pure-fractional* counting. According to this counting method, when a patent has multiple inventors, it is allocated fractionally to each country in proportion to the number of inventors from each country. Suppose, for example, that a patent contains two German inventors and one US inventor. On the basis of the pure-fractional method, 0.67 is attributed to Germany and 0.33 is attributed to the US[3].

Finally, an analysis of the technological specialization requires that patents are re-classified into meaningful categories. To this purpose, we have carried out a careful and in-depth work of reclassification of all patent documents on the basis of the International Patent Classification (IPC) codes assigned to patent documents by patent examiners. More specifically, patents have been re-classified according to three different systems, which take into account both the economic and the technological content of patents.

1) In the first place, patents have been classified according to the so-called Thematic Priorities of the 7th Framework Programme. Given that some of the resulting classes are rather large and heterogeneous (e.g. Thematic Area 2 - Food, Agriculture, Fisheries and Biotechnology), a few classes have been split. The resulting classification is reported in Table 2.
2) Second, patents have been classified according to their technological content, following and updating the classification originally elaborated by FhF-ISI, OST and INPI. This classification identifies 35 technology fields, which can be further aggregated into 5 broad technological fields (one of which is residual). The list of 35 fields is reported in Table 3.
3) Finally, patents have been classified according to their economic relevance for specific industries following NACE 1.1 classification[4]. In particular,

[2] Please note that patents containing two or more inventors are said to be co-invented, whereas patents assigned to two or more applicants are said to be co-patented. So, co-invention refers to collaboration among individual inventors, while co-patenting refers to collaboration among companies.

[3] Other alternatives exist. For example, following a full-fractional method, in the example given in the text, one full patent is attributed to Germany and one full patent is attributed to the US.

[4] See http://epp.eurostat.ec.europa.eu/portal/page/portal/nace_rev2/introduction for details on NACE classification.

patents have been reclassified into 22 fields (2 of which residual), which in turn are aggregations of NACE Rev. 1.1 2- and 3-digit classes (see Table 4).

Table 2- Classification of patents according to FP7 Thematic Priorities

1. Health
2. Food, Agriculture and Fisheries
3. Biotechnology
4. ICT
5. Nanosciences/Nanotechnologies
6. Materials (excl. nanotech)
7. New Production Technologies
8. Construction Technologies
9. Energy
10. Environment
11. Aeronautics
12. Automobiles
13. Other Transport Technologies
14. Space
15. Security
16. Green Energy

It is important to note that IPC codes can be assigned to more than one technological or economic class. As a consequence, a given patent can be also allocated to more than one technological or economic class, e.g. health and biotechnology. Similarly to what done for inventors and applicants, we have adopted a pure-fractional method of counting. Thus, a patent classified in two classes- *i* and *j* – is allocated for 0.5 to class *i* and for 0.5 to class *j*.

Tables C1, C2 and C3 in the Annex 1 report the distribution of patents according to the FP, the IPC and the NACE classifications for the three patent systems under examination, plus the Triadic patents.

Table 3 - Classification of patents into 35 technological fields (FhG-ISI, OST, INPI)

I: Electrical engineering
1 Electrical machinery, apparatus, energy
2 Audio-visual technology
3 Telecommunications
4 Digital communication
5 Basic communication processes
6 Computer technology
7 IT methods for management
8 Semiconductors
II: Instruments
9 Optics
10 Measurement
11 Analysis of biological materials
12 Control
13 Medical technology
III: Chemistry
14 Organic fine chemistry
15 Biotechnology
16 Pharmaceuticals
17 Macromolecular chemistry, polymers
18 Food chemistry
19 Basic materials chemistry
20 Materials, metallurgy
21 Surface technology, coating
22 Micro-structural and Nano -technology
23 Chemical engineering
24 Environmental technology
IV: Mechanical engineering
25 Handling
26 Machine tools
27 Engines, pumps, turbines
28 Textile and paper machines
29 Other special machines
30 Thermal processes and apparatus
31 Mechanical elements
32 Transport
V: Other fields
33 Furniture, games
34 Other consumer goods
35 Civil engineering

Table 4 - Classification of patents according to NACE rev 1.1

1	Manufacture of food products and beverages and manufacture of machinery for these products (15 + 29.53)
2	Manufacture and sales of textiles and manufacture of machinery for these products (17 + 29.54 + 51.41/2 + 51.83 + 52.41/2)
3	Reproduction of recorded media and related manufactured goods (22.3 + 24.64/5)
4	Manufacture of basic chemicals and manufacture of paints, varnishes and similar coatings, and glues and gelatines (24.1 + 24.3 + 24.62)
5	Manufacture of pharmaceuticals (24.4)
6	Manufacture of plastic products (25.2)
7	Manufacture of other non -metallic mineral products (26)
8	Manufacture of general purpose machinery and machine tools (29.1 + 29.2 + 29.4)
9	Manufacture of office machinery and computers (30)
10	Manufacture of electrical motors, generators and transformers (31.1)
11	Manufacture of electricity distribution and control apparatus; manufacture of insulated wire and cable; manufacture of accumulators, primary cells and primary batteries; electricity, gas, steam and hot water supply (31.2 +31.3 + 31.4 + 40)
12	Manufacture of electronic valves and tubes and other electronic components (32.1)
13	Manufacture of medical and surgical equipment (33.1)
14	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, industrial process control equipment and optical instruments and photographic equipment (33.2 + 33.3 + 33.4)
15	Manufacture of motor vehicles, manufacture of parts and accessories for motor vehicles and their engines (34.1 + 34.3)
16	Manufacture of aircraft and spacecraft (35.3)
17	Services for computer and related activities (72 except 72.5)
18	Machinery and equipment (29 except 29.1/29.2/ 29.4/29.53/29.54)
19	Electrical Machinery (31.5+31.6+31.0)
20	Telecommunication equipment (32.1+32.3)

Table 5 - Summary of the main possible levels and sublevels of analysis

	Levels of analysis	
	Main level	Sublevel
Patent Offices	EPO USPTO WIPO Triadic	Patent applications / granted Patents granted Patent applications / granted -
Geographical level	Area Country	Address of inventors (I)/applicants (A) Address of inventors (I)/applicants (A)
Classification	FP Thematic Priorities IPC 35 technological fields NACE economic classification	 5 broad technological areas

Table 5 summarises the main levels and sublevels of analysis. Thus, for example, if we consider EPO, the analysis of specialisation can be carried out at the level of patent applications *and/or* at the level of patents granted. Given the choice made at the previous stage, the specialisation profile can be assessed at the level of broad areas and/or at the level of countries. Finally, given the choice made at the previous stages, the specialisation analysis can be carried at the level of FP7 Thematic Area, at the level of 35 technological fields and/or NACE rev 1.1 codes.

2. ANALYSIS OF SPECIALISATION PATTERNS

In order to analyse the technological specialisation of areas and countries, we will adopt the so-called Revealed Technological Advantage (RTA) index, which is defined as:

$$RTA_{ij} = \frac{X_{ij}/\sum_i X_{ij}}{\sum_j X_{ij}/\sum_i \sum_j X_{ij}}$$

where X_{ij} is the number of patents of area (or country) i in technology j. The numerator of the expression represents the share of technology j among all patents of area (or country) i. In other words, it represents the relative

importance of technology *j* in the patenting activity of area *i*. On the other hand, the denominator represents the share of *all* patents in *all* areas (countries) accounted for by technology *j*, i.e. it represents the relative importance of technology *j* in the patenting activities worldwide.

The RTA index ranges from zero to infinite. A value of zero indicates that area *i* has not patented in technology *j* and thus it is fully de-specialised in that technology. The RTA takes value one when the weight of technology *j* in the patenting activities of area *i* is exactly equal to the weight that this technology has on the patenting at the world level. This implies that a value of the RTA greater than one indicates that area *i* is relatively specialised in technology *j*. On the contrary, a value of RTA lower than one indicates that area *i* is relatively de-specialised in that technology (see, for example Allansdottir, et al. (2001), Archibugi (1992), Laursen (1998)). The comparison of the different levels of specialization in the various technological and economic fields allows drawing conclusions about the relative strengths and weaknesses of different areas and countries[5].

Figures 3 to 6 report the share of worldwide patents, respectively for EPO (applications), USPTO (granted), WIPO (applications) and Triadic, for the four most important geographical areas[6]. Two major points have to be noted. First, the ranking of areas changes according to the patent office considered. Thus, if we take the EPO patent applications, ERA ranks first with a share of patents stably above 40%. On the contrary, if we take USPTO patents granted, the share of ERA is always lower than the one of Asia, which is turn lower than the share of US applicants. The latter account for the bulk of patenting activity, with a share around 60%. Part of the explanation of these differences has to do with the well-known home advantage. Proximity to markets and to the patent office affects the costs and the benefits from patenting, thereby causing domestic organisations to display a higher propensity to patent at home.

[5] Please note that the RTA index has to be interpreted with caution for those areas and countries, which have registered a relatively small number of patents.

[6] In these graphs, North-America comprises US and Canada.

Figure 3 - Share of EPO patent applications by geographical area (address of applicant)

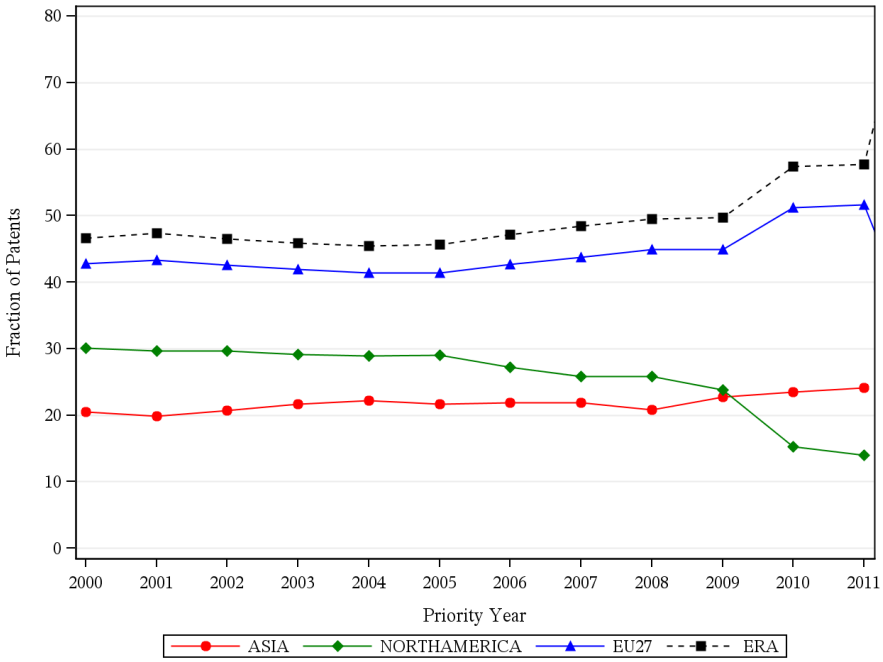


Figure 4 - Share of USPTO patents granted by geographical area (address of applicant)

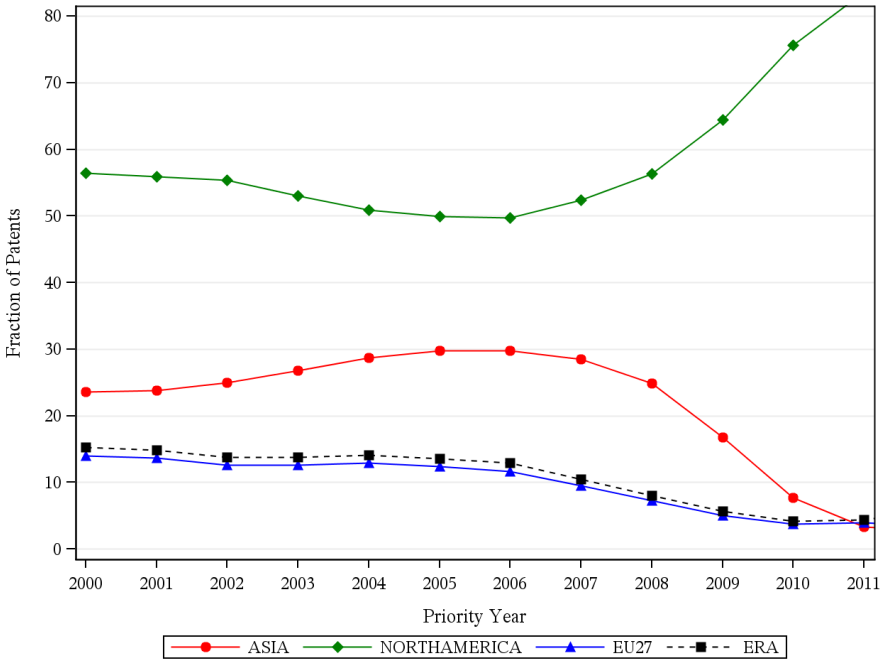


Figure 5 - Share of WIPO patent applications by geographical area (address of applicant)

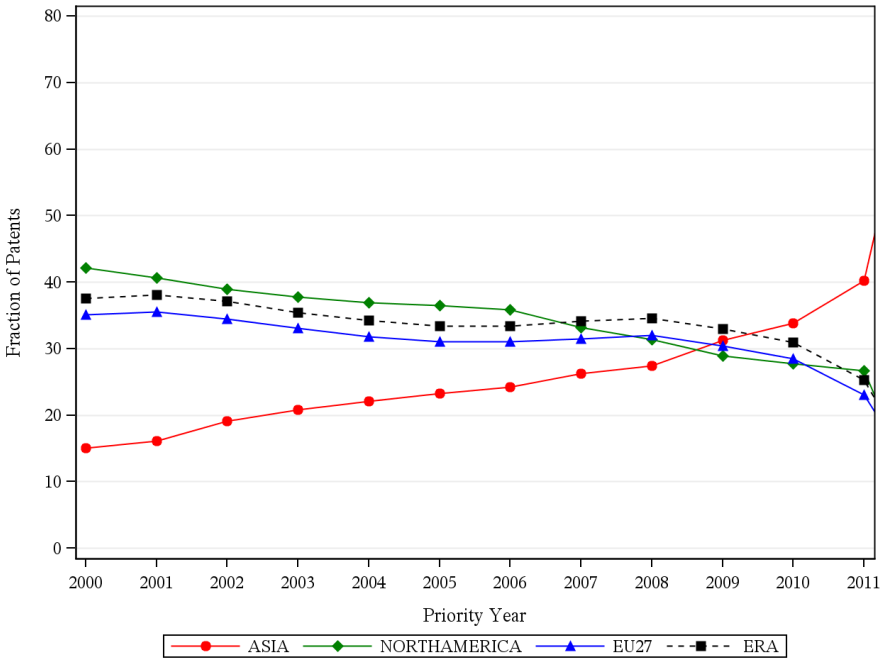
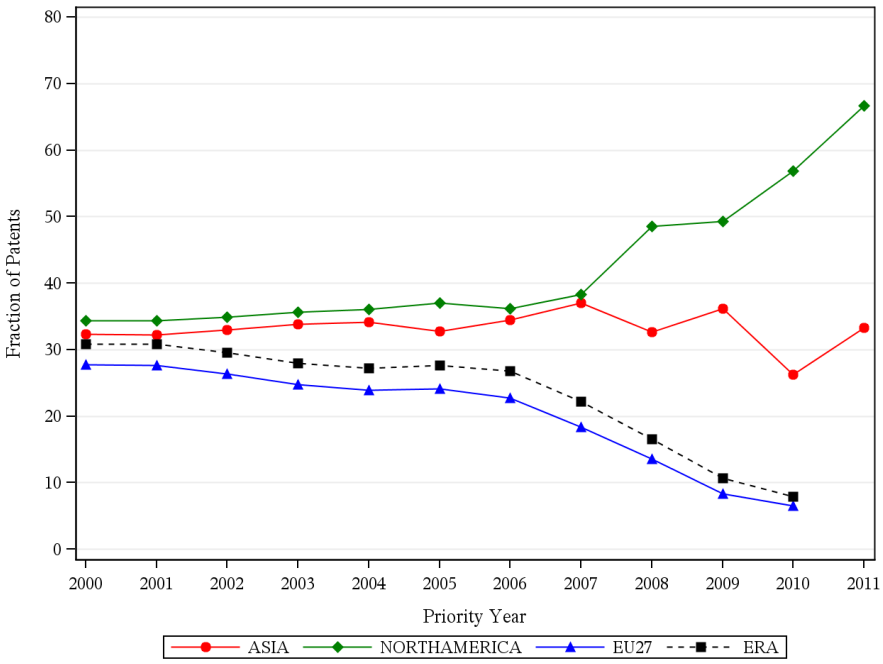


Figure 6 - Share of TRIADIC patents by geographical area (address of applicant)



The second point to observe is that all the time series present to a larger or smaller extent a rather erratic trend. For example, in the case of EPO patent applications, the share of ERA starts increasing after 2005. Rather than signalling an increase in the inventive performance of European companies, this increase is most likely to reflect the fact that the time lag between filing (priority) and publication affects in a differential way firms from different areas and countries. Similarly, the fast growth in the share of USPTO patents granted accounted for by US applicants after 2004 and the corresponding decline of Asia and ERA should not be interpreted as a sudden improvement in the US inventive performance, but as an artefact of the lags between application and grant that affect differently US and non-US companies. Similar considerations apply to Triadic patents, though one should take into account that in absolute terms we are talking about small numbers. Therefore, the trends observed in Figure 6 should be interpreted with some caution. On the other hand, WIPO patenting activity shows a different trend. In particular, it is quite striking the increase of the share of Asia, ranking first by patents application from 2010 onwards. Finally, we observe that not surprisingly the share of patents of ERA countries follows the EU27 time series in all the patent systems considered. This suggests that the patenting activity of ERA is mainly driven by the 27 member states, and more particularly by the largest ones, such as Germany, France, United Kingdom and Italy.

2.1 Specialisation by FP7 Thematic Priorities: broad geographical areas

Tables 6 to 9 report, respectively for the EPO, WIPO, USPTO and Triadic patents, the value of the RTA index of ERA, EU27, Asia and the United States, by FP7 Thematic Priorities computed over the entire period 2000-2012 (locating patents according to the address of applicants[7]). In order to facilitate the interpretation of the tables, values of the RTA greater than one (i.e. indicating relative specialisation) are marked in green, while values lower than one (i.e. indicating relative de-specialisation) are marked in red.

[7] The values of RTAs calculated by locating patents according to inventors' address are reported in the appendix. Generally speaking, they confirm the same patterns of specialisation observed by locating patents according to the applicants' address.

Table 6 – RTA index, FP7 Thematic Priorities, 2000-2012

European Patent Office (by Applicant)

Thematic Priorities	EU27	ERA	ASIA	USA
Health	0.7928049	0.8661641	0.5400776	1.5292185
Food, Agriculture and Fisheries	1.2285002	1.2694375	0.4484431	0.9409353
Biotechnology	0.9135157	0.9331093	0.6508894	1.3720515
ICT	0.7611545	0.7243387	1.495204	1.0667727
Nanosciences/Nanotechnologies	0.7816546	0.7620459	1.1851047	1.2854821
Materials (excl. nanotech)	0.980761	0.9853125	1.0403951	1.0449626
New Production Technologies	0.9877214	1.0280588	0.8107045	1.1137821
Construction Technologies	1.5954841	1.574984	0.2538213	0.5576102
Energy	1.0709618	1.0571183	1.1234697	0.8395368
Environment	0.991652	0.9781233	1.1258878	0.9196653
Aeronautics	1.4074861	1.3013	0.1622668	1.1823109
Automobiles	1.3602376	1.2819776	1.0840692	0.5296499
Other Transport Technologies	1.3299485	1.3142983	0.9549933	0.39357
Space	1.1050629	1.0212429	0.6746376	1.2927347
Security	0.9009903	0.8888286	0.8963724	1.1914016
Green Energy	0.9171395	0.9103823	1.1904288	0.9786298

Table 7 - RTA Index, FP7 Thematic Priorities, 2000-2012

World Intellectual Property Organization (by Applicant)

Thematic Priorities	EU27	ERA	ASIA	USA
Health	0.8618597	0.8980166	0.6151595	1.3807968
Food, Agriculture and Fisheries	1.0726038	1.1239228	0.7502369	0.9757387
Biotechnology	0.935018	0.9370303	0.6720617	1.3199405
ICT	0.760408	0.7324614	1.3062024	1.0585319
Nanosciences/Nanotechnologies	0.7971186	0.7820032	0.9661758	1.2904377
Materials (excl. nanotech)	1.0352319	1.0378634	1.1511797	0.9098442
New Production Technologies	0.9905367	1.0035731	0.7728698	1.1569492
Construction Technologies	1.2832036	1.3124409	0.5292782	0.8552691
Energy	1.1347973	1.1230331	1.1721286	0.7426586
Environment	0.9750359	0.9682	1.1586691	0.8733302
Aeronautics	1.6080373	1.5357892	0.2120316	1.0109844
Automobiles	1.5950348	1.53194	0.9977775	0.5222255
Other Transport Technologies	1.3699388	1.428546	0.7437727	0.6449686
Space	1.0182162	0.966336	0.618798	1.2976222
Security	0.9188929	0.9098436	0.8223163	1.153208
Green Energy	0.9124757	0.9090198	1.2115662	0.8971746

Table 8 - RTA INDEX, FP7 Thematic Priorities, 2000-2012

United States Patent Office (by Applicant)

Thematic Priorities	EU27	ERA	ASIA	USA
Health	1.1872	1.3114111	0.3504524	1.2959386
Food, Agriculture and Fisheries	1.1316821	1.2139987	0.3625201	1.2852682
Biotechnology	1.0034033	1.0453627	0.5425268	1.2669859
ICT	0.7208516	0.6850626	1.1729739	0.9799568
Nanosciences/Nanotechnologies	0.8735825	0.8317435	1.2652406	0.9630737
Materials (excl. nanotech)	1.4025933	1.3882966	0.9974779	0.965616
New Production Technologies	1.0774966	1.1244545	0.7877909	1.107394
Construction Technologies	1.0325352	1.0600321	0.2749722	1.3041329
Energy	1.2421846	1.2370159	1.1563956	0.8723581
Environment	1.0186171	1.0197228	1.0988498	0.951185
Aeronautics	2.3405409	2.1691363	0.1397727	1.2009802
Automobiles	1.5502015	1.4937489	1.1805099	0.8545801
Other Transport Technologies	0.9732847	0.9932683	0.7546421	1.0130771
Space	0.9909663	0.9040513	0.5983173	1.3342911
Security	1.0459762	1.0406617	0.679599	1.1776511
Green Energy	0.9549165	0.9618556	1.2207549	0.8982855

Table 9 - RTA INDEX, FP7 Thematic Priorities, 2000-2012

Triadic patents (by Applicant)

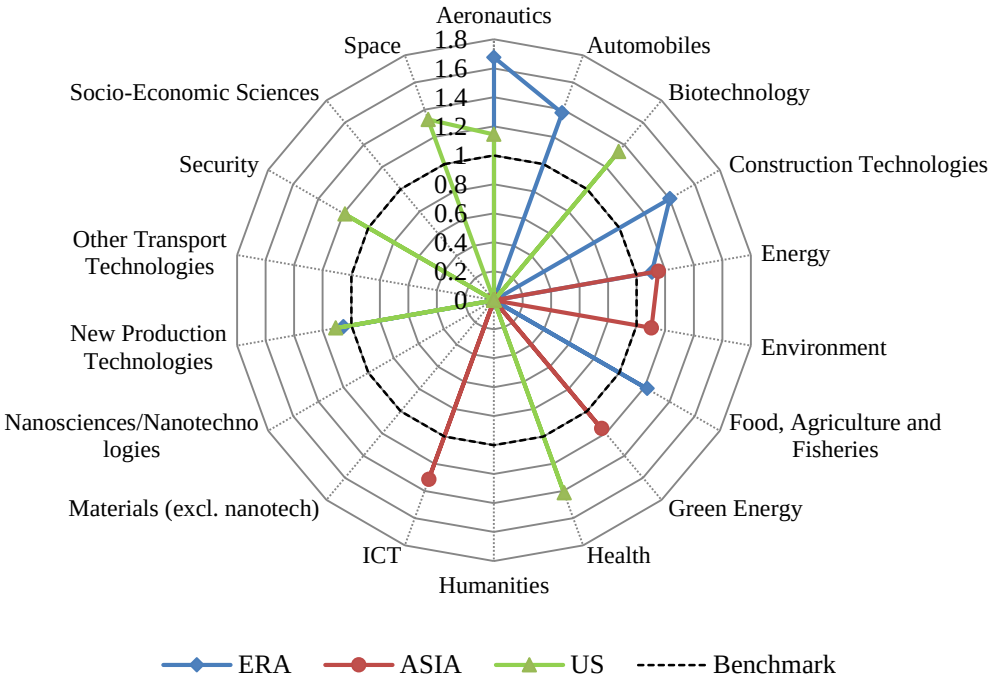
Thematic Priorities	EU27	ERA	ASIA	USA
Health	0.9687698	1.1061682	0.3473985	1.4558074
Food, Agriculture and Fisheries	1.1814176	1.2740202	0.5988312	1.1107549
Biotechnology	0.9586831	0.9896087	0.5701792	1.390257
ICT	0.7875742	0.7208199	1.2851147	0.9692829
Nanosciences/Nanotechnologies	0.8705626	0.8252875	0.9590139	1.1737099
Materials (excl. nanotech)	1.2282142	1.2131356	0.8592539	0.9900557
New Production Technologies	0.969833	1.0640746	0.9011804	1.0590339
Construction Technologies	1.7264319	1.6553723	0.7175608	0.7013178
Energy	1.0554761	1.0087227	1.1541865	0.8549701
Environment	0.9593056	0.9250569	1.0296579	1.0115956
Aeronautics	1.8950514	1.6957768	0.2217936	1.1840396
Automobiles	1.281035	1.1922283	1.5201801	0.4155345
Other Transport Technologies	1.0378294	1.040625	1.5515032	0.3855937
Space	1.1057295	0.9788361	0.6526709	1.3845674
Security	0.8047023	0.7951836	0.8913908	1.2276294
Green Energy	0.9226095	0.8964095	1.0022259	1.0503776

Figure 7 summarizes the specialization pattern according to the FP7 thematic priorities. The radar graph highlights for every geographical area only the classes for which the RTA is consistently greater than one in each of the four patent systems considered. The value shown is the average across the different patent offices. In a similar way, figure 8 summarizes the de-specialization pattern (i.e. the classes for which the RTA is consistently less than one in each of the four patent systems considered). Note that the value of RTA in figure 8 are reversed (points closer to the centre have values of RTA closer to one, while points located nearer the external border have values closer to zero).

As far as the ERA is concerned, we observe that the major areas of technological strength are Food, Agriculture and Fisheries, Construction and Construction Technologies, Aeronautics, Automobiles, Energy and New Production technology. Other transport technologies is a class of specialization in all offices except the USPTO where the RTA takes a value slightly lower than one. The latter result, however, is probably due to the fact that, for the USPTO patent system, the computation of the index is based on patents granted and not on patent applications; consequently, the time lag between filing and granting may bias the value of RTA of European countries (see discussion above) for the USPTO. Turning to the fields of technological weakness, ERA is characterized by values consistently lower than one in Green Energy, Information and Communication Technologies, Nanosciences and Nanotechnologies.

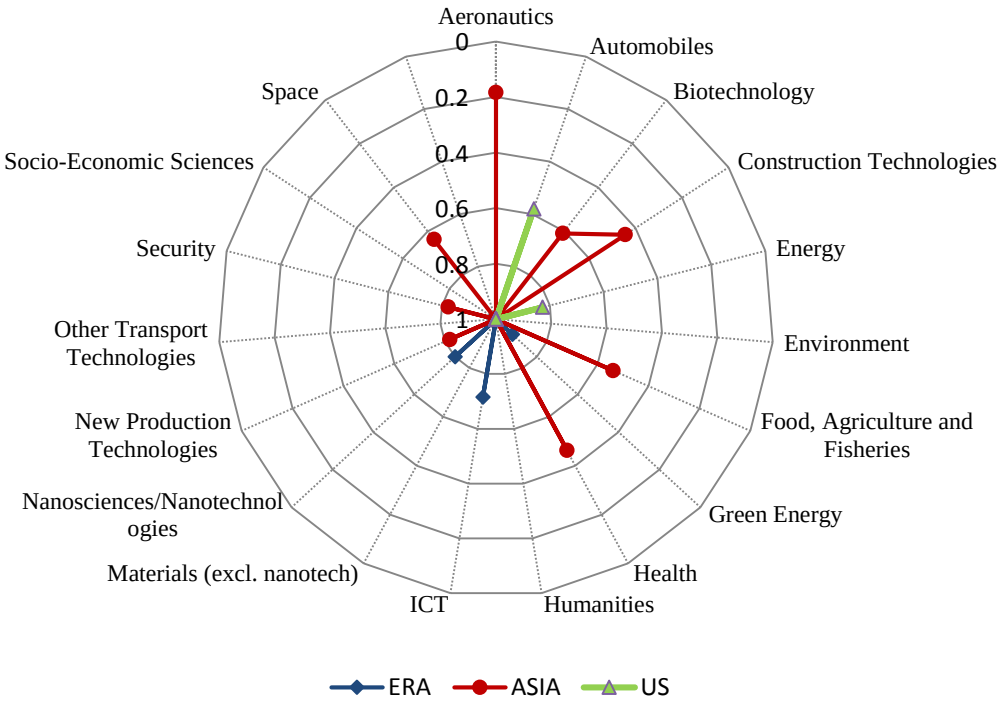
Focusing our attention on the US, we observe that Aeronautics, Biotechnology, Health, New Production Technology, Security and Space are the major technological fields of specialization. The fields of technological weakness of North America are Energy and Automobiles. It has to be noted that the value of RTA for Other Transport Technologies is greater than one only in the USPTO patent system, possibly because of the time lag effect discussed above.

Figure 7 - Areas of strength by FP7 Thematic Priorities – Broad Geographical Areas



Concerning Asia, its pattern of specialisation is to some extent complementary to that of ERA. The major areas of technological strength are Information and Communication Technologies together with Energy, Environment and Green Energy, while a high level of de-specialisation is found in technological areas such as Health, Food, Agriculture and Fisheries, Biotechnology, Construction and Construction Technologies, New Production Technologies, Aeronautics, Security and Space. Furthermore, it is important to note that Asia concentrates its technological strengths in a limited number of areas. In fact Asia presents very high values of RTA in some particular areas and very low RTA values in other thematic areas. This feature is confirmed and further analysed in the following section where Diversification Indexes are considered.

Figure 8 - Areas of weakness by FP7 Thematic Priorities – Broad Geographical Areas



2.2 Specialisation by IPC technological fields: broad geographical areas

Turning the attention to the classification of patents according to the IPC technological fields, Tables 10 to 13 report the values of RTA of ERA, EU27, Asia and the United States, respectively for the EPO, WIPO, USPTO and Triadic patents. To summarise the main results, the values of RTAs have been also computed by aggregating the 35 technology fields into six broader technological areas, as reported in Figures 9 and 10. Figure 9 summarizes the specialization pattern through a radar graph by highlighting for each geographical area only the areas for which the RTA is consistently greater than one in each of the four patent systems considered. The value shown is the average across the different systems. In a similar way, figure 10 summarizes the de-specialization pattern (i.e. the classes for which the RTA is consistently less than 1 in each of the four patent systems considered).

Table 10 - RTA INDEX, IPC 35 technology fields, 2000-2012

European Patent Office (by Applicant)

IPC 35 technology fields	EU27	ERA	ASIA	USA
Electrical machinery	0.9932321	0.9896501	1.3919936	0.7395232
Audio-visual technology	0.7157453	0.6948878	2.1356402	0.6275169
Telecommunications	0.7954299	0.7486626	1.5172252	0.9759481
Digital communication	0.893766	0.8360212	1.1416969	1.1331381
Basic communication processes	0.9035177	0.8712791	1.2336059	1.0598264
Computer technology	0.7102307	0.686457	1.1316183	1.3900264
IT methods for management	0.6878444	0.6881491	0.696211	1.7142534
Semiconductors	0.6948421	0.6681993	1.7139893	1.0563797
Optics	0.6206585	0.6027358	2.0086626	0.953946
Measurement	1.0302594	1.0918526	0.865277	0.9735785
Biological materials analysis	0.8633631	0.8935356	0.6294309	1.4529304
Control	1.0982982	1.085116	0.84349	0.9920549
Medical technology	0.7215568	0.7961831	0.5127317	1.6564641
Organic fine chemistry	1.1202093	1.120736	0.8326467	0.9717963
Biotechnology	0.8971663	0.9119635	0.7201091	1.3496304
Pharmaceuticals	0.834725	0.9015297	0.5749878	1.4425439
Macromolecular chemistry	0.9300335	0.9200393	1.1554977	1.0995374
Food chemistry	1.0512277	1.1699265	0.6097471	0.9601401
Basic materials chemistry	0.9505131	0.9523973	0.8376582	1.2668446
Materials, metallurgy	0.9947288	0.9812187	1.2818775	0.81065
Surface technology, coating	0.8984571	0.9032678	1.0743119	1.1804262
Micro-structural/nano-tech	0.8132952	0.806918	0.8842028	1.3983067
Chemical engineering	1.1548877	1.1565667	0.6749362	0.996842
Environmental technology	1.1706582	1.1418732	0.9446132	0.8032962
Handling	1.3041924	1.3676063	0.5698253	0.7437961
Machine tools	1.2494369	1.2561078	0.8268335	0.7187002
Engines, pumps, turbines	1.1475835	1.1125855	0.9961912	0.8642911
Textile and paper machines	0.9913495	1.008956	1.3201873	0.8033531
Other special machines	1.2803067	1.2672026	0.6458822	0.7997119
Thermal processes and apparatus	1.2870727	1.269779	1.0156368	0.5632939
Mechanical elements	1.3589294	1.3149871	0.826799	0.6464858
Transport	1.3802651	1.3065784	0.9641727	0.5438005
Furniture, games	1.2772132	1.2949395	0.6150911	0.7203482
Other consumer goods	1.2043394	1.2290904	0.8770157	0.6857887
Civil engineering	1.6193505	1.5954431	0.2273401	0.5383808

Table 11 - RTA INDEX, IPC 35 technology fields, 2000-2012

World Intellectual Property Organization (by Applicant)

IPC 35 technology fields	EU27	ERA	ASIA	USA
Electrical machinery	0.9985106	0.9839638	1.3982892	0.7347229
Audio-visual technology	0.7703725	0.757436	1.6451216	0.7172674
Telecommunications	0.7809866	0.7440548	1.4851334	0.9205936
Digital communication	0.9128886	0.8685505	1.2366482	0.992708
Basic communication processes	0.9777279	0.9471933	1.0260389	1.0409154
Computer technology	0.7125664	0.6944397	0.891521	1.3817197
IT methods for management	0.4790044	0.4907365	0.7590345	1.6391721
Semiconductors	0.619203	0.6007558	1.5920246	1.0341224
Optics	0.7097424	0.6915092	1.5681026	0.8936667
Measurement	1.1299354	1.1493627	0.8345044	0.974521
Biological materials analysis	0.977653	0.9766482	0.5908448	1.3260332
Control	1.0942606	1.0953461	0.7484092	1.0526732
Medical technology	0.7915767	0.8260606	0.5334782	1.4970855
Organic fine chemistry	1.1418692	1.1543942	1.0255576	0.9271673
Biotechnology	0.9111437	0.9099039	0.7561552	1.2818059
Pharmaceuticals	0.8942555	0.928153	0.6934023	1.2941461
Macromolecular chemistry	0.9790608	0.9738701	1.2838715	0.9402457
Food chemistry	0.989611	1.0710592	0.9876194	0.874769
Basic materials chemistry	1.0121105	1.0200253	0.9081866	1.0940252
Materials, metallurgy	1.0317862	1.02371	1.3681138	0.6764812
Surface technology, coating	0.8558465	0.8569518	1.2416549	1.0343128
Micro-structural/nano-tech	0.840115	0.8178498	0.9420675	1.201749
Chemical engineering	1.1981695	1.1951294	0.7726966	0.9600044
Environmental technology	1.1284522	1.1136374	1.0309196	0.830631
Handling	1.3007853	1.3438503	0.7343217	0.8429909
Machine tools	1.3150597	1.2977884	0.9824175	0.7338138
Engines, pumps, turbines	1.4543424	1.4258673	0.949205	0.5981143
Textile and paper machines	1.2114124	1.2307661	1.0104012	0.8304315
Other special machines	1.2178729	1.2209114	0.8551204	0.8259098
Thermal processes and apparatus	1.1915314	1.2041947	1.1808786	0.6247952
Mechanical elements	1.5323346	1.4947987	0.8546954	0.6426386
Transport	1.5649736	1.5225291	0.8721249	0.5832643
Furniture, games	1.0640771	1.103805	0.7669224	0.9818692
Other consumer goods	1.145541	1.2078789	0.9554921	0.7980507
Civil engineering	1.2859661	1.3138923	0.517653	0.8558784

Table 12 - RTA INDEX, IPC 35 technology fields, 2000-2012

United States Patent Office (by Applicant)

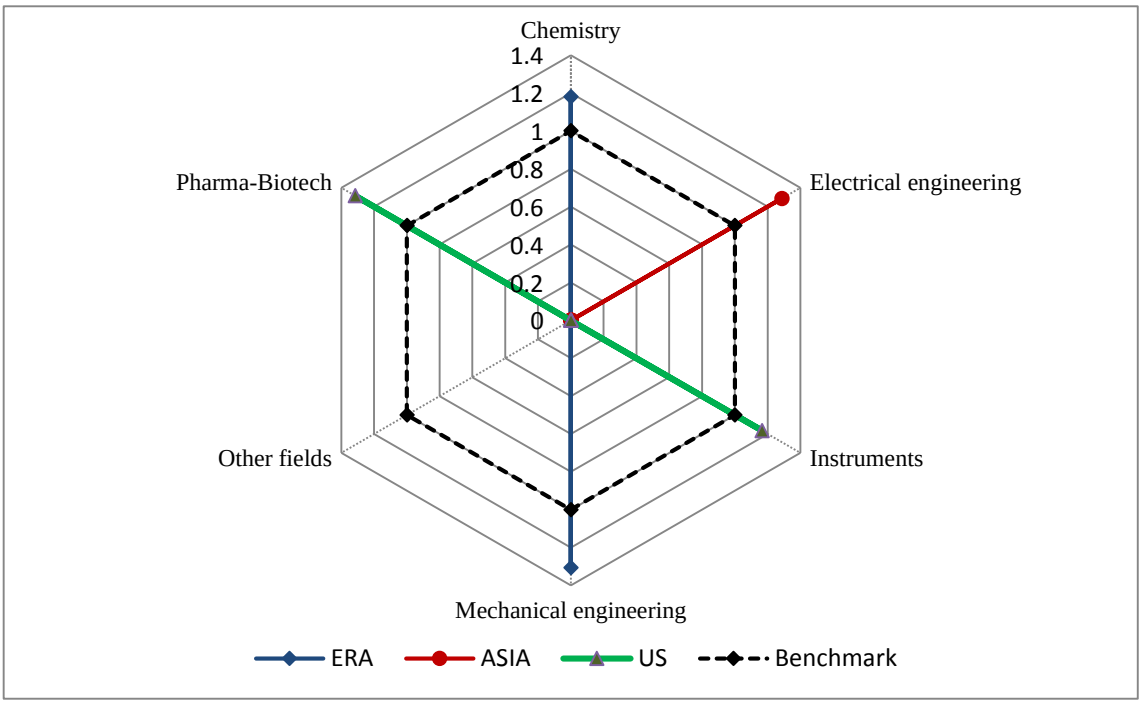
IPC 35 technology fields	EU27	ERA	ASIA	USA
Electrical machinery	0.938192	0.9302004	1.3175012	0.75849
Audio-visual technology	0.7044482	0.682243	1.7699946	0.6527889
Telecommunications	0.9576589	0.9100934	1.0824449	0.9712913
Digital communication	0.9030615	0.8485274	0.7296529	1.1899892
Basic communication processes	0.9132422	0.865985	1.0744008	0.9485433
Computer technology	0.5903229	0.5670746	0.8280314	1.2245799
IT methods for management	0.50296	0.5296937	0.3248268	1.5469763
Semiconductors	0.5893072	0.5534928	1.5326708	0.7488825
Optics	0.6359609	0.617107	1.9906306	0.6192125
Measurement	1.2222643	1.289927	0.8300472	1.0419091
Biological materials analysis	1.1158584	1.114053	0.4542855	1.2851977
Control	0.9140696	0.9153446	0.8111332	1.1228901
Medical technology	0.8835273	1.0187646	0.3223141	1.3915685
Organic fine chemistry	1.9189295	1.8754997	0.803572	0.9509408
Biotechnology	1.0064557	1.0504958	0.5479116	1.2640718
Pharmaceuticals	1.5777683	1.666323	0.3806156	1.171832
Macromolecular chemistry	1.4949061	1.4658886	1.0830635	0.9375758
Food chemistry	0.9793492	1.2624699	0.3773088	1.308703
Basic materials chemistry	1.3406746	1.3126791	0.7691817	1.1013361
Materials, metallurgy	1.4091805	1.3934298	1.1741485	0.8510033
Surface technology, coating	1.0408959	1.0367509	1.168137	0.9673156
Micro-structural/nano-tech	1.0453732	1.0251601	0.8241832	1.1155553
Chemical engineering	1.4655768	1.470462	0.6447483	1.0903115
Environmental technology	1.2642456	1.2408128	0.7834937	1.0817685
Handling	1.4382032	1.5744999	0.6930791	1.0376764
Machine tools	1.3730424	1.4304614	0.7517471	0.9636961
Engines, pumps, turbines	1.642065	1.6039589	1.0585296	0.8728318
Textile and paper machines	1.1417434	1.130444	1.5672419	0.6718136
Other special machines	1.214145	1.2509751	0.5734409	1.145882
Thermal processes and apparatus	1.0591746	1.0934247	0.8805889	1.0221159
Mechanical elements	1.7470554	1.6995775	0.9725574	0.8770378
Transport	1.49153	1.4367621	0.9986697	0.92661
Furniture, games	0.6690373	0.6754153	0.4720057	1.2583855
Other consumer goods	1.00235	1.0123438	0.733685	1.0954766
Civil engineering	0.9808021	1.0046699	0.2462046	1.3322454

Table 13 - RTA INDEX, IPC 35 technology fields, 2000-2012

Triadic patents (by Applicant)

IPC 35 technology fields	EU27	ERA	ASIA	USA
Electrical machinery	0.9276994	0.885958	1.4071188	0.7197953
Audio-visual technology	0.765369	0.6936596	1.7895058	0.5267701
Telecommunications	0.783529	0.7163591	1.3041939	0.9584498
Digital communication	0.8408765	0.7570701	1.0241838	1.1677065
Basic communication processes	0.996061	0.9243197	1.1906694	0.8877278
Computer technology	0.655129	0.607292	1.0030233	1.3068876
IT methods for management	0.4286471	0.4298743	0.7270174	1.7281102
Semiconductors	0.8405499	0.7668239	1.2331306	0.9783351
Optics	0.7288407	0.692305	1.5088562	0.7980052
Measurement	1.0648106	1.1900345	0.9171791	0.9478268
Biological materials analysis	0.9314062	0.9922897	0.447445	1.5060313
Control	0.8056463	0.7964946	1.2192665	0.9753315
Medical technology	0.6778876	0.808628	0.4010655	1.6044049
Organic fine chemistry	1.6148463	1.614283	0.6338884	0.8747392
Biotechnology	0.9497243	0.973394	0.6190019	1.3534203
Pharmaceuticals	1.1906364	1.3187459	0.2977798	1.360165
Macromolecular chemistry	1.2420211	1.208702	0.8602888	1.008283
Food chemistry	1.1170767	1.2610698	0.6137186	1.0738583
Basic materials chemistry	1.1772934	1.1637072	0.7276068	1.1538002
Materials, metallurgy	1.1280587	1.0814667	1.1227996	0.8124825
Surface technology, coating	0.9403877	0.9163821	0.9302763	1.1727017
Micro-structural/nano-tech	1.0063572	0.940982	0.6909995	1.3433497
Chemical engineering	1.3009903	1.2625543	0.6604622	1.1209645
Environmental technology	1.1452843	1.0784676	1.0604737	0.8825092
Handling	1.2399814	1.4298727	0.7785361	0.8868857
Machine tools	1.1779573	1.2090954	1.038408	0.7956689
Engines, pumps, turbines	1.2528705	1.1613341	1.1401159	0.7622202
Textile and paper machines	0.8683792	0.8774453	1.3483176	0.8005882
Other special machines	1.1144742	1.1558486	0.8642201	0.9717261
Thermal processes and apparatus	0.9667571	0.9518424	1.2232888	0.8259317
Mechanical elements	1.3059038	1.2419655	1.1726599	0.6791677
Transport	1.3211518	1.2305119	1.4340669	0.4475571
Furniture, games	0.8814158	0.9633274	0.9890404	0.9845157
Other consumer goods	1.0509113	1.1115316	1.0515422	0.8639231
Civil engineering	1.7351958	1.6531658	0.6980584	0.7153013

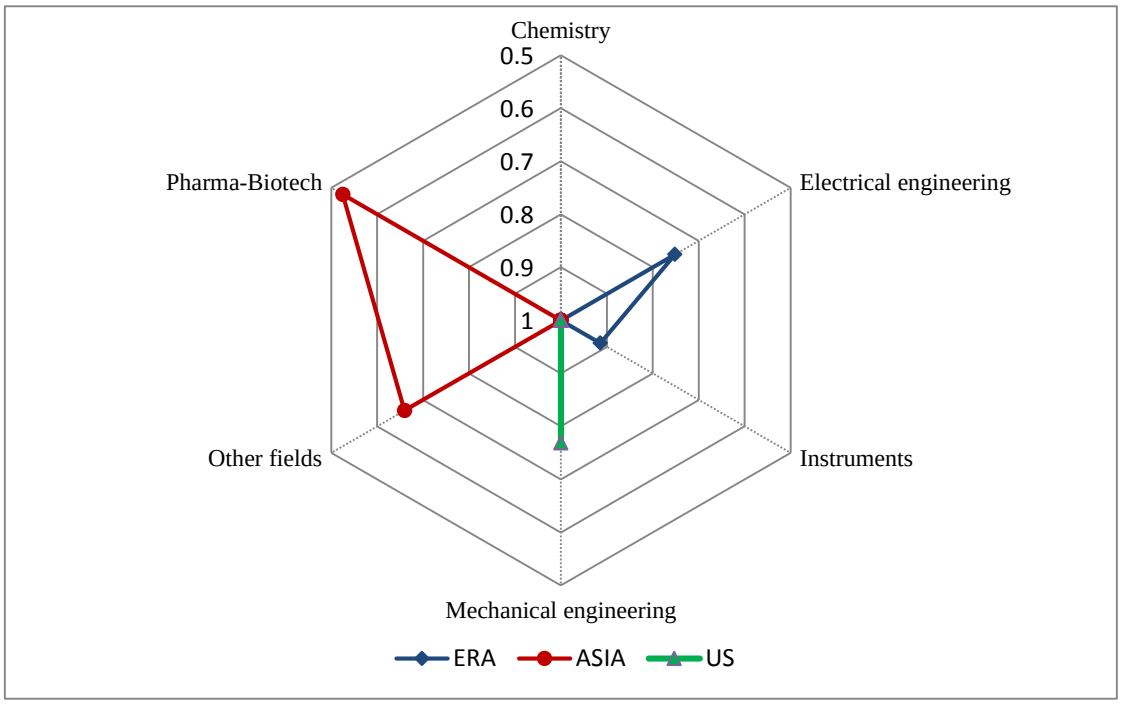
Figure 9 - Areas of strength by broad bechnological areas (IPC35) – Broad geographical areas



As far as the ERA is concerned, the major areas of technological strength are Mechanical Engineering and Chemistry. The former represents the area of major strength and includes sector such as Mechanical Elements (average RTA 1.44), Handling (1.44), Civil Engineering (1.39)[8]. The specialization in Chemistry is driven by Organic Chemistry (average RTA 1.44) and Chemical Engineering (1.27). The major area of weakness is the Electrical Engineering: fields such as Audio-visual technology, Telecommunications, Computer technology, IT methods for management and Semiconductors present values of RTA consistently lower than one in all the four patent systems. These results are thus fully consistent with those reported above for the FP7 Thematic Priorities.

[8] The other classes are Tansport (1.37), Engines, pumps, turbines (1.33), Other Special Machines (1.22). A few classes belonging to this area do not appear as specialized: Textile and Paper Machine, Thermal Processes and Apparatus.

Figure 10 - Areas of weakness by broad bechnological areas (IPC35) – Broad geographical areas



Regarding Asia, this geographical area is strongly specialised in the broad field of Electrical Engineering. Values greater than one of RTAs are found in the following fields: Electrical machinery, Audio-visual technology, Telecommunications, Basic communication processes and Semiconductors. Moreover, some specific areas such as Optics and Textile and paper machines present high values of the corresponding RTA, suggesting a high degree of specialisation in these technological fields. As far as the areas of relative de-specialisation are concerned, these are generally found in Pharmaceutical and Biotechnology, but many of the classes at the disaggregated level belong to chemical-related sectors (Basic Materials chemistry, Chemical Engineering). The fact that this latter broad area does not appear as de-specialized in Figure 10 depends on the results of the RTA for the WIPO, which is slightly above one (1.05). Furthermore, specific classes of weakness are Furniture, Games and Civil engineering, both included into the residual category Other fields.

Once again, these results are fully consistent with those discussed above with regard to the classification of patents according to FP7 Thematic Priorities.

Among the areas of major technological strength of the US one finds Biotechnology and Pharmaceuticals. Moreover, the broad area of scientific instruments represents a field of technological strength as suggested by the values of the RTA for Analysis of biological materials and Medical technology, both consistently above one. Looking at the ICT a composite scenario emerges with two different path of specialization: US shows high values of the RTA in Computer technology and IT methods for management, while it is relatively weaker in Telecommunication and Audiovisual Technology. As far as the major fields of technological de-specialisation are concerned, the patterns is to some extent complementary to the ERA. US is particularly weak in the broad area of mechanical engineering, particularly Machine tools, Engines, pumps, turbines, Textile and paper machines, Mechanical elements and Transport.

2.3 Specialisation by NACE sectors

As a final step, we examine the specialisation patterns at the level of NACE industries. Values of the RTA index of the ERA, EU27, Asia and the United States are reported in Tables 14 to 17 for each of the four patent systems considered here.

As far as the ERA is concerned, values of RTA consistently greater than one can be found in Food products and beverages, Machinery and equipment, Plastic products, Motor vehicles and Aircraft and spacecraft, Non-metallic mineral products, Sales of textiles. On the other hand, the sectors in which the European area presents major weakness are Office machinery and computers, Electronic components, Electricity distribution and control apparatus, Services for computer and related activities and Telecommunication equipment.

Regarding Asia, the data show that this area is strongly specialized in Electronic components, Electricity distribution and control apparatus, Electrical motors, generators and transformers and Office machinery and

computers, Telecommunication equipment. At the same time, it presents a relative de-specialization in Food products and beverages, Pharmaceuticals, Plastic products, Medical and surgical equipment, Aircraft and spacecraft, Machinery and equipment, Non-metallic mineral products, Recorded media and related goods, Sales of textiles, Services for computer and related activities

Finally, the US presents high levels of specialization in Services for computer and related activities, Pharmaceuticals, Medical and surgical equipment, Reproduction of recorded media, Sales of textiles. On the other hand, the values of RTA are consistently lower than one, thereby suggesting relative weakness, in Motor vehicles, Electrical motors, generators and transformers, Electrical machinery, Electricity distribution and control apparatus, General purpose machinery and machine tools, Telecommunication equipment.

Table 18 summarizes the main findings of this section by providing a summary view of the major fields of specialization and de-specialization for each geographical area and according to the different classification systems of patents adopted here. In this respect, it is quite important to observe that despite the fact that the different classifications of patents have been elaborated with different objectives in mind, the overall picture emerging from the analysis is rather consistent. In particular, the ERA looks strongly specialized in relatively traditional technological fields, related to the transport and mechanical technologies, while at the same time major weaknesses are associated to fast growing technologies related to the ICT and nanotechnology areas

Table 14 - RTA INDEX, NACE Classification, 2000-2012
European Patent Office (by Applicant)

Nace Classification	EU27	ERA	ASIA	USA
Food products and beverages	1.0527236	1.1735138	0.5749556	0.9857775
Sales of textiles	1.0552588	1.0565215	0.7767671	1.1568386
Recorded media and related goods	0.8860238	0.8914127	0.9189374	1.3058578
Basic chemicals of paints, varnishes	0.9752464	0.9727839	1.0515885	1.0461975
Pharmaceuticals	0.8533264	0.9040249	0.6229825	1.4237232
Plastic products	1.2599901	1.2909667	0.603558	0.8198145
Non-metallic mineral products	1.244271	1.2349474	0.7320318	0.8389889
General purpose machinery and machine tools	1.2386081	1.2309824	0.8870882	0.7375298
Office machinery and computers	0.674679	0.6507304	1.5651888	1.1456085
Electrical motors, generators and transformers	1.0365336	1.0453286	1.4650187	0.6044283
Electricity distribution and control apparatus	0.5731122	0.5564253	2.2644053	0.7958595
Electronic components	0.7143488	0.6938532	1.6775834	1.0356166
Medical and surgical equipment	0.7758194	0.844473	0.5718139	1.5344087
Instruments and appliances	0.9633978	0.9721085	1.030329	1.0547456
Motor vehicles	1.3340597	1.2478149	1.1084757	0.5644492
Aircraft and spacecraft	1.2759092	1.2353698	0.6460167	0.84349
Services for computer and related activities	0.6859971	0.6861942	0.7044624	1.7111741
Machinery and equipment	1.3141401	1.3227289	0.6946352	0.7058244
Electrical machinery	1.1332735	1.125145	0.9847749	0.8110688
Telecommunication equipment	0.821937	0.782161	1.4562885	0.9787266

Table 15 - RTA INDEX, NACE Classification, 2000-2012
World Intellectual Property Organization (by Applicant)

Nace Classification	EU27	ERA	ASIA	USA
Food products and beverages	0.9900497	1.0722251	0.9512746	0.9009845
Sales of textiles	1.0606471	1.0918516	0.9665414	1.075543
Recorded media and related goods	0.9094817	0.9219519	0.9816397	1.1099324
Basic chemicals of paints, varnishes	1.034769	1.035094	1.1456364	0.9106629
Pharmaceuticals	0.8825152	0.9067605	0.714151	1.3230213
Plastic products	1.2739519	1.3084208	0.7486974	0.854849
Non-metallic mineral products	1.0981879	1.089678	0.9815408	0.9126814
General purpose machinery and machine tools	1.3250078	1.316275	0.9999148	0.6872248
Office machinery and computers	0.7265278	0.7074128	1.1253761	1.1809392
Electrical motors, generators and transformers	1.1684403	1.1531786	1.4562437	0.5216258
Electricity distribution and control apparatus	0.6053427	0.5860516	1.9174	0.7291636
Electronic components	0.6749532	0.6571833	1.5247629	1.0137333
Medical and surgical equipment	0.8631443	0.8950137	0.6334067	1.3554931
Instruments and appliances	1.0285616	1.0219687	0.9620987	1.0187233
Motor vehicles	1.5819788	1.5049555	0.9862364	0.5646931
Aircraft and spacecraft	1.4447207	1.4672291	0.548899	0.7744784
Services for computer and related activities	0.4803111	0.491948	0.7583456	1.6380979
Machinery and equipment	1.2584933	1.2972462	0.786757	0.8172203
Electrical machinery	1.1131767	1.0969348	1.0226868	0.8794932
Telecommunication equipment	0.8343473	0.8030445	1.3895504	0.9262743

Table 16 - RTA INDEX, NACE Classification, 2000-2012
United States Patent Office (by Applicant)

Nace Classification	EU27	ERA	ASIA	USA
Food products and beverages	0.9609674	1.2420201	0.3647044	1.3203666
Sales of textiles	1.6637241	1.5726852	0.5656888	1.1546937
Recorded media and related goods	1.0348378	1.0185583	0.951954	1.0873728
Basic chemicals of paints, varnishes	1.5162903	1.4910894	0.9457576	0.9705912
Pharmaceuticals	1.3837477	1.4438784	0.4776655	1.1870684
Plastic products	1.2546081	1.3467501	0.6158402	1.102733
Non-metallic mineral products	1.2198263	1.2317136	0.9394085	1.0279774
General purpose machinery and machine tools	1.536825	1.5627278	0.8590569	0.9446132
Office machinery and computers	0.5718602	0.5481457	1.2037327	1.0279916
Electrical motors, generators and transformers	1.239205	1.2600223	1.6469816	0.6204093
Electricity distribution and control apparatus	0.6203728	0.5990904	1.818504	0.7373827
Electronic components	0.6366988	0.6032789	1.5547097	0.7529182
Medical and surgical equipment	1.0782617	1.1929097	0.3824242	1.313207
Instruments and appliances	1.0791951	1.0848409	1.0937539	0.9480719
Motor vehicles	1.6013802	1.5042519	1.1934456	0.8494116
Aircraft and spacecraft	1.4502558	1.4394052	0.5114253	1.1131702
Services for computer and related activities	0.5061873	0.5326166	0.3361026	1.5399818
Machinery and equipment	1.2829161	1.3069105	0.7282401	1.0754423
Electrical machinery	0.9267306	0.9205927	0.9262144	0.8797159
Telecommunication equipment	0.8915829	0.8533836	1.1106658	0.9621262

Table 17 - RTA INDEX, NACE Classification, 2000-2012
Triadic patents (by Applicant)

Nace Classification	EU27	ERA	ASIA	USA
Food products and beverages	1.0953745	1.2399939	0.5963167	1.1093543
Sales of textiles	1.1869351	1.1870529	0.7042119	1.174263
Recorded media and related goods	0.8827538	0.8934416	0.7436076	1.3698618
Basic chemicals of paints, varnishes	1.3122387	1.2777112	0.8227097	0.9645446
Pharmaceuticals	1.1479529	1.2418723	0.3942915	1.3438297
Plastic products	1.2041682	1.2858498	0.7961825	0.9494664
Non-metallic mineral products	1.0713503	1.0530927	0.8772747	1.1011635
General purpose machinery and machine tools	1.1932104	1.2054004	1.0434507	0.811328
Office machinery and computers	0.6049726	0.5587406	1.4268904	0.9660054
Electrical motors, generators and transformers	0.8906074	0.8803448	1.6632605	0.501739
Electricity distribution and control apparatus	0.516339	0.4882089	1.5924624	0.8381249
Electronic components	0.83904	0.7729729	1.2432592	0.9537814
Medical and surgical equipment	0.870869	0.9962654	0.3962293	1.4827951
Instruments and appliances	1.0088215	1.0216441	1.0065396	0.993636
Motor vehicles	1.3025557	1.1769867	1.4953108	0.4455365
Aircraft and spacecraft	1.3189121	1.2484616	0.8315895	0.9413151
Services for computer and related activities	0.4337393	0.4342524	0.735979	1.7148494
Machinery and equipment	1.2968059	1.3162651	0.9394411	0.8202068
Electrical machinery	1.0324066	0.9931442	1.2235537	0.8161214
Telecommunication equipment	0.815308	0.7460372	1.296086	0.9355418

Table 18 - Patterns of specialisation and de-specialisation by geographical area and type of classification, 2000-2012.

	Areas of	FP7 Thematic Priorities	IPC 35	NACE sectors
ERA	Strength	Aeronautics Automobiles Construction Technologies Energy Food, Agriculture and Fisheries New Production Technologies	Organic fine chemistry Chemical engineering Transport Machine tools Handling Engines, pumps, turbines Mechanical elements Civil engineering	Aircraft and spacecraft Food products and beverages General purpose machinery and machine tools Machinery and equipment Motor vehicles Non-metallic mineral products Plastic products Sales of textiles
	Weakness	Green Energy ICT Nanosciences/Nanotechnologies	Telecommunications Semiconductors Audio-visual technology Computer technology IT methods for management Optics	Electricity distribution and control apparatus Electronic components Office machinery and computers Services for computer and related activities Telecommunication equipment
Asia	Strength	Energy Environment Green Energy ICT	Materials, metallurgy Audio-visual technology Semiconductors Electrical machinery Telecommunications Optics Textile and paper machines	Electrical motors, generators and transformers Electricity distribution and control apparatus Electronic components Office machinery and computers Telecommunication equipment
	Weakness	Aeronautics Biotechnology Construction Technologies Food, Agriculture and Fisheries Health New Production Technologies Security Space	Chemical engineering Food chemistry IT methods for management Biological materials analysis Medical technology Handling Other special machines Furniture, games Civil engineering Pharmaceuticals Biotechnology	Aircraft and spacecraft Food products and beverages Machinery and equipment Medical and surgical equipment Non-metallic mineral products Pharmaceuticals Plastic products Recorded media and related goods Sales of textiles Services for computer and related activities
United States	Strength	Aeronautics Biotechnology Health New Production Technologies Security Space	Micro-structural/nano-tech IT methods for management Computer technology Biological materials analysis Medical technology Pharmaceuticals Biotechnology	Medical and surgical equipment Pharmaceuticals Recorded media and related goods Sales of textiles Services for computer and related activities
	Weakness	Automobiles Energy	Materials, metallurgy Electrical machinery Audio-visual technology Engines, pumps, turbines Mechanical elements Transport Textile and paper machines	Electrical machinery Electrical motors, generators and transformers Electricity distribution and control apparatus General purpose machinery and machine tools Motor vehicles Telecommunication equipment

2.4 Specialisation patterns by country

The analysis carried out above has adopted broad geographical areas as main units of analysis. In this section, we report results on the technological specialisation at the level of individual countries. Given the high number of analytical dimensions involved, i.e. 42 countries × 3 classifications systems (i.e. Thematic Priorities, IPC 35, NACE) × 4 patent systems (i.e. EPO, WIPO, USPTO, Triadic) × 2 methods of locating patents (i.e. applicant and inventors), the resulting number of tables is quite large. For this reason, we decided to focus this part of the report on the WIPO and the EPO patent systems. However, the full set of detailed tables with RTA values by country is reported as a set of Excel sheets.

In this section, we report information on the three *most specialised* (i.e. showing the highest values of the RTA) and the three most de-specialised countries (out of the 42 countries) for each of the three classification systems. This information is reported in Tables 19 to 24. Please note that in each table, a blue background color indicates an ERA country, whereas a red background color identifies a BRIC (Brasil, Russia, India, China) country. RTA values are shown among brackets.

An important point to note is that RTA values are rather sensitive to the country size. In particular, small countries (in terms of patents) tend to exhibit particularly high and low values of RTA in a few areas. The total number of patents applied for by these countries is very low. Yet, they concentrate their patenting activity in a relatively small number of areas, so that the share of these areas on their total patenting activity is very high, compared to the corresponding share at the worldwide level, thereby resulting in abnormally high and low values of the RTA index. In order to address this problem, we have proceeded in the following way. For each Thematic Area / Technology field / NACE sector, we have calculated the total number of patents for each of the 42 countries. For the resulting distribution, we have computed the median number of patents and then reported results in Tables 19 to 24 only for countries with a total number of patents above the median value.

Table 19 - Most specialised and despecialised countries. 2000-2012

FP7 Thematic Priorities –European Patent Office (by Applicant)

Thematic Priorities	Most specialised countries	Most despecialised countries
Health	India (3.17)	Finland (0.28)
	Israel (2.5)	South Korea (0.33)
	Ireland (2.07)	Japan (0.53)
Food, Agriculture and Fisheries	Denmark (2.74)	South Korea (0.27)
	Norway (2.34)	China (0.44)
	Spain (2.08)	Japan (0.47)
Biotechnology	India (2.92)	Finland (0.45)
	Denmark (2.74)	Italy (0.45)
	Belgium (1.95)	Sweden (0.55)
ICT	China (2.31)	Denmark (0.24)
	South Korea (2.19)	Austria (0.27)
	Finland (2.16)	Spain (0.31)
Nanosciences/Nanotechnologies	South Korea (1.39)	Finland (0.43)
	United States (1.29)	Italy (0.45)
	Netherlands (1.27)	Denmark (0.45)
Materials (excl. nanotech)	India (2.33)	China (0.48)
	Belgium (1.64)	South Korea (0.55)
	Japan (1.14)	Sweden (0.56)
New Production Technologies	Ireland (1.71)	China (0.41)
	Switzerland (1.53)	South Korea (0.45)
	United Kingdom (1.31)	Luxembourg (0.63)
Construction Technologies	Norway (4.08)	Japan (0.24)
	Austria (3.41)	South Korea (0.26)
	Spain (2.66)	Israel (0.54)
Energy	Brazil (1.84)	Israel (0.48)
	Germany (1.29)	Finland (0.6)
	Luxembourg (1.27)	Netherlands (0.65)
Environment	Denmark (2)	Sweden (0.64)
	Norway (1.71)	Finland (0.74)
	Spain (1.26)	Switzerland (0.79)
Aeronautics	Russian Federation (4.77)	Japan (0.18)
	Brazil (3.37)	Netherlands (0.2)
	Spain (3.27)	Switzerland (0.24)
Automobiles	Czech Republic (2.47)	Denmark (0.21)
	Luxembourg (2.46)	Finland (0.23)
	Liechtenstein (2.27)	South Korea (0.27)
Other Transport Technologies	Norway (3.99)	South Korea (0.32)
	Austria (2.7)	United States (0.39)
	Italy (2.52)	Belgium (0.56)
Space	France (3.88)	Netherlands (0.49)
	Spain (1.97)	Japan (0.66)
	Israel (1.46)	Sweden (0.67)
Security	Finland (2.18)	Belgium (0.45)
	Israel (2.15)	Italy (0.52)
	China (1.67)	Denmark (0.52)
Green Energy	Denmark (2.27)	Sweden (0.54)
	Norway (1.64)	Finland (0.6)
	South Korea (1.48)	Italy (0.75)

Table 20 - Most specialised and despecialised countries. 2000-2012

FP7 Thematic Priorities - World Intellectual Property Organization (by Applicant)

Thematic Priorities	Most specialised countries	Most despecialised countries
Health	India (2.09)	Finland (0.28)
	Israel (1.82)	South Korea (0.55)
	Ireland (1.71)	China (0.57)
Food, Agriculture and Fisheries	Brazil (2.37)	China (0.6)
	Spain (2.23)	Austria (0.63)
	Denmark (2.12)	Finland (0.67)
Biotechnology	Denmark (2.26)	Finland (0.5)
	Belgium (1.94)	Sweden (0.55)
	Spain (1.5)	Japan (0.6)
ICT	China (2.08)	Italy (0.34)
	Finland (1.9)	Switzerland (0.37)
	South Korea (1.46)	Denmark (0.38)
Nanosciences/Nanotechnologies	United States (1.29)	China (0.27)
	Ireland (1.24)	Finland (0.46)
	Japan (1.12)	Italy (0.49)
Materials (excl. nanotech)	India (2.11)	Israel (0.47)
	Belgium (1.94)	China (0.55)
	Japan (1.34)	Sweden (0.59)
New Production Technologies	Ireland (1.35)	China (0.46)
	Switzerland (1.28)	India (0.65)
	United Kingdom (1.22)	Belgium (0.69)
Construction Technologies	Norway (5.34)	Japan (0.36)
	Austria (2.42)	Israel (0.64)
	Spain (2.16)	Switzerland (0.79)
Energy	Brazil (1.63)	Israel (0.54)
	Germany (1.47)	India (0.57)
	Russian Federation (1.44)	Finland (0.64)
Environment	Denmark (1.7)	Sweden (0.72)
	Norway (1.53)	Israel (0.73)
	Russian Federation (1.31)	Switzerland (0.75)
Aeronautics	France (3.4)	Japan (0.17)
	Spain (3.26)	Netherlands (0.21)
	Russian Federation (3.19)	South Korea (0.22)
Automobiles	Germany (2.39)	Israel (0.29)
	France (2.08)	Finland (0.3)
	Sweden (1.9)	Denmark (0.31)
Other Transport Technologies	Norway (6.85)	Japan (0.57)
	Italy (2.64)	Belgium (0.6)
	Spain (2.5)	United States (0.64)
Space	Russian Federation (5.13)	China (0.26)
	France (3.52)	South Korea (0.33)
	Spain (1.83)	Germany (0.38)
Security	Finland (2.01)	Belgium (0.5)
	Israel (1.95)	India (0.52)
	Sweden (1.46)	Italy (0.58)
Green Energy	Denmark (1.87)	Sweden (0.57)
	Norway (1.39)	Finland (0.62)
	Japan (1.32)	India (0.68)

Table 21 - Most specialised and despecialised countries. 2000-2012

IPC 35 technology fields –European Patent Office (by Applicant)

Macro classes	IPC 35 technology fields	Most specialised countries	Most despecialised countries
Electrical Engineering	Electrical machinery	South Korea (1.64)	Israel (0.42)
		Japan (1.39)	Sweden (0.45)
		Austria (1.34)	Belgium (0.5)
	Audio-visual technology	South Korea (3.6)	Italy (0.26)
		Netherlands (2.22)	Spain (0.4)
		Japan (1.98)	Switzerland (0.48)
	Telecommunications	China (3.91)	Austria (0.17)
		Finland (3.61)	Denmark (0.21)
		South Korea (2.72)	Belgium (0.24)
	Digital communication	China (5.61)	Denmark (0.13)
		Finland (4.12)	Austria (0.14)
		Sweden (2.82)	Belgium (0.24)
	Basic communication processes	Netherlands (2.38)	Spain (0.29)
		Finland (1.62)	Denmark (0.39)
		Sweden (1.37)	Austria (0.44)
	Computer technology	Ireland (1.63)	Spain (0.24)
		Finland (1.52)	Austria (0.28)
		South Korea (1.49)	Denmark (0.32)
	IT methods for management	Ireland (6.58)	Belgium (0.32)
		United States (1.71)	Italy (0.34)
		Finland (1.35)	Spain (0.42)
	Semiconductors	South Korea (2.14)	Denmark (0.15)
		Japan (1.73)	Sweden (0.18)
		Netherlands (1.47)	Spain (0.22)
Instruments	Optics	Japan (2.19)	Spain (0.23)
		South Korea (1.65)	Italy (0.36)
		Netherlands (1.54)	Finland (0.37)
	Measurement	Switzerland (1.8)	China (0.42)
		Norway (1.7)	South Korea (0.43)
		United Kingdom (1.29)	Spain (0.57)
	Biological materials analysis	United Kingdom (1.63)	South Korea (0.35)
		Israel (1.57)	China (0.36)
		Denmark (1.55)	Italy (0.46)
	Control	Ireland (1.82)	China (0.37)
		Spain (1.34)	Belgium (0.48)
		United Kingdom (1.32)	South Korea (0.54)
	Medical technology	Israel (2.99)	South Korea (0.29)
		Ireland (1.98)	Finland (0.37)
		United States (1.66)	China (0.4)
Pharma Biotech	Biotechnology	Denmark (3.05)	Italy (0.4)
		India (2.91)	Finland (0.45)
		Belgium (1.93)	Sweden (0.52)
	Pharmaceuticals	India (5.55)	South Korea (0.37)
		Slovenia (5.32)	Japan (0.51)
		Israel (2.24)	Germany (0.57)

Table 21 cont.

Macro classes	IPC 35 technology fields	Most specialised countries	Most despecialised countries
Chemistry	Organic fine chemistry	India (7.66)	Finland (0.22)
		Slovenia (4.4)	Sweden (0.36)
		Hungary (3.97)	Austria (0.41)
	Macromolecular chemistry	Belgium (2.44)	Sweden (0.14)
		Netherlands (1.45)	Israel (0.28)
		Japan (1.29)	Spain (0.31)
	Food chemistry	Denmark (4.5)	Sweden (0.32)
		Netherlands (3.02)	South Korea (0.37)
		Norway (2.58)	Austria (0.52)
	Basic materials chemistry	Brazil (1.96)	Sweden (0.21)
		Netherlands (1.48)	Finland (0.41)
		Belgium (1.35)	South Korea (0.41)
	Materials, metallurgy	Luxembourg (2.97)	Israel (0.42)
		Austria (2.06)	Netherlands (0.6)
		Belgium (1.71)	China (0.63)
	Surface technology, coating	Belgium (1.54)	China (0.4)
		Luxembourg (1.34)	South Korea (0.46)
		Japan (1.23)	Israel (0.52)
	Micro-structural/nano-tech	Russian Federation (3.18)	Spain (0.43)
		South Korea (1.85)	Denmark (0.43)
		Norway (1.54)	United Kingdom (0.49)
	Chemical engineering	Norway (1.93)	South Korea (0.5)
		Denmark (1.37)	China (0.55)
		Germany (1.26)	Israel (0.67)
	Environmental technology	Norway (2.06)	South Korea (0.47)
		Austria (1.47)	China (0.64)
		Luxembourg (1.41)	Israel (0.69)
Mechanical Engineering	Handling	Italy (2.75)	South Korea (0.27)
		Switzerland (2.19)	Israel (0.39)
		Spain (1.87)	China (0.4)
	Machine tools	Liechtenstein (8.78)	South Korea (0.25)
		Greece (3.57)	Netherlands (0.4)
		Austria (2.1)	Belgium (0.51)
	Engines, pumps, turbines	Brazil (2.41)	Netherlands (0.23)
		Luxembourg (2.27)	South Korea (0.31)
		Denmark (1.66)	Finland (0.32)
	Textile and paper machines	Czech Republic (2.12)	Israel (0.42)
		Belgium (2.09)	Denmark (0.44)
		Finland (1.97)	South Korea (0.48)
	Other special machines	Italy (2.01)	South Korea (0.33)
		Belgium (1.88)	China (0.36)
		Luxembourg (1.75)	Japan (0.72)
	Thermal processes and apparatus	Turkey (5.18)	Israel (0.46)
		South Korea (2.22)	United States (0.56)
		Italy (1.95)	Netherlands (0.64)

Table 21 cont.

Macro classes	IPC 35 technology fields	Most specialised countries	Most despecialised countries
Mechanical Engineering	Mechanical elements	Liechtenstein (3.64)	South Korea (0.29)
		Germany (1.84)	Israel (0.32)
		Norway (1.53)	China (0.35)
	Transport	Luxembourg (2.1)	South Korea (0.27)
		Spain (1.74)	Finland (0.33)
		Germany (1.73)	Denmark (0.35)
Other Fields	Furniture, games	Turkey (5.73)	Finland (0.46)
		Italy (2.57)	Japan (0.47)
		Austria (2.56)	Israel (0.68)
	Other consumer goods	Turkey (10.25)	Finland (0.4)
		Brazil (2.54)	Sweden (0.54)
		Belgium (2.44)	Japan (0.62)
	Civil engineering	Norway (4.37)	Japan (0.21)
		Poland (4.17)	South Korea (0.24)
		Austria (3.46)	Israel (0.52)

Table 22 - Most specialised and despecialised countries. 2000-2012
IPC 35 technology fields - World Intellectual Property Organization (by Applicant)

Macro classes	IPC 35 technology fields	Most specialised countries	Most despecialised countries
Electrical Engineering	Electrical machinery	Japan (1.58)	India (0.37)
		Austria (1.41)	Israel (0.48)
		Germany (1.3)	Belgium (0.49)
	Audio-visual technology	Netherlands (2.81)	India (0.21)
		Japan (1.91)	Italy (0.27)
		South Korea (1.64)	Spain (0.4)
	Telecommunications	China (3.57)	Switzerland (0.23)
		Finland (3.1)	Belgium (0.28)
		Sweden (2.33)	Austria (0.34)
	Digital communication	China (4.51)	Switzerland (0.26)
		Finland (3.66)	Denmark (0.37)
		Sweden (2.42)	Belgium (0.42)
	Basic communication processes	Netherlands (2.66)	Italy (0.31)
		Ireland (1.72)	Belgium (0.45)
		Sweden (1.52)	India (0.47)
	Computer technology	Israel (1.89)	Italy (0.33)
		Finland (1.45)	Spain (0.4)
		United States (1.38)	Belgium (0.45)
	IT methods for management	Ireland (1.89)	Germany (0.29)
		South Korea (1.67)	Denmark (0.31)
		United States (1.64)	Italy (0.31)
	Semiconductors	Japan (1.95)	Denmark (0.15)
		South Korea (1.32)	Sweden (0.21)
		Netherlands (1.12)	Spain (0.24)
Instruments	Optics	Japan (1.97)	India (0.18)
		Netherlands (1.3)	Spain (0.34)
		South Korea (1.09)	Austria (0.4)
	Measurement	Norway (1.58)	India (0.42)
		Switzerland (1.49)	China (0.48)
		United Kingdom (1.29)	South Korea (0.52)
	Biological materials analysis	United Kingdom (1.49)	China (0.27)
		Denmark (1.48)	South Korea (0.48)
		Belgium (1.4)	India (0.55)
	Control	Ireland (1.65)	Belgium (0.49)
		Russian Federation (1.45)	China (0.55)
		Norway (1.4)	India (0.68)
	Medical technology	Israel (2.48)	Finland (0.3)
		Ireland (2.14)	India (0.39)
		United States (1.5)	China (0.4)
Pharma Biotech	Biotechnology	Denmark (2.42)	Finland (0.48)
		Belgium (1.95)	Sweden (0.51)
		Spain (1.43)	Italy (0.6)
	Pharmaceuticals	India (3.4)	Finland (0.27)
		Denmark (1.82)	Netherlands (0.51)
		Belgium (1.6)	South Korea (0.54)

Table 22 cont.

Macro classes	IPC 35 technology fields	Most specialised countries	Most despecialised countries
Chemistry	Organic fine chemistry	India (6.56)	Sweden (0.33)
		Czech Republic (3.05)	China (0.49)
		Hungary (2.73)	Denmark (0.56)
	Macromolecular chemistry	Belgium (2.9)	Israel (0.26)
		Japan (1.6)	Sweden (0.28)
		Italy (1.26)	Spain (0.42)
	Food chemistry	Denmark (3.1)	Sweden (0.41)
		India (2.68)	Germany (0.5)
		Switzerland (2.34)	Austria (0.56)
	Basic materials chemistry	India (1.8)	Sweden (0.26)
		Belgium (1.77)	Finland (0.45)
		Brazil (1.5)	Austria (0.53)
	Materials, metallurgy	Russian Federation (2.34)	Netherlands (0.58)
		Austria (2.07)	Denmark (0.64)
		Belgium (1.88)	United Kingdom (0.64)
	Surface technology, coating	Belgium (1.62)	India (0.38)
		Japan (1.6)	China (0.45)
		Germany (1.05)	Israel (0.51)
	Micro-structural/nano-tech	South Korea (2.25)	China (0.3)
		Russian Federation (1.61)	Italy (0.34)
		Spain (1.34)	Belgium (0.48)
	Chemical engineering	Russian Federation (2.01)	China (0.62)
		Norway (1.68)	Israel (0.63)
		Belgium (1.38)	South Korea (0.67)
	Environmental technology	Norway (1.88)	China (0.71)
		Russian Federation (1.7)	Israel (0.74)
		France (1.3)	Switzerland (0.75)
Mechanical l Engineering	Handling	Italy (2.88)	China (0.51)
		Switzerland (2.18)	Israel (0.59)
		Finland (1.86)	South Korea (0.7)
	Machine tools	Austria (2.26)	Netherlands (0.53)
		Germany (1.8)	China (0.63)
		Italy (1.71)	Belgium (0.64)
	Engines, pumps, turbines	Russian Federation (2.43)	Netherlands (0.35)
		Germany (2.16)	Israel (0.42)
		Brazil (2.12)	Finland (0.5)
	Textile and paper machines	Finland (3.78)	India (0.56)
		Czech Republic (2.93)	Denmark (0.61)
		Belgium (2.53)	China (0.62)
	Other special machines	Italy (2.06)	China (0.47)
		Spain (1.76)	South Korea (0.79)
		Belgium (1.74)	Finland (0.81)
	Thermal processes and apparatus	Turkey (5.89)	United States (0.62)
		Brazil (2.29)	Israel (0.68)
		Italy (2.19)	Netherlands (0.71)

Table 22 cont.

Macro classes	IPC 35 technology fields	Most specialised countries	Most despecialised countries
Other fields	Mechanical elements	Germany (2.32)	India (0.35)
		Norway (2.25)	Israel (0.35)
		Brazil (1.53)	South Korea (0.49)
	Transport	France (2.12)	Finland (0.44)
		Germany (2.11)	Netherlands (0.47)
		Norway (1.76)	Israel (0.48)
	Furniture, games	Turkey (3.99)	Finland (0.41)
		Italy (2.04)	Japan (0.5)
		Austria (1.81)	Germany (0.78)
	Other consumer goods	Turkey (10.33)	Finland (0.4)
		Brazil (3.02)	India (0.46)
		Italy (2.39)	Japan (0.64)
	Civil engineering	Norway (5.39)	Japan (0.34)
		Austria (2.41)	Israel (0.64)
		Spain (2.3)	Switzerland (0.78)

Table 23 - Most specialised and despecialised countries. 2000-2012

NACE Classification –European Patent Office (by Applicant)

NACE Classification	Most specialised countries	Most despecialised countries
Food products and beverages	Denmark (4.43)	Sweden (0.3)
	Netherlands (3.05)	South Korea (0.35)
	Switzerland (2.52)	Austria (0.5)
Sales of textiles	Italy (1.61)	South Korea (0.22)
	Austria (1.47)	Sweden (0.39)
	Denmark (1.25)	China (0.49)
Recorded media and related goods	India (1.34)	South Korea (0.3)
	United States (1.31)	China (0.42)
	Belgium (1.25)	Italy (0.5)
Basic chemicals of paints, varnishes	India (2.12)	Sweden (0.31)
	Belgium (1.96)	China (0.53)
	Norway (1.37)	Israel (0.65)
Pharmaceuticals	India (6.18)	Finland (0.29)
	Israel (2.21)	South Korea (0.51)
	Denmark (2.17)	Japan (0.55)
Plastic products	Italy (2.18)	South Korea (0.33)
	Luxembourg (1.95)	China (0.41)
	Spain (1.78)	Israel (0.49)
Non-metallic mineral products	Liechtenstein (2.37)	South Korea (0.37)
	Austria (2.37)	China (0.41)
	Belgium (2.21)	Sweden (0.74)
General purpose machinery and machine tools	Liechtenstein (2.2)	Netherlands (0.5)
	Italy (1.59)	China (0.53)
	Germany (1.58)	Israel (0.54)
Office machinery and computers	South Korea (2.01)	Denmark (0.29)
	Japan (1.55)	Italy (0.34)
	Netherlands (1.54)	Spain (0.35)
Electrical motors, generators and transformers	Brazil (2.99)	Netherlands (0.27)
	Japan (1.62)	Belgium (0.38)
	Germany (1.43)	Sweden (0.43)
Electricity distribution and control apparatus	South Korea (3.78)	Sweden (0.24)
	Japan (2.08)	Belgium (0.24)
	China (1.32)	Finland (0.27)
Electronic components	South Korea (2.18)	Denmark (0.14)
	Japan (1.67)	Spain (0.22)
	Netherlands (1.47)	Sweden (0.24)
Medical and surgical equipment	Israel (2.56)	South Korea (0.32)
	Ireland (1.88)	Finland (0.37)
	Switzerland (1.61)	Japan (0.6)
Instruments and appliances	Netherlands (1.27)	China (0.44)
	United Kingdom (1.21)	Luxembourg (0.54)
	Japan (1.15)	South Korea (0.6)
Motor vehicles	Luxembourg (2.78)	Israel (0.23)
	Czech Republic (1.91)	South Korea (0.26)
	Germany (1.89)	China (0.27)
Aircraft and spacecraft	Norway (2.69)	South Korea (0.22)
	Russian Federation (2.2)	China (0.5)
	Austria (2.11)	Belgium (0.51)

Table 23 cont.

NACE Classification	Most specialised countries	Most despecialised countries
Services for computer and related activities	Ireland (6.54)	Belgium (0.31)
	United States (1.71)	Italy (0.34)
	Finland (1.39)	Denmark (0.43)
Machinery and equipment	Turkey (4.79)	Israel (0.58)
	Belgium (2.15)	Japan (0.62)
	Italy (2.11)	China (0.67)
Electrical machinery	Austria (1.58)	Israel (0.53)
	France (1.39)	Norway (0.53)
	Germany (1.31)	Belgium (0.54)
Telecommunication equipment	China (3.61)	Austria (0.28)
	Finland (3.09)	Italy (0.31)
	South Korea (2.36)	Belgium (0.32)

Table 24 - Most specialised and despecialised countries. 2000-2012

NACE Classification –World Intellectual Property Right (by Applicant)

NACE Classification	Most specialised countries	Most despecialised countries
Food products and beverages	Denmark (3.11)	Sweden (0.4)
	India (2.65)	Germany (0.5)
	Spain (2.37)	Austria (0.55)
Sales of textiles	Turkey (2.42)	Israel (0.38)
	Switzerland (1.75)	Sweden (0.4)
	Italy (1.71)	China (0.47)
Recorded media and related goods	Russian Federation (1.32)	China (0.5)
	Japan (1.21)	Denmark (0.53)
	Switzerland (1.2)	South Korea (0.53)
Basic chemicals of paints, varnishes	Belgium (2.16)	Sweden (0.37)
	India (1.7)	Israel (0.5)
	Japan (1.31)	Denmark (0.57)
Pharmaceuticals	India (3.86)	Finland (0.31)
	Denmark (1.86)	Japan (0.58)
	Belgium (1.66)	Sweden (0.62)
Plastic products	Italy (2.44)	India (0.47)
	Brazil (1.89)	China (0.49)
	Switzerland (1.86)	Israel (0.58)
Non-metallic mineral products	Belgium (2.28)	Israel (0.44)
	Austria (1.8)	India (0.51)
	Spain (1.75)	China (0.62)
General purpose machinery and machine tools	Germany (1.75)	India (0.49)
	Austria (1.68)	Israel (0.58)
	Norway (1.66)	Netherlands (0.66)
Office machinery and computers	Netherlands (1.68)	Italy (0.36)
	Israel (1.54)	Denmark (0.42)
	Japan (1.2)	Spain (0.45)
Electrical motors, generators and transformers	Turkey (2.38)	Netherlands (0.33)
	Brazil (2.14)	Israel (0.43)
	Germany (1.85)	India (0.45)
Electricity distribution and control apparatus	Japan (2.33)	Sweden (0.23)
	South Korea (1.66)	India (0.24)
	South Korea (1.66)	Belgium (0.25)
Electronic components	Japan (1.88)	Denmark (0.15)
	Netherlands (1.28)	Spain (0.26)
	South Korea (1.17)	Finland (0.27)
Medical and surgical equipment	Israel (2.02)	Finland (0.32)
	Ireland (1.87)	South Korea (0.54)
	Denmark (1.55)	China (0.55)
Instruments and appliances	Netherlands (1.2)	India (0.4)
	Japan (1.18)	China (0.48)
	United Kingdom (1.16)	South Korea (0.64)
Motor vehicles	Germany (2.54)	Israel (0.31)
	France (1.77)	Netherlands (0.32)
	Sweden (1.67)	Switzerland (0.39)
Aircraft and spacecraft	Norway (4.8)	Japan (0.43)
	Russian Federation (2.77)	Belgium (0.58)
	Austria (2.52)	India (0.65)

Table 24 cont.

NACE Classification	Most specialised countries	Most despecialised countries
Services for computer and related activities	Ireland (1.89)	Germany (0.29)
	South Korea (1.66)	Italy (0.31)
	United States (1.64)	Denmark (0.31)
Machinery and equipment	Turkey (5.06)	Israel (0.64)
	Norway (2.53)	China (0.72)
	Italy (2.12)	Japan (0.73)
Electrical machinery	Austria (1.5)	India (0.39)
	Germany (1.39)	Belgium (0.54)
	Netherlands (1.27)	Norway (0.62)
Telecommunication equipment	China (3.17)	Belgium (0.36)
	Finland (2.74)	Switzerland (0.38)
	Sweden (2.05)	Italy (0.4)

As far as the Thematic Priorities are concerned, it is interesting to note that BRICs feature prominently among the most specialised countries. For example, India ranks first both at the EPO and at the WIPO in the priority area of Health and Materials, whereas Brazil ranks first in the priority area of Energy and China rank first in ICT for both offices. Regarding the ERA, it is quite remarkable that the only ERA country appearing among the three most specialised countries in ICT (both at the EPO and at WIPO) is Finland. Similarly, in the area of Nanotechnologies, Netherland ranks third at the EPO, and Ireland second at the WIPO.

The European weakness in ICT is confirmed by looking at the classification according to IPC 35 technology fields. The ERA country that performs better is again Finland, which ranks first both at the EPO and WIPO in Telecommunications, and partly Sweden and the Netherlands. With the exception of these three countries, no other ERA country appears in the list of most specialised areas. With reference of Health and Biotechnology it is quite striking to observe the position of India, which ranks first in Pharmaceuticals at the EPO and second at the WIPO, while ranking second in Biotechnology at the EPO.

A quick glance at Table 21 confirms that the real strength of ERA is in the broad area of mechanical engineering, at least as far as EPO is concerned. In almost all such technological areas, the three most specialised countries

belong to the European area, with the exception of Brazil and South Korea. The picture changes slightly when one looks at the WIPO (see Table 22). In particular, Russia and Brazil enter the picture of the most specialised countries in several fields. This difference between the EPO and WIPO derives probably by the fact that companies that patent in these technological fields are typically small and medium sized companies. These companies patent at the EPO, but not necessarily they extend protection outside the European area through the WIPO system.

Finally, the picture emerging from the classification according to NACE economic sectors is by and large consistent with the findings outlined above. The European weakness is concentrated in ICT-related fields, notably electronic components, services for computers and office machinery and computers, even though in this latter sector two out of three of the most specialised countries at WIPO are European, i.e. Netherlands, Israel, moreover Netherland perform quite well in many sectors both at WIPO and EPO. A further sector of weakness is Electricity distribution in which no ERA country is ranked among the three most specialised ones either at the EPO or at WIPO.

Once again, the areas of European strength are found in sectors such as Motor Vehicles, General purpose machinery, Sales of Textile, Machinery and Equipment and Electrical Machinery. Yet, also the fields of Medical and surgical equipment and Instruments and appliances feature several ERA countries in the list of the most specialised ones.

As far as other countries are concerned, it is quite interesting to note the position of India, which ranks first in Pharmaceuticals both at the EPO and at WIPO. Moreover, it is also quite interesting to observe that the presence of BRIC countries in the list of most specialised areas increases as one moves from the EPO to the WIPO system. For example, while in the sector of Food products and beverages the three most specialised countries at the EPO belong to the ERA, the India ranks first at WIPO is India. A similar dynamic can be seen in Plastic Product, dominated by ERA country at the EPO, but comprehending Brazil at the second place in the WIPO ranking. This pattern

probably reflects the different use of patent systems by firms located in different countries. Whereas small and medium sized European companies mainly seek protection in the European area through the EPO, firms located in BRICs use to a larger extent the WIPO system to seek protection in other markets.

3. DIVERSIFICATION AND EVOLUTION OF SPECIALISATION PATTERNS

The analysis presented above was essentially static. Over time, countries can choose to enlarge the range of technologies they master or to reinforce fields where they are already specialized. It is therefore interesting to take into account indicators able to provide a proxy of the level of composition of technological specializations and of its evolution over time.

The analysis of technological diversification profiles allows investigating the processes of transition and structural changes that characterize innovative activities of the five core areas. According to this, the focus of attention in this section is to examine the degree of technological diversification, defined as the spread of patent portfolio over technology fields (FP7/IPC/NACE), respectively for EU27, Candidate countries, EFTA, ERA, Asia and United States. The aim of the following analysis is to investigate to what extent the specialisation patterns examined above have remained stable or have changed over time. In this study, the degree of technological diversification is measured by the reciprocal of the coefficient of variation[9] (CV) of RTA indexes, across technology and industry fields and for two patent systems, EPO and WIPO. Formally, the Diversification Index (DIV) is defined as follows:

$$DIV_{i,t} = \frac{1}{\mathrm{CV}_{RTA_{i,T}}} = \frac{\mu_{\mathrm{RTA}_{i,t}}}{\sigma_{RTA_{i,T}}}$$

[9] The coefficient of variation, abbreviated CV, is a statistical measure often used in the analysis of business concentration across firms within an industry, as opposed to concentration or dispersion across sectors within a firm. Generally speaking, CV is defined as the standard deviation of a group of values divided by their mean.

Where μ_{RTA} is the mean of the RTA index of area *i* at time *t* across technological sectors and σ_{RTA} is the standard deviation of the RTA distribution of the same area.

Low values of the Diversification Index suggest concentration of an area's profile of specialisation in few technological fields: in this situation, the geographical area presents very high values of RTA in some particular technological sectors and very low RTA values in others technological sectors. Conversely, high values of the Diversification Index imply that RTA values across technological classes are closer to the mean, thereby suggesting a more balanced and diversified profile of technological specialisation.

It is important to take into account the time dimension of the analysis because a decrease of the DIV index over time indicates increasing technological concentration, whereas an increase of the DIV index over time implies increasing technological diversification of a given geographical area. As mentioned above, the data set covers the period 2000-2012. Yet, due to the presence of various time lags, data from the most recent years tend to be incomplete. Moreover, the degree of incompleteness varies across patent systems. This incompleteness is likely to bias the analysis, with the consequent risk of misinterpreting the trends. To avoid misleading results, the time period of the analysis, concerning the Diversification index, has been restricted to period 2000-2009. In addition to this, the values of the RTA index may fluctuate if they are computed on an annual basis. For this reason, the period 2000-20069has been split into two subperiods of equal length, i.e. 2000-2004 and 2005-2009, and we have examined the evolution of the DIV index across these two time periods. Finally, we have focused our attention on the two most relevant patent systems for European countries, namely EPO and WIPO.

As argued above, the analysis is carried for each geographical area and for the different classifications of patents adopted here. Results are reported in Tables 25 to 30.

Tables 25 and 26 illustrate the profiles of technological diversification at the level of FP7 Thematic Priorities, respectively at the EPO and at WIPO (by

assigning patents to geographical areas according to the address of applicants).

Table 25 - Diversification Index, FP7 Thematic Priorities
European Patent Office (by Applicant)

AREA	2000-2004	2005-2009	Trend (%)
EU27	4.174	4.590	9.97
CANDIDATE	1.386	1.412	1.88
EFTA	2.023	2.025	0.1
ERA	4.308	4.954	15
ASIA	2.559	2.222	-13.17
USA	3.271	3.116	-4.74

Table 26 - Diversification Index, FP7 Thematic Priorities
World Intellectual Property Organization (by Applicant)

AREA	2000-2004	2005-2009	Trend (%)
EU27	4.460	3.985	-10.65
CANDIDATE	1.214	1.567	29.08
EFTA	2.115	1.927	-8.89
ERA	4.447	4.149	-6.7
ASIA	2.921	2.901	-0.68
USA	4.331	3.884	-10.32

Results indicate that EU-27 and ERA are characterized by a relatively low degree of concentration of technological specialisation; they present in fact higher values of the technological diversification index than any other world area. Moreover, the values of the diversification index for the ERA remain fairly stable. By looking at the sign of the variation is interesting to note that WIPO and EPO exhibit opposite signs. This could be due to different patenting strategies, depending on the destination office.

Regarding the US, we observe quite contrasting patterns at the EPO and at WIPO. As far as the former is concerned, we observe that DIV values are significantly lower than for the ERA; this evidence suggests that the spread of innovative activities across different technological fields is lower compared to European Countries. Moreover, the United States exhibit a decline of the diversification index over time. On the contrary, if one looks at WIPO, the value of the DIV index is comparable to the one for ERA. The decreasing trend, i.e. concentration of the innovative activity, is confirmed.

As far as Asia is concerned, the value of the diversification index is lower than the one observed for both ERA and United States, thereby indicating that this area is strongly focusing its technological efforts on a relatively reduced number of technological areas, such as nanosciences, nanotechnologies and information and communications technologies (ICT). In addition to that, it is worth noting that the value of the DIV index reduces over time thus suggesting a process of increasing technological concentration in few technological fields.

Tables 27 and 28 report the value of the diversification index when patents are classified according to IPC 35 technology fields. In a similar way, Tables 29 and 30 report the value of the diversification index when patents are classified according to NACE sectors. Since the results obtained are similar to the ones observed when classifying patents on the basis of FP7 Thematic Priorities, we summarise them shortly:

- the trends of the index for all offices and classifications are on average negative, meaning that at the world level all the geographical areas under consideration tend to concentrate the innovative activities around few fields;
- ERA shows relatively higher values of the diversification index compared to other areas, especially when patents are classified into 35 fields and EPO patents are considered. However, contrary to what observed for Thematic Priorities at the EPO level, the values of the DIV index show a slight decreasing trend suggesting a reduction in the extent of diversification of technological specialisations, hence confirming the results for Thematic Priorities at the WIPO level;
- Asia presents very low values of the diversification index, irrespectively, to some extent, of the classification adopted and the patent system considered. Moreover, these values tend to decrease slightly over time, except for the case of NACE classification at the WIPO level. These findings confirm that the relative technological advantage of Asia is concentrating in a relatively low number of technological fields and industries;

- The patterns observed for the United States confirm the results of the FP7 thematic priorities: the breadth of the patenting activity is somehow located between Asia and the ERA area. US diversification index is consistent across the two patent systems considered here, but tend to be substantially higher for the WIPO than for the EPO. This is probably due to the differential strategies adopted by US firms with respect to seeking patent protection in different markets. Consistently to what observed at the general level, the trend over time is decreasing.

Finally, the values of the DIV index for each patent classification, for the two subperiods considered, for the two patent systems considered and for each of the 42 countries are reported in Tables 31 to 36.

Table 27 - Diversification Index, IPC 35 technology fields
European Patent Office (by Applicant)

AREA	2000-2004	2005-2009	Trend (%)
EU27	4.386	4.272	-2.6
CANDIDATE	0.624	0.639	2.4
EFTA	2.197	1.962	-10.7
ERA	4.414	4.259	-3.51
ASIA	2.555	2.085	-18.4
United States	3.055	2.882	-5.66

Table 28 - Diversification Index, IPC 35 technology fields
World Intellectual Property Organization (by Applicant)

AREA	2000-2004	2005-2009	Trend (%)
EU27	4.556	3.926	-13.83
CANDIDATE	0.713	0.653	-8.42
EFTA	2.528	2.125	-15.94
ERA	4.546	3.879	-14.67
ASIA	2.925	3.156	7.9
United States	3.941	3.336	-15.35

Table 29 - Diversification Index, NACE Classification
European Patent Office (by Applicant)

AREA	2000-2004	2005-2009	Trend (%)
EU27	4.291	4.138	-3.57
CANDIDATE	1.145	1.021	-10.83
EFTA	2.158	1.951	-9.59
ERA	4.330	4.161	-3.9
ASIA	2.441	2.100	-13.97
United States	3.445	3.147	-8.65

Table 30 - Diversification Index, NACE Classification
World Intellectual Property Organization (by Applicant)

AREA	2000-2004	2005-2009	Trend (%)
EU27	3.883	3.560	-8.32
CANDIDATE	1.175	1.014	-13.7
EFTA	2.096	2.078	-0.86
ERA	3.963	3.572	-9.87
ASIA	3.113	3.129	0.51
United States	4.265	3.408	-20.09

Table 31 - Diversification index - FP7 Thematic Priorities
European Patent Office (by Applicant)

Country	2000-2004	2005-2009	Trend (%)
Austria	1.199	1.530	27.61
Belgium	2.071	1.829	-11.69
Bulgaria	0.963	3.095	221.39
Cyprus	0.473	0.683	44.4
Czech Republic	1.727	1.966	13.84
Denmark	1.367	1.448	5.93
Estonia	1.476	1.838	24.53
Finland	1.251	1.433	14.55
France	1.862	1.315	-29.38
Germany	2.785	2.927	5.1
Greece	1.421	1.680	18.23
Hungary	1.535	1.649	7.43
Ireland	1.805	2.191	21.39
Italy	1.407	1.520	8.03
Latvia	1.586	1.772	11.73
Lithuania	0.576	1.100	90.97
Luxembourg	1.427	1.550	8.62
Malta	0.810	0.698	-13.83
Netherlands	2.204	2.077	-5.76
Poland	1.860	1.665	-10.48
Portugal	1.169	1.567	34.05
Romania	0.927	1.777	91.69
Slovakia	1.338	1.140	-14.8
Slovenia	1.319	1.290	-2.2
Spain	1.638	1.725	5.31
Sweden	2.921	1.970	-32.56
United Kingdom	2.922	2.325	-20.43
Croatia	0.983	1.603	63.07
Macedonia			.
Turkey	1.221	1.318	7.94
Iceland	0.795	0.653	-17.86
Liechtenstein	1.062	1.026	-3.39
Norway	1.385	1.135	-18.05
Switzerland	1.937	1.944	0.36
Israel	1.667	1.767	6
China	2.155	1.174	-45.52
India	0.942	0.965	2.44
Japan	2.540	2.193	-13.66
South Korea	1.473	1.323	-10.18
Brazil	2.290	1.354	-40.87
Russian Federation	0.826	1.347	63.08
United States	3.271	3.116	-4.74

Table 32 - Diversification index - FP7 Thematic Priorities
World Intellectual Property Organization (by Applicant)

Country	2000-2004	2005-2009	Trend (%)
Austria	1.772	2.019	13.94
Belgium	2.209	1.948	-11.82
Bulgaria	1.427	1.410	-1.19
Cyprus	0.355	0.801	125.63
Czech Republic	1.697	2.532	49.2
Denmark	1.956	1.623	-17.02
Estonia	1.640	1.430	-12.8
Finland	1.479	1.622	9.67
France	2.729	1.320	-51.63
Germany	2.179	2.141	-1.74
Greece	1.254	2.044	63
Hungary	2.366	3.095	30.81
Ireland	2.968	2.259	-23.89
Italy	1.692	1.748	3.31
Latvia	0.612	1.495	144.28
Lithuania	0.702	1.762	151
Luxembourg	0.845	1.436	69.94
Malta	0.934	1.737	85.97
Netherlands	2.178	2.390	9.73
Poland	1.594	2.101	31.81
Portugal	2.034	1.821	-10.47
Romania	0.856	1.092	27.57
Slovakia	1.243	1.885	51.65
Slovenia	1.314	1.494	13.7
Spain	1.776	1.763	-0.73
Sweden	2.538	2.045	-19.42
United Kingdom	3.658	2.895	-20.86
Croatia	0.798	1.599	100.38
Macedonia	1.375	0.735	-46.55
Turkey	1.143	1.358	18.81
Iceland	1.079	0.717	-33.55
Liechtenstein	1.635	0.795	-51.38
Norway	0.950	0.865	-8.95
Switzerland	2.427	2.083	-14.17
Israel	1.928	2.109	9.39
China	1.987	1.597	-19.63
India	1.118	1.606	43.65
Japan	2.431	2.330	-4.15
South Korea	3.330	2.304	-30.81
Brazil	2.525	1.989	-21.23
Russian Federation	1.052	2.021	92.11
United States	4.331	3.884	-10.32

Table 33 - Diversification index - IPC 35 technology fields

European Patent Office (by Applicant)

Country	2000-2004	2005-2009	Trend (%)
Austria	1.304	1.593	22.16
Belgium	1.773	1.718	-3.1
Bulgaria	1.023	1.678	64.03
Cyprus	1.209	1.335	10.42
Czech Republic	1.224	1.533	25.25
Denmark	1.075	1.254	16.65
Estonia	1.522	0.925	-39.22
Finland	1.025	1.179	15.02
France	3.207	2.594	-19.11
Germany	2.649	2.479	-6.42
Greece	1.279	1.280	0.08
Hungary	0.963	1.282	33.13
Ireland	1.003	1.050	4.69
Italy	1.496	1.456	-2.67
Latvia	1.250	0.740	-40.8
Lithuania	1.079	1.048	-2.87
Luxembourg	1.311	1.356	3.43
Malta	1.039	0.848	-18.38
Netherlands	1.662	1.817	9.33
Poland	1.275	1.238	-2.9
Portugal	1.108	1.583	42.87
Romania	0.862	1.429	65.78
Slovakia	1.454	1.075	-26.07
Slovenia	1.022	0.646	-36.79
Spain	1.345	1.691	25.72
Sweden	1.858	1.373	-26.1
United Kingdom	2.842	2.894	1.83
Croatia	0.802	1.240	54.61
Macedonia			.
Turkey	0.565	0.596	5.49
Iceland	0.733	0.762	3.96
Liechtenstein	0.674	0.649	-3.71
Norway	1.579	1.165	-26.22
Switzerland	2.077	1.873	-9.82
Israel	1.520	1.504	-1.05
China	1.262	0.689	-45.4
India	0.582	0.596	2.41
Japan	2.472	2.038	-17.56
South Korea	1.133	1.114	-1.68
Brazil	1.347	1.140	-15.37
Russian Federation	1.681	1.299	-22.72
United States	3.055	2.882	-5.66

Table 34 - Diversification index - IPC 35 technology fields

World Intellectual Property Organization (by Applicant)

Country	2000-2004	2005-2009	Trend (%)
Austria	1.861	2.043	9.78
Belgium	1.554	1.641	5.6
Bulgaria	1.322	1.099	-16.87
Cyprus	1.148	1.470	28.05
Czech Republic	1.460	1.468	0.55
Denmark	1.606	1.432	-10.83
Estonia	1.374	1.163	-15.36
Finland	1.035	1.193	15.27
France	3.784	3.056	-19.24
Germany	2.237	2.103	-5.99
Greece	1.407	1.533	8.96
Hungary	1.648	1.725	4.67
Ireland	2.032	2.162	6.4
Italy	1.596	1.625	1.82
Latvia	1.134	0.943	-16.84
Lithuania	0.788	0.979	24.24
Luxembourg	0.829	1.032	24.49
Malta	1.416	1.170	-17.37
Netherlands	1.335	2.161	61.87
Poland	1.477	1.671	13.13
Portugal	1.616	1.794	11.01
Romania	0.999	1.228	22.92
Slovakia	1.159	1.529	31.92
Slovenia	0.924	0.837	-9.42
Spain	1.468	1.903	29.63
Sweden	1.976	1.708	-13.56
United Kingdom	3.295	3.162	-4.04
Croatia	0.926	1.343	45.03
Macedonia	1.032	1.368	32.56
Turkey	0.572	0.589	2.97
Iceland	0.966	0.902	-6.63
Liechtenstein	1.202	0.891	-25.87
Norway	1.281	1.081	-15.61
Switzerland	2.246	1.899	-15.45
Israel	1.889	1.984	5.03
China	1.578	0.898	-43.09
India	0.645	0.758	17.52
Japan	2.441	2.189	-10.32
South Korea	1.660	1.887	13.67
Brazil	0.265	0.936	253.21
Russian Federation	1.845	2.035	10.3
United States	3.941	3.336	-15.35

Table 35 - Diversification index - NACE classification

European Patent Office (by Applicant)

Country	2000-2004	2005-2009	Trend (%)
Austria	1.461	1.691	15.74
Belgium	1.589	1.496	-5.85
Bulgaria	0.879	2.497	184.07
Cyprus	1.245	1.114	-10.52
Czech Republic	1.747	1.666	-4.64
Denmark	1.016	1.345	32.38
Estonia	1.079	1.245	15.38
Finland	1.180	1.493	26.53
France	2.722	3.041	11.72
Germany	2.665	2.578	-3.26
Greece	1.723	1.427	-17.18
Hungary	1.238	1.160	-6.3
Ireland	0.922	0.865	-6.18
Italy	1.768	1.775	0.4
Latvia		1.150	.
Lithuania	0.873	1.051	20.39
Luxembourg	1.752	1.295	-26.08
Malta	0.749	0.595	-20.56
Netherlands	1.601	1.530	-4.43
Poland	1.487	1.357	-8.74
Portugal	1.474	1.496	1.49
Romania	0.929	1.251	34.66
Slovakia	1.345	1.104	-17.92
Slovenia	1.210	0.661	-45.37
Spain	1.620	1.734	7.04
Sweden	2.019	1.451	-28.13
United Kingdom	3.352	3.082	-8.05
Croatia	1.090	1.529	40.28
Macedonia			.
Turkey	0.945	0.943	-0.21
Iceland	0.906	0.696	-23.18
Liechtenstein	1.120	1.217	8.66
Norway	1.491	1.481	-0.67
Switzerland	2.106	1.880	-10.73
Israel	1.364	1.424	4.4
China	1.846	0.908	-50.81
India	0.642	0.667	3.89
Japan	2.449	2.380	-2.82
South Korea	1.288	0.930	-27.8
Brazil	1.169	1.652	41.32
Russian Federation	1.646	2.080	26.37
United States	3.445	3.147	-8.65

Table 36 - Diversification index - NACE classification

World Intellectual Property Organization (by Applicant)

Country	2000-2004	2005-2009	Trend (%)
Austria	1.890	1.953	3.33
Belgium	1.667	1.655	-0.72
Bulgaria	1.499	0.993	-33.76
Cyprus	1.074	1.314	22.35
Czech Republic	1.882	2.047	8.77
Denmark	1.458	1.567	7.48
Estonia	1.675	1.227	-26.75
Finland	1.286	1.630	26.75
France	3.167	2.165	-31.64
Germany	2.044	2.058	0.68
Greece	1.530	1.713	11.96
Hungary	2.128	2.095	-1.55
Ireland	2.059	1.967	-4.47
Italy	1.774	1.757	-0.96
Latvia	1.124	1.099	-2.22
Lithuania	0.764	0.956	25.13
Luxembourg	1.092	1.381	26.47
Malta	1.193	1.292	8.3
Netherlands	1.620	1.865	15.12
Poland	1.660	1.954	17.71
Portugal	1.258	1.958	55.64
Romania	1.221	1.778	45.62
Slovakia	1.373	1.858	35.32
Slovenia	1.175	1.324	12.68
Spain	1.629	1.696	4.11
Sweden	1.991	1.732	-13.01
United Kingdom	3.902	3.424	-12.25
Croatia	0.886	1.675	89.05
Macedonia	0.844	0.901	6.75
Turkey	0.932	0.901	-3.33
Iceland	1.266	1.159	-8.45
Liechtenstein	1.383	1.151	-16.78
Norway	1.074	1.104	2.79
Switzerland	2.066	2.001	-3.15
Israel	1.823	1.810	-0.71
China	2.076	1.260	-39.31
India	0.803	1.030	28.27
Japan	2.483	2.371	-4.51
South Korea	2.815	2.455	-12.79
Brazil	1.409	1.793	27.25
Russian Federation	1.800	2.215	23.06
United States	4.265	3.408	-20.09

4. SIMILARITIES AND DIFFERENCES IN PATTERNS OF SPECIALISATION

In this section, we examine the extent to which pairs of countries display similar or different patterns of technological specialisation. To this purpose, we use an indicator that has been widely used in the economic literature. The indicator measures the similarity between the distribution of patents of two countries across fields by computing the cosine of the angle between the two corresponding vectors. More precisely, for each country we computed the vector that represents the distribution of its patents across technological fields

$$F_i = (F_{i1}, F_{i2}, F_{i3} \ldots . F_{ik},)$$

where each entry denotes the share of country *i* in technology *j*. The cosine proximity (or angular distance) between the vectors representing the distribution of patents for a pair of countries, *i* and *j*, is defined as:

$$C_{ij} = \frac{F_i' F_j}{\sqrt{(F_i' F_i)(F_j' F_j)}}$$

The proximity index ranges between zero and one. It takes value one when countries *i* and *j* have exactly the same percentage distribution of patents across technological fields, while it takes value zero when the two countries patent in completely different fields.

Moreover, in order to detect changes in the patterns of specialisation, the value of cosine indexes has been calculated for two sub-periods, i.e. 2000-2004 and 2005-2009. The choice of these two subperiods is coherent with the choice made for the diversification index. Finally, the value of cosine index has been calculated only with reference to the EPO and the WIPO.

The application of the method described above yields a number of matrices (by patent system and classification of patents), whose cells report the values of the proximity index for pairs of countries. Since, reporting all matrices for the combination of analytical dimensions involved might be quite cumbersome, for each of the 42 countries we have computed the average proximity (as well as its standard deviation) with all other countries. Moreover, for each country, we have also calculated the value of the cosine

index by comparing its distribution of patents with the distribution of patents of broad geographical areas. This indicates to what extent the pattern of specialisation of a country (e.g. Italy) is similar or dissimilar to the pattern of specialisation of a broader geographical entity (e.g. EU27). This information is reported in Tables 37 to 48. A few interesting points can be observed.

First, the data confirm that the different patterns of specialisation between ERA/EU27, Asia and the US became even more dissimilar in the period 2000-2009. The value of the cosine index between EU27/ERA and Asia takes value decrease independently of the type of classification and the patent office considered. On average the value of the cosine index ERA – Asia decreased by 0.04 between 2000-04 and 2005-09, ranging from -0.2 (EPO – FP Thematic Priorities) to -0.05 (Wipo – IPC35 and Nace). Even though the absolute change is not large, the trend is worth being noted. Looking more in detail, it is also interesting to note that this trend is at least partly driven by the decrease in the value of the proximity index between China and EU27 (average decrease 0.24; range -0.19 : -0.27). South Korea and Japan showed similar trend even if with smaller variation. India is the only Asian country converging toward Europe in terms of patent portfolio. Within the ERA, the countries displaying the lower values of the cosine index with Asia are the EFTA and, especially, the Candidate countries.

The similarity index between EU27/ERA and US shows an analogous trend: on average it decreased by 0.17, a small variation but highly consistent across patent offices and classification systems. As far as individual countries are concerned, the case of Finland is worth being mentioned. Specifically, we notice that the pattern of specialisation of this country tends to get more dissimilar to the patterns of specialisation of the EU27 and ERA. Once again, this trend is visible at all levels, i.e. for the various combinations of patent system and patent classification. It is interesting to note that the divergence showed by Finland patent activity is more pronounced for the WIPO (average –0.04) than the EPO (average –0.006).

Table 37 - Technological similarity, FP7 Thematic Priorities, 2000-2004
European Patent Office (by Applicant)

Area	All countries (average)	All countries (std. dev.)	EU27	Candidate	EFTA	ERA	Asia	WORLD
Austria	0.79	0.15	0.91	0.95	0.93	0.92	0.69	0.83
Belgium	0.81	0.11	0.93	0.85	0.96	0.94	0.8	0.91
Bulgaria	0.73	0.13	0.79	0.85	0.87	0.8	0.58	0.73
Cyprus	0.84	0.1	0.97	0.86	0.95	0.98	0.87	0.97
Czech Republic	0.8	0.15	0.89	0.94	0.95	0.91	0.66	0.82
Denmark	0.8	0.13	0.83	0.86	0.95	0.85	0.65	0.82
Estonia	0.69	0.14	0.73	0.65	0.83	0.74	0.64	0.77
Finland	0.55	0.21	0.78	0.43	0.55	0.76	0.94	0.85
France	0.78	0.13	0.99	0.79	0.86	0.98	0.96	0.98
Germany	0.8	0.13	0.98	0.89	0.92	0.98	0.85	0.93
Greece	0.8	0.13	0.93	0.95	0.93	0.94	0.73	0.86
Hungary	0.74	0.17	0.74	0.75	0.91	0.76	0.58	0.76
Ireland	0.75	0.15	0.81	0.68	0.88	0.82	0.75	0.87
Italy	0.76	0.16	0.91	0.96	0.89	0.92	0.71	0.83
Latvia	0.81	0.11	0.87	0.88	0.95	0.88	0.73	0.87
Lithuania	0.58	0.16	0.66	0.73	0.66	0.66	0.49	0.59
Luxembourg	0.81	0.11	0.91	0.83	0.94	0.92	0.8	0.92
Malta	0.75	0.15	0.88	0.89	0.88	0.89	0.66	0.8
Netherlands	0.65	0.18	0.87	0.55	0.68	0.86	0.98	0.92
Poland	0.8	0.13	0.9	0.87	0.94	0.91	0.71	0.85
Portugal	0.8	0.13	0.87	0.93	0.94	0.88	0.64	0.81
Romania	0.75	0.13	0.79	0.8	0.85	0.8	0.62	0.77
Slovakia	0.74	0.16	0.87	0.9	0.89	0.88	0.67	0.79
Slovenia	0.77	0.15	0.78	0.87	0.93	0.8	0.56	0.76
Spain	0.81	0.13	0.92	0.95	0.95	0.93	0.7	0.85
Sweden	0.75	0.14	0.92	0.7	0.82	0.91	0.94	0.97
United Kingdom	0.83	0.1	0.96	0.82	0.96	0.96	0.88	0.98
EU27	0.82	0.12	1	0.86	0.92	1	0.92	0.98
Croatia	0.63	0.19	0.57	0.68	0.78	0.59	0.39	0.6
Macedonia	0.49	0.22	0.62	0.8	0.6	0.63	0.4	0.5
Turkey	0.69	0.18	0.83	0.96	0.8	0.84	0.62	0.73
CANDIDATE	0.77	0.15	0.86	1	0.9	0.87	0.63	0.78
Iceland	0.55	0.21	0.48	0.49	0.7	0.5	0.36	0.54
Liechtenstein	0.74	0.17	0.87	0.95	0.89	0.87	0.62	0.77
Norway	0.82	0.11	0.93	0.82	0.94	0.94	0.81	0.92
Switzerland	0.83	0.12	0.92	0.9	1	0.93	0.74	0.89
EFTA	0.83	0.11	0.92	0.9	1	0.93	0.74	0.9
Israel	0.72	0.15	0.77	0.65	0.83	0.78	0.75	0.85
ERA	0.82	0.11	1	0.87	0.93	1	0.91	0.98
China	0.73	0.14	0.92	0.71	0.78	0.91	0.97	0.96
India	0.61	0.2	0.58	0.53	0.76	0.59	0.48	0.64
Japan	0.71	0.16	0.93	0.64	0.76	0.92	1	0.96
South Korea	0.56	0.21	0.79	0.46	0.55	0.77	0.95	0.86
ASIA	0.7	0.17	0.92	0.63	0.74	0.91	1	0.96
Brazil	0.79	0.13	0.89	0.97	0.93	0.9	0.69	0.84
Russian Federation	0.81	0.12	0.88	0.82	0.97	0.89	0.74	0.88
United States	0.78	0.13	0.92	0.7	0.88	0.92	0.92	0.97
WORLD	0.8	0.12	0.98	0.78	0.9	0.98	0.96	1

Table 38 - Technological similarity, FP7 Thematic Priorities, 2005-2009
European Patent Office (by Applicant)

Area	All countries (average)	All countries (std. dev.)	EU27	Candidate	EFTA	ERA	Asia	WORLD
Austria	0.77	0.15	0.95	0.94	0.91	0.95	0.73	0.87
Belgium	0.81	0.1	0.95	0.84	0.93	0.96	0.81	0.93
Bulgaria	0.81	0.1	0.98	0.89	0.89	0.98	0.9	0.97
Cyprus	0.82	0.1	0.98	0.85	0.91	0.98	0.9	0.98
Czech Republic	0.79	0.14	0.93	0.87	0.94	0.94	0.71	0.87
Denmark	0.78	0.13	0.85	0.8	0.94	0.87	0.65	0.83
Estonia	0.73	0.11	0.8	0.62	0.86	0.82	0.69	0.82
Finland	0.58	0.19	0.76	0.57	0.53	0.74	0.96	0.85
France	0.78	0.12	0.97	0.85	0.82	0.96	0.97	0.99
Germany	0.78	0.14	0.98	0.95	0.9	0.98	0.81	0.91
Greece	0.81	0.13	0.94	0.88	0.96	0.95	0.73	0.89
Hungary	0.75	0.16	0.77	0.66	0.94	0.79	0.57	0.77
Ireland	0.76	0.1	0.81	0.63	0.86	0.82	0.81	0.89
Italy	0.75	0.16	0.94	0.98	0.89	0.94	0.71	0.85
Latvia	0.74	0.1	0.83	0.65	0.85	0.84	0.76	0.86
Lithuania	0.77	0.11	0.87	0.82	0.93	0.88	0.69	0.85
Luxembourg	0.82	0.08	0.95	0.85	0.91	0.96	0.87	0.96
Malta	0.71	0.14	0.84	0.77	0.83	0.84	0.64	0.78
Netherlands	0.79	0.1	0.94	0.77	0.84	0.94	0.96	0.98
Poland	0.8	0.13	0.94	0.89	0.93	0.94	0.74	0.88
Portugal	0.8	0.14	0.9	0.83	0.97	0.91	0.67	0.85
Romania	0.78	0.13	0.96	0.95	0.9	0.96	0.82	0.92
Slovakia	0.71	0.17	0.93	0.94	0.82	0.92	0.75	0.84
Slovenia	0.67	0.18	0.65	0.54	0.87	0.68	0.48	0.68
Spain	0.82	0.12	0.94	0.88	0.98	0.95	0.73	0.9
Sweden	0.67	0.15	0.82	0.64	0.66	0.81	0.96	0.9
United Kingdom	0.83	0.08	0.97	0.85	0.95	0.97	0.88	0.98
EU27	0.82	0.11	1	0.92	0.91	1	0.9	0.98
Croatia	0.76	0.15	0.79	0.73	0.94	0.81	0.6	0.79
Macedonia	.	.	.	.	.	.	.	.
Turkey	0.71	0.16	0.91	1	0.82	0.91	0.74	0.84
CANDIDATE	0.73	0.15	0.92	1	0.85	0.92	0.75	0.85
Iceland	0.55	0.2	0.48	0.37	0.73	0.51	0.35	0.54
Liechtenstein	0.72	0.15	0.84	0.89	0.91	0.86	0.59	0.78
Norway	0.75	0.12	0.86	0.74	0.87	0.86	0.68	0.82
Switzerland	0.81	0.12	0.91	0.85	1	0.93	0.71	0.89
EFTA	0.81	0.12	0.91	0.85	1	0.93	0.71	0.89
Israel	0.73	0.11	0.77	0.61	0.86	0.78	0.74	0.84
ERA	0.82	0.11	1	0.92	0.93	1	0.89	0.98
China	0.53	0.2	0.67	0.5	0.46	0.66	0.92	0.79
India	0.63	0.18	0.6	0.42	0.79	0.62	0.49	0.65
Japan	0.75	0.13	0.94	0.79	0.77	0.93	0.99	0.97
South Korea	0.59	0.19	0.77	0.63	0.54	0.75	0.96	0.85
ASIA	0.71	0.15	0.9	0.75	0.71	0.89	1	0.95
Brazil	0.78	0.15	0.89	0.86	0.94	0.9	0.67	0.84
Russian Federation	0.8	0.12	0.86	0.73	0.96	0.87	0.71	0.87
United States	0.8	0.08	0.91	0.74	0.89	0.91	0.91	0.97
WORLD	0.82	0.09	0.98	0.85	0.89	0.98	0.95	1

Table 39 - Technological similarity, FP7 Thematic Priorities, 2000-2004
World Intellectual Property Organization (by Applicant)

Area	All countries (average)	All countries (std. dev.)	EU27	Candidate	EFTA	ERA	Asia	WORLD
Austria	0.87	0.08	0.96	0.94	0.96	0.97	0.88	0.92
Belgium	0.81	0.1	0.88	0.76	0.94	0.88	0.83	0.87
Bulgaria	0.83	0.1	0.89	0.97	0.91	0.89	0.78	0.84
Cyprus	0.86	0.07	0.94	0.93	0.94	0.94	0.86	0.91
Czech Republic	0.84	0.11	0.9	0.94	0.95	0.9	0.79	0.84
Denmark	0.84	0.09	0.88	0.85	0.96	0.89	0.8	0.88
Estonia	0.78	0.07	0.86	0.78	0.87	0.86	0.79	0.86
Finland	0.67	0.15	0.86	0.57	0.66	0.85	0.92	0.88
France	0.87	0.07	1	0.84	0.94	1	0.97	0.99
Germany	0.86	0.07	0.98	0.88	0.94	0.98	0.93	0.95
Greece	0.85	0.09	0.91	0.96	0.93	0.92	0.8	0.87
Hungary	0.86	0.08	0.93	0.83	0.98	0.93	0.86	0.93
Ireland	0.81	0.09	0.92	0.71	0.91	0.92	0.9	0.96
Italy	0.84	0.1	0.91	0.97	0.94	0.92	0.79	0.85
Latvia	0.81	0.11	0.84	0.84	0.95	0.85	0.74	0.83
Lithuania	0.76	0.11	0.8	0.9	0.8	0.8	0.69	0.74
Luxembourg	0.8	0.1	0.89	0.75	0.93	0.9	0.84	0.87
Malta	0.74	0.11	0.8	0.81	0.86	0.81	0.69	0.75
Netherlands	0.69	0.14	0.87	0.57	0.69	0.86	0.94	0.9
Poland	0.86	0.09	0.94	0.94	0.95	0.94	0.85	0.89
Portugal	0.87	0.09	0.94	0.93	0.97	0.95	0.86	0.9
Romania	0.85	0.08	0.92	0.9	0.92	0.92	0.84	0.89
Slovakia	0.83	0.1	0.89	0.89	0.91	0.9	0.83	0.85
Slovenia	0.83	0.11	0.86	0.93	0.95	0.87	0.74	0.83
Spain	0.86	0.09	0.93	0.94	0.97	0.93	0.82	0.89
Sweden	0.82	0.09	0.96	0.75	0.86	0.96	0.96	0.98
United Kingdom	0.87	0.07	0.98	0.82	0.96	0.98	0.95	0.99
EU27	0.87	0.07	1	0.85	0.94	1	0.97	0.99
Croatia	0.81	0.1	0.84	0.89	0.93	0.85	0.71	0.82
Macedonia	0.69	0.15	0.75	0.92	0.7	0.75	0.64	0.66
Turkey	0.75	0.14	0.8	0.98	0.8	0.81	0.67	0.71
CANDIDATE	0.8	0.12	0.85	1	0.88	0.86	0.71	0.78
Iceland	0.69	0.12	0.73	0.55	0.81	0.74	0.7	0.79
Liechtenstein	0.84	0.09	0.93	0.92	0.94	0.94	0.85	0.88
Norway	0.84	0.07	0.93	0.85	0.92	0.93	0.86	0.9
Switzerland	0.86	0.09	0.92	0.87	1	0.93	0.84	0.91
EFTA	0.87	0.08	0.94	0.88	1	0.95	0.86	0.93
Israel	0.75	0.12	0.87	0.63	0.83	0.87	0.87	0.93
ERA	0.88	0.07	1	0.86	0.95	1	0.96	0.99
China	0.8	0.1	0.93	0.72	0.82	0.92	0.95	0.95
India	0.67	0.14	0.72	0.56	0.84	0.73	0.69	0.75
Japan	0.8	0.1	0.96	0.7	0.85	0.96	1	0.97
South Korea	0.79	0.1	0.95	0.73	0.81	0.95	0.97	0.96
ASIA	0.81	0.09	0.97	0.71	0.86	0.96	1	0.98
Brazil	0.86	0.09	0.92	0.96	0.96	0.93	0.82	0.88
Russian Federation	0.87	0.07	0.97	0.85	0.97	0.97	0.93	0.96
United States	0.82	0.1	0.95	0.7	0.9	0.95	0.95	0.99
WORLD	0.85	0.08	0.99	0.78	0.93	0.99	0.98	1

Table 40 - Technological similarity, FP7 Thematic Priorities, 2005-2009
World Intellectual Property Organization (by Applicant)

Area	All countries (average)	All countries (std. dev.)	EU27	Candidate	EFTA	ERA	Asia	WORLD
Austria	0.85	0.1	0.98	0.94	0.94	0.98	0.84	0.91
Belgium	0.82	0.09	0.92	0.74	0.93	0.92	0.81	0.88
Bulgaria	0.81	0.1	0.94	0.81	0.83	0.94	0.91	0.93
Cyprus	0.84	0.09	0.96	0.86	0.91	0.96	0.86	0.91
Czech Republic	0.85	0.1	0.95	0.85	0.97	0.96	0.8	0.9
Denmark	0.83	0.1	0.88	0.79	0.94	0.89	0.73	0.86
Estonia	0.8	0.09	0.89	0.64	0.82	0.88	0.9	0.93
Finland	0.66	0.17	0.79	0.55	0.59	0.78	0.96	0.89
France	0.86	0.08	0.99	0.83	0.9	0.99	0.95	0.99
Germany	0.83	0.11	0.97	0.93	0.92	0.97	0.84	0.9
Greece	0.87	0.1	0.94	0.87	0.98	0.95	0.78	0.9
Hungary	0.88	0.06	0.96	0.78	0.95	0.96	0.89	0.97
Ireland	0.84	0.07	0.9	0.7	0.91	0.9	0.85	0.94
Italy	0.83	0.11	0.94	0.97	0.95	0.95	0.76	0.86
Latvia	0.73	0.14	0.74	0.58	0.87	0.75	0.6	0.74
Lithuania	0.82	0.11	0.92	0.9	0.93	0.92	0.75	0.85
Luxembourg	0.84	0.11	0.9	0.8	0.97	0.91	0.73	0.86
Malta	0.85	0.1	0.93	0.86	0.97	0.94	0.77	0.88
Netherlands	0.84	0.09	0.96	0.75	0.85	0.95	0.98	0.99
Poland	0.87	0.09	0.96	0.84	0.97	0.97	0.83	0.92
Portugal	0.87	0.08	0.96	0.82	0.97	0.96	0.84	0.93
Romania	0.77	0.12	0.89	0.71	0.73	0.88	0.95	0.93
Slovakia	0.82	0.11	0.96	0.96	0.9	0.96	0.82	0.88
Slovenia	0.81	0.13	0.87	0.86	0.97	0.88	0.66	0.81
Spain	0.87	0.09	0.95	0.87	0.99	0.95	0.79	0.9
Sweden	0.77	0.12	0.88	0.64	0.73	0.87	0.96	0.95
United Kingdom	0.88	0.06	0.97	0.81	0.95	0.98	0.9	0.98
EU27	0.87	0.08	1	0.88	0.94	1	0.92	0.97
Croatia	0.83	0.11	0.88	0.82	0.96	0.89	0.71	0.85
Macedonia	0.78	0.1	0.84	0.85	0.9	0.85	0.66	0.79
Turkey	0.72	0.14	0.86	1	0.82	0.86	0.67	0.75
CANDIDATE	0.75	0.13	0.88	1	0.86	0.89	0.69	0.78
Iceland	0.66	0.15	0.65	0.52	0.8	0.66	0.49	0.65
Liechtenstein	0.71	0.14	0.74	0.67	0.85	0.75	0.55	0.71
Norway	0.77	0.1	0.86	0.74	0.85	0.86	0.76	0.82
Switzerland	0.85	0.11	0.93	0.86	1	0.93	0.74	0.87
EFTA	0.86	0.1	0.94	0.86	1	0.95	0.76	0.89
Israel	0.79	0.09	0.85	0.62	0.82	0.85	0.87	0.92
ERA	0.88	0.08	1	0.89	0.95	1	0.91	0.97
China	0.63	0.17	0.74	0.48	0.54	0.73	0.93	0.86
India	0.76	0.11	0.8	0.55	0.87	0.8	0.72	0.82
Japan	0.81	0.11	0.95	0.73	0.81	0.94	0.99	0.97
South Korea	0.76	0.13	0.9	0.71	0.73	0.89	0.98	0.95
ASIA	0.79	0.12	0.92	0.69	0.76	0.91	1	0.97
Brazil	0.83	0.12	0.93	0.92	0.96	0.93	0.73	0.84
Russian Federation	0.87	0.08	0.97	0.84	0.97	0.97	0.85	0.94
United States	0.85	0.07	0.93	0.71	0.88	0.93	0.93	0.98
WORLD	0.86	0.08	0.97	0.78	0.89	0.97	0.97	1

Table 41 - Technological similarity, IPC 35 technology fields, 2000-2004
European Patent Office (by Applicant)

Area	All countries (average)	All countries (std. dev.)	EU27	Candidate	EFTA	ERA	Asia	WORLD
Austria	0.69	0.17	0.87	0.74	0.84	0.88	0.65	0.8
Belgium	0.69	0.16	0.83	0.69	0.87	0.84	0.69	0.84
Bulgaria	0.61	0.15	0.75	0.66	0.79	0.76	0.51	0.69
Cyprus	0.61	0.15	0.79	0.63	0.77	0.79	0.63	0.78
Czech Republic	0.67	0.18	0.83	0.71	0.82	0.84	0.59	0.77
Denmark	0.7	0.17	0.78	0.67	0.92	0.8	0.6	0.81
Estonia	0.53	0.16	0.62	0.43	0.78	0.64	0.49	0.69
Finland	0.38	0.22	0.63	0.22	0.42	0.61	0.69	0.66
France	0.68	0.17	0.97	0.59	0.79	0.96	0.89	0.95
Germany	0.67	0.18	0.97	0.58	0.83	0.97	0.81	0.91
Greece	0.68	0.16	0.87	0.65	0.83	0.88	0.71	0.83
Hungary	0.61	0.21	0.64	0.67	0.76	0.66	0.46	0.67
Ireland	0.67	0.17	0.76	0.64	0.86	0.78	0.62	0.83
Italy	0.67	0.17	0.91	0.71	0.86	0.91	0.68	0.83
Latvia	0.57	0.19	0.64	0.54	0.79	0.66	0.47	0.67
Lithuania	0.36	0.16	0.48	0.23	0.45	0.48	0.36	0.45
Luxembourg	0.68	0.18	0.83	0.7	0.81	0.84	0.67	0.83
Malta	0.58	0.15	0.74	0.64	0.72	0.75	0.58	0.7
Netherlands	0.56	0.18	0.81	0.42	0.68	0.8	0.94	0.87
Poland	0.66	0.17	0.83	0.67	0.82	0.84	0.6	0.78
Portugal	0.68	0.17	0.8	0.72	0.81	0.81	0.5	0.74
Romania	0.56	0.18	0.67	0.53	0.67	0.68	0.43	0.61
Slovakia	0.6	0.16	0.8	0.56	0.76	0.8	0.6	0.73
Slovenia	0.63	0.2	0.67	0.74	0.77	0.69	0.49	0.68
Spain	0.71	0.17	0.9	0.75	0.85	0.9	0.63	0.82
Sweden	0.65	0.17	0.87	0.52	0.77	0.87	0.77	0.89
United Kingdom	0.75	0.16	0.93	0.71	0.94	0.94	0.79	0.95
EU27	0.72	0.17	1	0.64	0.88	1	0.87	0.97
Croatia	0.5	0.23	0.47	0.67	0.6	0.49	0.29	0.5
Macedonia	0.12	0.17	0.12	0.46	0.11	0.12	0.06	0.1
Turkey	0.43	0.15	0.54	0.89	0.49	0.54	0.42	0.49
CANDIDATE	0.57	0.14	0.64	1	0.66	0.65	0.46	0.61
Iceland	0.55	0.2	0.56	0.48	0.79	0.59	0.39	0.63
Liechtenstein	0.48	0.17	0.66	0.36	0.63	0.66	0.47	0.6
Norway	0.72	0.16	0.9	0.65	0.89	0.91	0.68	0.87
Switzerland	0.72	0.17	0.87	0.66	1	0.89	0.69	0.89
EFTA	0.73	0.17	0.88	0.66	1	0.9	0.7	0.9
Israel	0.64	0.18	0.72	0.54	0.86	0.74	0.64	0.83
ERA	0.73	0.17	1	0.65	0.9	1	0.87	0.98
China	0.58	0.16	0.77	0.6	0.66	0.77	0.78	0.82
India	0.48	0.23	0.47	0.56	0.6	0.49	0.34	0.53
Japan	0.58	0.18	0.88	0.43	0.71	0.87	1	0.92
South Korea	0.44	0.21	0.68	0.41	0.47	0.67	0.89	0.74
ASIA	0.59	0.19	0.87	0.46	0.7	0.87	1	0.92
Brazil	0.69	0.17	0.85	0.82	0.86	0.86	0.66	0.82
Russian Federation	0.71	0.16	0.85	0.67	0.92	0.87	0.68	0.87
United States	0.69	0.17	0.87	0.57	0.89	0.88	0.82	0.95
WORLD	0.72	0.16	0.97	0.61	0.9	0.98	0.92	1

Table 42 - Technological similarity, IPC 35 technology fields, 2005-2009
European Patent Office (by Applicant)

Area	All countries (average)	All countries (std. dev.)	EU27	Candidate	EFTA	ERA	Asia	WORLD
Austria	0.66	0.17	0.91	0.66	0.82	0.91	0.66	0.83
Belgium	0.7	0.13	0.84	0.71	0.84	0.85	0.65	0.82
Bulgaria	0.67	0.13	0.85	0.6	0.73	0.85	0.66	0.81
Cyprus	0.67	0.13	0.86	0.74	0.75	0.86	0.75	0.86
Czech Republic	0.68	0.16	0.88	0.59	0.8	0.88	0.6	0.8
Denmark	0.69	0.15	0.81	0.56	0.89	0.83	0.59	0.8
Estonia	0.65	0.14	0.77	0.48	0.81	0.78	0.57	0.76
Finland	0.42	0.21	0.63	0.3	0.41	0.62	0.79	0.71
France	0.68	0.13	0.96	0.58	0.76	0.95	0.9	0.95
Germany	0.66	0.17	0.97	0.61	0.82	0.96	0.76	0.89
Greece	0.68	0.16	0.85	0.54	0.84	0.86	0.57	0.79
Hungary	0.65	0.19	0.67	0.51	0.83	0.7	0.46	0.69
Ireland	0.65	0.13	0.75	0.49	0.83	0.77	0.66	0.84
Italy	0.67	0.17	0.92	0.71	0.83	0.92	0.63	0.82
Latvia	0.49	0.16	0.52	0.39	0.6	0.53	0.42	0.53
Lithuania	0.55	0.15	0.62	0.37	0.74	0.64	0.51	0.66
Luxembourg	0.64	0.15	0.87	0.55	0.76	0.87	0.72	0.85
Malta	0.55	0.16	0.68	0.67	0.69	0.69	0.42	0.6
Netherlands	0.66	0.13	0.89	0.52	0.84	0.89	0.85	0.93
Poland	0.69	0.15	0.87	0.68	0.83	0.87	0.59	0.8
Portugal	0.7	0.17	0.8	0.62	0.84	0.81	0.5	0.75
Romania	0.61	0.13	0.78	0.68	0.74	0.78	0.55	0.73
Slovakia	0.53	0.19	0.81	0.53	0.59	0.8	0.64	0.72
Slovenia	0.53	0.21	0.5	0.43	0.67	0.52	0.33	0.51
Spain	0.73	0.14	0.88	0.65	0.88	0.89	0.62	0.83
Sweden	0.55	0.16	0.76	0.41	0.58	0.75	0.82	0.81
United Kingdom	0.75	0.12	0.95	0.64	0.93	0.96	0.8	0.96
EU27	0.72	0.14	1	0.64	0.87	1	0.84	0.97
Croatia	0.62	0.18	0.64	0.5	0.77	0.66	0.43	0.65
Macedonia	.	.	.	.	.	.	.	.
Turkey	0.46	0.14	0.6	1	0.52	0.61	0.47	0.55
CANDIDATE	0.51	0.14	0.64	1	0.57	0.64	0.49	0.59
Iceland	0.54	0.2	0.54	0.34	0.78	0.57	0.35	0.61
Liechtenstein	0.55	0.15	0.7	0.42	0.74	0.71	0.46	0.65
Norway	0.63	0.17	0.81	0.53	0.78	0.82	0.51	0.73
Switzerland	0.7	0.14	0.85	0.56	1	0.88	0.65	0.87
EFTA	0.71	0.14	0.87	0.57	1	0.89	0.64	0.87
Israel	0.62	0.15	0.7	0.42	0.84	0.72	0.62	0.81
ERA	0.73	0.13	1	0.64	0.89	1	0.83	0.97
China	0.37	0.21	0.53	0.28	0.33	0.52	0.72	0.62
India	0.51	0.22	0.47	0.32	0.64	0.49	0.34	0.51
Japan	0.6	0.15	0.87	0.48	0.69	0.86	0.98	0.92
South Korea	0.43	0.19	0.64	0.47	0.42	0.62	0.92	0.74
ASIA	0.58	0.16	0.84	0.49	0.64	0.83	1	0.91
Brazil	0.69	0.15	0.85	0.62	0.87	0.87	0.6	0.82
Russian Federation	0.71	0.15	0.82	0.57	0.9	0.84	0.63	0.84
United States	0.68	0.13	0.86	0.49	0.87	0.87	0.82	0.95
WORLD	0.72	0.12	0.97	0.59	0.87	0.97	0.91	1

Table 43 - Technological similarity, IPC 35 technology fields, 2000-2004
World Intellectual Property Organization (by Applicant)

Area	All countries (average)	All countries (std. dev.)	EU27	Candidate	EFTA	ERA	Asia	WORLD
Austria	0.78	0.12	0.93	0.75	0.91	0.94	0.84	0.9
Belgium	0.71	0.15	0.84	0.63	0.89	0.85	0.79	0.85
Bulgaria	0.71	0.11	0.84	0.72	0.82	0.84	0.73	0.8
Cyprus	0.73	0.11	0.85	0.73	0.84	0.85	0.7	0.82
Czech Republic	0.75	0.13	0.87	0.82	0.9	0.88	0.75	0.82
Denmark	0.74	0.14	0.85	0.66	0.93	0.86	0.78	0.88
Estonia	0.62	0.1	0.73	0.57	0.77	0.73	0.64	0.76
Finland	0.47	0.16	0.67	0.31	0.49	0.66	0.64	0.66
France	0.79	0.12	0.99	0.7	0.92	0.99	0.92	0.97
Germany	0.75	0.12	0.96	0.66	0.88	0.96	0.88	0.91
Greece	0.76	0.12	0.89	0.76	0.9	0.9	0.76	0.86
Hungary	0.74	0.14	0.85	0.69	0.89	0.86	0.79	0.87
Ireland	0.73	0.13	0.87	0.63	0.91	0.88	0.81	0.93
Italy	0.77	0.12	0.91	0.8	0.94	0.91	0.79	0.87
Latvia	0.68	0.14	0.74	0.74	0.84	0.75	0.64	0.75
Lithuania	0.53	0.13	0.62	0.58	0.62	0.62	0.51	0.58
Luxembourg	0.67	0.13	0.8	0.63	0.78	0.8	0.7	0.77
Malta	0.59	0.13	0.72	0.58	0.72	0.72	0.57	0.64
Netherlands	0.57	0.15	0.79	0.44	0.65	0.78	0.89	0.82
Poland	0.76	0.12	0.9	0.81	0.88	0.9	0.76	0.84
Portugal	0.74	0.13	0.87	0.72	0.89	0.88	0.76	0.83
Romania	0.68	0.13	0.8	0.7	0.77	0.8	0.64	0.74
Slovakia	0.69	0.13	0.82	0.71	0.78	0.82	0.71	0.75
Slovenia	0.66	0.14	0.72	0.73	0.77	0.73	0.67	0.73
Spain	0.77	0.12	0.9	0.81	0.92	0.9	0.76	0.86
Sweden	0.7	0.13	0.9	0.57	0.79	0.9	0.81	0.89
United Kingdom	0.79	0.12	0.96	0.7	0.96	0.97	0.89	0.98
EU27	0.79	0.12	1	0.7	0.93	1	0.93	0.98
Croatia	0.7	0.14	0.77	0.8	0.81	0.78	0.62	0.74
Macedonia	0.41	0.15	0.41	0.75	0.38	0.41	0.35	0.36
Turkey	0.51	0.13	0.54	0.94	0.55	0.55	0.47	0.51
CANDIDATE	0.65	0.12	0.7	1	0.72	0.7	0.59	0.66
Iceland	0.62	0.16	0.72	0.48	0.81	0.73	0.64	0.78
Liechtenstein	0.67	0.12	0.8	0.66	0.78	0.8	0.75	0.77
Norway	0.72	0.13	0.86	0.69	0.83	0.86	0.69	0.8
Switzerland	0.76	0.13	0.9	0.69	0.99	0.91	0.81	0.92
EFTA	0.79	0.13	0.93	0.72	1	0.94	0.83	0.93
Israel	0.67	0.15	0.82	0.53	0.84	0.83	0.77	0.9
ERA	0.8	0.12	1	0.7	0.94	1	0.93	0.98
China	0.69	0.12	0.84	0.61	0.77	0.84	0.82	0.87
India	0.52	0.19	0.6	0.45	0.68	0.6	0.57	0.63
Japan	0.68	0.13	0.9	0.54	0.8	0.9	0.99	0.92
South Korea	0.69	0.12	0.88	0.66	0.74	0.87	0.93	0.89
ASIA	0.72	0.13	0.93	0.59	0.83	0.93	1	0.95
Brazil	0.78	0.11	0.9	0.87	0.93	0.91	0.79	0.88
Russian Federation	0.76	0.12	0.92	0.7	0.91	0.93	0.83	0.9
United States	0.74	0.14	0.92	0.6	0.91	0.92	0.89	0.98
WORLD	0.78	0.13	0.98	0.66	0.93	0.98	0.95	1

Table 44 - Technological similarity, IPC 35 technology fields, 2005-2009
World Intellectual Property Organization (by Applicant)

Area	All countries (average)	All countries (std. dev.)	EU27	Candidate	EFTA	ERA	Asia	WORLD
Austria	0.75	0.13	0.94	0.66	0.89	0.94	0.8	0.88
Belgium	0.73	0.13	0.85	0.58	0.89	0.86	0.71	0.84
Bulgaria	0.68	0.14	0.86	0.59	0.75	0.86	0.75	0.82
Cyprus	0.72	0.13	0.88	0.77	0.83	0.89	0.72	0.83
Czech Republic	0.75	0.13	0.9	0.64	0.9	0.9	0.7	0.83
Denmark	0.76	0.13	0.85	0.59	0.92	0.86	0.67	0.84
Estonia	0.68	0.11	0.78	0.45	0.77	0.78	0.71	0.81
Finland	0.49	0.19	0.65	0.32	0.44	0.64	0.81	0.73
France	0.77	0.1	0.98	0.62	0.87	0.97	0.88	0.94
Germany	0.71	0.13	0.95	0.62	0.84	0.95	0.79	0.86
Greece	0.76	0.13	0.89	0.65	0.91	0.9	0.68	0.84
Hungary	0.75	0.12	0.85	0.58	0.85	0.86	0.74	0.85
Ireland	0.73	0.11	0.84	0.55	0.88	0.85	0.75	0.9
Italy	0.76	0.12	0.92	0.77	0.93	0.93	0.71	0.85
Latvia	0.62	0.18	0.64	0.5	0.78	0.66	0.48	0.64
Lithuania	0.65	0.13	0.75	0.68	0.79	0.76	0.59	0.71
Luxembourg	0.62	0.13	0.74	0.54	0.77	0.75	0.58	0.74
Malta	0.7	0.11	0.78	0.63	0.84	0.79	0.62	0.75
Netherlands	0.71	0.12	0.9	0.52	0.84	0.9	0.89	0.94
Poland	0.78	0.12	0.92	0.65	0.93	0.93	0.75	0.89
Portugal	0.78	0.12	0.89	0.65	0.9	0.89	0.72	0.86
Romania	0.64	0.13	0.8	0.58	0.65	0.79	0.73	0.8
Slovakia	0.7	0.13	0.9	0.6	0.78	0.89	0.76	0.83
Slovenia	0.65	0.17	0.7	0.62	0.79	0.71	0.51	0.67
Spain	0.79	0.13	0.91	0.72	0.95	0.92	0.7	0.86
Sweden	0.65	0.13	0.82	0.48	0.65	0.81	0.86	0.86
United Kingdom	0.8	0.1	0.95	0.65	0.95	0.96	0.82	0.96
EU27	0.79	0.11	1	0.66	0.92	1	0.88	0.96
Croatia	0.72	0.15	0.79	0.63	0.87	0.8	0.59	0.76
Macedonia	0.52	0.12	0.6	0.49	0.65	0.61	0.45	0.58
Turkey	0.5	0.13	0.6	0.99	0.58	0.61	0.48	0.54
CANDIDATE	0.56	0.12	0.66	1	0.65	0.67	0.52	0.6
Iceland	0.61	0.16	0.66	0.44	0.8	0.68	0.46	0.68
Liechtenstein	0.6	0.17	0.67	0.47	0.75	0.68	0.49	0.63
Norway	0.65	0.14	0.8	0.53	0.76	0.8	0.59	0.71
Switzerland	0.75	0.14	0.88	0.64	0.99	0.9	0.69	0.87
EFTA	0.78	0.13	0.92	0.65	1	0.93	0.71	0.89
Israel	0.67	0.12	0.78	0.47	0.79	0.78	0.72	0.87
ERA	0.8	0.11	1	0.67	0.93	1	0.87	0.96
China	0.47	0.18	0.61	0.34	0.4	0.6	0.8	0.69
India	0.59	0.18	0.63	0.39	0.71	0.64	0.52	0.64
Japan	0.66	0.13	0.87	0.49	0.74	0.87	0.95	0.91
South Korea	0.61	0.14	0.77	0.55	0.59	0.76	0.94	0.86
ASIA	0.68	0.13	0.88	0.52	0.71	0.87	1	0.94
Brazil	0.76	0.13	0.9	0.79	0.93	0.91	0.68	0.84
Russian Federation	0.79	0.12	0.95	0.67	0.94	0.95	0.78	0.91
United States	0.75	0.11	0.89	0.53	0.87	0.89	0.84	0.96
WORLD	0.78	0.1	0.96	0.6	0.89	0.96	0.94	1

Table 45 - Technological similarity, NACE Classification, 2000-2004
European Patent Office (by Applicant)

Area	All countries (average)	All countries (std. dev.)	EU27	Candidate	EFTA	ERA	Asia	WORLD
Austria	0.76	0.15	0.91	0.79	0.92	0.92	0.68	0.84
Belgium	0.77	0.13	0.87	0.83	0.93	0.89	0.72	0.86
Bulgaria	0.73	0.15	0.84	0.8	0.91	0.85	0.64	0.79
Cyprus	0.77	0.12	0.91	0.63	0.9	0.91	0.81	0.92
Czech Republic	0.75	0.15	0.86	0.92	0.91	0.87	0.61	0.8
Denmark	0.78	0.14	0.84	0.75	0.96	0.86	0.66	0.85
Estonia	0.69	0.14	0.77	0.49	0.86	0.79	0.7	0.83
Finland	0.48	0.22	0.7	0.34	0.49	0.69	0.82	0.75
France	0.74	0.15	0.97	0.63	0.83	0.97	0.92	0.96
Germany	0.75	0.14	0.97	0.74	0.88	0.97	0.82	0.91
Greece	0.76	0.14	0.9	0.7	0.92	0.9	0.69	0.84
Hungary	0.68	0.18	0.67	0.62	0.82	0.69	0.53	0.71
Ireland	0.74	0.14	0.82	0.68	0.88	0.83	0.79	0.89
Italy	0.74	0.16	0.92	0.88	0.9	0.92	0.69	0.83
Latvia	0.7	0.14	0.79	0.63	0.83	0.8	0.7	0.82
Lithuania	0.59	0.17	0.62	0.64	0.72	0.64	0.51	0.63
Luxembourg	0.78	0.12	0.92	0.69	0.9	0.92	0.77	0.91
Malta	0.62	0.14	0.75	0.58	0.76	0.75	0.59	0.7
Netherlands	0.65	0.17	0.85	0.51	0.72	0.85	0.97	0.92
Poland	0.77	0.14	0.85	0.75	0.93	0.87	0.65	0.83
Portugal	0.74	0.15	0.84	0.69	0.9	0.85	0.6	0.79
Romania	0.73	0.15	0.83	0.83	0.9	0.84	0.6	0.77
Slovakia	0.67	0.16	0.78	0.63	0.83	0.79	0.59	0.73
Slovenia	0.71	0.16	0.73	0.67	0.85	0.75	0.56	0.74
Spain	0.78	0.14	0.93	0.81	0.94	0.93	0.7	0.87
Sweden	0.69	0.16	0.89	0.56	0.77	0.88	0.88	0.91
United Kingdom	0.81	0.12	0.95	0.71	0.96	0.96	0.86	0.97
EU27	0.79	0.13	1	0.74	0.91	1	0.9	0.98
Croatia	0.6	0.2	0.54	0.59	0.73	0.56	0.37	0.58
Macedonia	0.33	0.19	0.39	0.27	0.42	0.4	0.21	0.32
Turkey	0.53	0.17	0.67	0.95	0.68	0.67	0.45	0.57
CANDIDATE	0.65	0.15	0.74	1	0.81	0.75	0.5	0.67
Iceland	0.63	0.18	0.61	0.76	0.81	0.63	0.45	0.65
Liechtenstein	0.68	0.17	0.83	0.67	0.84	0.84	0.59	0.74
Norway	0.8	0.13	0.95	0.83	0.97	0.95	0.78	0.92
Switzerland	0.8	0.13	0.91	0.8	1	0.92	0.72	0.9
EFTA	0.81	0.13	0.91	0.81	1	0.93	0.73	0.9
Israel	0.71	0.16	0.77	0.57	0.85	0.78	0.73	0.85
ERA	0.79	0.13	1	0.75	0.93	1	0.89	0.98
China	0.66	0.16	0.85	0.54	0.72	0.84	0.88	0.89
India	0.53	0.2	0.47	0.45	0.62	0.49	0.39	0.53
Japan	0.66	0.17	0.9	0.49	0.73	0.89	1	0.95
South Korea	0.54	0.21	0.76	0.44	0.56	0.75	0.93	0.83
ASIA	0.66	0.17	0.9	0.5	0.73	0.89	1	0.95
Brazil	0.77	0.15	0.9	0.85	0.94	0.91	0.65	0.83
Russian Federation	0.8	0.13	0.91	0.76	0.98	0.92	0.73	0.9
United States	0.76	0.14	0.9	0.61	0.89	0.91	0.91	0.97
WORLD	0.78	0.13	0.98	0.67	0.9	0.98	0.95	1

Table 46 - Technological similarity, NACE Classification, 2005-2009
European Patent Office (by Applicant)

Area	All countries (average)	All countries (std. dev.)	EU27	Candidate	EFTA	ERA	Asia	WORLD
Austria	0.74	0.17	0.94	0.73	0.9	0.94	0.66	0.86
Belgium	0.73	0.13	0.87	0.84	0.88	0.88	0.65	0.83
Bulgaria	0.76	0.12	0.95	0.7	0.85	0.95	0.8	0.92
Cyprus	0.71	0.13	0.87	0.54	0.82	0.87	0.78	0.88
Czech Republic	0.76	0.16	0.91	0.7	0.91	0.92	0.64	0.85
Denmark	0.77	0.13	0.88	0.65	0.96	0.89	0.66	0.86
Estonia	0.71	0.15	0.82	0.57	0.89	0.83	0.63	0.81
Finland	0.51	0.2	0.7	0.47	0.49	0.69	0.9	0.78
France	0.74	0.12	0.96	0.64	0.81	0.95	0.94	0.97
Germany	0.73	0.16	0.97	0.76	0.87	0.97	0.74	0.89
Greece	0.77	0.17	0.92	0.72	0.93	0.93	0.63	0.85
Hungary	0.72	0.18	0.75	0.52	0.91	0.77	0.54	0.76
Ireland	0.72	0.11	0.81	0.55	0.86	0.82	0.8	0.9
Italy	0.72	0.17	0.93	0.84	0.89	0.94	0.63	0.83
Latvia	0.66	0.13	0.71	0.52	0.77	0.72	0.62	0.75
Lithuania	0.72	0.13	0.77	0.56	0.86	0.79	0.68	0.82
Luxembourg	0.67	0.14	0.88	0.51	0.79	0.88	0.76	0.86
Malta	0.62	0.16	0.73	0.55	0.74	0.74	0.5	0.67
Netherlands	0.75	0.11	0.92	0.7	0.88	0.92	0.88	0.96
Poland	0.78	0.16	0.92	0.71	0.94	0.93	0.65	0.87
Portugal	0.76	0.17	0.84	0.63	0.94	0.86	0.57	0.81
Romania	0.71	0.15	0.91	0.73	0.82	0.91	0.72	0.85
Slovakia	0.63	0.17	0.84	0.66	0.74	0.84	0.63	0.76
Slovenia	0.57	0.2	0.53	0.4	0.69	0.55	0.38	0.56
Spain	0.79	0.14	0.93	0.7	0.96	0.94	0.67	0.88
Sweden	0.58	0.17	0.78	0.5	0.61	0.77	0.91	0.85
United Kingdom	0.8	0.11	0.96	0.68	0.96	0.97	0.84	0.98
EU27	0.78	0.13	1	0.76	0.91	1	0.85	0.97
Croatia	0.73	0.17	0.78	0.5	0.93	0.8	0.55	0.78
Macedonia	.	.	.	.	.	.	.	.
Turkey	0.54	0.15	0.72	1	0.64	0.72	0.5	0.64
CANDIDATE	0.57	0.14	0.76	1	0.69	0.76	0.53	0.68
Iceland	0.56	0.21	0.52	0.42	0.76	0.55	0.36	0.58
Liechtenstein	0.7	0.18	0.84	0.56	0.89	0.86	0.53	0.77
Norway	0.75	0.16	0.92	0.81	0.92	0.93	0.64	0.85
Switzerland	0.78	0.14	0.9	0.67	1	0.92	0.67	0.89
EFTA	0.78	0.14	0.91	0.69	1	0.93	0.67	0.89
Israel	0.69	0.14	0.75	0.46	0.87	0.76	0.71	0.84
ERA	0.79	0.12	1	0.76	0.93	1	0.84	0.97
China	0.42	0.21	0.58	0.34	0.39	0.56	0.82	0.68
India	0.54	0.21	0.48	0.3	0.65	0.5	0.37	0.53
Japan	0.67	0.14	0.89	0.53	0.72	0.88	0.98	0.95
South Korea	0.5	0.2	0.68	0.48	0.47	0.67	0.94	0.79
ASIA	0.64	0.16	0.85	0.53	0.67	0.84	1	0.93
Brazil	0.75	0.17	0.9	0.68	0.94	0.91	0.59	0.83
Russian Federation	0.77	0.15	0.88	0.63	0.97	0.9	0.67	0.88
United States	0.76	0.1	0.89	0.57	0.9	0.9	0.88	0.96
WORLD	0.78	0.11	0.97	0.68	0.89	0.97	0.93	1

Table 47 - Technological similarity, NACE Classification, 2000-2004
World Intellectual Property Organization (by Applicant)

Area	All countries (average)	All countries (std. dev.)	EU27	Candidate	EFTA	ERA	Asia	WORLD
Austria	0.85	0.09	0.96	0.81	0.95	0.96	0.89	0.93
Belgium	0.79	0.12	0.86	0.74	0.93	0.87	0.82	0.87
Bulgaria	0.8	0.1	0.91	0.78	0.89	0.91	0.82	0.86
Cyprus	0.81	0.09	0.9	0.73	0.9	0.91	0.84	0.88
Czech Republic	0.83	0.12	0.9	0.87	0.96	0.9	0.8	0.86
Denmark	0.82	0.11	0.89	0.74	0.95	0.89	0.82	0.91
Estonia	0.82	0.09	0.92	0.71	0.94	0.92	0.88	0.94
Finland	0.59	0.15	0.77	0.49	0.58	0.76	0.78	0.76
France	0.85	0.09	1	0.74	0.93	0.99	0.96	0.98
Germany	0.82	0.09	0.97	0.75	0.89	0.97	0.9	0.92
Greece	0.84	0.1	0.93	0.82	0.96	0.93	0.83	0.89
Hungary	0.82	0.11	0.9	0.7	0.94	0.91	0.86	0.93
Ireland	0.79	0.11	0.92	0.69	0.9	0.92	0.91	0.96
Italy	0.84	0.1	0.92	0.91	0.96	0.92	0.81	0.87
Latvia	0.81	0.1	0.86	0.86	0.94	0.87	0.77	0.85
Lithuania	0.72	0.11	0.81	0.66	0.84	0.81	0.72	0.77
Luxembourg	0.79	0.11	0.87	0.79	0.88	0.88	0.77	0.83
Malta	0.66	0.12	0.76	0.78	0.77	0.77	0.65	0.7
Netherlands	0.66	0.14	0.84	0.51	0.69	0.84	0.92	0.88
Poland	0.84	0.1	0.92	0.82	0.95	0.93	0.84	0.89
Portugal	0.84	0.1	0.92	0.8	0.96	0.93	0.84	0.9
Romania	0.79	0.12	0.89	0.78	0.89	0.89	0.79	0.84
Slovakia	0.78	0.11	0.85	0.75	0.87	0.86	0.79	0.82
Slovenia	0.78	0.12	0.82	0.83	0.9	0.83	0.75	0.83
Spain	0.85	0.1	0.93	0.86	0.96	0.94	0.83	0.9
Sweden	0.75	0.11	0.92	0.63	0.79	0.92	0.89	0.91
United Kingdom	0.85	0.09	0.97	0.75	0.96	0.98	0.95	0.99
EU27	0.85	0.09	1	0.77	0.93	1	0.96	0.98
Croatia	0.79	0.12	0.83	0.86	0.92	0.85	0.72	0.82
Macedonia	0.57	0.12	0.62	0.58	0.62	0.63	0.55	0.57
Turkey	0.61	0.13	0.66	0.97	0.7	0.66	0.53	0.59
CANDIDATE	0.72	0.12	0.77	1	0.82	0.77	0.63	0.71
Iceland	0.71	0.13	0.77	0.75	0.85	0.78	0.72	0.81
Liechtenstein	0.77	0.11	0.87	0.91	0.87	0.87	0.76	0.81
Norway	0.82	0.1	0.92	0.9	0.92	0.92	0.83	0.87
Switzerland	0.84	0.1	0.91	0.78	1	0.92	0.85	0.92
EFTA	0.85	0.1	0.93	0.82	1	0.94	0.86	0.93
Israel	0.74	0.13	0.87	0.56	0.84	0.87	0.88	0.93
ERA	0.86	0.08	1	0.77	0.94	1	0.96	0.98
China	0.76	0.11	0.88	0.6	0.81	0.88	0.88	0.91
India	0.61	0.16	0.63	0.49	0.73	0.64	0.63	0.69
Japan	0.78	0.11	0.95	0.61	0.85	0.95	0.99	0.96
South Korea	0.77	0.11	0.93	0.64	0.8	0.92	0.96	0.94
ASIA	0.8	0.1	0.96	0.63	0.86	0.96	1	0.98
Brazil	0.83	0.1	0.9	0.89	0.95	0.91	0.8	0.86
Russian Federation	0.84	0.09	0.96	0.81	0.96	0.96	0.9	0.93
United States	0.81	0.11	0.94	0.65	0.91	0.94	0.95	0.99
WORLD	0.84	0.09	0.98	0.71	0.93	0.98	0.98	1

Table 48 - Technological similarity, NACE Classification, 2005-2009
World Intellectual Property Organization (by Applicant)

Area	All countries (average)	All countries (std. dev.)	EU27	Candidate	EFTA	ERA	Asia	WORLD
Austria	0.82	0.11	0.97	0.74	0.93	0.97	0.82	0.91
Belgium	0.8	0.12	0.9	0.69	0.94	0.9	0.76	0.88
Bulgaria	0.74	0.12	0.89	0.7	0.81	0.89	0.79	0.84
Cyprus	0.8	0.12	0.92	0.73	0.92	0.92	0.77	0.87
Czech Republic	0.82	0.12	0.92	0.72	0.95	0.93	0.74	0.88
Denmark	0.82	0.11	0.89	0.66	0.94	0.9	0.74	0.88
Estonia	0.79	0.09	0.88	0.51	0.84	0.87	0.87	0.92
Finland	0.6	0.17	0.74	0.5	0.54	0.73	0.91	0.81
France	0.83	0.09	0.98	0.66	0.89	0.98	0.93	0.98
Germany	0.78	0.11	0.96	0.73	0.88	0.96	0.8	0.88
Greece	0.83	0.12	0.93	0.71	0.96	0.94	0.75	0.88
Hungary	0.83	0.09	0.92	0.59	0.89	0.92	0.87	0.94
Ireland	0.8	0.09	0.88	0.61	0.89	0.89	0.85	0.94
Italy	0.81	0.12	0.94	0.85	0.96	0.94	0.74	0.86
Latvia	0.73	0.14	0.77	0.52	0.86	0.78	0.63	0.77
Lithuania	0.79	0.11	0.88	0.65	0.9	0.89	0.72	0.83
Luxembourg	0.75	0.11	0.86	0.56	0.87	0.87	0.72	0.84
Malta	0.8	0.09	0.89	0.62	0.89	0.9	0.82	0.89
Netherlands	0.8	0.09	0.93	0.69	0.88	0.93	0.92	0.96
Poland	0.84	0.11	0.95	0.68	0.96	0.95	0.8	0.91
Portugal	0.84	0.11	0.92	0.66	0.95	0.93	0.79	0.91
Romania	0.75	0.12	0.91	0.6	0.76	0.9	0.91	0.91
Slovakia	0.76	0.11	0.9	0.73	0.84	0.9	0.79	0.85
Slovenia	0.73	0.15	0.76	0.67	0.86	0.78	0.57	0.74
Spain	0.84	0.11	0.93	0.73	0.98	0.94	0.76	0.9
Sweden	0.7	0.13	0.84	0.54	0.67	0.83	0.93	0.88
United Kingdom	0.85	0.09	0.96	0.69	0.96	0.97	0.88	0.98
EU27	0.85	0.09	1	0.74	0.93	1	0.9	0.97
Croatia	0.83	0.12	0.91	0.66	0.96	0.91	0.74	0.89
Macedonia	0.68	0.09	0.79	0.67	0.78	0.79	0.71	0.78
Turkey	0.57	0.13	0.69	1	0.7	0.69	0.51	0.6
CANDIDATE	0.63	0.12	0.74	1	0.75	0.75	0.56	0.66
Iceland	0.69	0.16	0.69	0.59	0.84	0.71	0.5	0.7
Liechtenstein	0.68	0.14	0.76	0.55	0.82	0.76	0.57	0.73
Norway	0.76	0.12	0.9	0.9	0.89	0.9	0.73	0.82
Switzerland	0.82	0.12	0.91	0.7	1	0.92	0.73	0.89
EFTA	0.83	0.12	0.93	0.75	1	0.94	0.75	0.9
Israel	0.76	0.1	0.83	0.5	0.83	0.84	0.83	0.91
ERA	0.85	0.09	1	0.75	0.94	1	0.9	0.97
China	0.54	0.18	0.65	0.37	0.45	0.64	0.86	0.74
India	0.65	0.16	0.66	0.39	0.72	0.66	0.58	0.69
Japan	0.76	0.11	0.93	0.56	0.8	0.92	0.96	0.96
South Korea	0.71	0.13	0.84	0.58	0.68	0.83	0.97	0.91
ASIA	0.75	0.12	0.9	0.56	0.75	0.9	1	0.96
Brazil	0.81	0.13	0.92	0.82	0.96	0.92	0.69	0.84
Russian Federation	0.84	0.11	0.97	0.74	0.97	0.97	0.81	0.93
United States	0.82	0.09	0.92	0.59	0.89	0.92	0.9	0.98
WORLD	0.84	0.08	0.97	0.66	0.9	0.97	0.96	1

The pattern involving EU27 and Candidate countries is not so clear: the similarity index relative to the EPO show a slow dynamic of convergence, the opposite holds if we look at the results based on WIPO data.

In order to allow a better visual interpretation of the results on similarities of specialisation patterns, we have applied Multidimensional Scaling (MDS) analysis. More specifically, we have proceeded in the following way:

1) Proximity matrices among the 42 countries have been computed for the WIPO patents and for two of the three types of patent classifications adopted here.
2) These matrices have been used as inputs in MDS analysis. In brief, MDS is a statistical technique, which permits to represent in a bi- or three-dimensional space *N* objects according to the criterion that units more *similar* must be located *closer* than others. This step generated a series of maps, in which points represent countries and pairs of countries whose distribution of patents is more similar (i.e. the value of the D_{ab} index is lower) are positioned closer to each other, than pairs of countries that are less similar[10]. This methodology is thus able to uncover groups of countries whose profile of technological specialisation is more similar and that are thus more likely to be direct competitors. Loosely speaking, two countries that are close to each other in the MDS maps represent similar countries, while countries that are far apart represent two dissimilar countries.

To represent the MDS maps, we have excluded the smaller countries in terms of total number of patents and have focused only on the major patenting countries. Due to their specialisation in few technological areas, the inclusion of small countries would bias the resulting maps. Figures 11 and 12 report maps computed by classifying patents according to the FP7 Thematic Priorities, respectively, for the periods 2000-2004 and 2005-2009, whereas Figures 13 and 14 refer to similar maps computed according to the IPC 35 fields classification[11].

[10] It is important to note that the graphical representation obtained by applying MDS techniques entails some degree of distortion in reproducing the real distances among objects. Hence, the graphs reported in the text should be interpreted with some caution. For the maps reported in the text, the so-called *stress* index, which provides a sort of goodness of fit measure, takes values, which are generally considered as acceptable, i.e. the corresponding bi-dimensional maps can be taken as fair representations of the input distance matrices. The PROC-MDS procedure, of the statistical software package SAS, has been used to develop MDS plots.

[11] Maps for the NACE classification are not reported as the MDS algorithm did not converge and results were not reliable.

For both types of classification, one notes the existence of a well defined and quite stable cluster of European countries formed by Germany, Italy, Austria (and Norway). This group of countries shows a common pattern of technological specialisation in automobiles, transport and construction technologies. A second cluster of European countries comprises Denmark, Switzerland and Belgium, which have developed over time similar patterns of specialisation based on health, food and biotechnology. As far as the other European countries are concerned, we observe that Finland and the Netherlands share a very similar specialization during the first subperiod 2000-2004 (even though this is more evident with respect to the FP7 than to the IPC 35 classification). However, in the second period of time 2005-2009, the Netherlands departs from this cluster, while at the same time China is joining it. This cluster, which seems to include also Sweden and South Korea in the second period of time, is characterized by a strong specialisation in ICT and nanoscience related sectors. A fourth and more fuzzy cluster includes United States, Japan, United Kingdom and France. This cluster is positioned between the first and third clusters noted above, by sharing with the first a specialisation in mechanical-related fields such as transport technologies and automobiles, and with the third a specialisation in some ICT-related fields. Finally, one also notes that Israel and India display well distinct patterns of specialisation, the former on health and materials, the latter on health and security.

Figure 11 – MDS Map, FP7 Thematic Priorities, 2000-2004
World Intellectual Property Organization (by applicant)

Figure 12 – MDS Map, FP7 Thematic Priorities, 2005-2009
World Intellectual Property Organization (by applicant)

Figure 13 – MDS Map, IPC 35 technological fields, 2000-2004
World Intellectual Property Organization (by applicant)

Figure 14 – MDS Map, IPC 35 technological fields, 2005-2009
World Intellectual Property Organization (by applicant)

5. CONCLUSIONS

This report has provided a broad overview of the most recent patterns of technological specialisation at the level of countries and world geo-areas. The analysis has used data from four different patent systems (EPO, WIPO, USPTO and Triadic) and three different classifications of patents (FP7 Thematic Priorities, IPC 35 technology fields and 22 NACE sectors). Results obtained are affected by the choice of the patent system examined due to various factors, such as the home advantage effect and the lags between filing and granting dates. In this respect, the USPTO and the Triadic patent systems yield results that are not always consistent with those obtained by using EPO and WIPO data. Regarding classifications, the NACE classification presents some peculiar features, for example by mixing up in the same class both final products and manufacturing processes.

However, despite the variety of data sources and classification approaches, the report outlines a few robust facts. The first major finding regards the complementarity in the specialisation patterns of three major world areas. If we look at the decade 2000-2010, the ERA is characterised by a marked specialisation in mechanical-related areas and technologies (including transport) and by a rather strong de-specialisation in ICT and nanotechnologies. Conversely, Asia is markedly specialised in ICT and nanotechnologies and de-specialised in biotechnology, pharmaceuticals and aerospace. Finally, the United States present a profile of strong specialisation in pharmaceuticals, biotechnology, space and the more service-oriented segments of ICT and it is de-specialised in most mechanical-related fields.

Results also show that the ERA is characterised by a higher degree of diversification of its technological strengths across a wider set of areas compared to United States and Asia. The latter, in particular, focuses its technological specialisation in a narrow set of fields, most notably ICT and nanotechnology. From a dynamic perspective, moreover, whereas Asia and United States show a tendency towards an increasing concentration of their technological efforts in a narrower number of domains, the opposite pattern seems to hold for the ERA. In other words, the fragmentation of research efforts that affects the ERA translates apparently into its specialisation profile and dynamics.

The analysis at the level of countries, i.e. within broad geo-areas, also provides some interesting results. More specifically, we have applied a methodology aimed at assessing the extent to which pairs of countries display similar or dissimilar patterns of specialisation. The results of this analysis partly depend upon the patent system examined and the classification adopted. Yet, some general patterns and trends can be discussed. First of all, the existence of well defined groups of countries sharing similar profiles of specialisation clearly emerge from the analysis. In particular, a group of countries- strongly specialised in ICT and nanotechnologies- comprises China, South Korea and Finland. Even though they do not belong to this group, Sweden and Netherlands are not located very distantly from it. The majority of other large European countries- Germany, Italy, Austria, and Norway are located in a central cluster, whose marking characteristic is a specialisation in traditional, mechanical-oriented technologies. France, UK and Sweden, on the other hand, are closely positioned with the United States and Japan. Finally, smaller clusters comprising smaller countries specialised in niche areas, such as food and health, are also detected.

More interesting is the dynamics displayed by these patterns. In particular, from the first to the second half of the '00s, we observe a strong tendency for countries to group around more well defined clusters and the distance between pairs of countries tends to increase. In this respect, the distance between European countries seems to increase with the formation of several sub-European clusters, each of which specialised in specific areas. Once again, this dispersion in technological efforts across a too wide spectrum of fields is likely to be a further reflection of the fragmentation of the ERA.

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The report provides a descriptive analysis of the patterns of technological specialization at the level of broad geographical areas and countries, using patent data as the main indicator of inventive performance. Using data from PATSTAT for the EPO, WIPO, USPTO and Triadic patents, it computes revealed technological advantages for the period 2000-2012. To this purpose, patents are re-classified following three alternative classifications according to: a) Thematic Priorities of the 7th Framework Programme; b) NACE Rev. 1.1 industrial sectors; and c) 35 IPC technological fields.

Results show that the European Research Area (ERA) is characterised by a marked specialisation in mechanical-related areas and technologies (including transport) and by a rather strong de-specialisation in ICT and nanotechnologies. Conversely, Asia is markedly specialised in ICT and nanotechnologies and de-specialised in biotechnology, pharmaceuticals and aerospace.

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