World Corporate Top R&D Investors:

Innovation and IP bundles

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BETTER POLICIES FOR BETTER LIVES

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Foreword

Innovation and technological development are crucial for economic growth and development and for the competitiveness of industries. Evidence shows that technical progress and innovation lead to a more efficient use of labour and capital inputs, and thus foster productivity, one of the main drivers of growth in most OECD countries for more than two decades.

World regions and countries are competing to attract and retain those segments of global value chains that contribute most to value and job creation. In a context of increasing globalisation and interdependence of knowledge generation and its exploitation, policies aiming at reinforcing the scientific and technological competitiveness of economies need to rely on a wide range of science, technology and innovation indicators reflecting increasingly complex innovation systems.

A main actor in innovation systems is the business sector. Evidence shows that a very large proportion of the R&D investments financed and executed by the business sector worldwide is concentrated in a relatively small number of world-leading corporate innovators, in many cases large multinational groups. These companies also account for a significant proportion of the patents and trademarks filed in the most important intellectual property offices around the world.

In this respect, the original data and statistics on the innovation output of the world's top corporate R&D investors presented in this report are extremely relevant for the support of evidence-based research and innovation policies. The report builds on the efforts to collect up-to-date, reliable and comparable company data on the top corporate R&D investors worldwide carried out by the European Commission since 2004 (the EU Industrial R&D Investment Scoreboard publication) and on the solid knowledge and experience of the OECD in developing and providing robust and state-of-the-art indicators on science, technology and industry (see for example OECD's STI Scoreboard publications).

Essentially descriptive in nature, the company based data and statistics on the patents and trademarks portfolios of the world's top corporate investors open the door to further research into, and analysis of, companies' global strategies for knowledge development and exploitation.

The main target audience of this report is the policy and research community, as well as analysts with an interest in supporting evidence-based policy making in the area of innovation and industrial policies. The underlying company data on patents and trademark will be made publicly available. The objective is to allow practitioners to make intensive use of these data to contribute to the advancement of knowledge and empirical evidence on companies' innovative activities and performance.

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Acronyms

CTM	Community Trade Mark
EPC	European Patent Convention
EPO	European Patent Office
EU28	European Union
ICT	Information and communication technology
IP AUS	IP Australia
IP5	Five IP offices (EPO, JPO, KIPO, SIPO and USPTO)
IPC	International Patent Classification
IPR	Intellectual Property Rights
ISIC	International Standard Industrial Classification of All Economic Activities
JPO	Japan Patent Office
KIPO	Korean Intellectual Property Office
OHIM	Office for Harmonization in the Internal Market
R&D	Research and Development
SIPO	State Intellectual Property Office of the People's Republic of China
TM	Trademark
USPTO	United States Patent and Trademark Office
WIPO	World Intellectual Property Organization

Abbreviations

In selected figures, the ISO codes for countries or economies are reported.

AUS	Australia	**GBR**	United Kingdom
AUT	Austria	**IND**	India
BEL	Belgium	**IRL**	Ireland
BMU	Bermuda	**ISR**	Israel
CAN	Canada	**ITA**	Italy
CHE	Switzerland	**JPN**	Japan
CHN	China	**KOR**	Korea
CUW	Curacao	**LUX**	Luxembourg
CYM	Cayman Islands	**NLD**	Netherlands
DEU	Germany	**NOR**	Norway
DNK	Denmark	**NZL**	New Zealand
FIN	Finland	**SWE**	Sweden
FRA	France	**USA**	United States

Executive Summary

This report looks at the innovative output of world's top Research and Development (R&D) investors using patents and trademarks as proxy indicators. Essentially descriptive in nature, the study presents statistics about the patent portfolio of companies, and their trademark strategies to launch new products, and looks at the extent to which companies bundle these two forms of Intellectual Property Rights (IPR) to protect and appropriate the returns of their knowledge-based assets. The newly constructed dataset provides interesting insights about the innovation strategies of the world's leading corporate R&D investors.

The patent portfolio of top corporate R&D investors

Patenting activities highlight heterogeneous industry and firm-specific behaviours

Top corporate R&D investors show a high degree of heterogeneity in their propensity to patent. The structural features of the industry in which companies operate are a relevant determinant, but not the only one, as important differences also emerge across companies operating in the same industry. The highest propensity to patent is shown by companies operating in the 'Electrical equipment' industry, and the lowest by companies operating in the 'Pharmaceuticals' industry.

Patent applications are concentrated in a narrow set of technologies

Overall, the world top corporate R&D investors considered in this report, accounting for over 90% of global business R&D spending, own 66% of all patent families covering five large IP offices worldwide (IP5).

The patenting activity of these companies focuses mostly on technologies related to *Electrical engineering* (accounting for almost half of total patent families) and *Mechanical engineering* (accounting for one-fifth of the total). Over the last 10 years, the greatest increases in patent filings have been in the fields of *Computer technology* and *Electrical machinery* (the two most represented technological fields). In general, patent filings related to Information and Communication Technologies (ICT) have increased while the share accounted for by technologies such as *Organic chemistry* and *Pharmaceuticals* has been declining.

Of the top 10 patenting companies in the sample, nine are headquartered in Asia, and eight belong to the ICT sector. Overall, their patent portfolio accounts for one-quarter of the total patents owned by the top R&D investors.

The technological concentration of patent portfolios varies widely across industries. Companies with a higher industrial diversification master a wider range of technologies. Technological diversification also relates to the geographical diversification of the companies' subsidiary structure, but to a much lesser extent. Among the four industries accounting for the highest number of top R&D investors, 'Machinery' displays the highest technological diversification. Companies operating in the 'Computers and electronics' industry also master a relatively wide array of technologies, while companies in the 'Pharmaceutical' industry show a much narrower specialisation profile.

Top corporate R&D investors pursue distinct filings strategies across Intellectual Property (IP) offices and over time

The distribution of IP5 patent families reflects the changes in the global innovation and economic landscape of the last decade. The current picture is more balanced, reflecting the rapid increases in filings at the Korean and Chinese international patent offices.

Key indicators used to proxy the technological and economic value of patents show that, compared with European Patent Office (EPO) filings, applications at the Unites States Patent and Trademark Office (USPTO) are of smaller family size, fact which might reflect the attractiveness of the US market *vis-à-vis* other markets. At the same time, these patent families exhibit higher radicalness but lower average technological scope.

Top corporate R&D investors differentiate their filing strategies across the IP5 offices depending upon the technological field of the invention to protect. Patent families filed at the Korean Intellectual Property Office (KIPO), the USPTO and the SIPO (the State Intellectual Property Office of the People's Republic of China) are largely oriented towards *Electrical engineering* applications, while EPO patent family members show a stronger orientation towards *Mechanical engineering* and *Chemistry*. Patent family members at the Japan Patent Office (JPO) are the most oriented towards *Instruments*, and also account for the second highest share in *Mechanical engineering.*

The geographical distribution of technological advantages reveals a wider specialisation of European and US-based companies

Top corporate R&D investors located in Europe and the United States are relatively more specialised in a wider array of technologies, including those that are fundamental to address grand challenges such as health, ageing and the environment. Companies based in Korea, China and Japan show a high degree of specialisation in ICT-related technologies whereas European-based companies show lower revealed technological advantages. Japan based companies appear to specialise in a wider array of technologies than those in Korea or China.

Top corporate R&D investors rely on international knowledge to develop their technologies

About one-quarter of companies' patent portfolios have been developed by teams of inventors residing in countries that are different from the location of the headquarters. For companies operating in 'Mining', 'Finance & Insurance' and 'Pharmaceuticals' industries international patents account for more than half of their portfolios.

The trademarks portfolio of top corporate R&D investors worldwide

The geographical distribution of trademark (TM) applications is largely driven by the location of company headquarters

Trademark applications mirror the location of company headquarters, with most of them in the United States, Japan, Germany, the United Kingdom and France. Top corporate R&D investors tend to be more active at USPTO than at the Office for Harmonization in the Internal Market (OHIM). The office with the highest home specificity is JPO: more than three-quarters of applications to JPO come from companies headquartered in Japan. At the IP Australia, levels of trademarking activities are low, but top R&D investors from Switzerland are particularly active in that office.

Trademark applications are concentrated in a few classes and a few products fields

Most trademark applications made by top corporate R&D investors relate to goods alone or to goods and services jointly and most are filed in the *Instruments and computers* and the *Pharmaceutical products* classes. Services-related trademarks pertain mainly to *R&D and software.* Trademark applications related to knowledge assets come from a small number of countries featuring developed and competitive markets for research. Companies tend to deploy consistent international trademark strategies across classes. Top corporate R&D investors from China and Korea exhibit a strong orientation towards *ICT and audiovisuals*-related trademarks.

Trademark applications feature salient industry specificities

Significant industrial specificities emerge with respect to the use of trademarks, trademark intensity (i.e. number of trademarks per euro of net sales) and concentration ratios. The 'Pharmaceuticals', 'Chemicals', 'Food products', 'Electrical equipment' and 'Textiles' industries appear as very active in trademarking. Companies operating in 'Computers and electronics', conversely, exhibit relatively low levels of trademarking activity at the offices considered. 'Pharmaceuticals' and 'Computers and electronics' appear as the most 'diversified' industries, as they own trademarks registered in a variety of good and services classes.

The adoption of common word mark strategies in international markets remains limited

Trademarks signal the uniqueness of goods and services through the use of signs as words, images, sounds or any combination of these. While word marks constitute the most common type of mark application of top corporate R&D investors, only a low share of identical word marks is protected across the different offices. In addition, top corporate R&D investors seem more likely to adopt close trademarking strategies in the European and the US markets.

The IP bundle: the combined use of patents and trademarks

Top corporate R&D investors use patents and trademarks as complementary protection means

The combined use of patents and trademarks (IP bundle) is favoured by the majority of companies in the US and European markets. Alternative means of protection (or no protection) are more frequently used at JPO, where Japan-based companies predominate in terms of overall IP filings. Companies operating in the 'Chemicals', 'Pharmaceuticals', 'Food products', 'Computers and electronics' and 'Other manufactures' industries are more likely to combine the two IP rights analysed. Services-oriented companies operating in the 'IT services' and 'Finance and Insurance' industries tend to protect their assets primarily through trademarks. All in all, patents remain the most commonly used means of protection at USPTO, EPO/OHIM and JPO. Industries with low patent propensities (e.g. 'Food products' and 'Pharmaceuticals') tend to have more trademark applications.

The joint commonality of patent families and word marks is industry specific

Top corporate R&D investors file more frequently patents related to the same technical invention than word marks related to the use of identical word(s) in different offices. The 'Textiles and apparel' industry represents an exception to this trend. In the case of

applications at USPTO and OHIM by companies in the 'Pharmaceuticals' and 'Food products' industries common patents account for a large proportion (about one-half) while identical words in trademarks are much less frequent (less than 15%). Conversely, industries with the lowest shares of common patents (e.g. 'Computers and electronics' and 'Textiles apparel') are more likely to employ the very same word in their trademark applications at these two offices.

Few product fields relate to a wide range of patented technologies

Top corporate R&D investors operating in a broad range of technological areas mainly trademark products related to *Instruments and computers* and/or *Pharmaceutical products*. Trademarks related to *R&D and software* are owned by companies with very different technological backgrounds. Few companies present technology/product combinations in line with the profile of the industry in which they operate. The 'Pharmaceuticals' industry shows the strongest uniformity, with more than half of its companies featuring an IP portfolio mainly composed of patents in *Pharmaceuticals* and trademarks in *Pharmaceutical products*.

1. Innovation output: looking at the other side of R&D investment

Over the last decades, many important policy initiatives put in place worldwide (as the European Union's strategy for jobs and growth Europe 2020[1]) aimed at fostering innovation and technological development through increased spending in R&D and shifting the balance between public and private investment in R&D.

These supply-push policies are motivated by the expectation that higher R&D spending - in particular larger R&D spending by the business sector - would lead to more technological development, innovation, competitiveness and eventually more and higher quality jobs.

To what extent do businesses turn investment in R&D into new technologies, improved processes or new products launched on global markets? The long standing tradition of measuring R&D spending by businesses has generally not been paralleled by a similar wealth of statistics on the innovation output generated by such R&D spending.

This report addresses this vacuum by looking at the patent and trademark-related activities of the top 2000 corporate R&D investors worldwide. In 2012 these companies accounted for €539 billion total annual R&D investment, corresponding to more than 90% of total business R&D expenditure of OECD countries plus Argentina, China, Romania, Russian Federation, Singapore, South Africa, and Chinese Taipei. Top corporate R&D investors own 66% of all IP5 patent families worldwide and account for an average 8% of 2012 trademark applications at the USPTO, the JPO, the OHIM and IP Australia (respectively 6%, 16%, 11% and 7%).

Patents are legal instruments used to protect inventions[2] developed by firms, institutions or individuals. Patents give owners the right to exclude others from making, using, selling, offering for sale or importing the patented invention for the term of the patent. This is usually 20 years from the filing date of the application, and the right exists only for the country or countries designated for protection.

Patent data have for more than half a century been used to proxy innovation output (see e.g. Pavitt, 1985, and Acs and Audretsch, 1989, and Griliches, 1990, for early surveys); whereas trademark-related data have recently been used to proxy non-R&D based innovations and innovation in services, and have been found to relate to innovative and marketing activities (see Millot, 2012, and Squicciarini et al., 2012, for overviews)[3].

This report is essentially descriptive in nature and develops indicators of: *i)* the technological profiles of top corporate R&D investors; *ii)* the areas in which they trademark their (new) products and processes; and *iii)* the extent to which top corporate R&D investors worldwide rely on the IP 'bundle', i.e. on more than one IPR type at the same time, to protect their knowledge-based assets and better appropriate the returns from their innovation-related investment.

Accordingly, the report is structured in four key sections, as follows.

[1] See http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/ec/115346.pdf
[2] Article 28 of the Trade-Related Intellectual Property Rights [TRIPS] Agreement.
[3] A thorough discussion of the pros and cons of using such innovation proxies, which is out of the scope of the present report, can be found in the studies mentioned above, as well as in the literature that followed.

Section 2 describes the dataset developed for this analysis, and in particular the linking of patent and trademark data from key IP offices to the data of the top 2000 R&D corporate investors worldwide.

Section 3 looks at the patent portfolios of these top corporate R&D investors and provides information about the technology fields in which patent protection is sought, the technological breath and radicalness of those patents, as well as the patent protection strategies that such companies pursue worldwide and their geographical scope. It also investigates industry specificities in companies' propensity to patent.

Likewise, section 4 describes the trademark portfolios of the 2000 top corporate R&D investors, including those companies' propensity to rely on trademarks, as well as the goods and/or services classes in which protection is sought. Furthermore industry-specific differences in trademark strategies pursued by the top corporate R&D investors are investigated. A final sub-section looks at the extent to which these corporations pursue similar marketing and positioning strategies in different markets. To this end an experimental approach is devised, which exploits information about trademarks consisting solely (or mainly) of words - here termed 'word marks' - and investigates the extent to which the very same word marks are protected at different intellectual property offices.

Section 5 concludes by shedding some light on the extent to which top corporate R&D investors worldwide rely on the joint use of patents and trademarks to protect the knowledge-based assets they generate. [4]

[4] In OECD (2013) industrial designs are included in the definition of the IP bundle. The same cannot be done in the present study due to data limitations.

2 The data

2.1 The corporate structure and location of top R&D investors

The analysis presented in this report is based on the sample of the *top 2000 corporate R&D investors worldwide* published in the 2013 edition of the EU Industrial R&D Scoreboard[5], which features the ranking of the companies that invested the most, i.e. the largest sums, in R&D in the year 2012.

These companies are either parents of (a number of) subsidiaries and participated, or are independent companies. In the former case, the R&D spending figure considered for the ranking is the one that appears in their consolidated accounts[6], and that includes the spending made by their subsidiaries. Overall, the top R&D investors considered in the present study had more than 500,000 'controlled' subsidiaries (defined as firms owned for more than 50% by the parent) [7] in 2012.

As patents and trademarks can be applied for by parent companies and/or by any of their subsidiaries, the figures presented in the remainder of this report have been compiled based on patent and trademark data mirroring the IP activity of both the 2000 top R&D investors, and their 'controlled' subsidiaries[8] during the period 2010-12. The corporate structure of the 2000 top R&D investors worldwide used for this purpose is the one resulting at the end of 2012.

This conservative choice, and the consequent focus on a relatively short period of time, is driven by lack of information about the pre-2012 corporate structure of top R&D performers. This makes it impossible to accurately map the intellectual property-related activities of top corporate R&D performers over time, and the extent to which company dynamics as mergers, acquisitions and divestment might have shaped patent and trademark stock and flows.

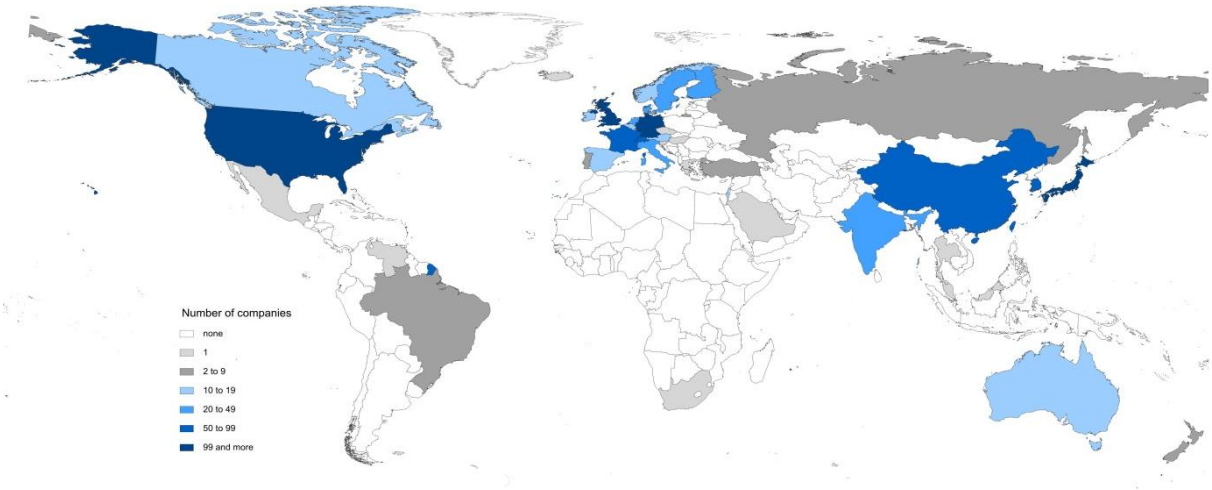
As a matter of fact, it might be reasonable to hold that the corporate structure of top R&D performers over the two years preceding the 2012, i.e. 2010-11 was sufficiently similar to the one observed in 2012[9], and that statistics based on this three-year period should provide a substantially accurate picture of their IP-related activities. Conversely, the same might not be true if longer time frames were to be considered[10].

Figure 2.1a shows the geographic distribution of the headquarters of the 2000 top corporate R&D investors considered in this report. In 2012, more than 60% of these companies (i.e. 1247) were headquartered in four countries, namely the United States, Japan,

[5] Report available at: http://iri.jrc.ec.europa.eu/scoreboard13.html.
[6] For more information on the EU R&D Scoreboard data and methodology, refer to the report, in particular to its Annex 2 – Methodological notes.
[7] This includes "branches", which account for about 34% of all subsidiaries.
[8] Despite the efforts made to try and fully map the group structure of the companies considered, the existence of other controlled affiliates cannot be fully ruled out. While there is no reason to think that this bias, if it exists, would systematically affect only one or some of the industries considered, omitting to account for the patent and trademark activities of these (at present) unknown affiliates might nevertheless lead to underestimated statistics.
[9] During the period considered, i.e. 2010-2012, countries also differed with respect to their position in the business cycle, as most OECD economies were still in recession, while other countries continued to growth. This might also have shaped corporate dynamics and innovative activities in a way that, in any case, cannot be assesses.
[10] This is true even if most part of top corporate R&D performers persistently show among top R&R investors worldwide.

Germany and the United Kingdom, and about 9% (i.e. 175 companies) in China and Chinese Taipei.

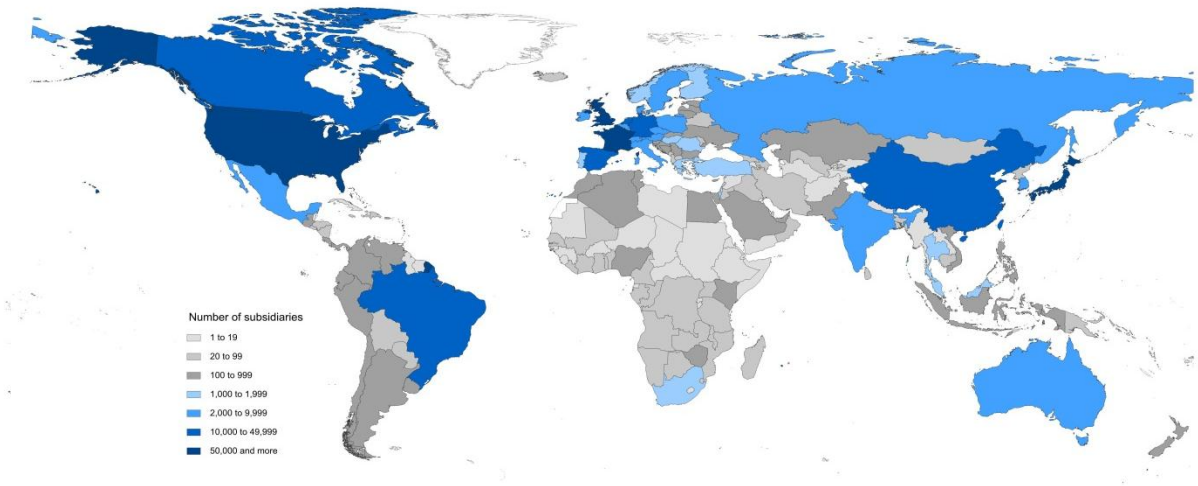
Figure 2.1a - Location of the world top R&D investors' headquarters, 2012



Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013. Map source: ARCTIQUE© - All rights reserved.

While headquarters are concentrated in a relatively small set of countries, the affiliates of top corporate R&D investors appear spread across 202 economies around the globe, as can be seen from Figure 2.1b. Despite their seemingly ubiquitous location, though, more than 60% of these affiliates are located in four countries, i.e. the United States, Japan, France and the United Kingdom.

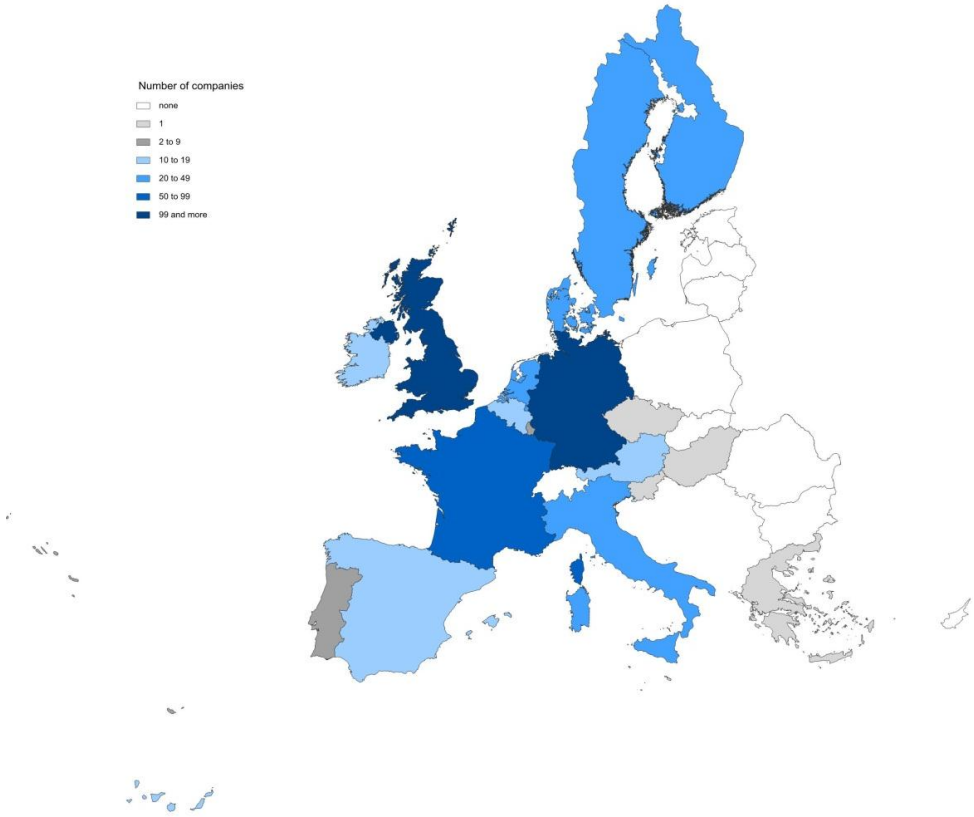
Figure 2.1b - Location of the world top R&D investors' subsidiaries, 2012



Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013. Map source: ARCTIQUE© - All rights reserved.

Figure 2.2a details the extent to which top corporate R&D investors worldwide are headquartered in Europe, and shows that, in general, Eastern European member countries do not see the presence of such headquarters.

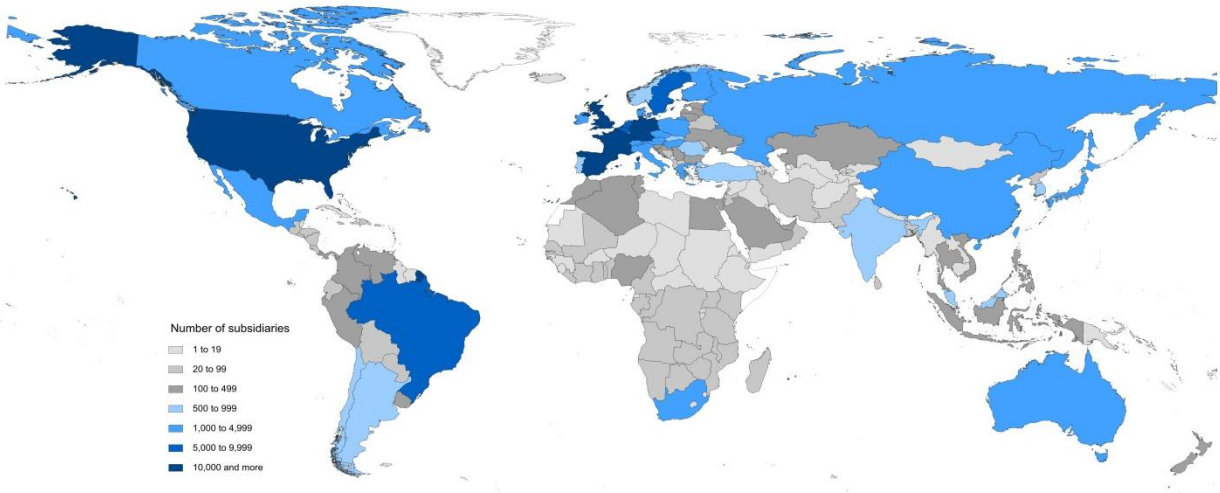
2.2a Location of the world top R&D investors, headquarters, European Union, 2012



Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013. Map source: ARCTIQUE© - All rights reserved.

The picture changes by the time the location of the affiliates of top corporate R&D investors headquartered in the European Union is considered. As can be seen from Figure 2.2b, top R&D investors headquartered in Europe have affiliates located worldwide, and importantly so in Eastern European countries, North America and Brazil, as well as Russia and Australia.

Figure 2.2b – Subsidiaries' location of the European's top R&D investors, 2012

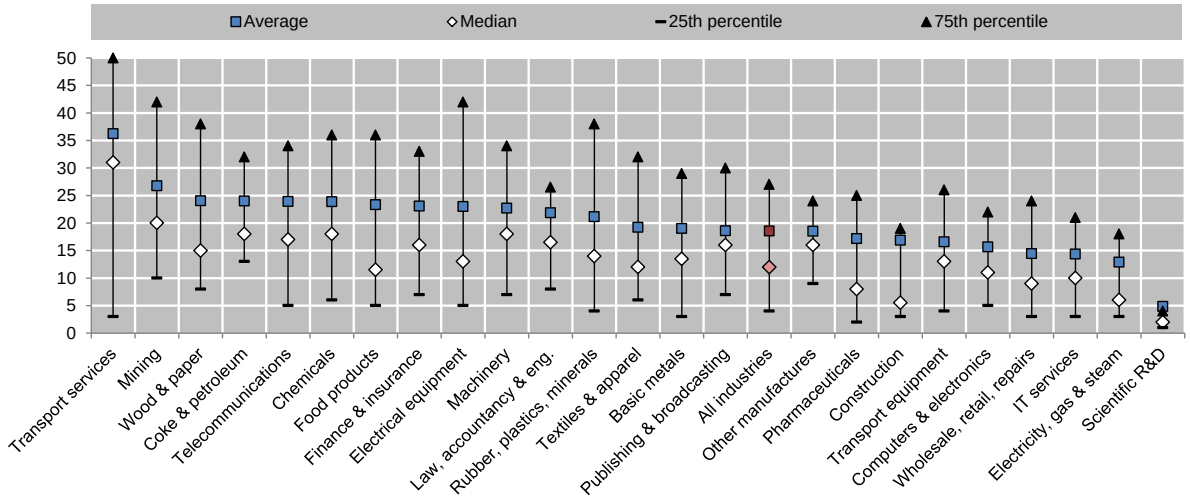


Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013. Map source: ARCTIQUE© - All rights reserved.

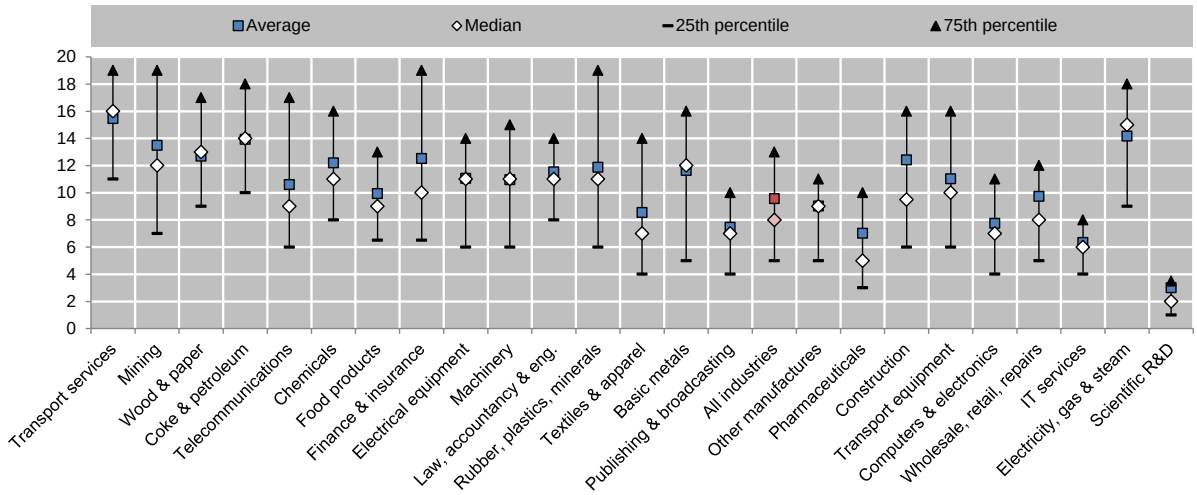
Figure 2.3 shows the extent to which the top 2000 R&D investors worldwide diversify their subsidiaries' structure, both in terms of geographical location and of industrial activities of the affiliates. Statistics are shown according the main industry of activity of the headquarters, and ranked according to the average number of countries covered.

Figure 2.3 – Diversification of subsidiaries of the top world R&D investors, 2012

a) Geographical location of subsidiaries, number of countries in the corporate structure



b) Industry classifications of subsidiaries, number of industries in the corporate structure, ISIC, rev.4



Note: Data relate to industries companies with at least 10 companies in the top 2000 corporate R&D sample. The industry classification used refers to an aggregation of the NACE, rev. 2 list into 38 industries.

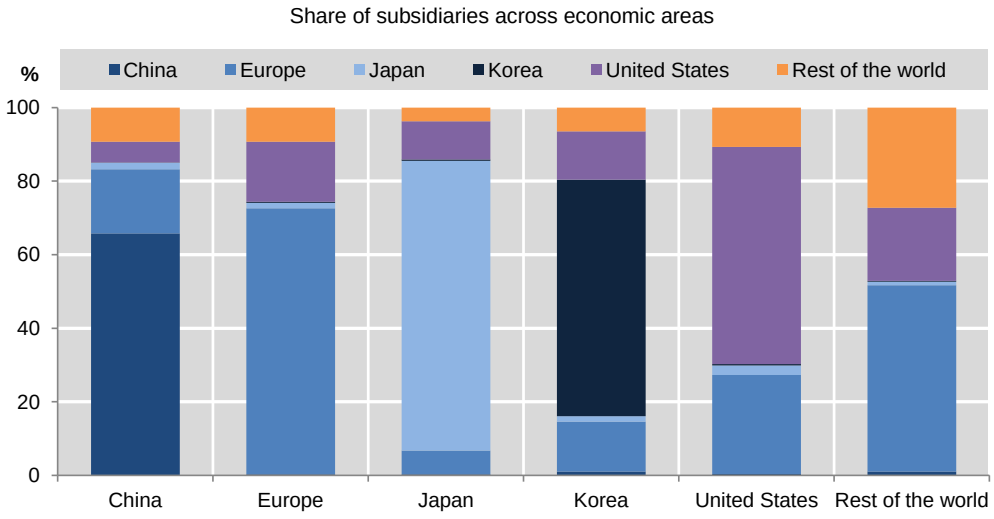
Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013.

Although some industries are the most (or least) diversified over both dimensions considered, heterogeneous strategies emerge, as rankings differ across the geographical and industrial dimensions.

'Transport services' is the relatively most diversified industry both geographically and at the industry level whereas 'Scientific R&D' lies at the other extreme of the spectrum. While some industries show a level of diversification persistently below or above the average on both dimensions (e.g. 'Computers and Electronics' and 'Pharmaceuticals, two among the most represented industries in terms of top R&D investors), others exhibit divergent patterns. For example, firms in the 'Construction' industry appear industrially diversified but

geographically concentrated.

Figure 2.4 – Distribution of subsidiaries by geographical location, 2012



Note: the x axis shows the location of the headquarters.
Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013.

Figure 2.4 provides further insights about the geographical location of the affiliates and participated of top corporate R&D performers, vis-à-vis the location of the headquarters. Data suggest that top corporate R&D performers seemingly concentrate their subsidiaries[11] in the very same area where the headquarters are located. Organisational and market-related strategies, as well as the attempt to minimise organisation and communication-related costs might contribute to explain the patterns observed.

Japan's top corporate R&D investors show the highest share of national subsidiaries (79%), whereas in the case of US investors only 59% of their subsidiaries are located at home. An important presence of US top corporate R&D investors' affiliates can also be found in Europe (27%), whereas European companies show a relatively smaller share of subsidiaries located in the United States than their American counterparts (16%).

China and Korea exhibit similar and high proportions of national subsidiaries (around 65%), but differ in the extent to which they penetrate key markets: Korean companies have a similar percentage of subsidiaries in Europe and the United States (around 13%), whereas Chinese companies are particularly present in Europe (17% as compared to about 6% in the United States). Finally, companies headquartered in the rest of the world appear to have the highest share of subsidiaries located in Europe (about one half) and an important percentage in the United States (about 20%), whereas their presence in key Asian countries is almost negligible (about or below 1% in the case of Japan, China and Korea).

2.2 Linking company data to IP data: a matching approach

Characterising the IP portfolio of companies requires linking IPR data to enterprise data. To this end, the names of the top corporate R&D investors and of their subsidiaries have been matched to the applicants' names provided in patents' and trademarks' documents (see also

[11] The term 'subsidiaries' is used in order to refer to any type of affiliates or participated company included in the present study.

2.3 and 2.4). The linking has been carried out on a by-country basis using a series of algorithms contained in the Imalinker system (Idener Multi Algorithm Linker) developed for the OECD by IDENER, Seville, 2013.

The matching exercise carried out is implemented over a number of key steps:

- The names of top corporate R&D investors and subsidiaries and of the firms included in the IPR-related data are separately harmonised using country-specific 'dictionaries'. These aim at dealing with legal entities denomination (e.g. 'Limited' and 'Ltd'), common names and expressions, as well as phonetic and linguistic rules, which may affect how enterprise names are written. Failing to account for such a feature of the data might mistakenly lead to e.g. not consider a company only because its name has been misspelt or shortened in some parts, or consider twice the same company as its misspelled name makes it look like different entities. The compilation of suitable country and language-specific dictionaries requires country level and language-related knowledge.

- In a second step, a series of string-matching algorithms – mainly token-based and string-metric-based, like token frequency matching, Levenshtein (1965) and Jaro-Winkler (Winkler, 1999) distances – compares the harmonised names from the two datasets and provides a matching accuracy score for each pair. The precision of the match, which depends on minimising the number of false positive matches, is ensured through a selection of pairs of company names / IPR owners made on the basis of high-score thresholds imposed on the algorithm.

- A post processing stage is handled manually and requires reviewing the results of the matches; assessing the proportion of non-matched patenting firms (possibly false negatives, i.e. firms that the algorithm failed to recognise as part of the sample) within the top R&D performers and affiliates; and identifying new matches on a case by case basis (e.g. allowing for lower thresholds for a given algorithm), by correcting and augmenting dictionaries and through manual searches.

The matching was performed using the names of both the top corporate R&D investors and their subsidiaries. IP portfolios have then been aggregated at the level of the headquarters: patents and trademarks owned by a given subsidiary are thus fully attributed to the mother company of the group[12].

Overall, 97% of top R&D performing companies could be matched to at least one patent applicant, either directly or through one or more subsidiary firms. The same overall matching rate is observed for trademark applications.

Table 2.1 and Table 2.2 report the matching rates obtained at the level of the companies/groups and the share of matched subsidiary firms, according to the location of the parent company.

As can be seen, matching rates vary across the economies in which the top corporate R&D investors are located, and are seemingly affected by factors such as the structure of the group, the extent to which subsidiaries are accounted for, and the location of the affiliates.

[12] This is regardless of the precise structure of the group. In practical terms this choice implies that the patents and trademarks of a certain subsidiary are attributed to the mother R&D performer under all circumstances, and independently of the exact share of the affiliate that the mother company owns (whether e.g. 60% or 70%).

The extent to which subsidiary firms could be paired with IP data is shown in table 2.2. Typically, the matching scores observed for subsidiary firms are lower than those observed for their headquarters, in the case of both patents and trademarks. This suggests that while basically all top corporate R&D performers worldwide do directly own an IP portfolio, the same cannot be said for their subsidiaries. Also, IPR portfolios appear to be distributed in an uneven fashion across countries and industries, thus signalling the existence of market-specific and activity-specific strategies and behaviours, as will become clearer later.

Table 2.1 - Linking top 2000 R&D performers to IP data, matching scores at the level of the companies, by companies' headquarter location

	Top 2000 R&D Performers	Matched to patent applicants		Matched to trademark applicants	
	Companies	Companies	%	Companies	%
Australia	15	14	*93.3*	15	*100.0*
Austria	12	12	*100.0*	12	*100.0*
Belgium	13	13	*100.0*	13	*100.0*
Bermuda	10	9	*90.0*	8	*80.0*
Brazil	8	8	*100.0*	8	*100.0*
Canada	17	17	*100.0*	17	*100.0*
Cayman Islands	49	38	*77.6*	35	*71.4*
China	98	94	*95.9*	73	*74.5*
Chinese Taipei	82	82	*100.0*	76	*92.7*
Curaçao	1	1	*100.0*	1	*100.0*
Czech Republic	1	1	*100.0*	1	*100.0*
Denmark	25	24	*96.0*	25	*100.0*
Finland	20	20	*100.0*	20	*100.0*
France	75	72	*96.0*	75	*100.0*
Germany	130	125	*96.2*	130	*100.0*
Greece	1	0	*0.0*	1	*100.0*
Hungary	1	1	*100.0*	1	*100.0*
Iceland	1	1	*100.0*	1	*100.0*
India	22	20	*90.9*	20	*90.9*
Ireland	11	11	*100.0*	11	*100.0*
Israel	15	15	*100.0*	15	*100.0*
Italy	30	29	*96.7*	30	*100.0*
Japan	353	351	*99.4*	351	*99.4*
Korea	56	56	*100.0*	55	*98.2*
Liechtenstein	1	1	*100.0*	1	*100.0*
Luxembourg	4	3	*75.0*	3	*75.0*
Malaysia	1	1	*100.0*	1	*100.0*
Malta	1	0	*0.0*	1	*100.0*
Mexico	1	1	*100.0*	1	*100.0*
Netherlands	34	32	*94.1*	34	*100.0*
New Zealand	2	2	*100.0*	2	*100.0*
Norway	11	10	*90.9*	11	*100.0*
Portugal	4	4	*100.0*	4	*100.0*
Russian Federation	4	4	*100.0*	3	*75.0*
Saudi Arabia	1	1	*100.0*	1	*100.0*
Singapore	5	4	*80.0*	5	*100.0*
Slovenia	1	1	*100.0*	1	*100.0*
South Africa	1	1	*100.0*	1	*100.0*
Spain	16	16	*100.0*	16	*100.0*
Sweden	40	38	*95.0*	38	*95.0*
Switzerland	54	54	*100.0*	54	*100.0*
Thailand	1	1	*100.0*	1	*100.0*
Turkey	6	2	*33.3*	4	*66.7*
United Kingdom	106	94	*88.7*	102	*96.2*
United States	658	649	*98.6*	656	*99.7*
Venezuela	1	1	*100.0*	1	*100.0*
Virgin Islands (British)	1	1	*100.0*	1	*100.0*

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; the Worldwide Patent Statistical Database, EPO, December 2014; and OECD Trademark database (internal), 2014.

Table 2.2 - Linking top 2000 R&D performers to IP data, matching scores at the level of the subsidiaries, by companies' headquarter location

	Top 2000 R&D Performers	Matched to patent applicants		Matched to trademark applicants	
	Subsidiaries	Subsidiaries	%	Subsidiaries	%
Australia	2 664	511	*19.2*	735	*27.6*
Austria	1 764	350	*19.8*	306	*17.3*
Belgium	6 425	739	*11.5*	1 917	*29.8*
Bermuda	378	62	*16.4*	52	*13.8*
Brazil	1 798	1 037	*57.7*	476	*26.5*
Canada	2 457	447	*18.2*	690	*28.1*
Cayman Islands	872	84	*9.6*	70	*8.0*
China	3 159	461	*14.6*	190	*6.0*
Chinese Taipei	3 271	597	*18.3*	389	*11.9*
Curaçao	702	449	*64.0*	359	*51.1*
Czech Republic	285	13	*4.6*	1	*0.4*
Denmark	3 106	706	*22.7*	790	*25.4*
Finland	3 783	550	*14.5*	581	*15.4*
France	85 029	27 939	*32.9*	25 954	*30.5*
Germany	49 983	10 092	*20.2*	10 939	*21.9*
Greece	22	0	*0.0*	0	*0.0*
Hungary	107	4	*3.7*	1	*0.9*
Iceland	57	16	*28.1*	5	*8.8*
India	1 756	293	*16.7*	350	*19.9*
Ireland	3 094	780	*25.2*	886	*28.6*
Israel	1 354	214	*15.8*	248	*18.3*
Italy	10 124	1 002	*9.9*	1 882	*18.6*
Japan	92 423	25 142	*27.2*	30 820	*33.3*
Korea	2 778	1 161	*41.8*	950	*34.2*
Liechtenstein	803	121	*15.1*	253	*31.5*
Luxembourg	1 744	280	*16.1*	166	*9.5*
Malaysia	469	4	*0.9*	11	*2.3*
Malta	39	0	*0.0*	3	*7.7*
Mexico	2 283	223	*9.8*	391	*17.1*
Netherlands	12 444	2 521	*20.3*	3 522	*28.3*
New Zealand	89	8	*9.0*	10	*11.2*
Norway	1 757	144	*8.2*	118	*6.7*
Portugal	907	9	*1.0*	50	*5.5*
Russian Federation	3 883	49	*1.3*	10	*0.3*
Saudi Arabia	210	74	*35.2*	7	*3.3*
Singapore	266	67	*25.2*	53	*19.9*
Slovenia	29	1	*3.4*	1	*3.4*
South Africa	64	20	*31.3*	15	*23.4*
Spain	14 558	4 686	*32.2*	6 451	*44.3*
Sweden	9 572	1 398	*14.6*	1 307	*13.7*
Switzerland	13 700	3 837	*28.0*	3 237	*23.6*
Thailand	38	3	*7.9*	1	*2.6*
Turkey	140	3	*2.1*	4	*2.9*
United Kingdom	52 036	15 207	*29.2*	15 450	*29.7*
United States	116 434	50 780	*43.6*	48 908	*42.0*
Venezuela	23	1	*4.3*	1	*4.3*
Virgin Islands (British)	7	0	*0.0*	0	*0.0*

Note: The data is broken down according to the location of the R&D company, wherever the location of the subsidiary firms.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; the Worldwide Patent Statistical Database, EPO, December 2014; and OECD Trademark database (internal), 2014.

2.3 Innovative output: patent data

To better reflect the inventive activity that top corporate R&D performers carry out worldwide, the statistics presented here are based on patent applications filed at the five top IP offices (IP5) in the world: EPO, JPO, KIPO, SIPO and USPTO.[13]

Depending on a number of factors and on the market strategies that companies pursue, innovators may want to protect the very same invention in different countries. This being the case, they need to file a set of related patent applications in each national or regional office where protection is sought. Consequently, the first patent filing made to protect a given invention worldwide (the so called 'priority' filing) is often followed by (a series of) subsequent and related filings, thus giving birth to a so called patent 'family' (see Martínez, 2011, for a discussion).

To avoid counting several times those patents that have been filed at different IP offices with the aim to protect the very same invention, patent portfolios hence need being consolidated on the basis of the families that patents belong to.

The notion of patent families considered in this study follows the 'extended' family definition, in which patent applications are directly or indirectly linked through the priority filings. The scope of extended patent families is broader than that of mere patent 'equivalents', i.e. patents filed at different IP offices claiming the exact same priority patent, as patents in the same family encompass the incremental steps that may have followed an original invention. The definition also accounts for sets of patents filed at a given IP office (e.g. JPO) that may have been recombined into a single patent application filed at another IP office (e.g. EPO). Consequently, patent families do not reflect here single and unique inventions, but groups of inventions. This to some extent might lead to underestimate the possible incremental innovative steps that companies might take in relation to other, prior or more important, inventions. In any event, such a choice should not affect the present analysis, as R&D projects are generally heterogeneous in aim and in the size of the funding involved, and there is no ex-ante reason to believe that systematic biases exist. Moreover, as companies generally do not disclose information on the nature and the timing of their research projects, it is difficult to try and precisely link R&D inputs to patent output other than using a time-based criterion (i.e. their assumed simultaneity, based on evidence as Hall at al., 1986) and information about possible priority and patent family documents.

Three alternative definitions have been proposed in this respect. Going from definition 1 to definition 3 the filing requirements needed for patents to be taken into account become progressively stricter. In this way it is possible to each time define a subset of comparatively more valuable patents, in terms of families they belong to:

- Definition 1: Families of patent applications with members filed at one or more IP5 offices, including single filings. This implies that applications filed only in one of the IP5 offices, i.e. EPO, USPTO, JPO, KIPO and SIPO, are taken into account.
- Definition 2: Families of patent applications with members filed at least in one of the IP5, excluding single filings. This implies that applications filed only in one of the

[13] The five IP offices (IP5) is a forum of the five largest intellectual property offices in the world that was set up to improve the efficiency of the examination process for patents worldwide. The IP5 Offices together handle about 80 per cent of the world's patent applications, and 95 per cent of all work carried out under the Patent Cooperation Treaty (PCT), see http://www.fiveipoffices.org/.

IP5 offices, i.e. EPO, JPO, KIPO, SIPO and USPTO, are considered only in so far as another family member has been filed in any other office worldwide (anywhere in the world, not necessarily at another IP5 office).

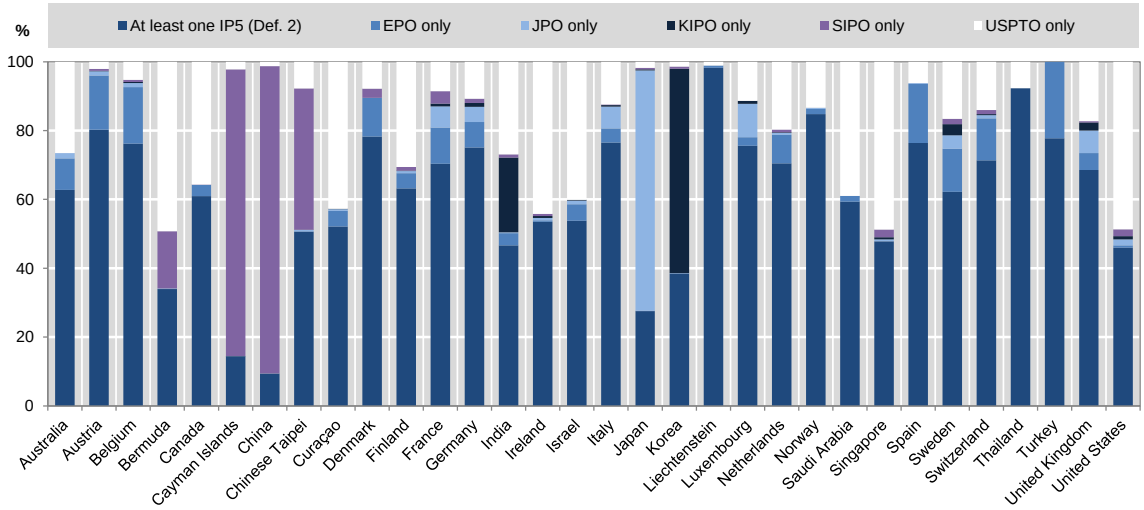
- Definition 3: this is the most restrictive definition, as families of patent applications are considered only in so far as family members have been applied in at least 2 IP5 offices. For instance, patents filed at the USPTO will only be considered if an equivalent filing has been made in any of the remaining IP5 offices. This is irrespective of whether equivalent applications in non-IP5 offices also exist.

No rank or order exists with respect to the IP5 offices, and all are considered to be equally important.

As shown in figure 2.5, the inclusion of single filings in Definition 1 (patents filed only once worldwide) introduces country biases: companies located in Japan tend to apply for a large proportion of patents in their home IP office only, with single filings at JPO that represented 70% of patent families originating from Japanese companies in 2010-12. This phenomenon is even more pronounced for Chinese companies, which seemingly tend to protect their inventions on their own market, with 93% of patent families from Chinese companies that are made of single filings.

Figure 2.5 - Patent filing routes by companies' headquarter location, 2010-12

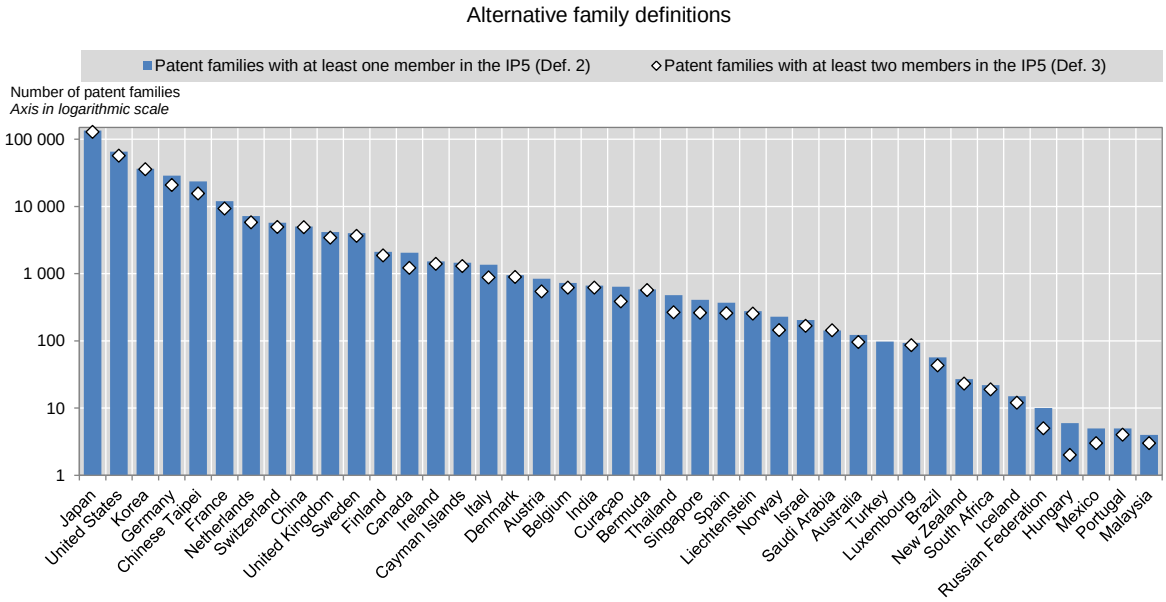
Distribution of patent families with at least one member in one of the IP5 offices, including single filings *(Def. 1)*



Note: Data relate to economies with at least 100 patent families filed by the top corporate R&D investors worldwide in 2010-12.
Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

As it rules out singletons, i.e. single filings, from the family definition, Definition 2 provides a more balanced picture of the patenting activity of top R&D performers, and helps shedding light on their strategic behaviour. By imposing a higher threshold whereby only patent families with members in at least two of the IP5 are considered, counts of patent families relying on Definition 3 further help reflect the relative value of inventions made by those companies. On average, it is observed that 85% of patent families owned by the top R&D performers cover patents filed at two or more of the IP5 offices. The proportion varies with the location of the headquarters of the companies considered in the current sample.

Figure 2.6 - Portfolio of patent families by companies' headquarter location, 2010-12



Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

Definition 2 and 3 are highly correlated, as shown in figure 2.6 and table 2.3 below. Table 2.3 in particular uses data about the patent portfolio of top corporate R&D investors over the period 2010-12 to show the correlation between the different definitions considered (left hand side of the table) and the Spearman's rank correlation (right hand side of the table). The latter provides information about the extent to which the positioning of the top R&D investors changes depending on the specific patent family definition considered.

The correlations shown suggest that using Definition 2 instead of Definition 1 to leave inventions of relatively lower importance or value (i.e. the singletons) outside of the analysis would lead to somewhat different results (with a simple correlation value of .858 and a Spearman correlation value of 0.862). Conversely relying either on Definition 2 or Definition 3 would basically lead to obtaining the very same results (as correlation values are .993 and .983 in the case of simple and rank correlations, respectively).

In an attempt to be as encompassing as possible when accounting for the innovation output of top corporate R&D investors and to construct indicators related to inventions of 'comparable' technological and economic value, in what follows the analysis will be based on the less restrictive of the internationally comparable measures proposed, i.e. Definition 2.

Table 2.3 - Correlation of value and rank between definitions, 2010-12

	Correlation			Spearman's rank correlation		
	Def. 1	*Def. 2*	*Def.3*	*Def. 1*	*Def. 2*	*Def.3*
Def. 1	1.000	0.858	0.862	1.000	0.836	0.823
Def. 2	0.858	1.000	0.993	0.836	1.000	0.983
Def. 3	0.862	0.993	1.000	0.823	0.983	1.000

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

Table 2.4 presents the top 50 patenting companies ranked on the basis of their patent portfolios, defined according to Definition 2. The importance of Asia in this respect can be immediately seen. Of the top ten patenting companies, nine are headquartered in Asia, eight belong to the ICT sector, and account for 25% of all the patents owned by these investors. More precisely, Samsung Electronics (Korea) ranks first, owning almost 5% of the patent portfolio of the top 2000 R&D investors worldwide; other large Asian companies operating in the 'Electronics' and ICT industries follow in the ranking. Notably, 22 top performers are Japanese companies, whereas only 9 US-headquartered top R&D investors and 6 European ones make it in the top 50 list.

As could be expected from the correlation figures shown above, the ranking of top R&D investors in terms of patenting activity over the period considered is basically identical when Definitions 2 and 3 are considered. With the exception of three companies, namely Volkswagen AG, Blackberry Limited and Sei Investments Company, the same corporate R&D investors persistently rank among the top 50, irrespective of the patent family definition used.

Table 2.4 - Top 50 patenting companies, 2010-12

Top 50 patenting companies according to Definition 2 and shares of their patent portfolio in the total top R&D performers' one, comparison with the ranking obtained using Definition 3 in the last columns.

		Definition 2		Definition 3		
		Share	Rank	Share	Rank	*Diff.*
Samsung Electronics Co.,Ltd.	KR	4.7	*(1)*	5.4	*(1)*	
Hon Hai Precision Industry Co., Ltd.	TW	3.0	*(2)*	2.3	*(5)*	*+3*
Toshiba Corporation	JP	2.8	*(3)*	3.1	*(3)*	
Canon Inc.	JP	2.8	*(4)*	3.1	*(2)*	*-2*
Panasonic Corporation	JP	2.3	*(5)*	2.5	*(4)*	*-1*
Sony Corporation	JP	2.0	*(6)*	2.3	*(6)*	
Hitachi Ltd.	JP	1.9	*(7)*	2.1	*(7)*	
General Electric Company	US	1.9	*(8)*	2.1	*(9)*	*+1*
Fujitsu Limited	JP	1.9	*(9)*	2.1	*(8)*	*-1*
Foxconn Technology Co., Ltd.	TW	1.7	*(10)*	1.8	*(10)*	
Fujifilm Holdings Corp.	JP	1.6	*(11)*	1.7	*(11)*	
Robert Bosch GMBH	DE	1.4	*(12)*	1.1	*(19)*	*+7*
LG Corp.	KR	1.4	*(13)*	1.6	*(12)*	*-1*
Toyota Motor Corporation	JP	1.3	*(14)*	1.4	*(13)*	*-1*
Siemens AG	DE	1.2	*(15)*	1.1	*(18)*	*+3*
General Motors Company	US	1.2	*(16)*	1.2	*(15)*	*-1*
Seiko Epson Corporation	JP	1.2	*(17)*	1.3	*(14)*	*-3*
Samsung Display Co.,Ltd.	KR	1.1	*(18)*	1.2	*(16)*	*-2*
Ricoh Co., Ltd.	JP	1.1	*(19)*	1.2	*(17)*	*-2*
Denso Corporation	JP	1.0	*(20)*	1.0	*(22)*	*+2*
Dow Chemical Company (The)	US	1.0	*(21)*	0.9	*(26)*	*+5*
LG Electronics Inc.	KR	0.9	*(22)*	1.0	*(20)*	*-2*
International Business Machines Corp.	US	0.9	*(23)*	0.8	*(29)*	*+6*
Samsung Electro-Mechanics Co.,Ltd.	KR	0.9	*(24)*	1.0	*(21)*	*-3*
Mitsubishi Electric Corporation	JP	0.9	*(25)*	0.9	*(24)*	*-1*
Honda Motor Co., Ltd.	JP	0.8	*(26)*	0.9	*(25)*	*-1*
Huawei Technologies Co., Ltd.	CN	0.8	*(27)*	0.9	*(23)*	*-4*
Mitsumi Electric Co., Ltd.	JP	0.8	*(28)*	0.8	*(27)*	*-1*
Microsoft Corp.	US	0.7	*(29)*	0.8	*(28)*	*-1*
Sharp Corporation	JP	0.7	*(30)*	0.7	*(32)*	*+2*
Hyundai Motor Company Co.,Ltd.	KR	0.7	*(31)*	0.8	*(30)*	*-1*
Brother Industries Ltd.	JP	0.7	*(32)*	0.7	*(31)*	*-1*
Qualcomm Inc.	US	0.7	*(33)*	0.6	*(36)*	*+3*
SK Hynix Inc.	KR	0.6	*(34)*	0.7	*(33)*	*-1*
Kyocera Corporation	JP	0.6	*(35)*	0.7	*(35)*	
Telefonaktiebolaget LM Ericsson	SE	0.6	*(36)*	0.7	*(34)*	*-2*
United Technologies Corporation	US	0.6	*(37)*	0.6	*(38)*	*+1*
European Aeronautic Defence and Space Company Eads N.V.	NL	0.5	*(38)*	0.5	*(44)*	*+6*
Volkswagen AG	DE	0.5	*(39)*	0.4	*(55)*	*+16*
Sumitomo Electric Industries, Ltd.	JP	0.5	*(40)*	0.6	*(40)*	
NEC Corporation	JP	0.5	*(41)*	0.6	*(37)*	*-4*
Koninklijke Philips N.V.	NL	0.5	*(42)*	0.6	*(39)*	*-3*
Taiwan Semiconductor Manufacturing Company Limited	TW	0.5	*(43)*	0.5	*(42)*	*-1*
Blackberry Limited	CA	0.5	*(44)*	0.3	*(65)*	*+21*
Olympus Corp.	JP	0.5	*(45)*	0.6	*(41)*	*-4*
Sei Investments Company	US	0.5	*(46)*	0.4	*(57)*	*+11*
Sumitomo Chemical Company Limited	JP	0.5	*(47)*	0.4	*(51)*	*+4*
Samsung SDI Co.,Ltd.	KR	0.5	*(48)*	0.5	*(43)*	*-5*
Honeywell International Inc.	US	0.4	*(49)*	0.5	*(45)*	*-4*
Renesas Electronics Corporation	JP	0.4	*(50)*	0.4	*(47)*	*-3*

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

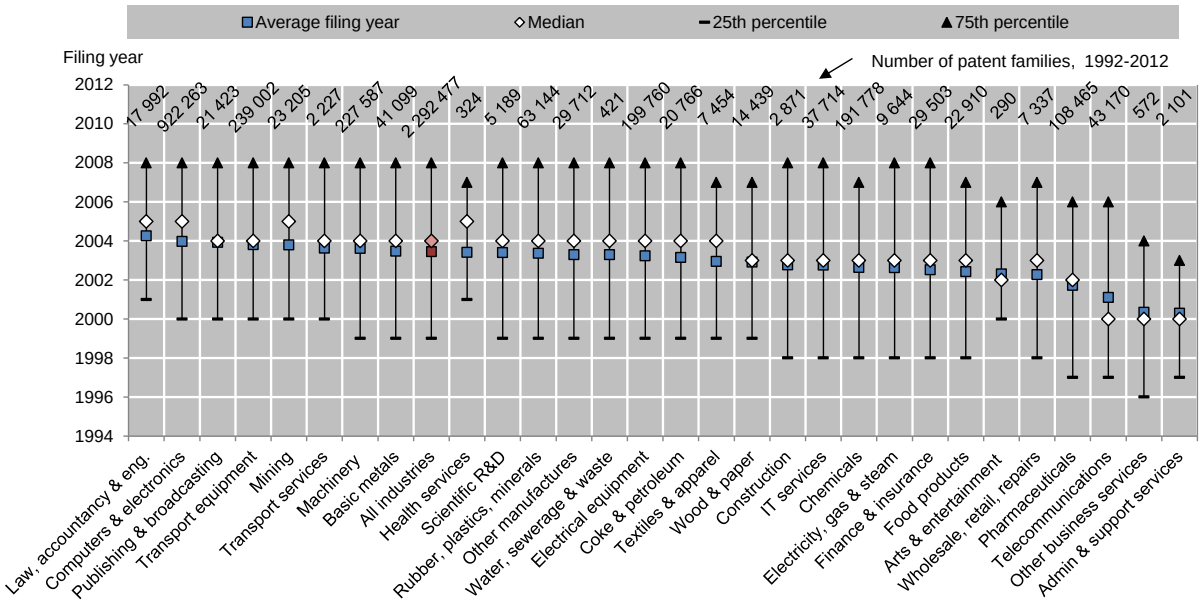
Figure 2.7 gives a flavour of the age distribution of the patent portfolios currently owned by the top corporate R&D investors, intended as the year in which patents were first filed. Statistics are shown by industry of the headquarters and age is based on the earliest filing date of any of the patent family members. The latest year for which patent applications are

observed is the 2012, as patent documents are typically made public (i.e. 'published) eighteen months after the filing date, and there is an additional delay for the information to be integrated and processed in the EPO's Worldwide Patent Statistical Database that is released twice a year (this analysis relies on the most recent version, i.e. the December 2014 version).

The average age of top corporate R&D investors' patent portfolio is of about 9 years, with industry-specific median and average values that are generally very similar. Differences across industries conversely emerge, with the patent portfolios of 'Telecommunication' and 'Pharmaceutical' industries top corporate R&D investors seemingly being on average among the oldest. 'Law, Accountancy and Engineering', 'Computer & Electronics' and 'Publishing and Broadcasting' are the industries that own the youngest portfolios (average filing date in 2004).

Figure 2.7 - Age of companies' patent portfolio by industry, ISIC, rev.4, 1992-2012

Statistical distribution, based on patent families' first filing dates



Note: Data relate to industries with at least 100 patent families.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

2.4. Innovative output: Trademark data

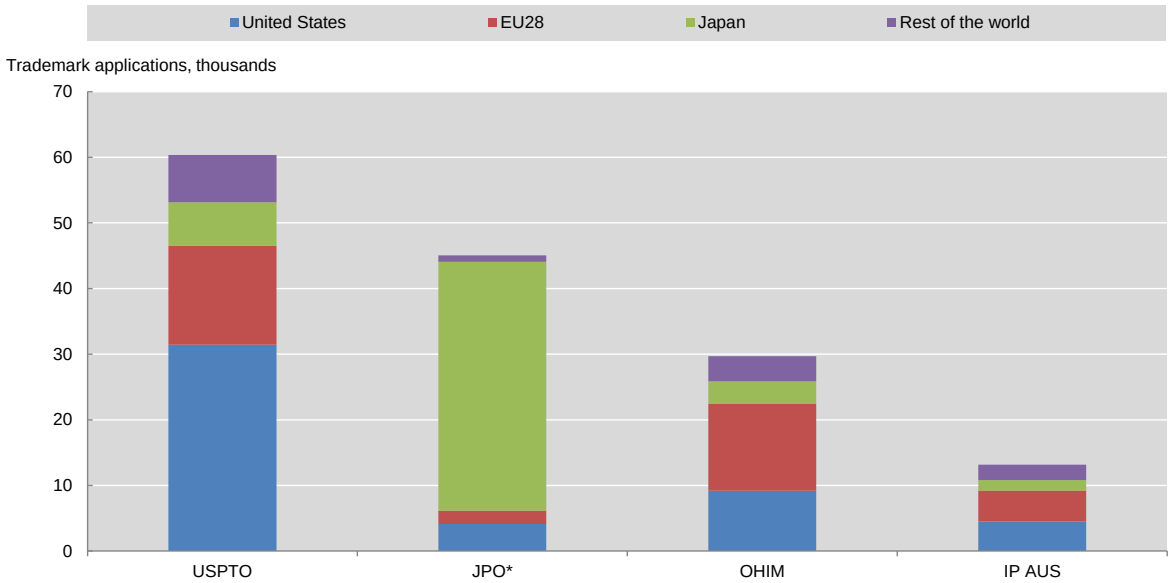
This section provides an overview of the trademark applications of the top corporate R&D investors across four IP offices worldwide: the USPTO[14], the OHIM, the Australian Intellectual Property Office (IP AUS) and the JPO. The USPTO, JPO and IP AUS are national offices, whereas the OHIM administers the Community Trademarks (CTM), i.e. trademarks that are valid throughout the European Community and that coexist with nationally granted trademarks[15].

Figure 2.8 shows the number of trademark applications filed by the top corporate R&D investors worldwide by IP office and location of the headquarters. IP offices are ranked

[14] For more details on USPTO trademark data, see Graham et al. (2013).
[15] For more details, see http://oami.europa.eu/ohimportal/en/.

according to the total number of TM applications related to the period 2010-12[16]. The overall level of TM applications received by the different offices may reflect, among others, the size and attractiveness of the markets that countries represent and the strategies that companies pursue in different markets, and can be influenced by the specific design of trademark systems (e.g. validity of trademarks linked to proving the actual use of such IPR). In the case of OHIM, the coexistence of national trademark systems may further shape the extent to which the system is used.

Figure 2.8 - Trademark applications by office and companies' headquarter location, 2010-12



Note: Trademark counts are based on the application date, the address of the applicant's headquarters and fractional counts. *Data for JPO are up to May 2012.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013 and OECD Trademark database (internal), 2014[17].

At USPTO, JPO and OHIM most TM applications belong to companies with headquarters located in the very same country of the office. This is particularly marked for JPO, where more than 80% of top R&D investors' applications come from companies with headquarters located in Japan. In contrast, residents' applications tend to be less preponderant at IP AUS, where more than two thirds of TM applications come from companies headquartered in the United States and the EU 28 member states.

The importance of trademarking activities by non-resident companies may reflect the degree of market penetration by foreign firms. In addition to the factors mentioned above, it may also be influenced by factors like institutional relationships and commercial agreements between countries and regions.

Table 2.5 lists the top trademark applicants among the top corporate R&D investors and shows the shares of applications they account for, and their ranking in terms of total trademark applications, at each of the offices considered. The 44 companies listed are the ones that rank amont the top 50 applicants in at least two of the four offices considered.

[16] Figures for the JPO only include applications up to May 2012.

[17] The OECD Trademark database (internal), 2014 refers to trademark data from various sources, namely: US Patent and Trademark Office Bulk Downloads: Trademark Application Text hosted by Reed Technology Information Services, OHIM Community Trademark Database CTM Download, April 2014, JPO Trademark Data, September 2012 and IP Australia Trademarks Data, April 2013.

Table 2.5 – Top trademarking companies, 2010-12

Share of companies in trademark applications filed by the top 2000 R&D performers and relative ranking, by office

Company name	Country	Industry	USPTO		OHIM		JPO		IP AUS	
			Share	Rank	Share	Rank	Share	Rank	Share	Rank
In the top 50 of the 4 offices										
JOHNSON & JOHNSON	US	Pharmaceuticals	2.1%	2	1.5%	5	0.8%	29	1.1%	10
LG ELECTRONICS	KR	Computers & electronics	1.0%	9	2.0%	1	0.5%	49	2.0%	2
SONY	JP	Computers & electronics	0.9%	10	1.1%	10	0.9%	22	0.7%	30
TAKEDA PHARMACEUTICAL	JP	Pharmaceuticals	0.6%	24	0.6%	17	0.8%	25	0.8%	21
In the top 50 of 3 offices										
ABBOTT LABORATORIES	US	Pharmaceuticals	0.4%	36	0.4%	44	0.2%	99	0.5%	39
BASF	DE	Chemicals	0.4%	49	0.6%	19	0.1%	235	0.9%	17
BAYER	DE	Pharmaceuticals	0.6%	20	0.7%	14	0.3%	82	0.8%	23
DIAGEO	GB	Food products	0.5%	27	0.5%	22	0.1%	230	0.4%	49
GLAXOSMITHKLINE	GB	Pharmaceuticals	1.4%	4	0.5%	30	0.5%	55	2.2%	1
HENKEL	DE	Chemicals	0.4%	33	0.5%	21	0.0%	357	0.4%	45
JARDEN	US	Electrical equipment	1.3%	7	0.5%	25	0.2%	104	0.5%	41
L'OREAL	FR	Chemicals	0.6%	19	1.9%	3	0.3%	79	1.7%	4
LVMH	FR	Textiles & apparel	0.5%	28	0.4%	34	0.1%	234	1.1%	11
MERCK US	US	Pharmaceuticals	0.6%	22	0.4%	45	0.1%	243	0.5%	35
NESTLE	CH	Food products	0.9%	11	0.5%	31	0.0%	561	1.5%	5
NISSAN MOTOR	JP	Transport equipment	0.4%	40	0.4%	35	0.7%	37	0.0%	563
NOVARTIS	CH	Pharmaceuticals	1.3%	6	2.0%	2	0.3%	73	1.8%	3
PFIZER	US	Pharmaceuticals	0.8%	13	0.5%	26	0.6%	41	0.2%	133
PROCTER & GAMBLE	US	Chemicals	1.4%	3	1.7%	4	0.4%	59	1.0%	14
RECKITT BENCKISER	GB	Chemicals	0.5%	30	1.3%	7	0.1%	250	1.0%	13
SAMSUNG ELECTRONICS	KR	Computers & electronics	0.7%	16	0.7%	15	0.1%	152	0.9%	15
SIEMENS	DE	Computers & electronics	0.4%	32	0.7%	16	0.0%	383	0.9%	19
In the top 50 of 2 offices										
ASAHI BREWERIES	JP	Food products	0.1%	385	0.0%	648	1.2%	14	0.5%	36
BALLY TECHNOLOGIES	US	Arts & entertainment	0.8%	12	0.0%	1322	0.0%	903	0.9%	18
BOEHRINGER INGELHEIM	DE	Pharmaceuticals	0.6%	21	0.2%	130	0.1%	185	1.2%	7
COLGATE-PALMOLIVE	US	Chemicals	0.4%	44	0.4%	49	0.0%	322	0.1%	274
DAIMLER	DE	Transport equipment	0.3%	65	0.4%	39	0.1%	195	0.4%	42
DOW CHEMICAL	US	Chemicals	0.4%	46	0.4%	41	0.2%	122	0.0%	378
ELI LILLY	US	Pharmaceuticals	0.7%	15	0.7%	13	0.3%	67	0.1%	229
FUJIFILM	JP	Computers & electronics	0.1%	167	0.2%	98	0.7%	35	0.4%	43
GENERAL ELECTRIC	US	Machinery	0.5%	26	0.5%	29	0.2%	120	0.4%	58
HASBRO	US	Other manufactures	0.7%	14	0.4%	38	0.1%	200	0.0%	1054
HEWLETT-PACKARD	US	Computers & electronics	0.4%	31	0.4%	43	0.2%	126	0.0%	818
HUAWEI	CN	Computers & electronics	0.4%	48	0.9%	12	0.1%	272	0.2%	142
ILLINOIS TOOL WORKS	US	Machinery	0.3%	62	0.5%	33	0.1%	251	0.7%	25
INTERNATIONAL GAME TECHNOLOGY	US	Other manufactures	0.6%	23	0.2%	126	0.0%	902	1.1%	8
KIRIN	JP	Food products	0.1%	335	0.0%	584	0.7%	33	0.9%	20
MERCK DE	DE	Pharmaceuticals	0.3%	59	0.6%	18	0.1%	242	0.7%	24
MONDELEZ	US	Food products	0.4%	34	0.3%	54	0.2%	136	0.8%	22
NINTENDO	JP	Other manufactures	0.2%	90	0.4%	40	1.2%	15	0.3%	89
SANOFI-AVENTIS	FR	Pharmaceuticals	0.7%	17	0.2%	129	0.2%	111	1.1%	9
SEI INVESTMENTS	US	Finance & insurance	0.6%	18	0.5%	28	0.1%	256	0.4%	60
SYNGENTA	CH	Chemicals	0.4%	50	0.3%	78	0.0%	562	0.6%	34
VOLKSWAGEN	DE	Transport equipment	0.3%	76	1.1%	8	0.0%	438	0.9%	16

Note: Trademark shares and ranks are calculated based on the total applications filed by the top 2000 R&D investors in each office in 2010-12, using fractional counts. The industry classification used refers to an aggregation of the NACE, rev. 2 list into 38 industries. Companies in each subgroup of the table or listed in alphabetical order.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014.

The picture that emerges is one that differs substantially from the one observed in the case of patent ownership. While ICT companies continue to play an important role in terms of trademark acivities, they are not the only ones, as 'Pharmaceuticals' and 'Chemicals' R&D investors also systematically appear among the top trademarking companies.

Also, companies' ranking tends to differ widely across offices. Only four companies are persistantly ranked among the top 50 applicants across the four offices. This suggests that companies pursue different TM strategies in the various markets. Different patterns may also be observed at the industry level. The ranking of companies in the 'Pharmaceuticals', 'Computers and electronics' and 'Chemicals' industries tends have a similar trademarking behaviour across different offices, whereas food product companies, for instance, seemingly

behave in a different way in different markets. This may depend on factors as the possibility or need to standardise products, or converseely the need to differentiate products and services according to the market targeted.

3. The patent portfolio of top corporate R&D investors

Key findings

- Patenting activities highlight heterogeneous industry and firm-specific behaviours
- Patent applications are concentrated around a narrow set of technologies
- Top corporate R&D investors pursue distinct filings strategies across IP offices and over time
- The geographical distribution of technological advantages reveals a wider specialisation of European and US based companies
- Top corporate R&D investors rely on international knowledge to develop their technologies

The rationale behind patent systems is to solve a problem of knowledge appropriability. To this end, ex ante guarantees to provide ex post exclusionary rights (and thus monopoly rents) are offered to inventors as an incentive to invest in discovery and development. This is done in exchange for supply of the invention to society and disclosure of the technical information related to it, in a manner that can be understood by qualified third parties. By providing information about new knowledge, patents may foster the diffusion of information that might otherwise be kept secret, and enable follow up inventions (see e.g. Scotchmer, 2004).

In particular, patent-based indicators, exploiting information contained in patent filings, convey information on the output and processes of the underlying inventive activities. Patents protect inventions and, although the relationship is not a simple one, research has shown that when the proper controls are applied, there is a positive relationship between patent counts and other indicators related to innovation and economic performance (productivity, market share, etc.). This relationship varies across countries, industries and over time. Indeed, before an invention can become an innovation, further entrepreneurial efforts are required to develop, manufacture and market it.

The statistical exploitation of the data contained in patent documents offers unique insights into invention processes. Among others, patents provide information on the technological content of inventions (i.e. their technical domain), the geographical location of the inventive process, and who contributed to develop the inventions. They help tracking the technological development and positioning of given entities in technology fields and areas (*e.g.* indexes of revealed technological advantages), and their evolution over time. Finally, because patents identify owners and inventors, they may also provide useful information about the organisation of the underlying research process.

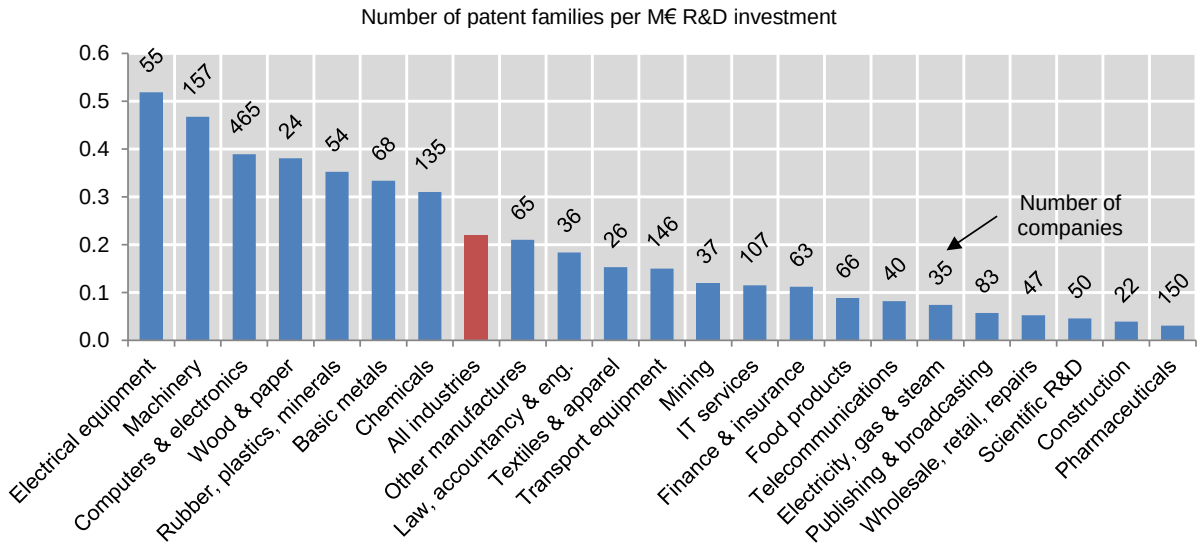
The data on the patent portfolio of top corporate R&D investors analysed in this section result from the methodology described in section 2.3. The analysis intends to cover different dimensions of companies' patenting behaviours and strategies, using state of the art indicators related to patent propensity, technological focus and concentration, patent value and international patterns.

3.1 Propensity to patent: stylised facts

The propensity to patent aims to capture the extent to which innovative efforts, measured in terms of R&D investment, translate into innovative output, as proxied by patents. This indicator is defined as the number of patents obtained per R&D euro (or dollar) spent (Scherer, 1983). Evidence suggests that the propensity to patent varies across industries, countries and over time, and is shaped by a number of factors, including framework conditions as market structure and regulations (see e.g. Mansfield, 1984; Acs and Audretsch, 1989).

Figure 3.1 shows the patent propensity of the top corporate R&D investors worldwide for the period 2010-12, as measured by the number of patent families filed per million Euros (M€) invested in R&D. 'Pharmaceuticals' companies emerge as those with the lowest propensity to patent, as these companies on average obtain only 0.03 patent families per each million Euros invested in R&D. At the other end of the distribution, 'Electrical equipment' companies conversely obtain 0.52 patent families per million Euros invested in R&D, thus exhibiting a patent propensity which is more than 17 times that of pharmaceutical companies. Such differences might be driven by some structural features of the industries considered, the degree of complexity and modularity of the products they produce, as well as differences in their strategic and competitive behaviours (see Somaya, 2012, for a review).

Figure 3.1 – Patent propensity of the Top R&D investors by industry, ISIC rev. 4, 2010-12



Note: Data relate to industries with at least 20 companies in the top 2000 top corporate R&D sample.

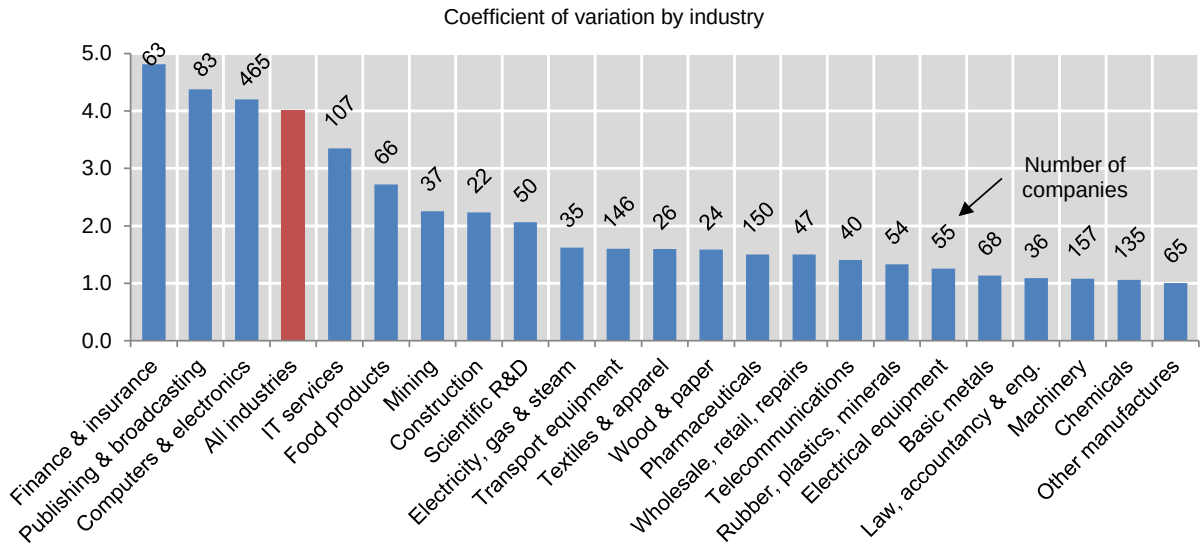
Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

In the case of 'Electrical equipment' companies, the figures shown imply that an average R&D investment of about 2 M€ is required per patent family. Companies operating in the 'Machinery' industry show a similar albeit slightly lower propensity to patent, and are followed by corporate investors in the 'Computer and electronics', 'Wood and paper', 'Basic metal', 'Rubber, plastic and minerals', and 'Chemicals' industries. All the other industries show patent propensities below the 0.22 value of the sample average, corresponding to an R&D investment of about 4.5 M€ per patent family. In the case of 'Pharmaceuticals' this

investment is of 32 M€ per patent family.

In the same way as the propensity to patent varies across industries, important differences also exist between firms operating in the very same industry. Figure 3.2 illustrates the extent to which the propensity to patent varies within industries, by showing the industry-specific coefficients of variation, which represent a standardised measure of variability[18].

Figure 3.2 –Variation in the patent propensity, by industry of top R&D investors, ISIC rev. 4, 2010-12



Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

A marked heterogeneity in the patent propensity of the firms belonging to the same industry emerges, as well as a somewhat negative correlation between the propensity to patent at the industry level and the coefficient of variation within the industry: the more the patents on average obtained per R&D investment at the industry level, the generally smaller the difference in the extent to which within-industry firm-specific propensities to patent vary.

Among the industries with relatively higher patents to R&D ratios 'Computers and electronics' is the only showing a high variability in the propensity to patent. 'Electrical equipment' and 'Machinery', the top two industries in terms of their propensity to patent, are conversely among the industries featuring the lowest within variability.

3.2 A patent-based technological profile

3.2.1 The technological focus of top corporate R&D investors

Patent data allows identifying the main technological fields in which top corporate R&D investors focus their inventive activities. Information about the technology classes in which patents are filed can in fact be used to proxy technological specialisation (e.g. Patel and Pavitt, 1997), and thus identify the technological competences at the basis of companies' output and performance.

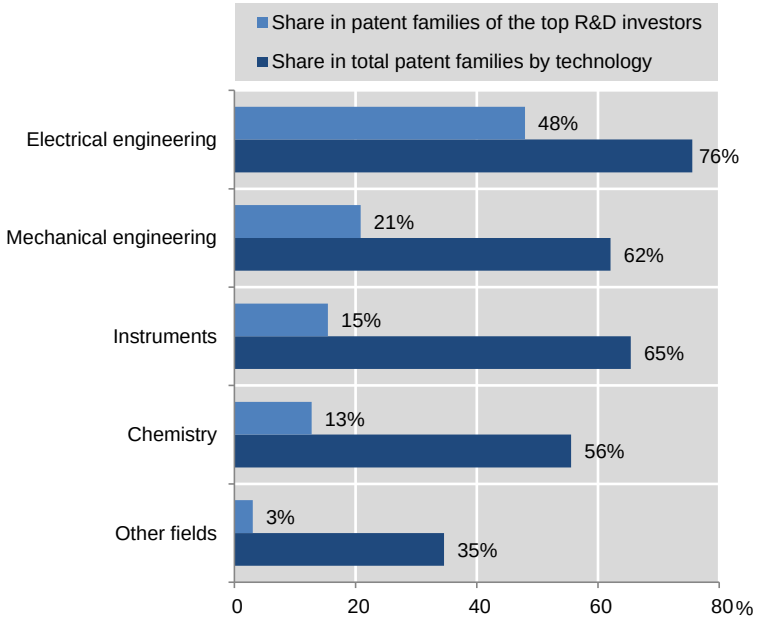
[18] The coefficient of variation is defined as the ratio of the standard deviation to the mean. It is a measure of variability relative to the mean of a given population and allows for meaningful comparisons between populations showing different averages.

To this end, the International Patent Classification (IPC) based technology concordance originally developed by Schmoch (WIPO, 2013c) is used in the present report. This hierarchical classification groups IPC classes into 35 technological fields belonging to five main technological areas, namely: *Electrical Engineering*, *Mechanical Engineering*, *Instruments*, *Chemistry*, and *Other Fields*.

Figure 3.3 shows the distribution of patents across the five technological areas of the WIPO classification. The patenting activity of the top 2000 corporate R&D investors worldwide appears to clearly focus on technologies related to *Electrical engineering*, which account for almost half of all patent families belonging to these companies. While other technology fields appear relatively less important in terms of shares they account within the patent portfolios of these companies, they are certainly not when the total numbers of IP5 patent families are considered. The 2000 top corporate R&D investors considered in the present report account for the vast majority of all IP5 patent families in *Electrical engineering* (76%) as well as *Mechanical engineering* (62%), *Instruments* (65%) and *Chemistry* (56%), and for the 35% on average of all IP5 patent families in other technological domains. Overall IP5 families owned by the world top corporate R&D investors represent 66% of all IP5 families worldwide.

Figure 3.3 - Distribution of patent families across technological areas, 2010-12

Share of patent families of world top R&D investors by technological area in overall patent portfolios, and share in total patent families by technology area

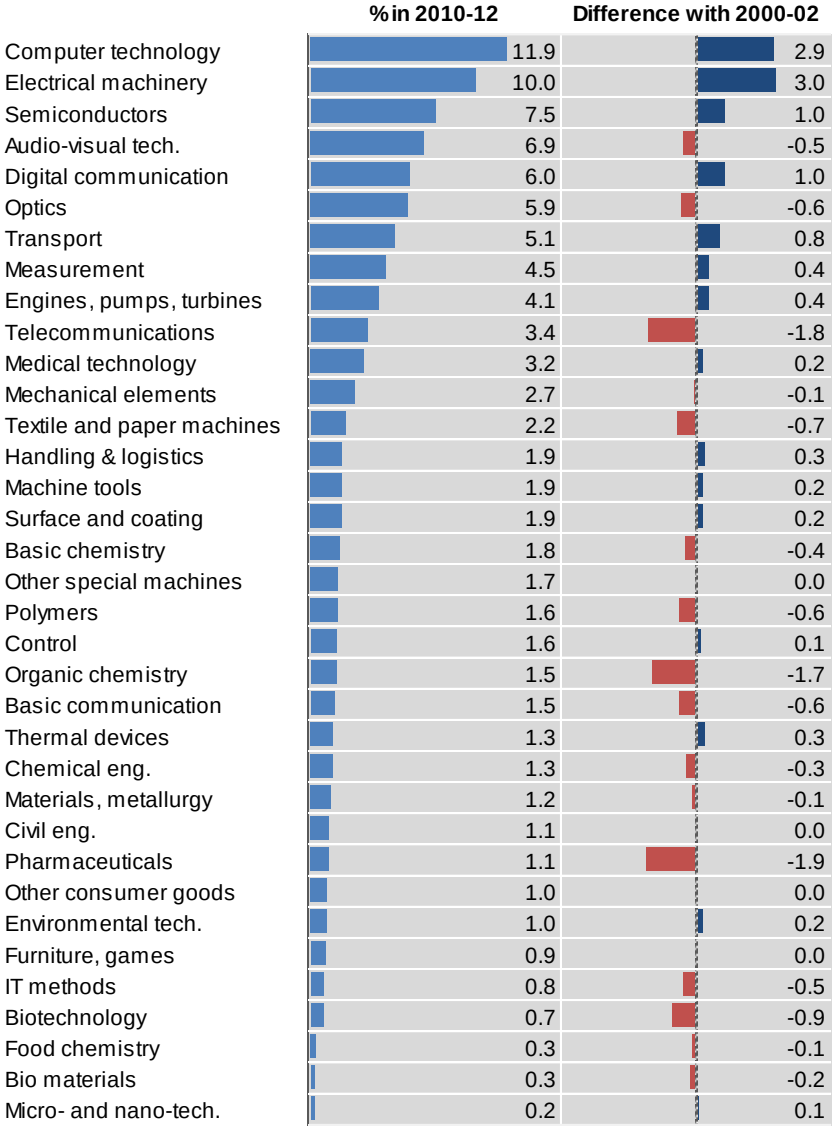


Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

Figure 3.4 further details the extent to which top corporate R&D investors file patents in the different technological fields. Technological fields are ranked according to their shares over the total number of patent families owned by the top corporate R&D investors. The distribution of patent families filed by these companies during the period 2010-12 is compared with that of the 2000-02; the resulting differences are reported in the last column on the right.

Figure 3.4 - Distribution of patent families across technological fields, 2010-12 - differences with respect to 2000-02

Share of patent families by technological area (left) and differences with respect to the 2000-02 (right)



Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

Top corporate R&D investors appear to have generally shifted their activities away from a number of technologies (including *Audio-visuals*, *Optics* and *Telecommunications)* while increasing, although to different extents, patenting in fields as *Computer technology*, *Electrical machineries*, *Semiconductors* and *Digital Communication*.

Inventions related to ICTs appears to have been the ones that have seen their share increasing the most over the total number of patents owned by the top corporate R&D investors worldwide.

Computer technology represents the technology in which top corporate R&D investors worldwide are more active, with a share over the total patent portfolio of about 12%. This is also one of the two technologies that experienced the highest growth in terms of patent filings over time: its share increased by almost 3 percentage points with respect the 2000-02 period.

Electrical machinery and *Semiconductors* are the second and third most patented technologies and have also experienced among the highest patent filing growth, with an

increase in percentage point of 3 and 1, respectively.

While the number of pharmaceutical top corporate R&D investors in the sample is high – they account for about 15% of the top corporate R&D investors and for 20.3%[19] of total R&D expenditures – *Medical technologies* and *Pharmaceuticals* account for a low share of patents (about 3%, and 1%, respectively in 2010-12). This could be expected given the statistics shown about the propensity to patent of the companies belonging to these industries. Moreover, whereas the relative weight of *Medical technologies* has slightly increased over the period considered, the other technologies related to the 'Pharmaceutical' industry (as shown also later) have declined in terms of relative weight in the sample: *Pharmaceuticals* (-1.9 percentage points), *Organic chemistry* (-1.7%), *Biotechnology* (-0.9%), *Basic chemistry* (-0.4%).

These differences may be driven by a wide array of industry, firm and product specific characteristics, including differences in the complexity and modularity of the products that these industries produce (e.g. mobile phones versus pharmaceutical compounds).

3.2.2 The technological concentration of patent portfolios

A concentration ratio (CR) index is here constructed to shed light on the extent to which top corporate R&D investors concentrate their inventive activities in a subset of technology fields. The concentration ratio is an index typically used in the competition literature to show the market share of the N largest firms in an industry. In the present case, a CR4 index is constructed, synthesising the proportion of patents that companies of a given industry *I* file in the top four technology fields in which they patent, out of the 35 technological fields identified in WIPO (2013c).

The CR4 for each industry *I* is calculated as follows:

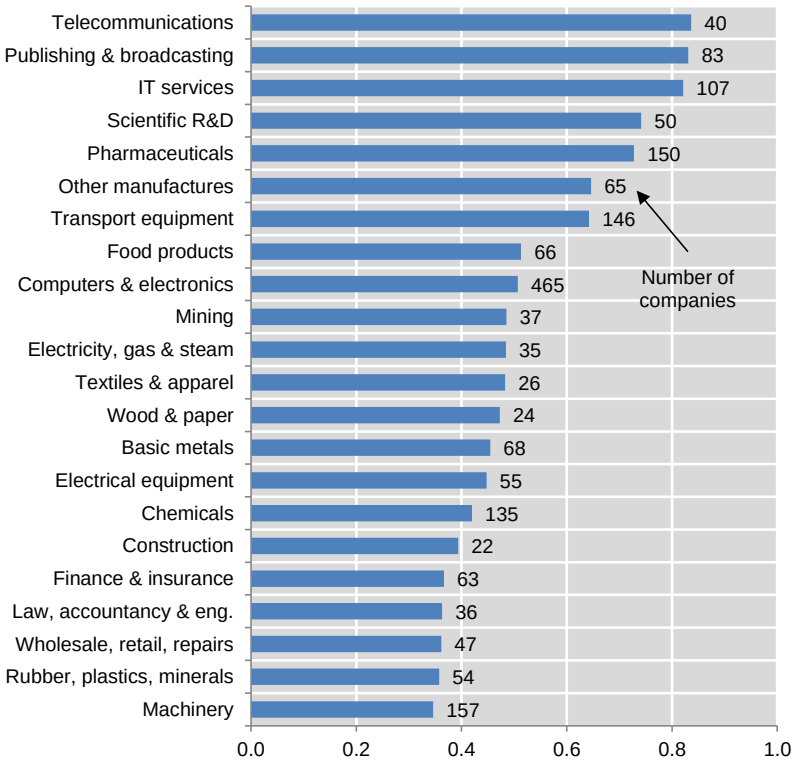
$$CR_{4,I} = \sum_{n=1}^{4} s_n$$

where s_n denotes the share of the *n-th* technological field over the total patents and 4 is the number of technological fields considered (ranked in a descending order) to compute the index.

Figure 3.5 reports the concentration indices for the industries featuring at least 20 of the top 2000 R&D investors worldwide. Except for 'Computers and electronics', ICT-related industries generally present a level of technological concentration that is much higher than that of other industries.

[19] The label Pharmaceutical denotes companies operating in the 'Health Care Equipment & Services' sector, and in 'Pharmaceuticals & Biotechnology'.

Figure 3.5 –Technological concentration (CR4) by industry, ISIC rev.4, 2010-12



Note: Data relate to industries with at least 20 companies in the top 2000 top corporate R&D sample. Figures in brackets indicate the number of companies available.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

'Telecommunications', 'Publishing & Broadcasting', and 'IT services' industries show the highest values in terms of technological concentration of their patent portfolios: they file more than 80% of their patents in four technology areas only. 'Scientific R&D', 'Pharmaceuticals', 'Other manufactures', and 'Transport equipment' follow in terms of concentration of their inventive activities in selected areas, with values above 60%. Of the industry considered, 'Machinery' is the one showing particularly low values of CR4 (below 40%), thus seemingly resulting as the less concentrated industry among those accounting for a high number of top R&D investing companies.

Table 3.1 shows the correlation coefficients between technological concentration, and the subsidiary diversification measures discussed in section 2.1. Technological concentration and industrial and geographical diversifications appear negatively correlated, although to different extents, as can be seen from the magnitude of the correlation coefficients. As the CR4 index is a concentration measure, its negative correlation with the number of industries in which subsidiaries operate indicates that the more technologically diversified companies operate in a relatively higher number of industries and are geographically more dispersed, i.e. operate in a relatively greater number of countries. Also, as could be expected, operating in a wide array of industries and being geographically diversified are positively correlated.

Table 3.1 - Correlation of technological concentration and subsidiary diversification, 2010-12

	Correlation			Spearman's rank correlation		
	CR4 technology	Number of industries	Number of countries	CR4 technology	Number of industries	Number of countries
CR4 technology	1			1		
Number of industries	-0.545	1		-0.465	1	
Number of countries	-0.154	0.704	1	-0.163	0.593	1

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

Mastering a wide array of technological competences is positively linked to operating in a large number of industries. The same holds, although not to the same extent, between technological and geographical diversification (as the correlation between technological specialisation and number of countries in which a company is located is on average -.154). Operating on a larger geographical scale might not necessarily involve a more diversified knowledge base, and activities might to some extent remain at the level of adapting products to the local tastes.

3.2.3 The technological profiles of selected industries

In what follows, further light is shed on the behaviour of those industries accounting for the highest number of top R&D investors. These industries are: 'Pharmaceuticals', 'Computer and Electronics', 'Machinery', and 'Transport equipment' industries.

Figure 3.6 shows the distribution of the patent portfolios over the different technology fields. It reveals the relatively higher concentration in a narrow set of technology fields by top corporate R&D investors in the 'Pharmaceuticals' and 'Transport Equipment' industries. The Pharmaceutical industry shows a technological profile based on *Pharmaceuticals* (mainly compounds), *Medical technologies* and *Organic chemistry*. With a share of about 10%, *Biotechnology* represents an important technology field on which pharmaceutical companies build their competitiveness. The 'Computers and electronics' industry, featuring the highest number of top R&D investors in the sample (465 companies), conversely shows a more diversified portfolio in terms of technology focus of its inventive activities. While more diversified, though, patenting activities mainly centre on ICT technologies, with *Electrical machinery*, *Optics* and *Measurement* representing important technologies for companies operating in this industry (share above 5%).

Figure 3.6 - Technological profiles of the 4 most represented industries, ISIC rev.4, 2010-12

Share of patents owned by selected industries by technology fields

Technological Field	Pharmaceuticals	Computers & Electronics	Machinery	Transport equipment
Electrical machinery	1	11	8	14
Audio-visual tech.	0	11	5	2
Telecommunications	0	5	2	1
Digital communication	0	10	1	1
Basic communication	0	3	0	0
Computer technology	1	17	7	4
IT methods	0	1	0	0
Semiconductors	1	12	3	1
Optics	1	7	10	1
Measurement	2	5	5	5
Bio materials	2	0	0	0
Control	0	2	2	2
Medical technology	18	3	2	0
Organic chemistry	16	0	0	0
Biotechnology	10	0	0	0
Pharmaceuticals	28	0	0	0
Polymers	3	0	0	0
Food chemistry	1	0	0	0
Basic chemistry	5	1	1	0
Materials, metallurgy	1	1	1	1
Surface and coating	1	2	2	2
Micro- and nano-tech.	0	0	0	0
Chemical eng.	2	1	2	1
Environmental tech.	0	0	2	3
Handling & logistics	1	1	4	1
Machine tools	0	1	6	2
Engines, pumps, turbines	0	1	10	14
Textile and paper machines	0	2	6	0
Other special machines	1	1	3	2
Thermal devices	0	1	2	2
Mechanical elements	0	1	7	9
Transport	0	1	5	28
Furniture, games	0	0	0	0
Other consumer goods	0	1	0	1
Civil eng.	0	0	3	1

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

While displaying clear sector specificities, companies in the 'Machinery' and the 'Transport equipment' industries show somewhat similar technological profiles. Both industries have important shares of patent portfolios in *Engines*, *Electrical machinery*, *Mechanical elements*, *Measurement*, and *Computer technologies*. In addition the 'Machinery' industry shows relevant shares of patents in *Machine tools*, *Material processing*, and *Audio-visual technologies*, whereas the 'Transport equipment' industry is very focused on *Transport technologies*.

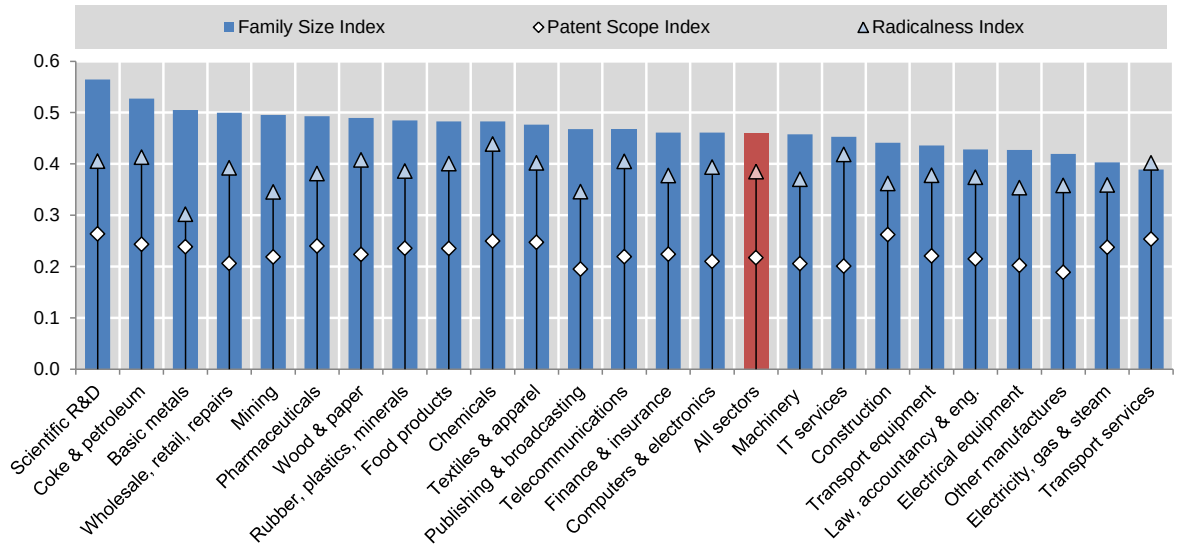
3.3 Technological and economic value of patents

The technological and economic value of patented inventions is known to vary widely across firms and sectors, and over time. Many indicators attempt to capture the different meanings that patent value may have for different stakeholders, such as inventors, firms, attorneys or policy makers.

The indicators proposed below are to be considered as proxies of the quality of inventions, intended as their technological and economic value. They only rely on information contained in published patent documents, and do not integrate any information about market transactions or the real use of patented technologies. The patent quality indicators used encompass the technological breadth of patents (measured by the patent scope), the expected economic value of patents (patent family size), and the extent to which the invention can be considered as a radical invention *vis-à-vis* prior art (see Squicciarini et al., 2013, for details about these and other patent indicators). The analysis focuses on EPO and USPTO patents that belong to IP5 families.

As can be seen from Figures 3.7a and 3.7b, Scientific R&D services hold EPO patent families of relatively high value, featuring strengths both in terms of economic value (family size) and of technological value (patent scope). Firms in the 'Chemical' and in the 'Coke and petroleum' industries, as well as in 'Telecommunications' and 'IT services' and 'Transport services' seemingly own European inventions of large technological breadth – as measured by patent scope - and of a marked technological impact, as measured by the radicalness index.

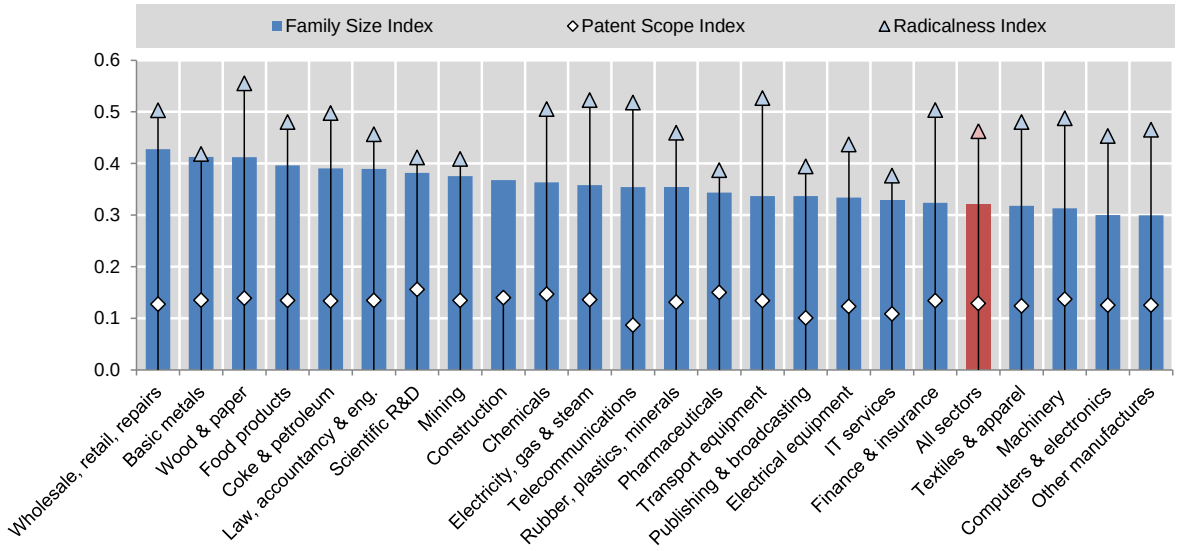
Figure 3.7a – Relative value of EPO patents, average indices by industry, ISIC rev. 4, 2010-12



Note: The data refer to patent applications filed to the EPO that belong to IP5 families. The family size and patent scope indices are normalised according to maximum value observed by patents in the same cohorts (filing date and WIPO technology fields). Data relate to industries with more than 150 EPO patents in the given period.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

Figure 3.7b – Relative value of USPTO patents, average indices by industry, ISIC rev. 4, 2010-12



Note: The data refer to patent applications filed to the USPTO that belong to IP5 families. The family size and patent scope indices are normalised according to maximum value observed by patents in the same cohorts (filing date and WIPO technology fields). Data relate to industries with more than 150 USPTO patents in the given period.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

The family size index of USPTO patents is, in general, relatively lower than that of EPO patents, which may to some extent reflect the attractiveness of the US market vis à vis other markets and the consequent less marked necessity to extend coverage in other countries, and mirror the important presence of US-headquartered top corporate R&D investors.

Also, it can be noticed that, in general, USPTO patents feature higher radicalness values than EPO ones. This can be due, at least in part, to the fact that information on patent citations - on which the radicalness index relies - is only available for USPTO granted patents, and not for all patent filings, as is the case for EPO patents. Hence, in the case of USPTO the indicator is based on patents known to have succeeded in the patent examination process and on a lower number of observations.

Comparing the different patent quality indicators proposed, it emerges clearly that, while the scope of USPTO patents does not seem to vary much across industries, their radicalness does so, with companies in a number of industries including 'Transport equipment', 'Telecommunications' and 'Wood & Paper' that seemingly tend to generate relatively more radical innovations.

Box 1. The economic and technological value of patents

The quality and value of patented inventions varies from patent to patent, at firm and industry level. A wide array of patent quality measures have been proposed in Squicciarini et al. (2013), with the aim of capturing the technological and economic value of patents and the possible impact that patents may have on subsequent technological developments.

The proposed indicators rely on a set of information contained in patent documents. Due to differences in rules and regulations of patent offices (e.g. different patent classification systems, citation procedures, etc.), indicators based on EPO patents shall not be strictly compared with those derived from e.g. USPTO patents. To account for variations due to the timing and the technical specificities of patents, indicators are normalised relying on information from the same cohorts, i.e. of patents filed in the same technology field in the same year.

Patent Scope

The scope of a patent is associated with its technological and economic value. The patent scope index is defined as the number of distinct 4-digit subclasses of the IPC to which the invention is allocated to. The larger the number of IPC classes, the broader the scope index, and the higher the potential technological and market value of patents.

Family Size

The economic value of patents, i.e. their patent family size, has been found to be associated with the number of jurisdictions in which the patent has been sought, and large international patent families have found to be particularly valuable. Owing to the Paris Convention (1883), applicants have up to 12 months from the first filing of a patent application (typically in the country of origin) to file applications in other jurisdictions regarding the same invention and claim the priority date of the first application.

The normalised patent family size index shown here refers to the number of patent offices at which a given invention has been protected.

Radicalness index

The definition of technologically radical inventions proposed here is an adaptation of the one proposed by Shane (2001), where the radicalness of a patent is measured as a time invariant count of the number of IPC classes not included in a given patent document but included in the patents cited by the same patent document. An invention should therefore be considered radical when a patent cites previous patents in different classes from the ones it is in. The higher the ratio, the more diversified the array of technologies on which the patent relies.

3.4 The international patterns of patent activity

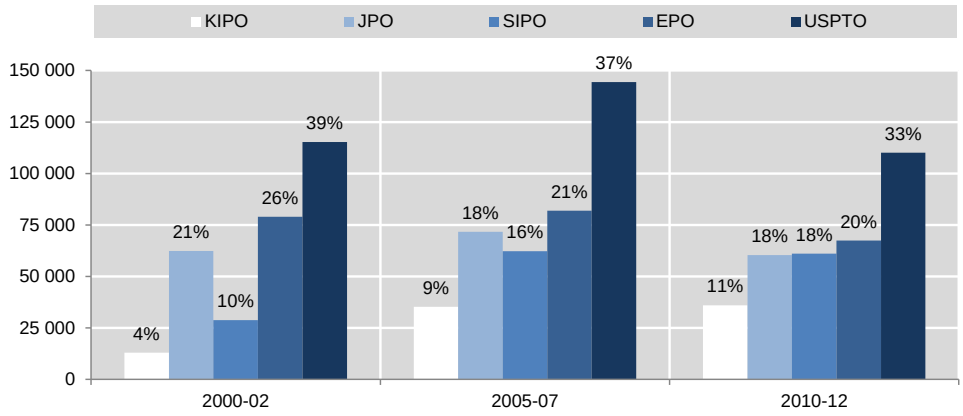
3.4.1 Patenting strategies across offices

Looking at the IP offices where top corporate R&D investors worldwide protect their inventions may indirectly provide important information about their innovative and market strategies. International patent filing strategies may in fact relate, among others, to companies' production and market strategies, to the characteristics of patent regimes and to taxation aspects.

Figure 3.8 shows the distribution of top corporate R&D investors' patents across the IP5 offices for the period 2010-12 (on the right), and compares them with similar figures related to the 2000-02 and 2005-07 periods. During the 2010-12 USPTO has been the most targeted patent office by the top 2000 R&D investors worldwide, recording about 33% of the total patent family filings. EPO, SIPO, and JPO account for similar albeit lower shares of

applications, i.e. 20 percent in the case of EPO and 18 percent in the case of both SIPO and JPO. Inventions patented at KIPO conversely represent about 11% of the total filings of the sample.

Figure 3.8 – Distribution of patent families by IP5 office, 2000-02, 2005-07 and 2010-12



Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

The above figures may to some extent reflect the methodological choice made in this report, i.e. to rely on patent applications exhibiting family members filed at least in one of the IP5 offices, thus excluding single filings, and to use fractional counts. In this way, it is possible to avoid double counting, to control for multiple filings of the same invention in different locations and to at least partially address the possible bias that may arise due to e.g. differences in patent procedures across offices.

Selecting only those patents filed in at least two offices worldwide seemingly has a different impact on the overall patent portfolio, depending on the office considered (see also section 2.3 in this respect). In particular, comparing the figures presented in this report with those of WIPO (2013b), which are based on simple patent counts, important differences arise. For instance, in the present report SIPO appears to be the third office in terms of patent family applications, whereas in the WIPO report it is the patent office registering the highest number of single patent filings (with almost 28% of the total worldwide patent applications). Moreover, the shares of USPTO and EPO on the total patent family portfolios are respectively 10 and 14 percentage points higher than in the WIPO report.

In terms of patenting activities of the top corporate R&D investors included in the present report, significant changes emerge across IP5 offices, over the last 10 years. The relative share of patents filed at USPTO declined from about 39% in 2000-02 to 33% in 2010-12. A similar pattern can be observed in the case of EPO. Such apparent decreases are in part due to USPTO and EPO experiencing lower patent filings' growth than that of KIPO and SIPO.[20] SIPO almost doubled its relative importance in terms of IP5 patent applications, whereas

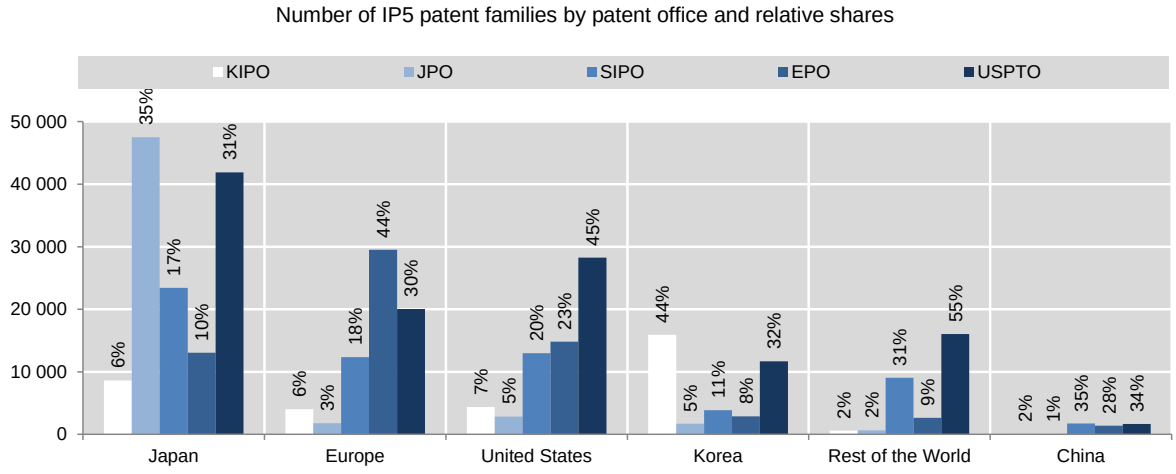
[20] In general terms, the lower number of patent applications observed in the last period might be in due in part to the methodology used in the present report. By considering patent applications with family members filed at least in one of the IP5 plus another patent offices (also at a national level), and given that time is needed to file patents at different offices, it might not be possible to fully observe what happens in the very last period, due to truncation.

KIPO's increase was almost threefold, moving from about 4% of total patent applications in the 2002-2002 to 11% in 2010-12.

These relative changes in patent applications across IP5 offices result in a more uniform distribution of patent filings over the 2010-12 period (right hand part of figure 3.8) than in the 2000-02 (see left part) and witness the extent to which the innovation and economic landscape has been changing in the last decade.

The growing importance of the Chinese market and the increasing relevance that IPR are having in China[21] is further reflected in figure 3.9, showing the distribution of inventions filed across patent offices by headquarters location of top R&D investors. Japanese (10%) and Korean (8%) companies file a relatively low share of their inventions at the EPO, corresponding to 10% and 8% respectively. The tendency to patent at the JPO is even lower for non-Japanese companies, the share being always below 5%. On the other hand, Japanese companies do file important shares of their patent family portfolios at the UPSTO (31%) and the SIPO (17%). Overall, Figure 3.9 shows the extent to which key markets are targeted, and the extent to which these figures differ according to the location of the headquarters of top corporate R&D investors.

Figure 3.9 – Family filings at different publication authorities, by companies' headquarter location, 2010-12



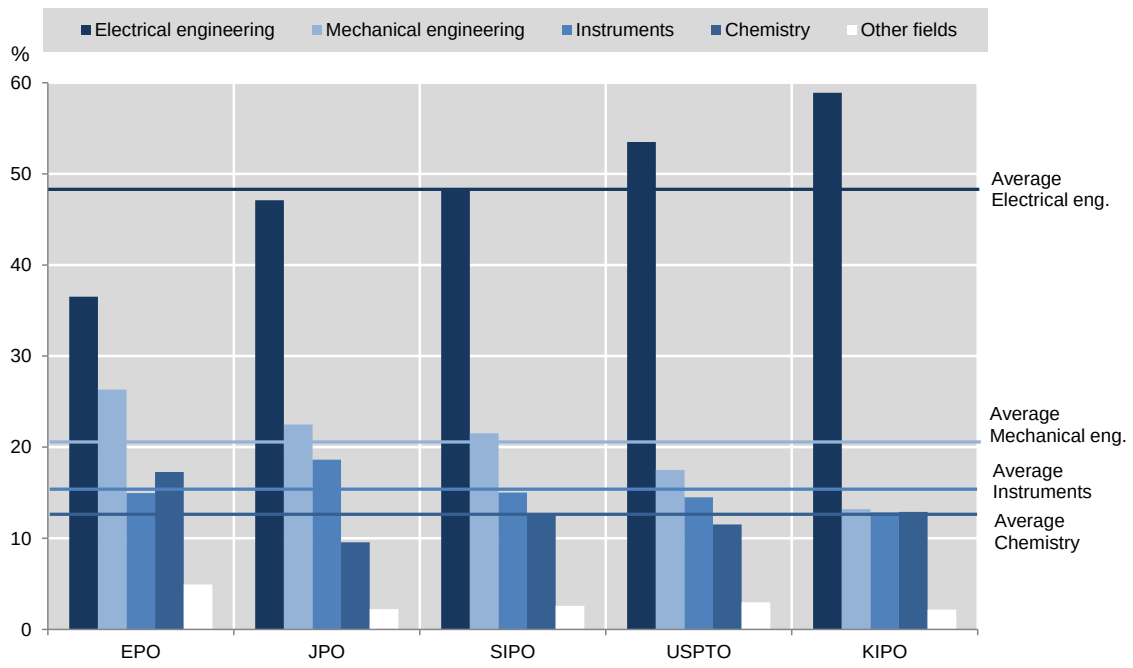
Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

Interesting insights can also be gained by investigating the extent to which specific technologies are patented in some offices rather than in others.

Figure 3.10 shows the distribution of patents across different technological areas at the patent offices considered. As it can be seen, the technological profiles of patent families filed at the KIPO, the USPTO and the SIPO are similar: they are largely oriented towards electrical engineering applications - with shares that are higher than the sample average - and show below average values for the other technology areas.

[21] See, e.g. Lei et al (2012), in this respect.

Figure 3.10 – Distribution of patents across technological areas by IP5 office, 2010-12



Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

On the other side of the spectrum there are the patents filed at the EPO, where the share of patents related to electrical engineering is the lowest, whereas the shares of patents related to mechanical engineering and chemistry are above the sample average. Patents families filed at the JPO show share of mechanical and electrical engineering close to the sample average and a higher share of instrument-related technologies. The SIPO presents a distribution of patents across technological areas mirroring that of the whole sample.

3.4.2 The relative technological advantages of world's areas

To shed further light on the technological specialisation of companies headquartered in different countries (see section 2.1), a Revealed Technological Advantage (RTA) index has been calculated. This provides an indication of the relative specialisation of companies in different technological domains (fields). The index is defined as the share of patents in a particular technology field of a given area divided by the share of patents in the same technology field filed at a global level:

$$RTA_{it} = \frac{ps_{it} / \sum_t ps_{it}}{\sum_i ps_{it} / \sum_i \sum_t ps_{it}}$$

where ps_{it} is the number of patents of area *i* in technology *t*. The numerator represents the share of technology *t* among all patents of area *i*, whereas the denominator represents the share of technology *t* among all patents. The index is equal to zero when the headquarters country holds no patent in a given technology; is equal to 1 when the area's share in a technology equals the share calculated at the global level (no specialisation); has a value between zero and one when a country has a relatively lower share than the one observed at

the global level; and has values above 1 when the share is higher (specialisation).

The comparison of the levels of specialisation in the various technological fields provides interesting information about the relative technological strengths of different economic areas and headquarters locations. Table 3.2 reports, the RTAs for Europe, the United States, Japan, Korea, China and the rest of the world for the period 2010-12. Values of the RTA greater than one (specialisation) are marked in blue. Europe and US-headquartered top corporate R&D investors show a relative specialisation in a rather high number of technologies, possibly reflecting technological advantages in fields requiring a wider range of competences or strategies encompassing technological diversification.

Table 3.2 – RTAs by geographical location of the headquarter, 2010-12

Field of Technology	Europe	United States	Japan	Korea	China	Rest of the World
Electrical machinery	1.0	0.7	1.1	1.3	0.5	1.1
Audio-visual tech.	0.4	0.5	1.2	1.6	0.6	2.1
Telecommunications	0.7	0.7	1.0	1.4	3.1	1.3
Digital communication	1.1	1.1	0.6	1.3	8.0	1.2
Basic communication	0.8	1.0	1.0	1.0	1.1	1.7
Computer technology	0.5	1.3	0.8	1.4	1.4	1.8
IT methods	0.8	1.8	0.7	1.0	0.6	1.2
Semiconductors	0.4	0.7	1.1	2.0	0.1	1.5
Optics	0.3	0.4	1.6	1.1	0.2	1.0
Measurement	1.4	1.1	0.9	0.5	0.3	0.8
Bio materials	1.6	1.6	0.7	0.6	0.0	0.1
Control	1.7	1.9	0.4	0.1	0.7	1.3
Medical technology	1.5	1.6	0.9	0.3	0.0	0.2
Organic chemistry	2.0	1.4	0.6	0.3	0.5	0.3
Biotechnology	1.8	1.6	0.6	0.6	0.1	0.2
Pharmaceuticals	2.0	1.8	0.5	0.2	0.1	0.6
Polymers	1.2	0.9	1.1	0.7	0.3	0.5
Food chemistry	2.1	1.8	0.5	0.2	0.0	0.1
Basic chemistry	1.4	1.3	1.0	0.5	0.2	0.3
Materials, metallurgy	1.2	0.7	1.3	0.5	0.3	0.3
Surface and coating	0.8	1.1	1.1	0.7	0.1	1.2
Micro- and nano-tech.	1.2	1.0	0.7	1.3	0.0	1.7
Chemical eng.	1.6	1.4	0.8	0.6	0.3	0.3
Environmental tech.	1.4	1.4	1.0	0.4	0.3	0.1
Handling & logistics	1.2	0.8	1.3	0.2	0.3	0.7
Machine tools	1.4	1.1	1.0	0.2	0.6	0.7
Engines, pumps, turbines	1.5	1.7	0.8	0.4	0.1	0.2
Textile and paper machines	0.5	0.6	1.8	0.2	0.2	0.1
Other special machines	1.4	1.0	1.1	0.3	0.1	0.4
Thermal devices	1.5	0.8	0.9	0.9	0.3	0.6
Mechanical elements	1.6	1.2	0.8	0.5	0.2	0.5
Transport	1.5	1.1	1.0	0.7	0.1	0.2
Furniture, games	1.7	0.8	0.9	0.5	0.7	0.7
Other consumer goods	1.9	0.8	0.7	1.4	0.2	0.4
Civil eng.	1.9	1.8	0.5	0.1	0.5	0.4

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

Moreover, Europe and US-headquartered top corporate R&D investors are often specialised in the very same technologies: *Measurement; Bio materials; Medical Technology; Organic chemistry; Biotechnology; Pharmaceuticals; Food Chemistry; Basic chemistry; Chemical engineering; Environmental Technologies; Machine Tools; Mechanical elements;*

Transport Civil engineering. Importantly, European and US top corporate R&D investors appear to be the only ones specialised in a number of technologies that are fundamental to address grand challenges as health, aging and the environment. Their specialisation is generally equal or above 1.4 in fields such as *Medical technology*, *Pharmaceuticals*, *Food chemistry*, *Biotechnology* and *Environmental Technologies*.

With respect to ICT-related technologies, Europe, the United States and China top R&D investors appear relatively less specialised in *Audio-visual technologies* and *Telecommunications*. Differently from the Unites States but similarly to Japan, European corporates appear also relatively less specialised in *Computer technology* and *IT methods for management.*

Compared to Europe and the United States, Japan headquartered companies appear to be specialised in a relatively smaller number of technology fields ranging from ICT to machinery, and feature values very close to zero (i.e. they are neither over nor under specialised) in a wide array of fields, including *Measurement*, *Medical technology* and *Polymers*. Also, Japan is the only location exhibiting a RTA score value above 1 in *Textile and paper machines* technologies, and shares a unique relative specialisation in *Handling & logistic* and *Materials, metallurgy* and *Polymers* with Europe.

The technological specialisation profile of Korean headquartered companies appears very much ICT-oriented, with RTA values higher than 1 for *Audio-visual technologies, Telecommunications, Digital communication, Basic communication, Computer technology, IT methods and Semiconductors*. Interestingly, Korean top R&D investors are the only specialised in all ICT-related technology fields, and in complementary areas as micro and nano-technologies.

Top R&D investors headquartered in China appear very much specialised in a subset of ICT related technologies mainly linked to communication. In particular, Chinese based companies show RTA values higher than one in four technologies, namely: *Telecommunications, Digital communication, Basic communication,* and *Computer technology.*

Top corporate R&D investors located in the rest of the world also appear very much specialised in ICT-related technologies.

3.4.3 The international roots of patented inventions

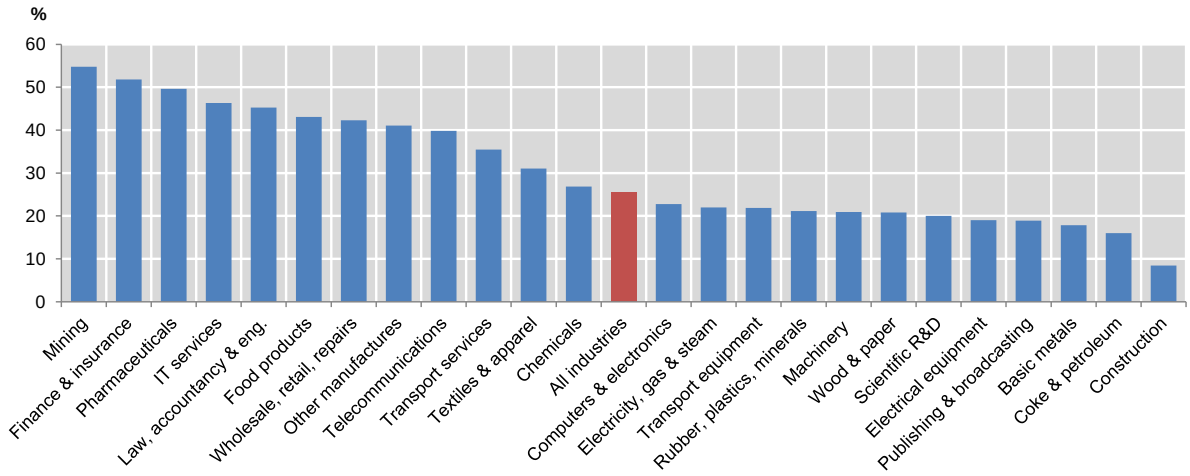
International knowledge sourcing constitutes a pivotal dimension today's worldwide innovation dynamics. In order to gain or maintain their competitive edge, companies may increasingly rely on international knowledge networks, often through cross-borders ownership, mergers and acquisitions, greenfield investments, collaborations and contractual research, and intellectual property transactions. At the same time, economies strive to strengthen their attractiveness for (large scale) technology and knowledge intensive activities, to boost high-quality jobs and competitiveness.

According to Figure 3.11, about 25% of top corporate R&D investors' patents have been developed by teams of inventors residing in countries that do not correspond to the headquarters' country. The extent to which companies rely on international knowledge varies

depending on the industry that companies belongs to. Top corporate R&D investors operating in 'Mining', 'Finance & Insurance' and 'Pharmaceuticals' are the ones that more markedly rely on international teams of inventors, with more than 50% of patents developed by inventors located abroad. Conversely, companies in a number of industries, including 'Basic metals', 'Coke & Petroleum' and 'Construction', present relatively lower shares of patents benefiting from international groups of inventors.

Figure 3.11 – Patents based on inventions made abroad, by industry, ISIC, rev.4, 2010-12

Share of patents with at least one inventor located outside the company's location



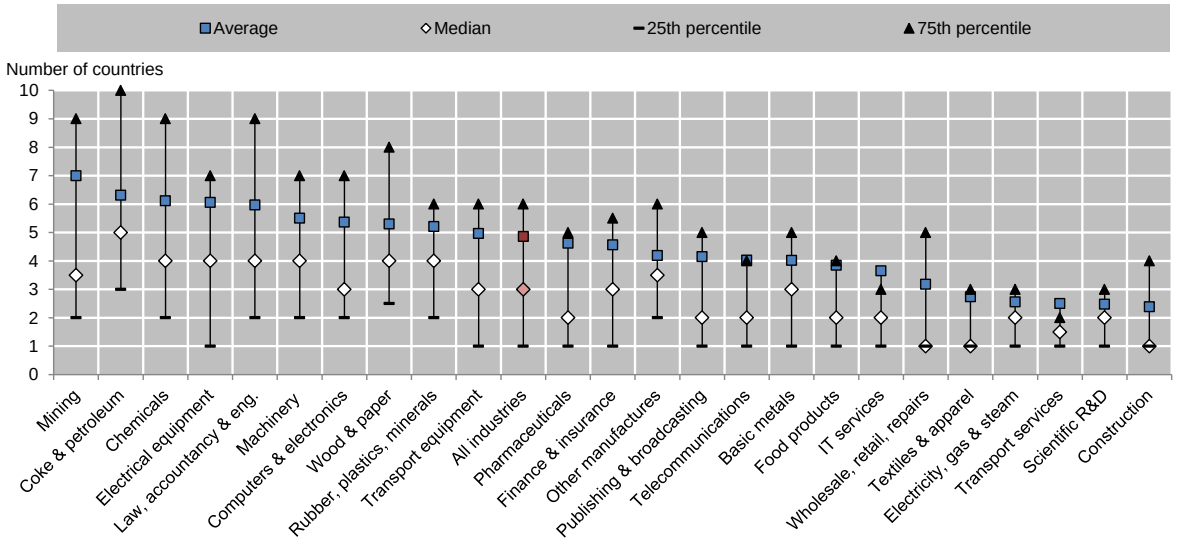
Note: Data relate to industries with at least 150 EPO and USPTO patent family members.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

Figure 3.12 show that, on average, top corporate R&D investors' patents have been developed in 5 countries. Also, as all technology-specific distributions appear positively skewed and the average number of inventors' countries is close to the 75th percentile, it can be inferred that it is a small number of companies relying on inventors located in a large number of countries that drives average values. Also it can be clearly seen that half of the companies in the top corporate R&D investors' sample generally rely on pools of inventors located in 1 to 4 countries.

Figure 3.12 – Diversification of inventors' location by industry, ISIC, rev. 4, 2010-12

Number of inventors' countries in companies' patent portfolios by industry (EPO and USPTO)



Note: The data is based on all the inventors' countries listed per each company' patent portfolios. Data relate to industries with at least 10 companies in the top 2000 corporate R&D sample.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and the Worldwide Patent Statistical Database, EPO, December 2014.

The extent to which companies rely on a geographically diversified knowledge base to develop new inventions also appears to vary greatly across industries. Patents from 'Mining', 'Coke & Petroleum', and 'Chemicals' industries show on average to have been developed by highly international teams of inventors. Conversely, and possibly against expectations based on a concept of science and research that becomes more and more open, patents developed by 'Scientific R&D' companies rely on comparatively smaller and more local teams of inventors.

4. The trademarks portfolio of top corporate R&D investors worldwide

Key findings

- The geographical distribution of trademark (TM) applications is largely driven by headquarters' location
- TM applications are concentrated in few classes and products fields
- TM behaviours exhibit market specificities
- TM applications feature salient industry specificities
- The adoption of common word mark strategies in international markets remains limited

Trademarks are distinctive signs such as words, pictures, logos, shapes, colours, sounds or any combination of those signs, allowing companies to differentiate their goods and services from those of their competitors. Trademarks are meant to reduce information and transaction costs for customers, by helping them identifying and choosing the products and services that best suit their needs. Depending on the IP office where firms apply for trademarks, the exclusive right to use these distinctive signs can be acquired on the basis of actual use or intent-to-use in commerce[22].

Trademarks filings have reached unprecedented levels in the last decades, mainly reflecting the growing importance for companies to distinguish their products from those of their competitors. This surge in trademarks filings worldwide might have been driven by a number of factors including the progressive globalisation of economic activities, the increasing role of services and service-intensive industries, and the need to move away from mere price-based competition.

In addition, recent evidence suggests that trademarks relate to the launch of new products and services (Mendonça et al 2004; Millot 2012, OECD 2013; and EPO-OHIM, 2013). As such, indicators based on trademarks may represent useful complements to traditional indicators of innovative activities based on patents or R&D investment, to shed light on non-R&D based innovations and innovation in the services sector.

The present section shows some statistics related to the trademark applications of top corporate R&D investors worldwide using data from four IP offices, namely: the OHIM, the USPTO, the JPO and IP AUS. It aims at offering some insights about the geographical and industry-specific distribution of trademark activities and the relative importance of distinct product fields, based on information contained in the TM applications of top corporate R&D investors. Furthermore, it sheds light on the differences that exist in firm-specific trademark intensities, as measured by the number of trademarks per Euro of net sales, and provides evidence about TM product fields concentration ratios at the industry level. To better understand the international strategies of the companies in the sample, trademarks activities are compared across IP offices. Finally, an experimental analysis based on common word marks, i.e. marks consisting solely of words and that are registered at different offices, is proposed.

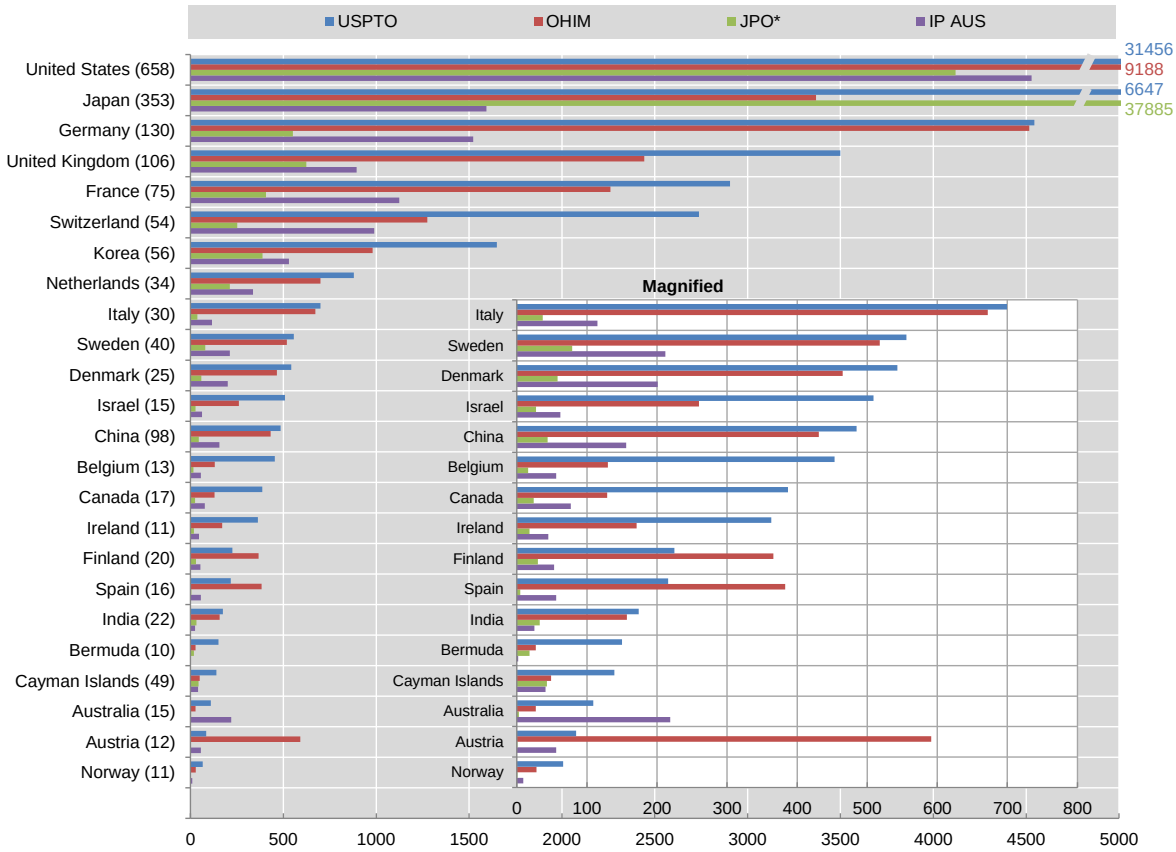
[22] In most jurisdictions trademark rights can be maintained subject to the actual use of the trademark. Failure to actively use the mark may expose the registration to removal from the register after a certain period of time (generally, three to five years). Certain jurisdictions, such as the United States, require actual use even for application purposes, although the Trade Related Aspects of Intellectual Property Rights Agreement (TRIPs, Article 15) states that it may constitute a condition for registrability, but not a condition for filing an application for registration.

4.1. The origins of trademark applications

4.1.1. Trademark activities by headquarters' location

Figure 4.1 shows the number of trademark applications by headquarters location and IP office of filing during the period 2010-12. Figures are ranked according to the amount of USPTO applications. In brackets it is shown the overall number of top corporate R&D investors headquartered in the country considered. Only countries featuring a minimum of ten corporate R&D performers are included in the figure.

Figure 4.1 – Trademark applications in the four offices, by companies' headquarter location, 2010-12



Note: Trademark counts are based on the application date, the address of the applicant's headquarters and fractional counts. The number in brackets corresponds to the number of companies in the total 2013 sample of top R&D investors. Data relate to countries with at least 10 companies in the top 2000 corporate R&D sample. Countries are ranked according to USPTO figures. *Data for JPO are up to May 2012.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014.

Overall, the differences in the total number of TM applications reflect the distribution of headquarters across countries, with comparatively larger groups of companies that tend to show higher volumes of trademarks. The picture that emerges is consistent with the one observed when analysing patenting patterns.

While the vast majority of TM applications at JPO belongs to home-based companies, i.e. companies located in Japan (80% of all applications), US-based companies, which account for the majority of companies in the sample, exhibit important trademarking activities both at home and abroad. US-based top R&D investors actually account for the highest number of

TM registrations requests at any of the offices considered, but the JPO. This may mirror the higher number of companies in the sample, but also a relatively higher penetration of US-based top R&D investors in worldwide markets.

In terms of overall number of trademarks, top corporate R&D performers headquartered in Germany, the United Kingdom and France follow their US and Japanese counterparts. As a word of caution, it should be noted that, in the case of Europe-based corporate R&D investors, the substantially lower numbers observed might to some extent be explained by the coexistence of national systems with the OHIM, and the likelihood that trademarks are protected at the relevant national offices.

While German and Italian companies exhibit similar numbers of TM applications at the USPTO and the OHIM, the same in general does not hold for the other European Union-headquartered R&D investors, or for investors located in OECD countries (e.g. Switzerland and Korea). The differences that emerge in terms of numbers of TM applications filed by the companies in the sample across the IP offices considered suggest the existence of clear preferences in terms of target markets.

Comparatively low trademarks volumes are also observed in the case of Asia-based top R&D investors (excluding Japanese companies). Due to the lack of additional information from these Asian countries, it is not possible to assess the extent to which these relatively low numbers reflect actual strategies and company behaviours, or simply the impossibility to get a more complete and balanced picture.

The generally higher level of trademark activities at the USPTO and the OHIM may reflect the sheer size and market attractiveness that the United States economy and Europe represent, and the rate at which new goods and services are launched on those markets[23].

Noteworthy is the particularly high penetration of trademarks belonging to Switzerland-based top R&D investors in Australia, mainly related to pharmaceutical products. This may be explained by the fact that the Australian economy is very active in various sub-sectors of the pharmaceutical industry[24] such as bio-medical research, biotechnology firms, originator firms[25] and generic medicines companies and services.

4.1.2. Goods and services trademark applications

Trademark applications may each designate one or several classes of the so called 'Nice classification', which details the types of goods and services that trademarks may relate to. This classification comprises 45 classes, 34 relating to goods and 11 to services[26]. The specification of goods and services classes limits the scope of the exclusivity right conferred

[23] The relatively lower level of applications at JPO is partly due to fact that our data are only up to May 2012.
[24] See http://www.industry.gov.au/industry/IndustrySectors/PharmaceuticalsandHealthTechnologies/Pharmaceuticals/Pages/PharmaceuticalsIndustryDataCard.aspx
[25] non-generic medicines companies, see http://ec.europa.eu/competition/sectors/pharmaceuticals/inquiry/2_Originator_Generic_competition.pdf
[26] See the 2015 version of the tenth edition of the "Nice Classification" or the International Classification of Goods and Services for the Purposes of the Registration of Marks (10th ed. 2015).

to the owner and, at the same time, prevents the exploitation of similar or identical signs by others in the designated classes.

The four IP offices considered in the present report all allow for a multi-class filing system, i.e. that applicants may use one single TM application to protect good and services belonging to several classes. The overall number of TM applications recorded is thus lower than it would have been in a single-class filing system such as, for example, the Chinese one[27]. In multi-class trademark systems, fees are generally increasing with the number of classes designated in an application.

Most trademark applications of top corporate R&D investors refer only to goods or to good and service classes jointly, although the distribution varies across IP offices. As shown in Figure 4.2, the share of joint good and service TMs applications of top corporate R&D investors is, in general, higher at the OHIM than at the other offices considered. This may to some extent be explained by the fee system in place at the OHIM, where applicants might designate up to three classes upon payment of the basic fee, and extra fees apply only from the fourth class of goods or services designated in an application.

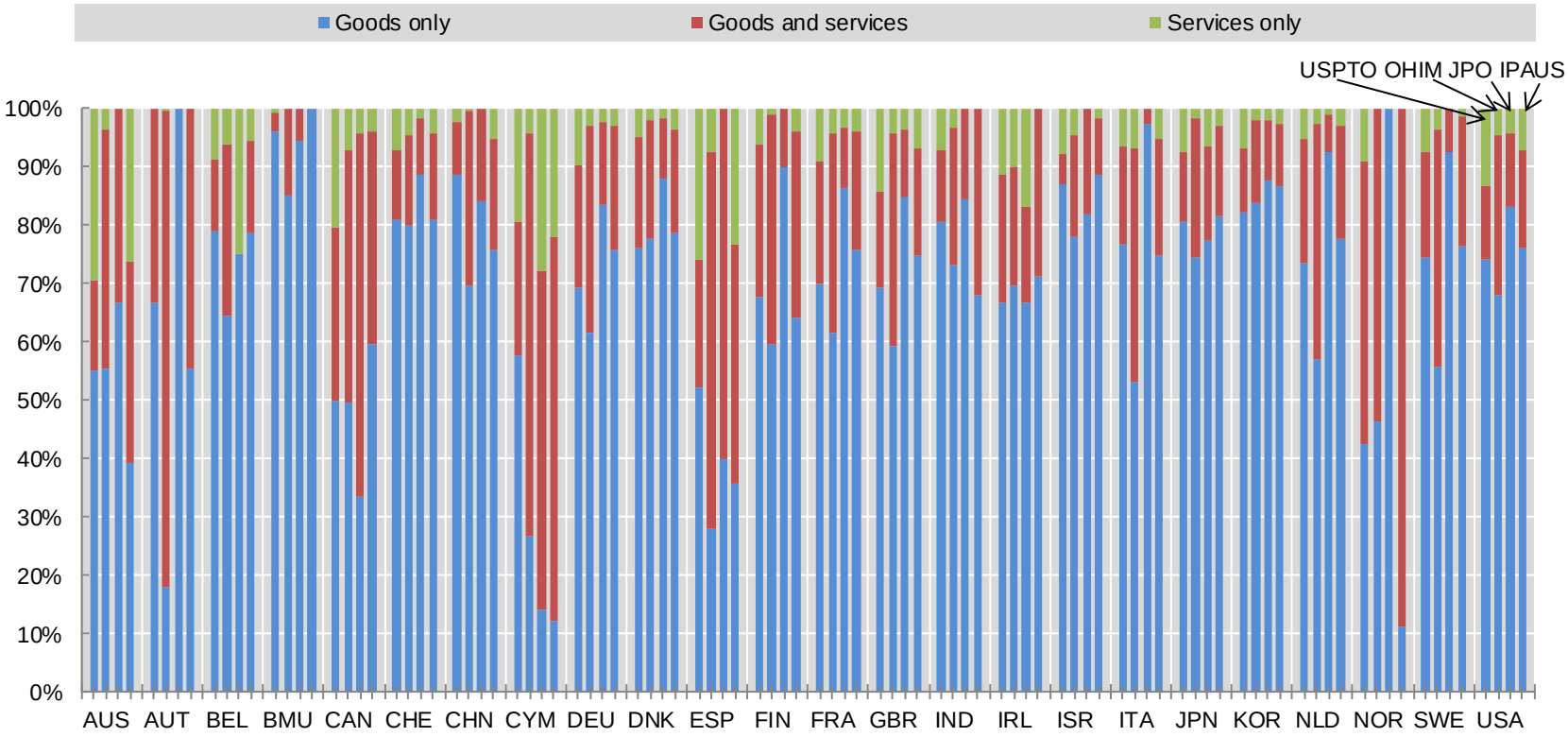
Top corporate R&D investors with headquarters located in Austria, Norway and Spain exhibit peculiar patterns in this respect, as more than half of their TM applications jointly relate to good and service classes at the OHIM. This share goes above 80% in the case of Austria-based R&D investors. Also, Norwegian top corporate R&D investors do not own any trademark solely related to services, except at the USPTO.

In most cases, less than one fifth of the TM applications of top R&D investors relate to service classes only. Exceptions include TM applications of Australia-based R&D investors at IP AUS and of Canada and Spain-based companies, especially at the USPTO.

Top R&D investors do not show higher shares of service-marks applications in their domestic markets than in foreign markets. This contrasts with the trends observed over all applicants at the USPTO, the OHIM and the JPO during the same period (see OECD STI 2013). The share of service-only marks is in general higher at the USPTO than at the OHIM or the JPO.

[27] In a single-class filing system, applicants have to file distinct applications for each and every class they want their trademarks to designate. This is the case of China, for instance, where single class TM are filed. For more details about countries that allow single or multiple class filings visit the web of the "International Trademark Association" (INTA, http://www.inta.org/Pages/Home.aspx), in particular http://www.inta.org/TrademarkBasics/FactSheets/Documents/Single%20Class%20vs%20MultiClass%20TM%20Applications%20Chart.pdf.

Figure 4.2 –Share of goods and services trademark applications at the four offices, by companies' headquarter location 2010-12



Total number of trademark applications by office and country of headquarters' location, 2010-12

	AUS	AUT	BEL	BMU	CAN	CHE	CHN	CYM	DEU	DNK	ESP	FIN	FRA	GBR	IND	IRL	ISR	ITA	JPN	KOR	NLD	NOR	SWE	USA
USPTO	109	85	453	150	387	2738	485	139	4544	543	216	225	2904	3498	174	363	509	700	6646	1649	879	66	556	31443
OHIM	27	592	130	27	129	1275	431	49	4517	465	383	366	2261	2443	157	171	260	672	3368	981	700	28	518	9188
JPO	3	1	16	18	24	251	44	43	551	58	5	30	406	624	33	18	28	37	37884	387	212	1	79	4120
IP AUS	219	56	56	2	77	989	156	41	1522	201	56	53	1124	895	25	45	62	115	1594	530	337	9	212	4530

Note: Trademark counts are based on the application date and the address of the applicant's headquarters (using fractional counts). Data relate to countries with at least 10 companies in the top 2000 corporate R&D sample.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014.

4.1.3 Main trademarks application fields by headquarters' location

To try to link trademarks fields to industries, the OECD (2013) has proposed product fields aggregates that group goods and service TM classes in a homogenous fashion with respect to the industry they might relate to[28]. This correspondence thus mainly relies on a qualitative assessment about the goods or services themselves, and the industries that are typically known to produce them.

Figure 4.3 shows the top three trademark application fields by office and location of the headquarters. Evidence suggests that, in general, top corporate R&D investors' TM applications relate to the same product fields in the four offices when two of the top three fields (in terms of number of applications) are considered. Differences conversely exist with respect to the top third field designated and with respect to the shares that top three fields account for.

Only top corporate R&D investors headquartered in the United Kingdom, Sweden and the United States appear to consistently file the majority on their TM applications in the very same 3 top classes, although differences exist in the proportion that these classes represent.

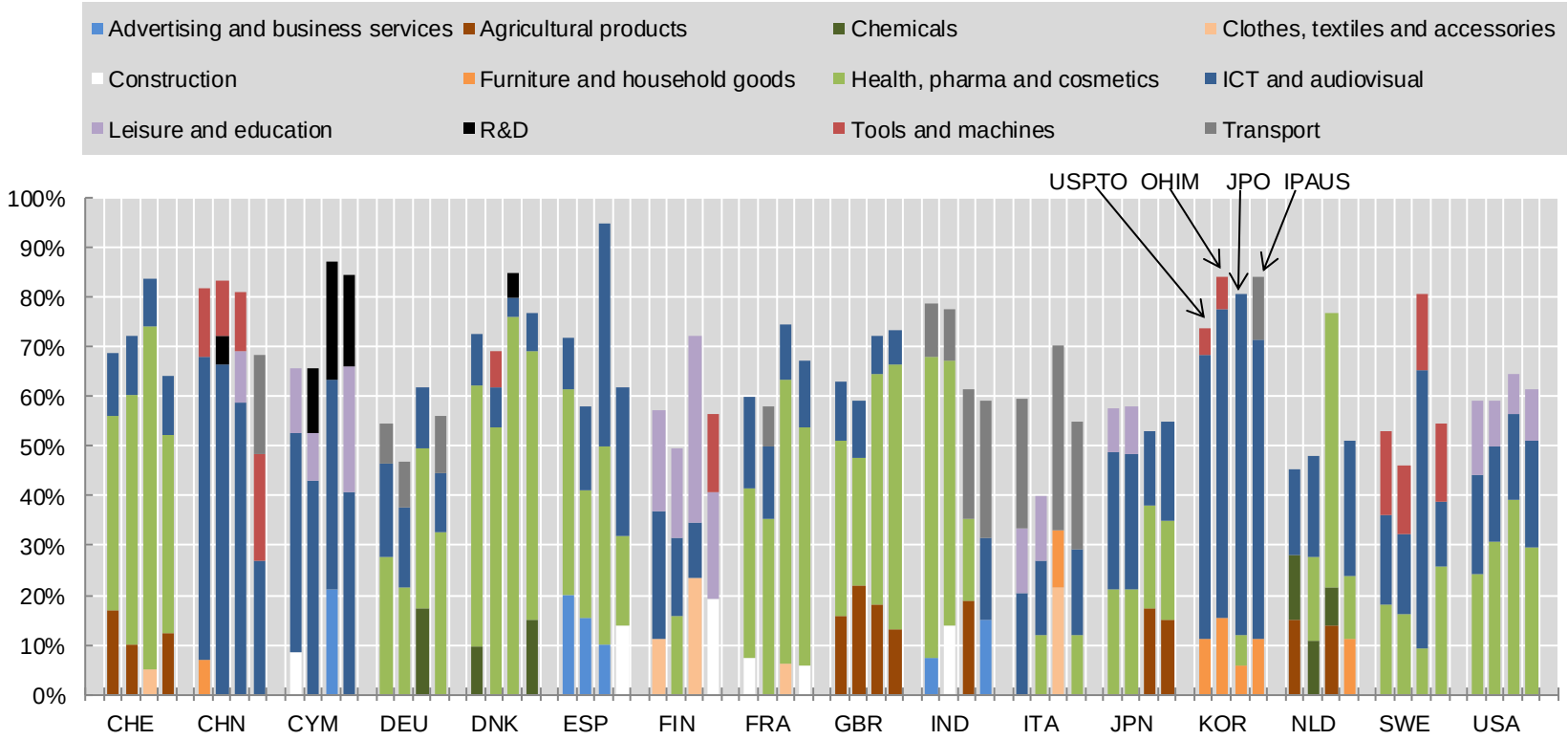
In general, TM applications of top R&D investors are concentrated in two fields, *Health, pharma and cosmetics* and *ICT and audiovisuals*. This pattern is more pronounced for companies headquartered in China and South Korea, exhibiting more than 60% of their applications in the *ICT and audiovisual* field at the USPTO, the OHIM and the JPO. A similar level of specialisation is observable in *Health, pharma and cosmetics* in the case of top corporate R&D investors from Denmark and Switzerland, as well as for India-based companies (but only at the USPTO and the OHIM).

Noteworthy is the similarity of Japanese and United States top R&D investors' profiles at the USPTO and the OHIM, which suggests that they pursue similar trademarking strategies in the two markets considered. In addition to being active in *ICT and audiovisual* and the *Health, pharma and cosmetics*, Japan and the United States' companies show a non-negligible activity in the *Leisure and education field*.

Significant shares related to the *Leisure and education* field are also observable in the case of Finland-based HQs. Italian top R&D investors conversely account for the highest shares of transport-related trademarks in the United States, Japan and Australia. Transport related-trademarks also show among the top three TM fields of Germany- and India-based companies at the OHIM, the USPTO and the IP AUS.

[28] The groups are as follows: Advertising and business services: classes 35, 36 and 45; Agricultural products: classes 29, 30, 31, 32, 33 and 34; Chemicals: classes 1, 2 and 4; Clothes, textiles and accessories: classes 14, 18, 22, 23, 24, 25, 26; Construction: classes 6, 17, 19, 27 and 37; Furniture and household goods: 11, 20 and 21; Health, pharmaceuticals and cosmetics: classes 3, 5, 10 and 44; ICT and audiovisual: classes 9 and 38; Leisure and education: classes 13, 15, 16, 28 and 41; Research and Development (R&D): class 42; Tools and machines: classes 7 and 8; Transport: classes 12 and 39, Hotels, restaurants and other services: classes 40 and 43.

Figure 4.3 – Top three trademark application fields, by office and companies' headquarter location, 2010-12



Number of firms filing trademark applications, by office and country of headquarters' location, 2010-12

	CHE	CHN	CYM	DEU	DNK	ESP	FIN	FRA	GBR	IND	ITA	JPN	KOR	NLD	SWE	USA
USPTO	51	36	23	116	23	14	17	67	82	16	26	286	44	30	29	614
OHIM	37	25	15	116	21	16	18	67	84	13	25	227	25	31	31	443
JPO	22	6	8	44	11	3	6	32	41	4	7	343	16	12	13	290
IP AUS	38	34	11	85	19	9	12	55	65	10	18	177	25	25	22	356

Note: Trademark counts are based on the application date, the address of the applicant's headquarters and the designated Nice classes (using fractional counts). Data relate to countries with at least 20 companies in the top 2000 corporate R&D sample.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014.

4.2. Corporate trademark applications by industry and international class

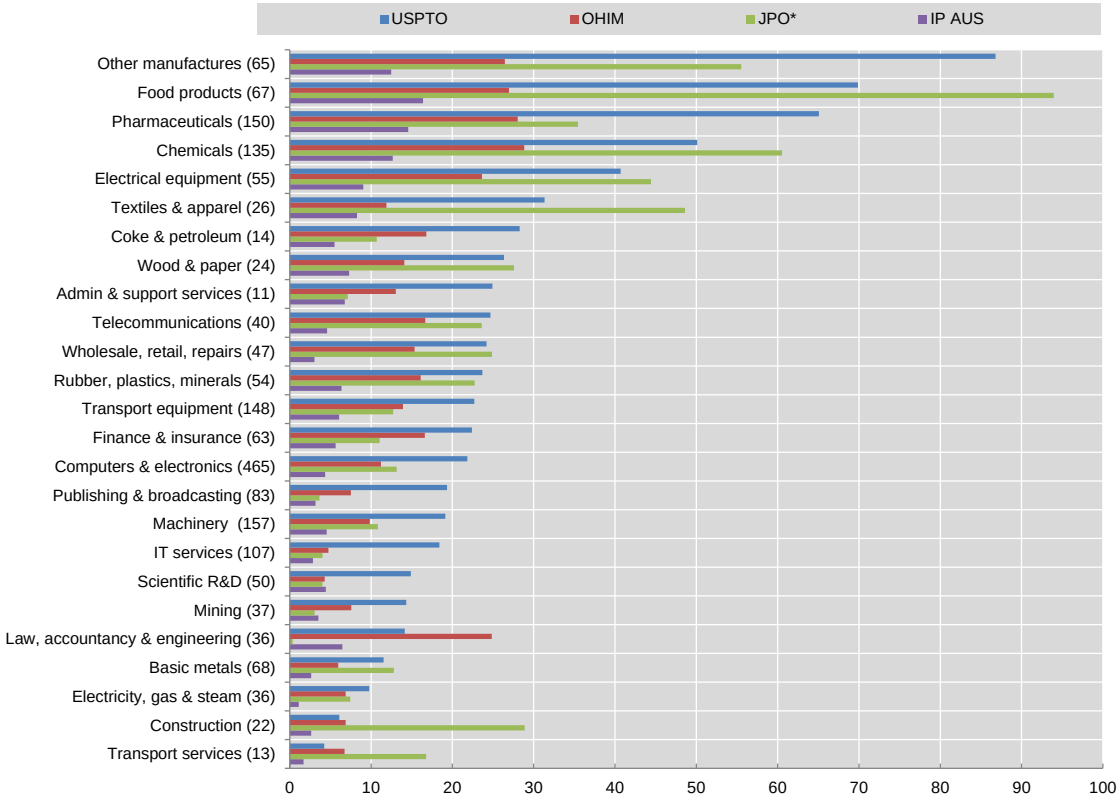
4.2.1. Trademark applications by industry

In what follows, the indicators proposed shed light on the industry-specific trademark activities of top corporate R&D investors.

Differently from patents, trademarks can be used in a number of instances and for a wide array of purposes, e.g. to signal the creation of a new business or when launching a new product or service. Hence, the likelihood that firms belonging to all industries use trademarks, including services industries, is very high, although the propensity to rely on trademarks and the trademarking strategies of firms may differ from one industry to another.

Figure 4.4 shows the industry-specific average number of trademark applications filed by the top corporate R&D investors over the period 2010-12. Statistics are presented by industry of the headquarters. Figure 4.5 further displays the by-industry TM intensity ratios, i.e. the number of TMs filed over sales. For comparison purposes, top corporate R&D investors are assigned to only one industry (ISIC, revision 4), corresponding to their principal field of economic activity.

Figure 4.4 – Average number of TM applications per company, by main industry affiliation, ISIC rev. 4, 2010-12



Note: Trademark counts are based on the application date, the main industry of the applicant's corporate group and fractional counts. The industry classification used refers to an aggregation of the NACE, rev. 2 list into 38 industries. Industries are ranked according to USPTO figures. Overall number of firms assigned to each industry displayed on the vertical axis, in parentheses. Data relate to industries with at least 10 companies in the top 2000 corporate R&D sample.

*Data for JPO are up to May 2012.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014

While suggesting the existence of broad industry-specific patterns, the numbers shown in Figure 4.4 hide the substantial heterogeneity that can be observed by looking at the within-industry distribution of TM applications (shown in Appendix 1). No clear pattern emerges with respect to the number of top corporate R&D investors in an industry and the extent to which they rely on trademarks. Relatively smaller (larger) groups of top R&D investors appear all along the distribution of the average number of TM applications per company. High ratios are found in small-size groups as 'Textiles', as well as in medium-sized groups as 'Food products', 'Electrical equipment' and in industries featuring relatively larger groups of top R&D investors, like 'Pharmaceuticals' and 'Chemicals'.

As could be expected, in most cases the average number of trademarks per company is higher at the USPTO and the JPO than at the OHIM. This may to some extent result from the coexistence in Europe of national trademark systems and the CTM system.

Also, comparing the average number of trademark applications at the USPTO and the JPO shows the extent to which they differ by industries and point to the possible existence of 'home'-specific behaviours, especially at JPO. This is further confirmed by the comparatively high value of JPO-related trademarks in industries as 'Food products', 'Chemicals', 'Textiles and apparel' and 'Construction', which are dominated by Japan-headquartered top corporate R&D investors (representing more than 30% of the total R&D investors in each industry).

Figure 4.5 shows statistics related to trademark intensity, intended as the average ratio of corporate TM applications divided by corporate net sales in each industry[29]. The index corresponds to the number of trademarks per billion Euros of net sales.

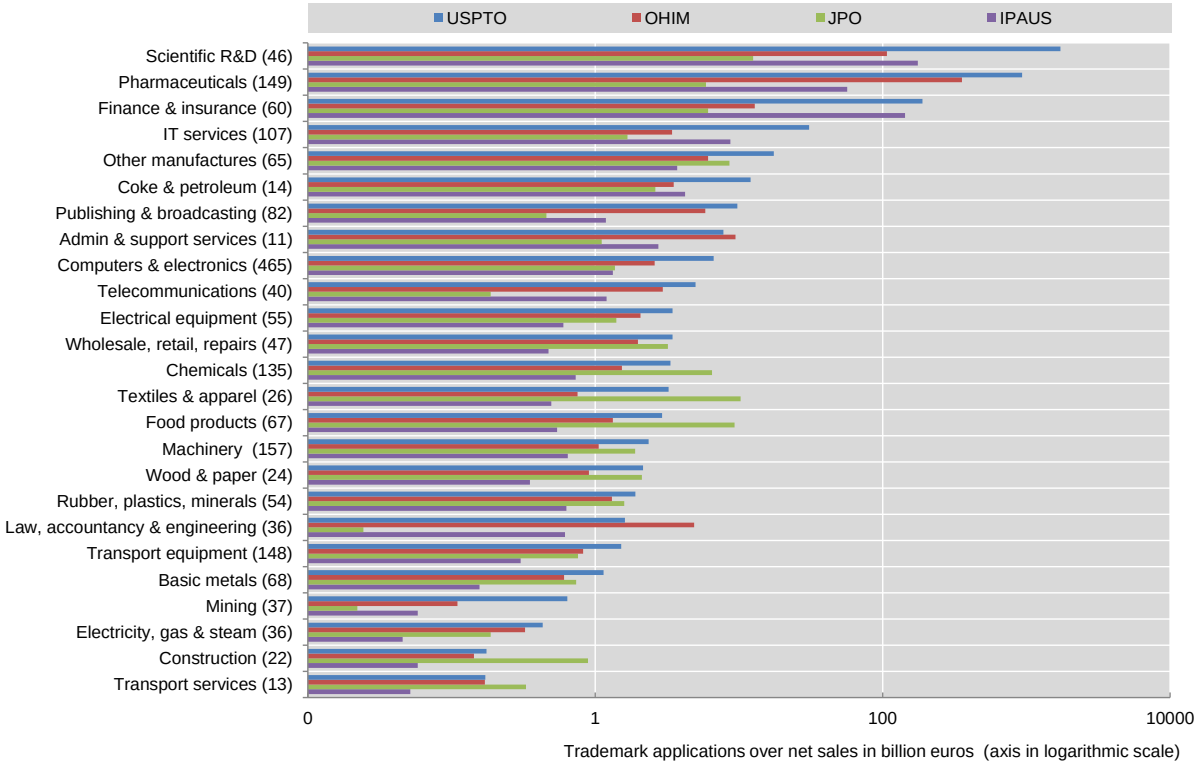
This index appears to vary widely across industries, thus suggesting that while all the companies in the current sample are 'heavy' R&D investors, they pursue different trademark strategies. Some top corporate R&D investors may rely on one or a few trademarks for a wide range of products (e.g. in the transport services), or conversely file several trademarks for each product or service launched on the market (e.g. in the Pharmaceutical sector).

Again, as in the case of the average number of trademarks by company, no clear relationship emerges between the number of top corporate R&D investors in an industry and the ratio of trademarks over sales. Also, no clear pattern emerges with respect to whether it is services industries or manufacturing ones that show the highest TM intensity. Top performers include 'Scientific R&D', 'Finance and insurance', 'IT services' and 'Publishing and broadcasting', as well as 'Pharmaceuticals' and 'Other manufactures' and 'Coke and petroleum'.

[29] At the individual corporate level, trademarks and net sales are computed as averages of the TM applications for the available years on the period 2010-2012.

Figure 4.5 – Trademark intensity by industry, ISIC rev. 4, 2010-12

Average number of trademark applications over net sales in thousand Euros



Note: Trademark counts are based on the application date, the main industry of the applicant's corporate group and fractional counts. The industry classification used refers to an aggregation of the NACE, rev. 2 list into 38 industries. Industries are ranked according to USPTO figures. Overall number of firms with sales information available in 2010, 2011 or 2012 in each industry displayed on the vertical axis, in parentheses. Data relate to industries with at least 10 companies with sales information in the top 2000 corporate R&D sample.

*Data for JPO are up to May 2012

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014

However, by comparing patenting propensities (shown in Figure 3.1) with trademark intensities, interesting industry-specific behaviours emerge. 'Publishing & broadcasting', 'Scientific R&D' and 'Pharmaceuticals' appear as low-patent-propensity but high-TM-intensity industries. This means that while they file relatively small numbers of patents related to the R&D investment they make, they apply for a relatively high number of trademarks in relation to their sales volumes. That is, one patent is likely associated to more than one trademark. At the other end of the spectrum can be conversely found industries as 'Basic metals' and 'Rubber, plastics & minerals', featuring high patent propensities but low trademark intensities. This might mirror the very nature of these industries, which generally rely on sophisticated technologies to produce intermediate goods, and hence do not reach out to final consumers to the extent that others, e.g. pharmaceuticals, do. Finally, 'Construction' and 'Electricity, gas and steam' companies generally exhibit low patent propensities as well as low trademark intensities. Industry structure and competition settings might in this case explain such behaviours.

4.2.2 Trademarks applications by good and service classes

The distribution of applications by international class shown in Figure 4.6 allows assessing the extent to which top corporate R&D investors use trademarks to differentiate their goods or services on the market, to try and steer customers' choices[30].

Two goods-related classes, namely *Instruments and computers* (class 9) and *Pharma products* (class 5) are persistently designated in at least 10% of top corporate R&D investors' TM applications in all IP offices considered (up to 20% of applications at the USPTO for the former). Although with lower shares, *Cleaning products* (class 3) and *Medical instruments* (class 10) also appear as important products lines of top corporate R&D investors.

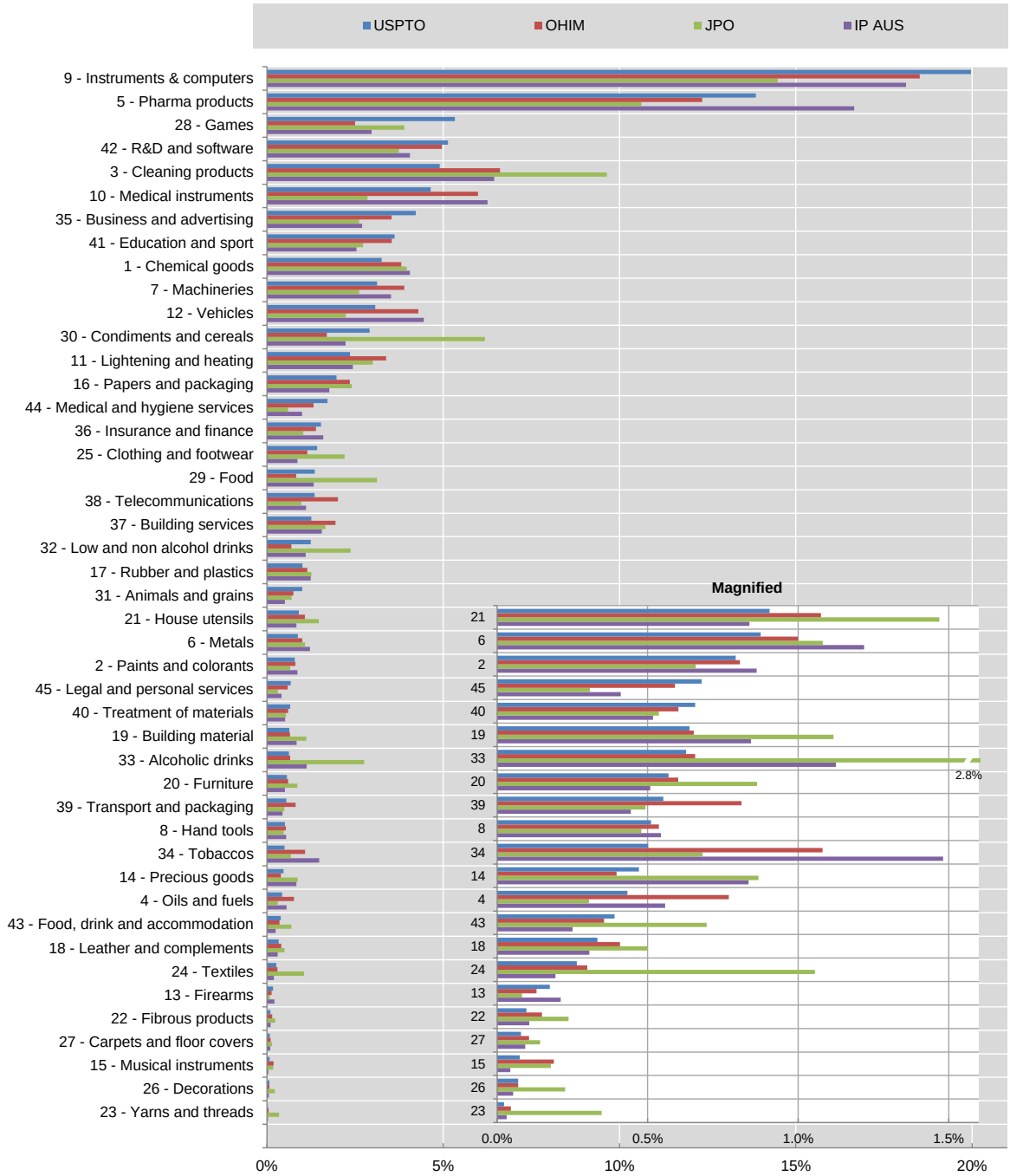
Marked differences across the offices considered also emerge, with the USPTO showing a comparatively higher share of designations in *Games* (class 28). In the case of JPO, classes as *Cleaning products* (class 3) and *Condiments and cereals* (class 30) show relatively higher values than in other offices, fact which may to some extent reflect the important share of Japan-headquartered top R&D investors operating in the 'Chemicals' and 'Food products' industries, as shown before. Similarly, the relatively higher shares of *Pharma products* at IP Australia may be explained by the importance of the pharmaceutical industry in the continent.

A closer look at service classes suggests that *R&D and software* (class 42) is the most designated service class in all offices considered, and figures among the top 5 classes at both the USPTO and the OHIM. Other important service classes in all offices include *Business and advertising* (class 35) and *Education and sport* (class 41).

In general, service classes account for relatively lower shares of top corporate R&D investors' applications at both the JPO and at the IP AUS. These differences are likely to be driven by several factors, including the specific fee system in place and the structure of the economies considered.

30 A fractional counting method is used to compute the share of goods and services classes designated in trademark applications. This means that e.g. if an application designates four classes, each class will be counted as 0.25.

Figure 4.6 – Distribution of trademark applications by international class, 2010-12



Note: Trademark counts by international classes are based on the application date and fractional counts. Classes are ranked according to USPTO figures. Classes' titles correspond to short labels based on the International Classification of Goods and Services for the Purposes of the Registration of Marks (Nice classification). For an exact description of the classes, see www.wipo.int/classifications/nivilo/nice/index.htm

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014.

4.2.3 Concentration of trademark classes by industry of origin

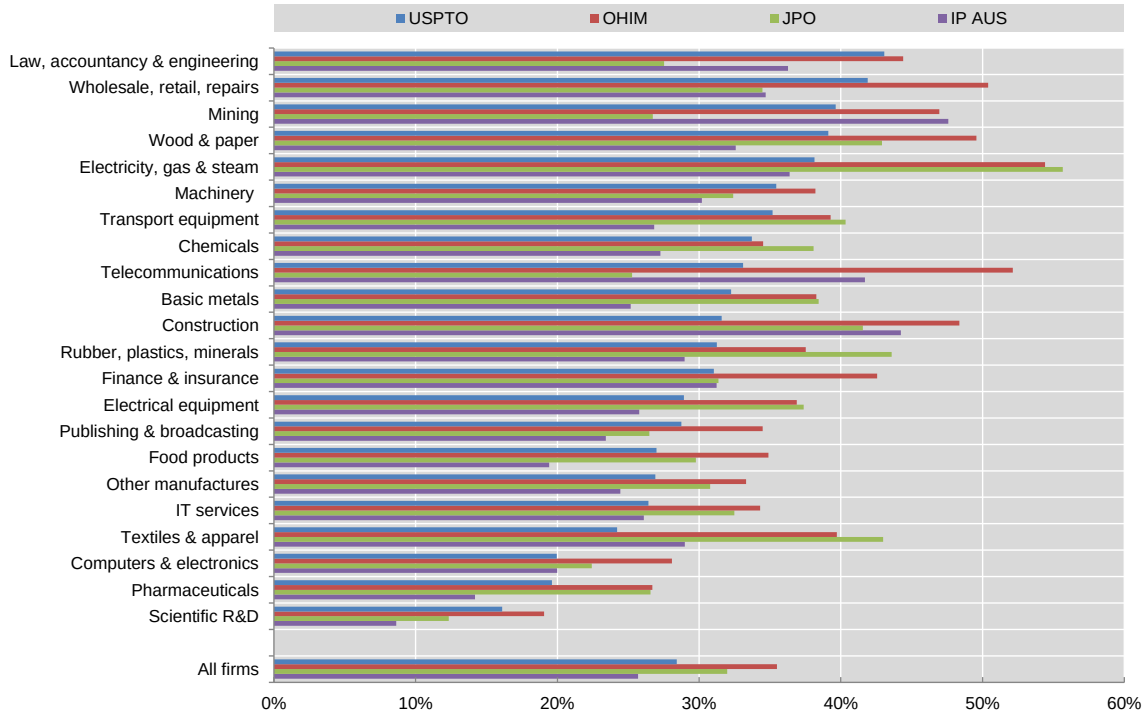
Figure 4.7 below shows statistics related to the concentration ratio of TM classes by industry of origin. This ratio corresponds to the average, at the industry-level, of the firm-specific shares of the three most frequently designated Nice classes contained in trademark applications. To ensure comparability across offices, the concentration ratio is based on the share of the top three classes, as this is the number of classes that can be designated at OHIM against payment of the basic fee (whereas 'pay-per-class' systems exist at the other offices).

In most industries, the concentration ratio appears to be lower at the USPTO than at the OHIM or the JPO, thus signalling strategies that rely more on customisation and diversification in the United States than in the other markets considered. The distribution of trademark applications across companies at the different offices (shown in Appendix 1) provides additional insights about the concentration of trademarking activities of top corporate R&D investors. The distribution of trademark applications at JPO and OHIM appears to be more skewed than at the USPTO, fact which contributes to explain the overall differences in concentration ratios observed across the offices.

Some services industries, e.g. 'Law, accountancy and engineering', 'Wholesale, retail and repair' and 'Telecommunications', appear to be relatively concentrated in terms of product classes they rely upon, and compared to manufacturing industries. This may be due to the design of the Nice classification, where service classes (11 classes) tend to be more aggregated than good classes (34 classes).

A number of interesting stylised facts emerge by comparing TM product class concentration with the patent-based technological concentration patterns shown in Figure 3.5. Some industries that are technologically specialised, in terms of patent fields they mostly rely upon, appear relatively diversified in terms of products trademarked. This is the case, for instance of 'Scientific R&D' and 'IT services'. Plausibly, the technologies developed by these industries may have a wide range of commercial applications. Conversely, companies in 'Wholesale, retail & repairs' own patents belonging to a relatively broad range of technologies, but rely on few TM product classes. To some extent this might be due to the somewhat heterogeneous nature of Nice classes and the consequent need or lack thereof to rely on multiple classes, or the specialisation of companies in different trade domains.

Figure 4.7 – Product class concentration ratio (CR3) of trademark applications by firms, industry average, 2010-12



Note: Trademark counts are based on the application date and the main industry of the applicant's corporate group. The industry classification used refers to an aggregation of the NACE, rev. 2 list into 38 industries. Data relate to industries with at least 20 companies in the top 2000 corporate R&D sample. The CR3 ratio is calculated as an industry average of the share of the top 3 Nice classes in each firm's trademark applications at the various offices considered. Industries are ranked according to USPTO figures.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014.

4.2.4 Knowledge-assets related trademarks

Relying on Nice classes and keyword searches in the goods' and services' description contained in TM applications[31], it is possible to identify trademarks related to various knowledge-based-assets[32]. Three main categories can be identified in this respect, namely: *R&D-related*, *ICT-related* and *IP-transactions-related* TMs. Figures 4.8, 4.9 and 4.10 break down the TM applications of top corporate R&D investors in these three categories, by headquarters' location.

The number of R&D-related trademarks per company and headquarters' country reported in Figure 4.8 reflects the activities of top corporate R&D investors in the Nice class number 42. Such activities mainly aim at protecting scientific and technological services and related research and design services, industrial analysis and research services, and the design and development of computer hardware and software. These R&D-related TM applications appear to be mainly stem from top corporate R&D investors headquartered in a few countries, known to have very developed and competitive markets for research. These include

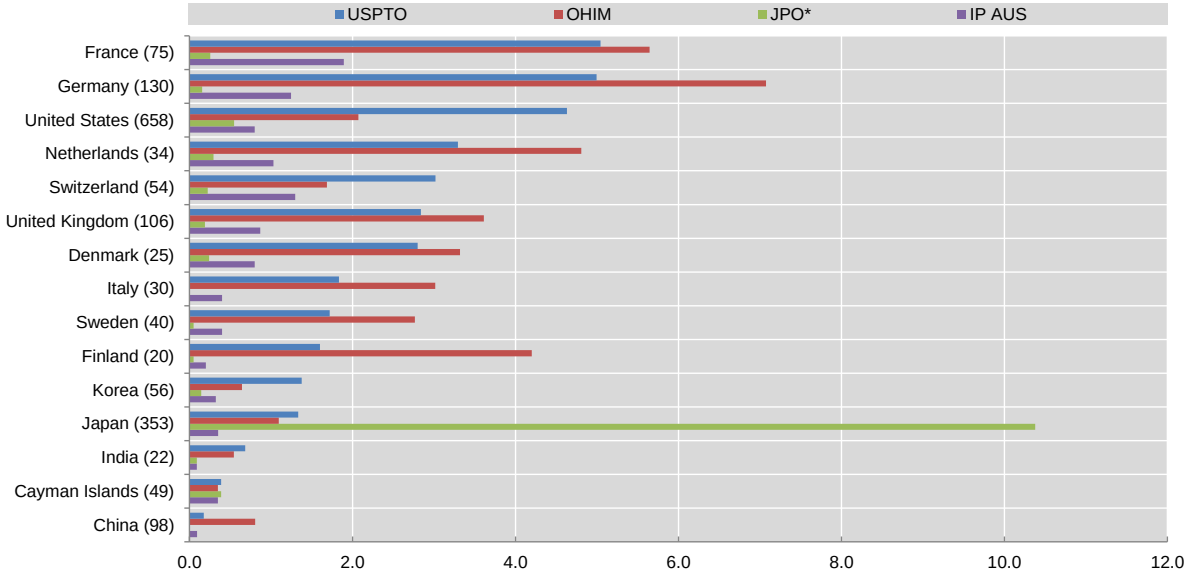
31 In addition to the Nice classes, TM applications must contain the list of goods and/or services for which trademark protection is sought. The items may be chosen by the applicant or selected from a list of goods and services previously validated by the office (offices generally recommend using the latter option, as submitting non-validated terms may lead to delays in registration).

32 See OECD STI (2013).

large countries such as France, Germany, the United Kingdom, the United States and Japan featuring high R&D spending and smaller countries, including Denmark, Finland, Sweden, Netherlands with high spending for R&D relative to their size.

A sort of a home 'home' bias emerges clearly, with Europe-based top R&D investors (with the exception of Switzerland-headquartered companies) showing a higher ratio of per company applications at the OHIM; US-based companies at the USPTO; and Japan-based companies at the JPO. This may reflect the importance of the home market when it comes to the protection of R&D-related assets and the relatively lower tradability of services as compared to manufactured goods.

Figure 4.8 – Number of R&D-related TM applications per company, by companies' headquarter location, 2010-12



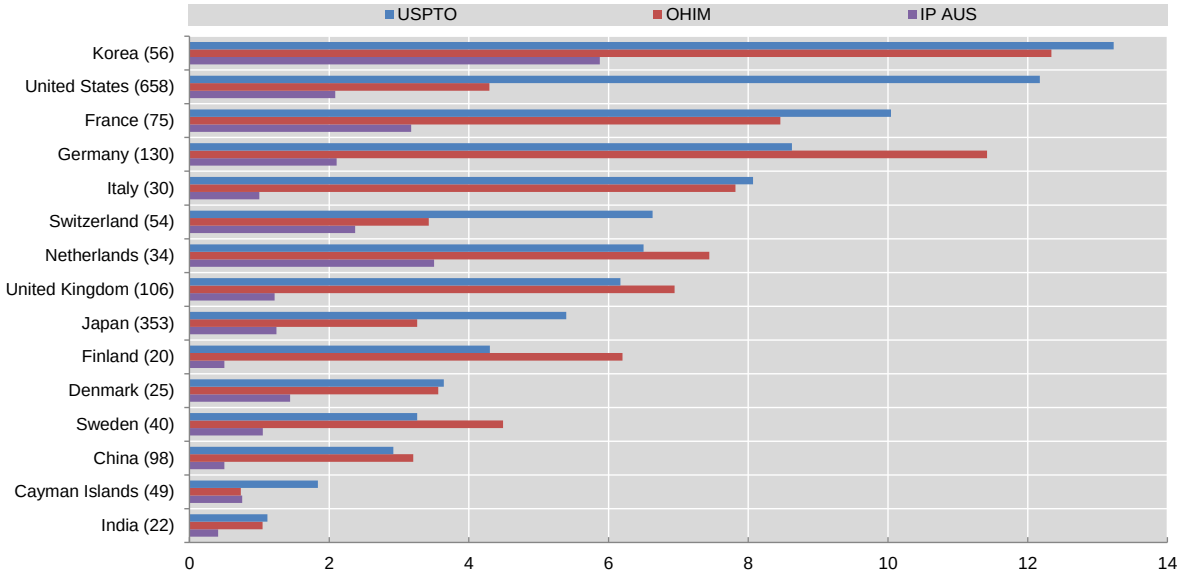
Note: Trademark counts are based on the application date, the address of the applicant's headquarters, and fractional counts. R&D-related trademarks refer to trademark applications designating class 42 of the Nice Classification. Overall number of firms assigned to each country displayed on the vertical axis, in parenthesis. Data relate to countries with at least 20 companies in the top 2000 corporate R&D sample. Countries are ranked according to USPTO figures.
*Data for JPO are up to May 2012.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014.

ICT-related trademark refer to TM applications in class 9 (*Instruments and computers*), class 28 (*Games*), class 35 (*Business and advertising*), class 38 (*Telecommunications*), class 41 (*Education and sport*) and/or class 42 (*R&D and software*) containing ICT-related keywords in the goods and services description[33]. Figure 4.9 shows that ICT-related TM applications of top R&D investors also belongs to companies headquartered in few countries featuring high absolute or relative levels of domestic R&D activities. The higher number of per company ICT-related TM applications belonging to top corporate R&D investors located in these countries may also signal the existence of specific corporate diversification and brand strategies, the size and sophistication of the local markets as well as the industrial and specialisation patterns of these economies.

[33] Complete list of keywords available on demand.

Figure 4.9 – Number of ICT-related TM applications per company, by companies' headquarter location, 2010-12

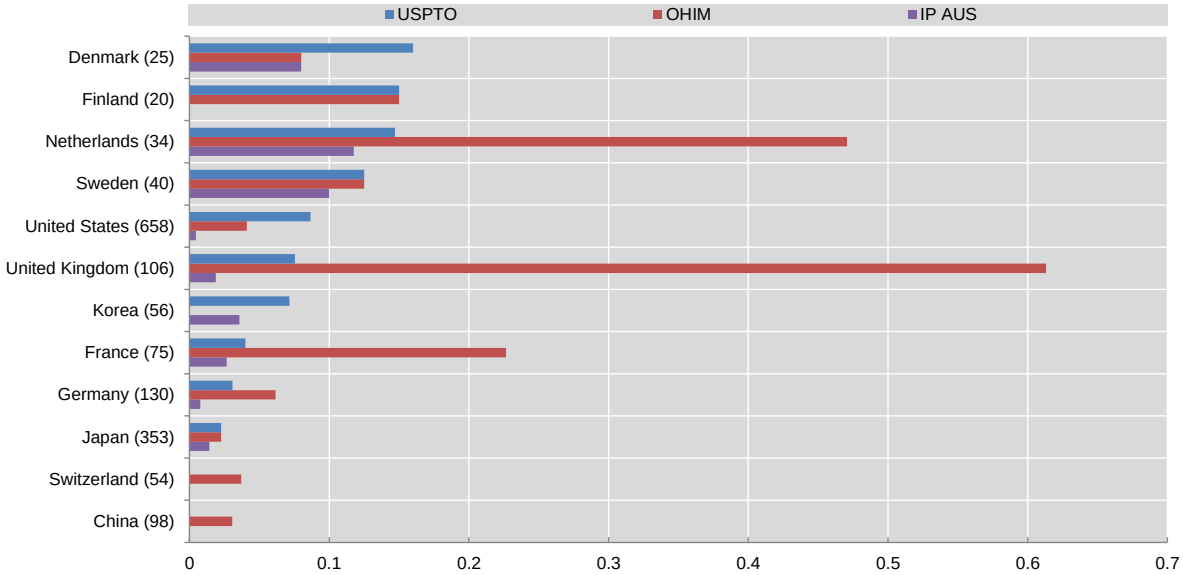


Note: Trademark counts are based on the application date, the address of the applicant's headquarters, and fractional counts. IP transactions-related trademarks refer to trademark applications designating class 45 of the Nice Classification and containing keywords related to IP transactions in the goods and services description (complete list of keywords available on demand). Overall number of firms assigned to each country displayed on the vertical axis, in parenthesis. Data relate to countries with at least 20 companies in the top 2000 corporate R&D sample. Countries are ranked according to USPTO figures.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014.

IP transaction-related TMs relate to the protection, management and commercialisation of IP rights, IP consultations and legal mediation in the field of IP. These trademarks are identified through a keyword search among trademarks registered in class 45 (*Legal and personal services*). The number of IP transaction-related TM applications per company appears very low, and signals that IP-related activities are only seldom branded and marketed in a somewhat independent fashion. The differences observed across the offices considered may to some extent reflect the relative importance or level of development of the markets for IP services in the countries considered.

Figure 4.10 – Number of IP transactions-related TM applications per company, by country, 2010-12



Note: Trademark counts are based on the application date, the address of the applicant's headquarters, and fractional counts. R&D-related trademarks refer to trademark applications designating class 42 of the Nice Classification. Overall number of firms assigned to each country displayed on the vertical axis, in parenthesis. Data relate to countries with at least 20 companies in the top 2000 corporate R&D sample. Countries are ranked according to USPTO figures.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014.

4.3. International trademark activities of top corporate R&D investors

4.3.1. A geographic perspective

Figure 4.11 provides a broad overview of the trademark activities of top corporate R&D investors by showing the distribution of applications across all Nice classes, at three key IP offices (the same table including data for IP AUS is available in Appendix 2). In line with what already observed before, the TM applications of top corporate R&D investors appear to be concentrated mainly in classes 9 (*Instruments and computers*) and/or 5 (*Pharma products*). This generally holds true irrespective of the location of the headquarters and the office of filing, again with the exception of TM applications filed by Japan-headquartered applicants at the JPO.

In terms of service trademarks (highlighted in bold in Figure 4.11), data confirm classes 42 (*R&D and software*), 35 (*Business and advertising*) and 41 (*Education and sport*) as the most frequently used services classes.

For EU-based and US-based companies, trademarking activities in the country of the headquarters are generally similar to the ones shown in foreign markets, in terms of distribution of applications across TM classes. The distributions of Japanese top R&D investors' classes at the USPTO and the OHIM also feature important similarities, and appear concentrated in few goods classes, including class 12 (*Vehicles*).

The observed higher average number of trademarks and TM intensity for applications at the JPO in class 3 (*Cleaning products*) and class 30 (*Condiments and cereals*) may to some extent stem from the relatively higher shares of these classes in Japan-based R&D investors' applications. However, the fact that also European firms exhibit a relatively higher share of applications in class 3 at JPO signals the possible existence of market-specific behaviours in the industry.

TM applications of Chinese and Korean top R&D investors mainly belong to the *Instruments and computers* class, in all offices considered. Other classes with lower although non-negligible shares of TM applications from companies headquartered in these two economies include class 7 (*Machinery*) for China-based HQ and class 11 (*Lightening and heating*) for top R&D investors headquartered in Korea.

Finally, and coherently with what observed in section 4.1.2, top R&D investors do not generally show higher shares of service-marks applications in their domestic markets than in foreign markets. This contrasts with the general trends observed when looking at all USPTO, OHIM and JPO applications over the same period (see OECD STI 2013).

Figure 4.11 – Distribution of trademark applications by Nice class, by companies' headquarter location and IP office, 2010-12

	USA			EU28			JPN			KOR			CHN			RoW		
	USPTO	OHIM	JPO	USPTO	OHIM	JPO	USPTO	OHIM	JPO	USPTO	OHIM	JPO	USPTO	OHIM	JPO	USPTO	OHIM	JPO
9-Instruments & computers	18.7	17.6	17.0	14.6	13.1	10.9	26.1	25.5	13.7	54.9	59.7	66.9	60.0	61.0	59.1	20.3	18.1	25.4
5-Pharma products	12.0	13.4	21.9	16.3	9.8	22.4	12.7	11.8	8.6	1.1					3.4	25.0	30.3	29.1
28-Games	8.3	2.7	3.3	1.7	2.7	2.7	3.9	3.3	4.1						8.0	2.0		
42-R&D and software	6.0	5.5	3.8	4.8	5.3	1.5	3.0	3.4	3.9	2.2	1.5		1.6	6.0		4.6	4.1	5.9
10-Medical instruments	5.5	8.8	10.6	4.1	4.3	5.3	3.6	6.0	1.8	1.0	1.5	1.0				3.9	7.7	8.0
3-Cleaning products	5.1	7.2	5.6	6.5	8.9	14.8	3.9	2.3	10.0			4.8		1.1		1.5	1.4	2.5
35-Business and advertising	4.6	3.4	2.0	4.5	4.2	2.5	2.8	2.3	2.7	3.4	1.9	2.4	1.4	1.7	8.0	3.5	3.0	4.1
41-Education and sport	4.0	3.8	2.3	3.6	3.9	1.8	3.1	3.3	2.9	2.2	1.8	1.3				2.7	2.2	1.5
30-Condiments and cereals	3.9	2.1	2.8	1.8	1.6	2.3	1.4		6.9			1.0			3.4	3.2	2.3	
1-Chemical goods	2.7	4.9	5.0	3.9	3.3	6.1	4.6	4.4	3.8							4.0	3.6	2.9
7-Machineries	2.4	2.9	2.5	3.6	4.3	2.1	4.6	4.7	2.6	5.4	6.7	4.9	13.2	9.5	11.4	2.8	2.7	
16-Papers and packaging	2.2	2.6	2.1	2.2	2.8	1.6	1.5	1.6	2.5						2.3	1.2	1.2	1.3
12-Vehicles	1.9	2.9	2.0	4.5	5.0	2.8	6.5	8.1	2.2	3.6	3.2	3.1	5.9	1.8			1.5	1.6
44-Medical and hygiene services	1.8	1.6	1.1	1.6	1.1		1.1	1.0								3.0	2.3	1.2
29-Food	1.8		1.2				1.1		3.5		1.1	1.0				1.2	1.0	
11-Lightening and heating	1.7	2.2	1.6	2.7	3.7	1.8	2.9	2.5	3.2	10.8	15.6	5.5	6.5	3.5	1.1	1.7	2.2	
25-Clothing and footwear	1.6		1.5	1.5	1.5	2.3	1.1	1.3	2.3	1.0								
36-Insurance and finance	1.5			2.3	2.3				1.1	1.3						1.1		
32-Low and non alcohol drinks	1.2			1.8					2.7			1.3						1.0
38-Telecommunications	1.1	1.5		1.7	2.4		1.4	1.8	1.0	2.3	2.3	1.8	1.2	5.5		1.1	1.4	3.1
37-Building services	1.1	1.4		1.7	2.5	1.1	1.4	1.5	1.8				2.3	2.5		1.2	1.9	1.1
34-Tobaccos			2.3		1.2	3.1		2.1										
31-Animals and grains																4.4	1.4	
6-Metals				1.3	1.2		1.2		1.2					1.4	2.3	1.0	1.4	
14-Precious goods																3.0	1.3	2.0
33-Alcoholic drinks				1.9	1.1	1.4		1.1	3.2									

Note: Trademark counts by international classes are based on the application date and the location of the applicant's headquarters, using fractional counts. Blue bars and percentages correspond to the distribution of Nice classes in the trademark applications of the region and office considered. Classes are ranked according to US figures at USPTO. Data relate to classes representing at least 2% of applications of one region at one office, and only percentages higher than 1% are displayed. Grey cells correspond to classes with no applications from the region/office considered.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014.

4.3.2. Word marks of top corporate R&D investors

In the case of patents, priority numbers, i.e. cross-reference numbers cited in patent documents claiming priority rights[34], help tracking patent applications related to the same inventions that are filed at several offices. Although trademarks are also given this possibility according to the Paris Convention, and priority rights can be claimed within six months from the date of the original trademark application, priorities are only seldom used by applicants. Only 12% of trademark applications at OHIM between 2008 and 2012 have a priority number, and only 2% of USPTO trademarks (13% of non-resident applications). Hence, relying on trademark priority data would provide a partial view of the extent to which firms use the same brands in different markets[35].

To try to shed light on the international trademarking strategies of top R&D investors worldwide, an experimental methodology is proposed here. This exploits information about the use of the very same word(s) when registering trademarks at different offices, to check whether companies use identical or differentiated word marks across markets. Statistics suggest that, of the set of distinctive signs that firms may use, word marks constitute the most common type of TM applications.

While this method allows identifying goods and services that are branded in exactly the same way in different countries, it nevertheless leads to spotting only those products that have identical word marks. This entails overlooking e.g. figurative or 3-dimensions trademarks, or trademarks using words having exactly the same meaning in different languages (e.g. “Mr Clean” in English-speaking countries, “Mastro Lindo” in Italian and “Monsieur Propre” in French).

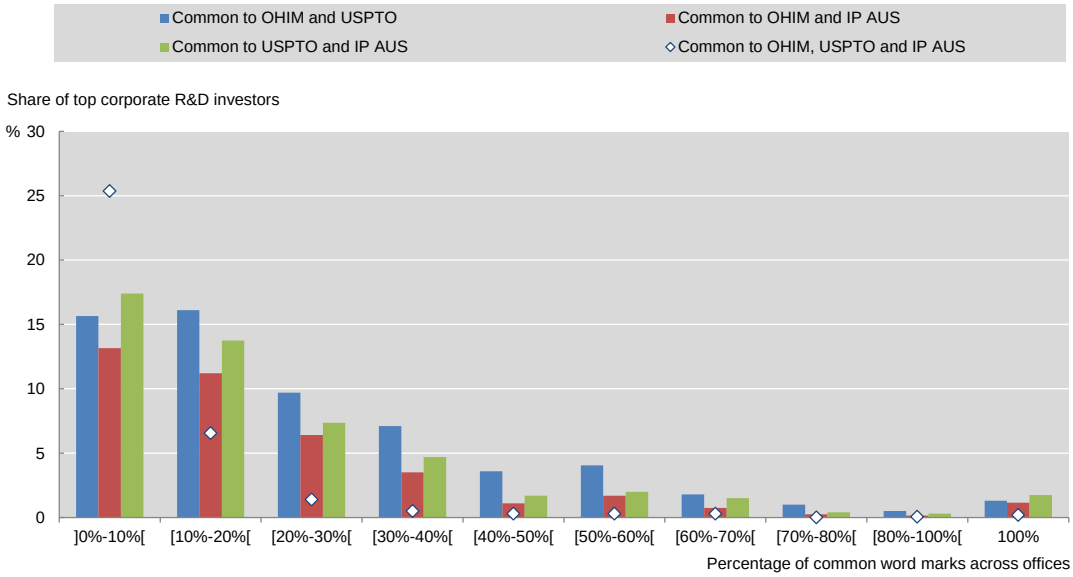
Figure 4.12 shows the share of top corporate R&D investors that have applied for identical word marks at the OHIM and/or the USPTO and/or the IP AUS between 2008 and 2012. The values are shown according to the percentage ranges of common word mark applications over the total word marks applications of the companies.

Overall, 61% of top R&D investors show to have applied for at least one identical word mark at the OHIM and the USPTO. This proportion goes down to 51% for a common word mark at the USPTO and the IP AUS. Such commonality is lowest between the OHIM and IP AUS, as about 39% of these companies have employed an identical word mark in their applications at the two offices. In any case, less than 2% of top corporate investors have filed all their word marks in an identical fashion in any two of the three offices. This suggests that the majority of firms tend to use a small set of core common trademarks across all the markets considered, and differentiate the majority of their trademark portfolio depending on the target market considered.

[34] Under the system of priority rights, established by the Paris Convention, applicants have up to 12 months from first filing their patent application in which to make further subsequent applications in each signatory country and claim the original priority date. The priority number is in particular used to build patent families.

[35] The very limited use of priorities in trademarks may be partly due to the fact that, contrary to technologies, trademarks are specific to the linguistic and cultural context in which they are supposed to be used. Companies thus tend to often adapt their trademarks to different markets. Examples are the French brand ‘Auchan’, which is traded as ‘Al Campo’ in Spain; the French brand ‘Danone’ traded as ‘Danonn’ in the United States, and the Coca-Cola Company brand mostly referred as ‘Coke’ in the US, versus ‘Coca-Cola’ in Europe.

Figure 4.12 – Share of companies with common word marks across OHIM, USPTO and IP AUS by percentage range of common word marks, 2008-12

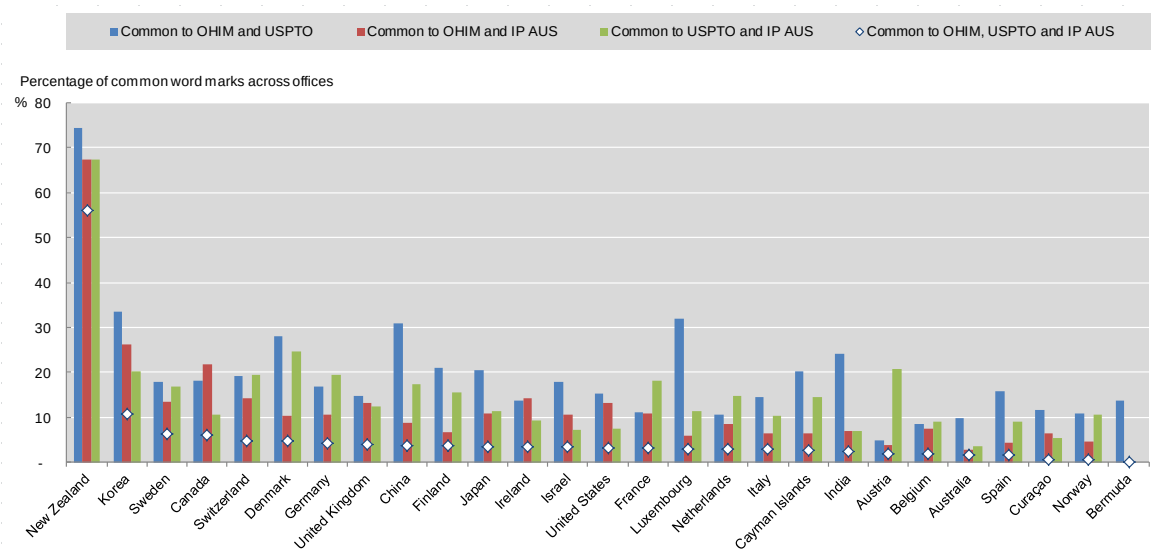


Note: How to read this figure: 9.7% of top R&D investors have between 20% and 30% of their word marks at OHIM and USPTO which are identical in the two offices. 1.4% have filed between 20% and 30% of their word marks at the OHIM, USPTO and IP AUS identically in the three offices.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014.

Figure 4.13 shows the shares of common word marks across the USPTO, OHIM and IP AUS, by headquarters location of the applicant.

Figure 4.13 – Percentage of common word marks between OHIM, USPTO and IP AUS, by companies' headquarter location, 2008-12



Proportion of word marks in overall trademark applications by office and country of applicant's headquarters																									
	NZL	KOR	SWE	CAN	CHE	DNK	DEU	GBR	CHN	FIN	JPN	IRL	ISR	USA	FRA	LUX	NLD	ITA	CYM	IND	AUT	BEL	AUS	ESP	CUW	NOR	BMU
USPTO	94	83	86	87	85	95	82	80	77	91	82	84	90	78	86	97	84	88	68	90	96	84	93	88	92	93	95
OHIM	89	89	88	95	91	94	91	82	84	87	88	89	97	87	92	95	86	88	86	94	96	86	94	77	96	95	97
IP AUS	86	88	86	96	86	95	91	86	79	87	89	85	96	87	92	94	91	93	86	90	91	89	88	88	90	88	50

Note: How to read this figure: 74% of word marks filed at OHIM and USPTO by New Zealand based corporate applicants are identical across the two offices. 56% of their word marks filed at OHIM, USPTO and IP AUS are identical across the three offices. Data relate to countries with at least 100 word mark applications at three offices taken together. Countries are ranked according to the share of common word marks in the three offices.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014.

As can be seen from the table at the bottom of the figure, the percentage of word marks of top corporate R&D investors' trademark applications is always higher than 75% for the countries and offices considered[36]. Except for New Zealand-based top R&D investors, which have 56% of identical word marks protected in the three offices considered, companies located in other countries feature only a minority of identical word marks across the offices considered.

For most countries, shares are highest in the case of the pair OHIM-USPTO, especially for top R&D investors headquartered in China, Luxembourg and India. This suggests that companies tend to adopt similar trademarking strategies in the European and the US markets, more frequently so than they do on the Australian market. Another common pattern that emerges is one whereby English-speaking countries (plus Korea and Israel) feature higher shares of common word marks between USPTO and IP AUS than they do at OHIM - IP AUS.

This exploratory comparison of common word mark shares across the different offices considered reveals the extent to which TM strategies differ across markets. The figures shown might mirror the fact that the very same products are branded in different ways in different markets or that companies propose (completely or partially) different products in different markets, and brand them in a different way. The differences observed might be explained by factors as corporate strategies; local customers' interests, language, culture and sophistication; and, more generally, the extent to which demand patterns – and hence supply strategies - differ across markets.

[36] With the sole exception of the word marks of Bermuda-based top R&D investors which represent 50% of their TM applications at the IP AUS.

5. The IP bundle: the combined use of patents and trademarks

Key findings

- Top corporate R&D investors use patents and trademarks as complementary protection means
- The joint commonality of patents and word marks is industry specific
- Few product fields relate to a wide range of patented technologies

The statistics and analysis proposed in previous sections of this report rely alternatively on patent or trademark data, with the aim to uncover a wide array of stylised facts related to the inventive output and the market and branding strategies of top corporate R&D investors. To gain a more comprehensive view of such dynamics, the present section combines patent and trademark data. This allows gaining further insights about the extent to which companies combine IP tools to better appropriate the results of their inventive activities and to successfully bring them onto the market.

The analysis presented in this section is based on data related to patents and trademarks registered at USPTO, EPO and OHIM, and JPO, which are comprised among the IP5 offices considered so far. Consistently, patent figures correspond to IP5 patent family members found in any of the three offices - a subset of Definition 2 described in Section 2 -, whereas trademark data refer to individual applications filed at the different offices.

USPTO and JPO trademark and patent data can be considered substantially homogeneous, as they are registered by the same institution and protected in the very same jurisdiction. In Europe, by contrast, trademarks and patents are not administered by the same office, and the scope of protection is heterogeneous. EPO patents are bundles of national ones and need being validated in each and every country where protection is sought, among the countries designated in the patent application. Only seldom EPO patents are validated in all the offices that can be designated, based on their being signatories to the European Patent Convention (EPC)[37]. Conversely the CTM system grants trademark owners exclusive rights in the 28 Member States of the European Union. Additionally, trademarks and patents in Europe can also be protected at the country level via the national IP offices routes, which are not taken into account in the present report.

These differences should be kept in mind when reading the figures presented throughout this section, as the heterogeneity of the IP assets considered may partially hinder the comparability of the statistics shown.

[37] See http://www.epo.org/law-practice/legal-texts/epc.html for more information about the EPC.

5.1. The IP portfolio of top corporate R&D investors

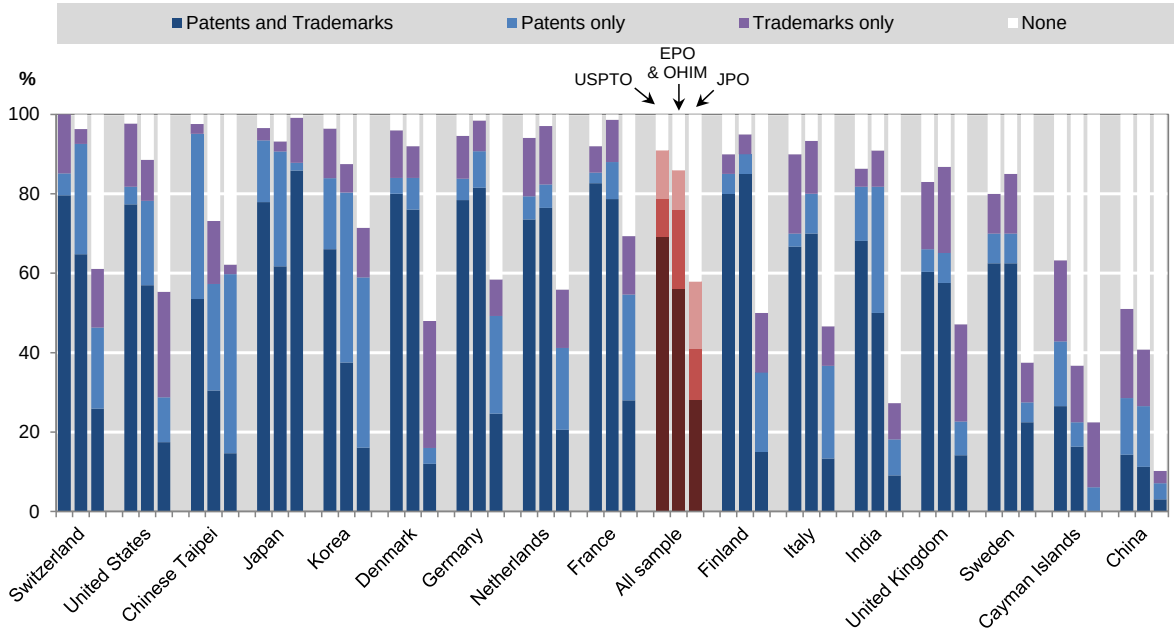
Patents and trademarks may constitute important tools for firms to compete in global markets and to differentiate themselves from their competitors. Hence, the joint analysis of patents and trademarks portfolios (i.e. of their IP bundle) should allow for a better understanding of the extent to which top R&D corporate investors introduce technological and non-technological (e.g. organisational, marketing, services) innovations onto the market and about their strategic behaviours.

Figure 5.1 and Figure 5.2 illustrate the use that world top R&D investors make of patents and trademarks, of trademarks only, of patents only or of none of the two IPR types. Data relate to the USPTO, the EPO and OHIM, and the JPO, and are displayed by headquarters location (Figure 5.1) and by industry (Figure 5.2).

As Figure 5.1 shows, the overall shares of the different IP strategies that companies pursue vary greatly, depending on the IP office considered and the location of the headquarters. Differences appear more pronounced when comparing USPTO or EPO/OHIM with JPO's.

Figure 5.1 –Top R&D investors with trademarks and patents, by companies' headquarter location, 2010-12

Share of companies with trademarks and/or patents filed at USPTO, EPO & OHIM, and JPO



Note: Data relate to countries with at least 20 companies in the top 2000 corporate R&D sample. Countries are ranked according to USPTO figures.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; the Worldwide Patent Statistical Database, EPO, December 2014; and OECD Trademark database (internal), 2014.

Evidence suggests that patents and trademarks are generally used in a complementary fashion rather than as substitutes, at least at the USPTO and the EPO/OHIM. Such a dual strategy is clearly preferred by top R&D performers headquartered in almost all countries (overall nearly 70% at the USPTO and 56% at the EPO/OHIM jointly use the two types of IPR). China-headquartered R&D investors (the majority of which use neither patents nor

trademarks), and Korea-headquartered top corporate R&D investors activities at the EPO/OHIM represent exceptions in this respect.

Companies headquartered in the United-States, France, Switzerland, Denmark, Finland, Germany, Japan and the Netherlands jointly use the two intellectual property rights at levels that are above the overall sample average, at both the USPTO and the EPO/OHIM. Within this first group, companies headquartered in the Netherlands tend to rely relatively more often on a trademarks-only strategy at the USPTO and the EPO/OHIM - about 15% of firms, a share that is substantially higher than the others. This is also true for US- and Switzerland-based companies' applications, but only at the USPTO. Very low shares of companies opting for a *Trademarks only* strategy at the EU and US offices emerge in relation to Japanese and Finnish top corporate R&D investors.

Companies located in Italy, India, Korea and Sweden also make a fairly high use of combined patent and trademark protection (more than 65% of firms at USPTO and more than 35% at OHIM). Within this group, the share of companies headquartered in Sweden and India that filed neither patents nor trademarks in the period analysed is relatively high, particularly at the USPTO, as compared to EPO/OHIM figures. Moreover, India- and Korea-based top R&D investors show a very high share of *Patent only* strategies at the EPO/OHIM (respectively 31% and 42%), which is also the case for Japan- and Switzerland-headquartered companies (respectively 29% and 28%).

In line with what observed in previous parts of this report, the behaviour of companies at JPO differs from the one observed at the other offices. The majority of top corporate R&D investors headquartered outside Japan seem to rely neither on JPO patents nor on JPO trademarks during the period 2010-12. This is particularly true for companies headquartered in China, Finland, India, Sweden, the United Kingdom and Denmark, with the *"none"* strategy chosen by more than 50% of companies. This reflects the low propensity of non-Japanese top R&D investors to file for IP protection at the JPO, and the predominance of Japan-based companies in overall JPO filings. Top corporate R&D performers headquartered in Japan conversely exhibit a very high reliance on both JPO patents and trademarks.

Chinese companies emerge as those that on average rely very little on the joint use of patents and trademarks (11% at the EPO/OHIM and 14% at the USPTO). Moreover, the proportion of China-headquartered top R&D performers that does not file USPTO, EPO/OHIM or JPO patents or trademarks is the highest (50% or more) of the whole sample.

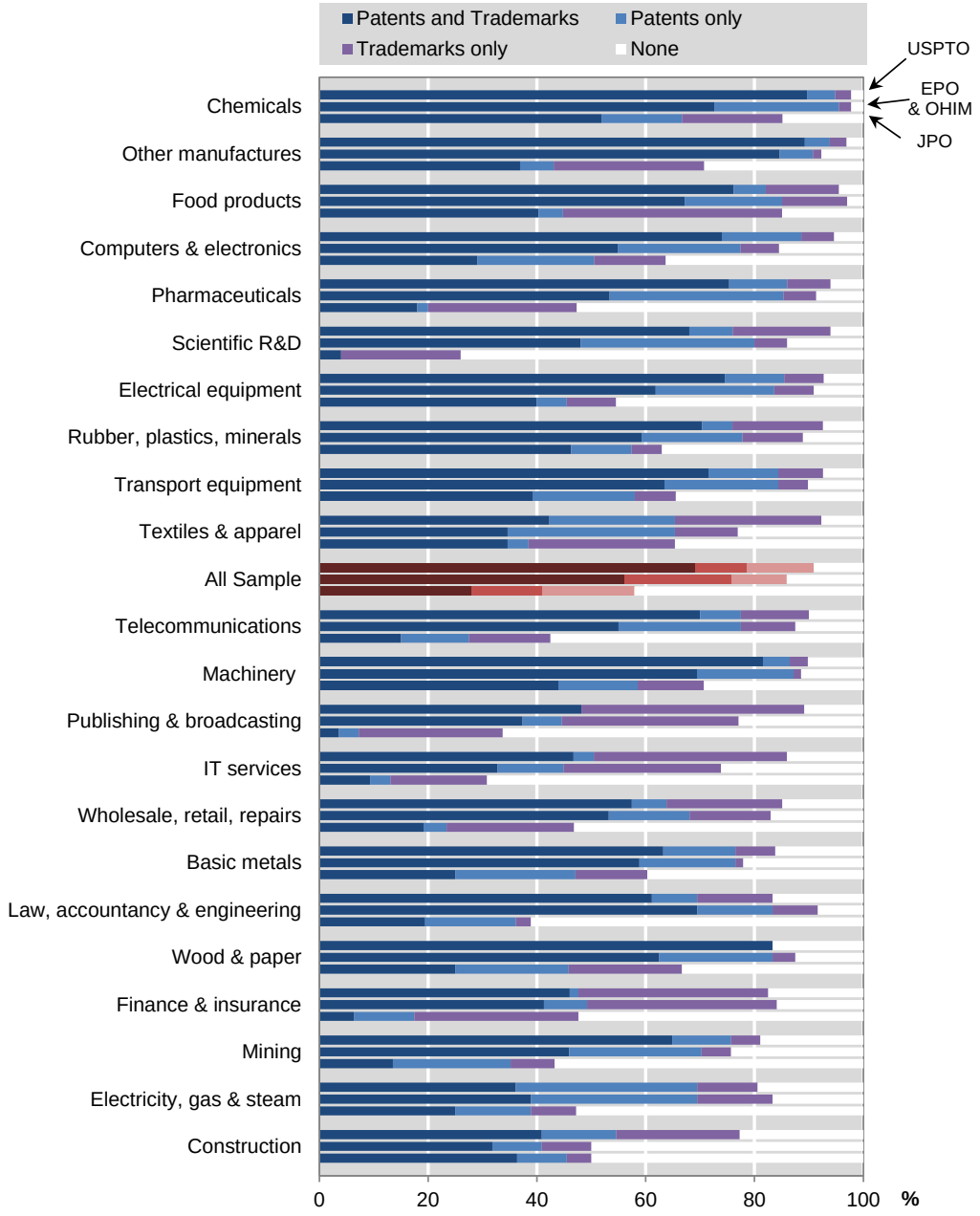
As shown in Figure 5.2, aggregating data at the industry level helps shedding further light on the IP behaviour of top corporate R&D performers. These specificities may contribute to explain the differences found at the country level, as industrial structure does differ across the economies considered. Overall, the joint use of patents and trademarks is still favoured by most industries, although shares appear to significantly vary depending on the industry and the IP office considered. The relative preference for *Patents only* or for *Trademarks only* strategies also differs across industries.

Coherently with what is observed in Figure 5.1, companies exhibit substantially similar behaviours at USPTO and EPO/OHIM, whereas they behave differently at JPO. As observed at the country level, at JPO the "*none"* strategy is much more frequent, and *Trademarks only* strategies appear particularly important for companies operating in industries such as 'Food

products' (about 40% of top corporate R&D investors), 'Publishing and broadcasting' and 'Finance and Insurance'.

Figure 5.2 - Top R&D investors with trademarks and patents, by industry, ISIC rev. 4, 2010-12

Share of companies with trademarks and/or patents filed at USPTO, EPO & OHIM, and JPO



Note: Data relate to industries with at least 20 companies in the top 2000 corporate R&D sample. Industries are ranked according to the USPTO figures.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; the Worldwide Patent Statistical Database, EPO, December 2014; and OECD Trademark database (internal), 2014.

A closer look at the USPTO and EPO/OHIM figures shows that top corporate R&D investors in 'Other manufactures' and 'Chemicals' industries report a joint use of patents and trademarks that is above 70%, and is above the overall sample's average. This dual IP protection strategy is less frequent in 'Construction', 'Textiles and apparel', 'Finance and

insurance', 'IT services', 'Publishing and broadcasting' and 'Electricity, gas and steam'. The latter sector reports higher shares of *Patents only* strategies, while the former ones tend to favour either dual IP strategies or the *Trademarks only* strategies. Other non-negligible shares of *Patents only* filing behaviours at the USPTO and the EPO/OHIM can be observed in the case of 'Computers and electronics', and 'Scientific R&D' companies.

A relatively high proportion of top corporate R&D investors in 'IT services' and 'Finance and insurance', as well as 'Construction' and 'Electricity, gas and steam' industries rely either on alternative means of protection or on no IP protection at all.

Figure 5.3 further explores the IP bundle-related behaviours of the top 2000 corporate R&D investors worldwide across industries, in terms of number of patents and trademarks applications in the US, Europe and Japan, in the years 2010-12. To allow for inter-industry comparisons, the average number of IPR per company is reported.

Overall, based on the offices and definitions considered, top corporate R&D investors worldwide seemingly file a higher number of patents than of TM applications. These patterns would likely be even more pronounced if individual patent applications were to be considered instead of patent families. However, the use of the two IP protection means varies widely across industries. Generally, top corporate R&D investors show a relatively higher IP activity in US market, with the average number of patents and trademarks that is largest at USPTO for more than half of the industries. This may relate to the size and attractiveness of the US market for both technologies and end-products.

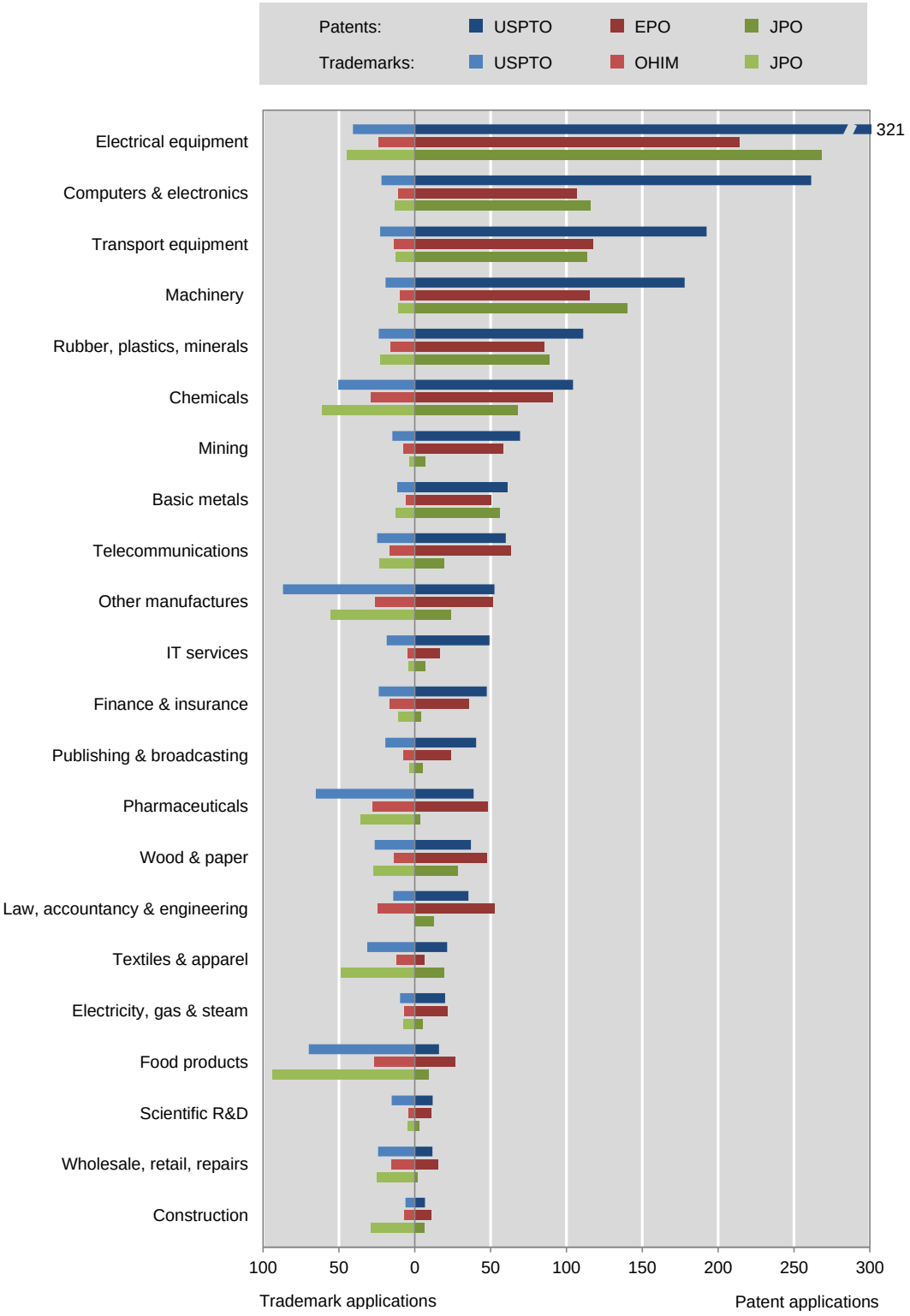
'Electrical Equipment' and 'Computers and electronics' industries outstand in terms of patented inventions per company. Moreover, in these industries the trademark-to-patent ratio is among the lowest. 'Transport equipment' and 'Machinery' show similar ratios and, to a lesser extent, a high propensity to patent. In these industries, innovation is seemingly based on the development of new technological solutions, likely affecting the different features of complex products, rather than on product differentiation.

Only few industries report trademarks numbers that are higher than patents' and feature low average numbers of patent applications per company. Among them 'Food products', 'Textiles and apparel', 'Wholesale, retail, repairs' when all offices are considered; and 'Pharmaceuticals' and 'Other manufactures' when the focus is on filings at the USPTO and the JPO. All these industries indicate a patent propensity below the sample average.

Finally, top R&D performers operating in the 'Chemical' industry display relatively high numbers in terms of both trademarks and patents applications.

Figure 5.3 - The IP bundle of world Top R&D investors, by industry, ISIC rev. 4, 2010-12

Average number of trademark and patent applications filed at USPTO, EPO & OHIM, and JPO per company



Note: Data relate to industries with at least 20 companies in the top 2000 corporate R&D sample. Industries are ranked according to the USPTO figures.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; the Worldwide Patent Statistical Database, EPO, December 2014; and OECD Trademark database (internal), 2014.

5.2. Patents and word marks: a look at commonalities across offices

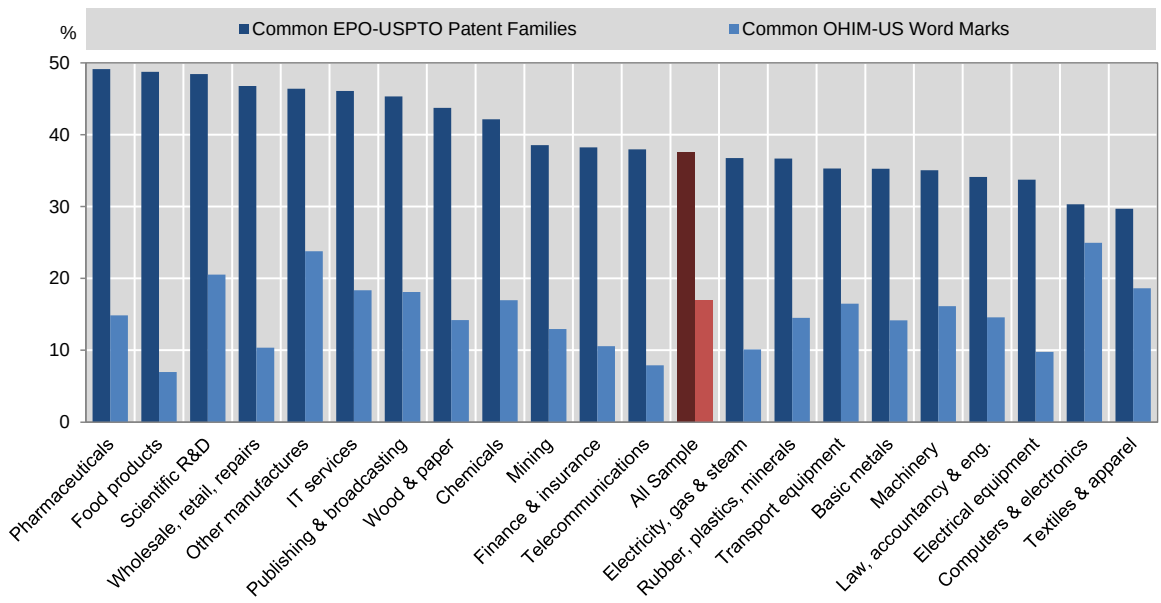
This section explores the commonalities in terms of patents and word marks of the top corporate R&D investors worldwide. As explained in 4.3.2, in principle IP data allow tracking applications related to the same technical inventions in the case of patents and to the same good(s) and/or service(s) in the case of trademarks. However, priority claims remain rarely used in trademark applications, making it difficult to track identical trademarks that are filed at different IP offices. Therefore, using trademark priority records would provide a partial view on the use of the same trademark in different markets.

The experimental methodology proposed in Section 4, which relies on word marks, is extended here to analyse the exploitation of the same patents and trademarks across geographical markets. To this end, information about the extent to which an invention is patented by different offices and about the use of the very same word(s) in TM applications filed at different offices is used. Such approach is meant to investigate whether companies have similar or differentiated patenting and trademarking strategies in different markets. The analysis is restricted to applications made to the USPTO and the EPO/OHIM, for which information on patent and word marks is available.

Figure 5.4 presents the shares of patents and word marks that are common to the US and European offices over the total number of patent and word mark applications in the sample. Companies are grouped according to the industries they belong to and values are ranked according to the shares of EPO-USPTO patent families.

Figure 5.4 - Joint IP protection in Europe and in the United States, by industry, ISIC rev.4, 2010-12

Average share of patent families filed simultaneously at EPO and at USPTO in total patent families with EPO and USPTO
and
Average share of common OHIM and USPTO word marks in total trademarks filed at OHIM and USPTO



Note: Data relate to industries with at least 20 companies in the top 2000 corporate R&D sample. Companies with at least 10 EPO-USPTO patent families or 10 OHIM-USPTO word marks are considered in the aggregation.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; the Worldwide Patent Statistical Database, EPO, December 2014 and OECD Trademark database (internal), 2014.

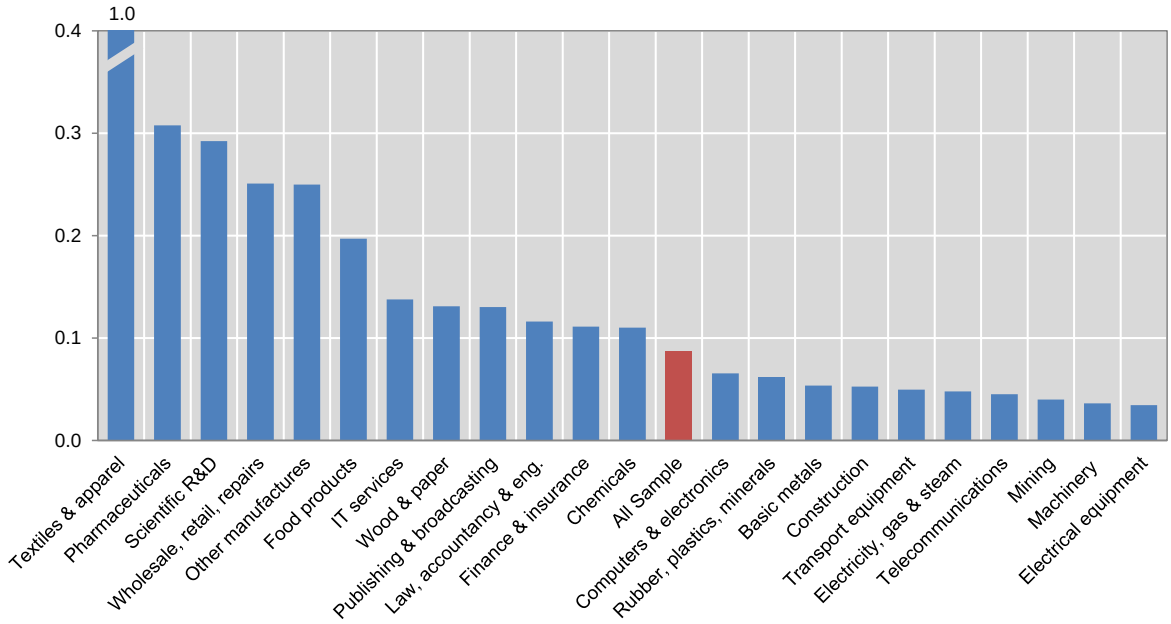
The fact that the share of common patents is higher than that of common word marks in all industries may signal that top corporate R&D investors likely differentiate their brands or products to a greater extent than they do in terms of technologies. 'Pharmaceuticals' and 'Food products' on the one hand, and 'Computers and electronics' and 'Textiles and apparel' industries on the other hand, delineate quite well the spectrum of combinations. 'Pharmaceuticals' and 'Food products' industries show the highest shares of EPO-USPTO patent families, and among the lowest shares of common word marks. Conversely 'Computers and electronics' and 'Textiles and apparel' exhibit the lowest shares of common patent families, and among the highest shares of common word marks.

Comparatively high proportions of common word marks are generally found in industries with important patent activities at both the EPO and the USPTO, such as 'Scientific R&D' and 'Other manufactures'. In addition, it can be noted that the majority of industries with a high average number of patents per company, such as 'Electrical equipment', 'Computer electronics' and 'Transport equipment' (see fig. 5.3) own amongst the lowest shares of common EPO-USPTO patent families. 'Computers and electronics', however, stands out because of its share of common word marks, which is the highest of the sample. In this industry, the proportion of common trademarks and patents looks very similar, possibly reflecting the international dimension of both the technology creation space and of end-product markets.

Figure 5.5 presents the number of common word marks per joint EPO-USPTO patent family. With the exception of 'Textile and apparel', all industries show lower numbers of common word marks than patent applications.

Figure 5.5 - Common OHIM-USPTO word marks per joint EPO-USPTO family, by industry, ISIC rev.4, 2010-12

Average number of common OHIM-USPTO word marks over the average number of joint EPO-USPTO families per company



Note: Data relate to industries with at least 20 companies in the top 2000 corporate R&D sample.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; the Worldwide Patent Statistical Database, EPO, December 2014 and OECD Trademark database (internal), 2014.

Industry-specific differences in the ratio common word mark to common patent clearly

emerge. The most frequent use of common word marks for the 'Textiles and apparel' industries may signal the existence of global strategies in terms of product diversification.

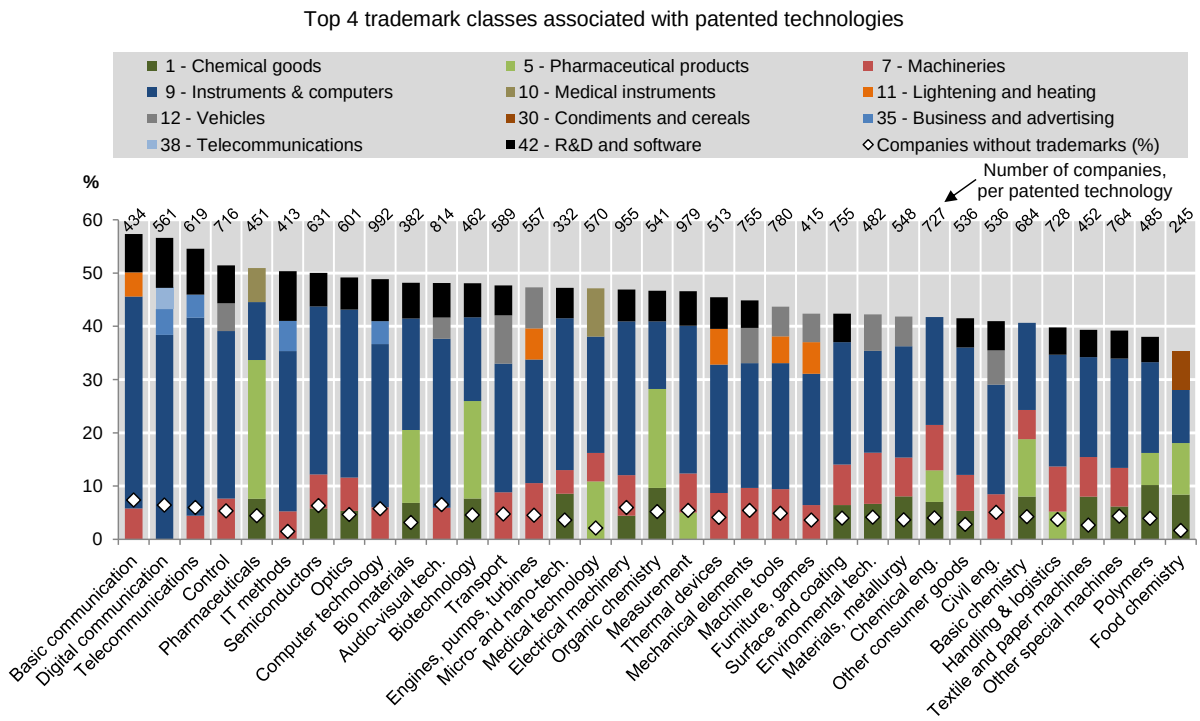
Most of the industries presenting a high number of common word marks relative to common patents are also those with a relatively higher average number of trademarks as compared to the average number of patents (see fig 5.3). These include, for instance the 'Textiles and apparel', 'Pharmaceuticals', 'Food products' and 'Other manufactures' industries.

5.3. Using trademarks as a complement to patent protection

Patents, and the technological developments that companies protect through them, are often accompanied by trademarks, aimed at differentiating goods on the market and at signalling their existence to prospect consumers. As the very same technology may lead to various commercial applications it might be interesting to look at the association between technology classes and product fields, and verify the extent to which different technologies relate to different product classes.

Figure 5.6 shows the composition in terms of Nice classes of the trademark portfolios of top corporate R&D investors owning patent families. Data are shown by the technology field in which patents are applied and calculations rely on patent and trademark data from EPO/OHIM, JPO and USPTO taken together. Only the top 4 trademark classes are reported. Similar indicators constructed at the level of each office are presented in Appendix 3.

Figure 5.6 – Composition of patenting companies' trademark portfolio, 2010-12



Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; the Worldwide Patent Statistical Database, EPO, December 2014 and OECD Trademark database (internal), 2014.

More than 90% of companies with at least one patent in any of the 35 technologies have

also filed at least one TM application at any of the three offices over the period 2010-12. Coherently with the statistics presented so far, the propensity to use trademarks along with patents appears to vary depending on the technological domain in which patenting companies are active.

Also, by looking at the combinations of product classes per technology, a number of patterns emerge. As reflected by the overall distribution of TM good-related classes discussed in Section 4, *Instruments and computers* (class 9) and/or *Pharmaceuticals products* (class 5) are the most frequently designated classes in TM applications. *Instruments and computers* indeed rank among the top 4 trademark classes protected by top R&D investors worldwide, and independently of the specific technologies covered by their patents. Companies with patents in *Basic or Digital Communication*, or *Telecommunications*, registered 40% of their TM in *Instruments and computers* class. Two additional classes, among the most frequent, include *Machineries* (class 7) and *Chemicals goods* (class 1), although they appear in much lower proportions than the top two classes. *Machineries* further stands out as a class designated in a broad range of technological domains (at least once in 28 out of the 35 technology fields).

Patented technologies related to *Pharmaceuticals*, *Bio materials* and *Biotechnology*, *Chemistry (Organic, Basic or Food Chemistry)* and *Polymers*, are frequently associated with TM applications in *Chemical goods* (class 1) and *Pharmaceutical products* (class 5). Furthermore *Vehicles* (class 12), representing a non-negligible share of trademarks applications, also shows some sort of 'horizontal' nature, as it is designated in about one third of the technology classes.

A closer look at TM services classes points out again the relative importance of *R&D and software* (class 42) for a broad range of technologies. More limited, are the frequencies of *Business and advertising* (class 35), which is designated only in association with *Digital Telecommunications*, *Telecommunications*, *IT methods* and *Computer technology*, and of *Telecommunication* (class 38).

The patterns observed mirror the substantial homogeneity of behaviours that can be observed when IP offices are considered in a separate fashion, as done in Appendix 3. The main noticeable differences across offices concern the extent to which patenting companies rely on trademarks.

The share of companies patenting at EPO that do not register trademarks at OHIM ranges between 20% and 40% across technology fields, whereas this share is always lower than 12% for USPTO, and above 40% for JPO. Also, the shares of the top 3 TM classes across patented technologies vary between 30% and 55% at the USPTO, 36% and 80% at the EPO/OHIM and between 37% and 75% at the JPO.

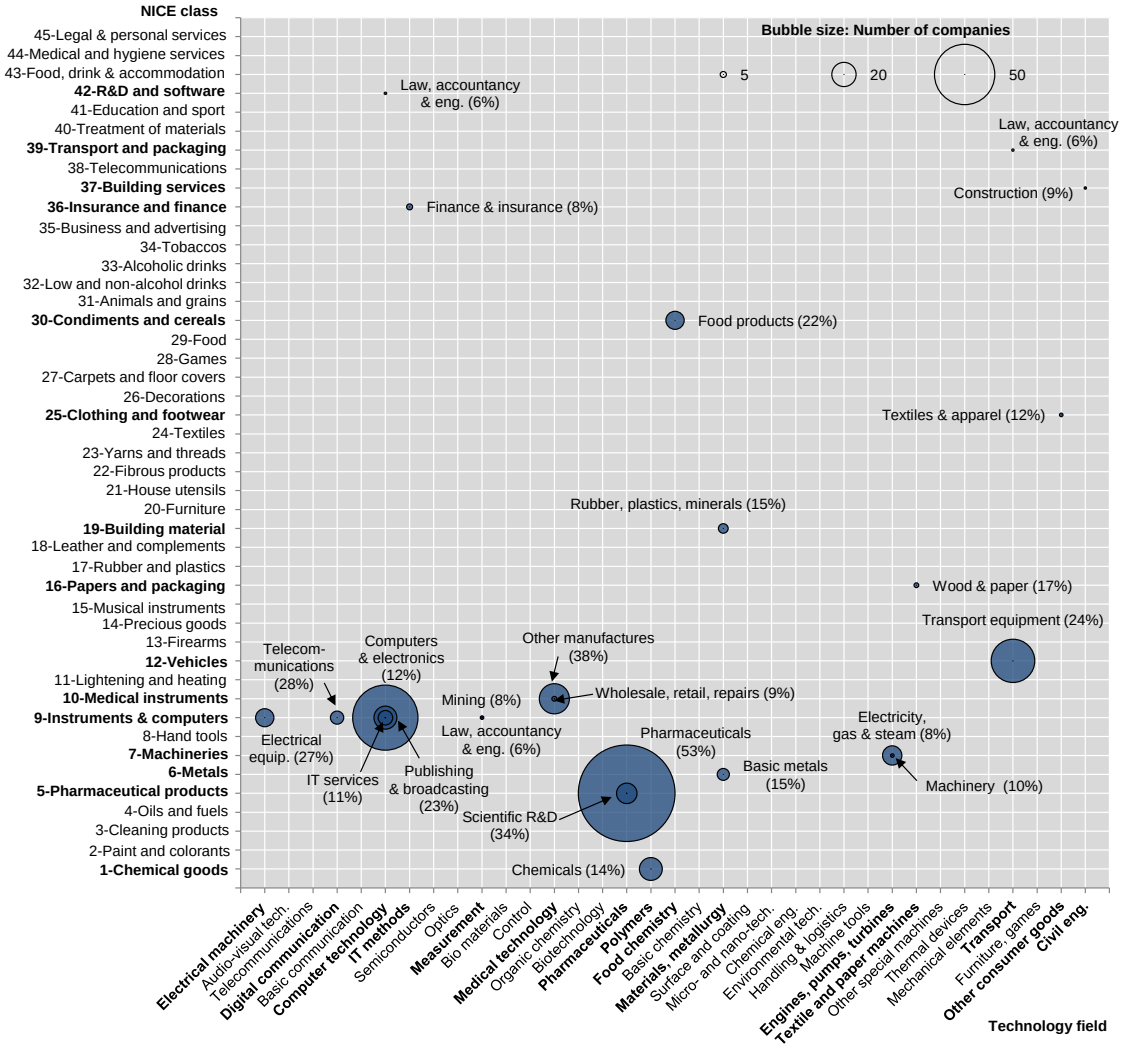
The three figures in Appendix 3 confirm the prominence of *Instruments and computers* (class 9) and/or *Pharmaceuticals products* (class 5), although percentages differ greatly across technologies and offices. In addition *Machineries* (class 7) also shows up among the classes used in conjunction with a broad range of technologies when offices are considered separately. Similarly, but for a narrower set of patented technologies, *Vehicles* (class 12) and *Chemicals goods* (class 1) (also *Medical Instruments* at the JPO), appear among the most designated TM classes in the offices considered.

Depending on the industry they belong to, top corporate R&D investors seemingly tend to combine different patented technologies with different trademark classes. Figure 5.7 proposes a disaggregation of the patent-and-trademark combinations at the industry level.

The x-axis reports the technology fields of companies' patent portfolios, and the y-axis presents the product classes designated in their TM applications. The circles indicate the most frequent combinations of technology and product classes observed in the IP bundle by industry. The size of the circles denotes the number of companies featuring these combinations, and the percentage points denote the proportion that these companies represent of the industry they belong to.

Figure 5.7 – Composition of the IP portfolio of companies, by industry, ISIC rev. 4, 2010-12

Most frequent combinations of the top patented classes and top trademark classes by company



Note: Data relate to industries with at least 20 companies in the top 2000 corporate R&D sample. The most frequent combinations of patent and TM classes are identified as the aggregation of the most patented technology with the most trademarked class in a given company's IP portfolio. The size of the bubbles denotes the number of companies featuring this combinations and the percentage points denote the proportion that these companies represent of the industry they belong to.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; the Worldwide Patent Statistical Database, EPO, December 2014 and OECD Trademark database (internal), 2014.

The technology fields and the type of products that top corporate R&D performers seek to protect tend to be aligned with the industry where they operate. However, only few industries show a high share of companies concentrated around related IPs. In 'Pharmaceuticals' and in 'Scientific R&D' industries, more than 50% and one third of companies (respectively), feature an IP portfolio mainly composed of patents in *Pharmaceuticals* and trademarks in

Pharmaceutical products. The combination of *Computer technology* and *Instruments & Computers* is most frequent for the following industries: 'Computers & electronics', 'IT services' or 'Publishing & Broadcasting'. However, the relative importance of this combination varies, with values of around 12% of companies in the former two industries and 23% in the latter.

More than one fifth of companies operating in the 'Food products' industry relies predominantly on patents relating to *Food chemistry* and trademarks related to *Condiments and cereals*. A similar pattern is observed for the bigger group of companies in the 'Transport equipment' industry, relying on *Transport*-related technologies and the *Vehicles* class. The same holds also true for much smaller groups of companies from industries such as 'Telecommunication' (relying on *Digital communication* and on *Instruments and computers* – class 6) and 'Electrical equipment' (*Electrical machinery* and *Instruments and computers* – class 9).

Conclusion

This report, result of a collaborative project between the EC-JRC and the OECD Directorate for Science, Technology and Innovation, sheds some light on the extent to which R&D spending by top corporations worldwide results in the development of new technologies and the launch of new products on global markets.

The wealth of indicators contained in, and dataset associated with, this joint report provide evidence in support of policy making by characterising the link between R&D spending - technological developments - launch of new products and processes. It further provides insights about the different strategies that top corporate R&D investors worldwide pursue, and about the existence of industry- and country-specific patterns. As top corporate R&D investors worldwide are at the technology frontier and account for a substantial amount of innovation-related investment and output, understanding and monitoring their behaviours might enhance policy makers' ability to design policies aimed at fostering innovation, productivity and, ultimately, more and better jobs.

The evidence proposed in this report suggests that top corporate R&D investors, who own 66% of all IP5 patent families worldwide, display a wide heterogeneity in their propensity to patent but concentrate their patent filings in a relatively narrow set of technologies, especially related to electrical and mechanical engineering. Also, over the last ten years, inventions related to ICTs have increased, whereas those related to pharmaceuticals have declined in relative terms.

The important and growing role of Asia for technological developments further emerges: of the top ten patenting companies in the sample nine are headquartered in Asia and eight belong to the ICT sector. Overall, these ten top corporate R&D performers account for one fourth of all the patents owned by these R&D investors.

Analysis based on the location and industrial activity of both headquarters and affiliate companies suggests that geographical and technological patterns are positively correlated, and that the degree of technological specialisation varies widely across industries. Companies that have a highly diversified corporate structure - in terms of industries to which their affiliates belong – appear also technologically diversified. Technological diversification further relates to geographical diversification (i.e. to the extent to which subsidiaries are located in countries other than the one of the headquarters), but to a less extent.

Top corporate R&D investors located in Europe and the United States appear relatively more specialised in a wider array of technologies, including those that are fundamental to address grand challenges such as health, ageing and the environment. Korean, Chinese and Japanese based companies show a high specialisation in ICT-related technologies where European-based show lower technological advantages in this field. Japanese based companies appear to be specialised in a wider array of technologies than Korean and Chinese ones.

Markets do matter, and top corporate R&D investors pursue distinct patent filings strategies across IP offices and over time, with the current picture that reflects the rapid increases of filings at the Korean and Chinese offices. Filing strategies across the IP5 offices

appear to further depend upon the technological field of the invention to protect. Patent families filed at the USPTO, the KIPO, and the SIPO are largely oriented towards *Electrical engineering*, while EPO patent families show a stronger orientation towards *Mechanical engineering* and *Chemistry*. Patent families at the JPO are the most oriented towards *Instruments* and *Mechanical engineering*.

In terms of the technological and economic value of patents, indicators further suggest that applications at the USPTO are generally protected in a relatively smaller number of countries, i.e. are of smaller family size, fact which might reflect the attractiveness of the US market *vis-à-vis* other markets. These patent families feature are comparatively narrower in technological scope but feature a higher radicalness vis-à-vis prior art.

Top corporate R&D investors appear to importantly rely on international knowledge to develop their technologies, as about one fourth of companies' patent portfolios have been developed by teams of inventors residing in countries that are different from the location of the headquarters. For companies operating in 'Mining', 'Finance & Insurance' and 'Pharmaceutical' industries patents featuring an international team of inventors correspond to more than half of the portfolios. These dynamics underline the importance of knowledge repositories and skills in driving inventive activities and shaping global value chains.

Target markets and home markets, i.e. the country of the headquarters, do matter also in the case of trademarking strategies. Trademarks are mostly filed by top corporate R&D investors headquartered in the United States, Japan, Germany, the United Kingdom and France and companies tend to be more active at the USPTO than at the OHIM. JPO is the office presenting the highest home specificity, as more than three quarters of patent applications come from Japan headquartered companies.

TM applications also exhibit significant industrial specificities in terms of number of trademarks, trademark intensity (i.e. number of trademarks per Euro of net sales) and concentration ratios. They are further concentrated in few classes and products fields, and mostly refer to goods or to goods and services jointly, especially in *Instruments and computers* and *Pharmaceutical products*. Services- related trademarks pertain mainly to *R&D and software*, with knowledge based assets-related trademarks reflecting applications from a narrow set of countries featuring developed and competitive markets for research. Top corporate R&D investors from China and Korea exhibit a strong orientation towards *ICT and audiovisuals*-related trademarks.

Overall, top corporate R&D investors use patents and trademarks as complementary protection means, and the combined use of these IPR is favoured by the majority of companies in the US and European markets. Companies from ‘Chemicals’, ‘Pharmaceuticals’, ‘Food products’, ‘Computers & electronics’ industries are keen on combining the two types of IPRs, whereas services-oriented companies operating in the ‘IT services’ and ‘Finance and insurance’ industries tend to protect their assets primarily through trademarks. All-in-all patents still constitute the most commonly used means of protection at the USPTO, the EPO/OHIM and the JPO, and firms in industries with low patent propensities as ‘Food products’ and ‘Pharmaceuticals’ tend to have more TM applications.

In terms of technological and product differentiation, the indicators proposed in the present report suggest that top corporate R&D investors more frequently pursue identical technological strategies than identical branding ones. Moreover, a negative correlation can be generally observed between technological and branding strategies, whereby companies in industries featuring high proportions of common patents exhibit low shares of identical word trademarks, and industries with the lowest shares of common patents (e.g. 'Computers and electronics' and 'Textiles apparel'), are more likely to employ the very same word in trademark applications filed at different offices.

Analysing the IP bundle and the extent to which technology areas align with the products' space a clear pattern emerges: few companies present technology/product combinations in line with the profile of the industry in which they operate. Also, the horizontality of R&D and software emerges, as TMs related to R&D and software are owned by companies having very different technological profiles. The 'Pharmaceutical' industry shows the strongest uniformity, with more than half of its companies featuring an IP portfolio mainly composed of patents in *Pharmaceuticals* and trademarks in *Pharmaceutical products*.

The stylised facts above represent but a small proportion of the wealth of information that can be extracted from the dataset constructed for the analysis. This is why the EC-JRC and the OECD have decided to put these data in the public domain, hoping that researchers, analysts and all those interested would use them in statistical and econometric analyses to generate evidence in support of policy making. Understanding the role of top players in shaping technology developments and their positioning on global knowledge networks is key to innovation policy making in today's globalised world.

References

Acs, Z. J. and Audretsch, D. B. (1989). Patents as a measure of innovative activity. *Kyklos*, 42(2): 171-180.

European Commission (2013). *The 2013 EU Industrial R&D Investment Scoreboard*, Luxembourg: Publications Office of the European Union.

European Patent Office (EPO) and Office for the Harmonization in the Internal market (OHIM) (2013). *Intellectual property rights intensive industries: contribution to economic performance and employment in the European Union*, September 2013, Joint project between the EPO and the OHIM.

Graham, S., Hancock, G., Marco, A., and Myers, A. (2013). The USPTO Trademark Case Files Dataset: Descriptions, Lessons, and Insights. SSRN Working Paper, http://ssrn.com/abstract=2188621.

Griliches, Z. (1990). Patent Statistics as Economic Indicators: A Survey. *Journal of Economic Literature*, 28: 1661-1707.

Hall, B. H., Griliches, Z., and Hausman, J. A. (1986). Patents and R and D: Is There a Lag? *International Economic Review*, 265-283.

Lei, Z., Sun Z. and Wright B. (2012). Are Chinese Patent Applications Politically Driven? Evidence from China's Domestic Patent Applications. Paper presented at the "Patent Statistics for Decision Makers Conference, OECD, Paris. (www.oecd.org/site/stipatents/4-3-Lei-Sun-Wright.pdf).

Levenshtein, V. I. (1965). Binary Codes Capable of Correcting Deletions, Insertions and Reversals. *Doklady Akademii Nauk* SSSR 163(4): 845-848.

Mansfield, E. (1984). R&D and innovation: some empirical findings. In Z. Griliches (ed.) "*R&D, Patents, and Productivity*" (pp. 127-154). University of Chicago Press.

Martínez, C. (2011). Patent families: when do different definitions really matter?. *Scientometrics*, 86(1): 39-63.

Mendonça, S., Pereira, T. S. and Godinho, M. M. (2004). Trademarks as an indicator of innovation and industrial change. *Research Policy*, 33(9): 1385-1404.

Millot, V. (2012). Trademarks strategies and innovative activities. PhD dissertation, University of Strasbourg, France.

OECD (2013). *Science, Technology and Industry Scoreboard 2013*, OECD Publishing.

Patel, P. and Pavitt, K. (1997). The technological competencies of the world's largest firms: complex and path-dependent, but not much variety. *Research policy*, 26(2): 141-156.

Pavitt, K. (1985). Patent statistics as indicators of innovative activities: possibilities and problems. *Scientometrics*, 7(1): 77-99.

Scherer, F. M. (1983). The propensity to patent. *International Journal of Industrial Organization*, 1(1): 107-128.

Scotchmer, S. (2004). *Innovation and Incentives*, MIT Press.

Shane, S. (2001). Technological opportunities and new firm creation. *Management Science*, 47(2): 205-220.

Somaya, D. (2012). Patent Strategy and Management: An Integrative Review and Research Agenda. *Journal of Management*, 38(4): 1084-1114.

Squicciarini, M., Dernis, H. and Criscuolo, C. (2013). Measuring patent quality: Indicators of technological and economic value. STI Working Paper N. 2013/3. OECD Publishing.

Squicciarini, M., Millot, V. and Dernis, H. (2012). Universities' trademark patterns and possible determinants. *Economics of Innovation and New Technology*, 21(5-6): 1–32.

Winkler, W. E. (1999). The State of Record Linkage and Current Research Problems. Statistics of Income Division, Internal Revenue Service Publication R99/04. www.census.gov/srd/papers/pdf/rr99-04.pdf

WIPO (2013a). NICE classification: The International Classification of Goods and Services for the Purposes of the Registration of Marks. World Intellectual Property Organization.

WIPO (2013b). *World Intellectual Property Indicators*. World Intellectual Property Organization.

WIPO (2013c). IPC-Technology Concordance Table. World Intellectual Property Organization.

Appendices

Appendix 1:
Distribution of TM applications per company, by industry, ISIC rev. 4, 2010-12

	Number of applications per company															
	USPTO				OHIM				JPO				IP AUS			
	Mean	Median	P25	P75	Mean	Median	P25	P75	Mean	Median	P25	P75	Mean	Median	P25	P75
Law, accountancy & engineering	14.1	6.5	1.0	22.5	24.8	6.5	1.0	23.5	0.4	0.0	0.0	0.0	6.5	1.0	0.0	5.5
Wholesale, retail, repairs	24.2	5.0	1.0	34.0	15.3	4.0	0.0	22.0	25.1	0.0	0.0	4.0	3.0	1.0	0.0	4.0
Mining	14.7	5.0	0.0	11.0	7.6	1.0	0.0	7.0	3.7	0.0	0.0	0.0	3.5	1.0	0.0	5.0
Wood & paper	26.4	14.0	2.0	44.0	14.1	2.5	0.0	21.0	27.6	0.0	0.0	21.0	7.3	1.0	0.0	7.5
Electricity, gas & steam	9.8	0.0	0.0	6.5	7.1	1.0	0.0	11.0	7.8	0.0	0.0	2.5	1.1	0.0	0.0	0.0
Machinery	19.2	6.0	2.0	20.0	9.9	3.0	0.0	10.0	10.9	1.0	0.0	8.0	4.5	1.0	0.0	4.0
Transport equipment	22.8	4.0	1.0	21.0	14.0	2.0	0.0	13.5	12.8	0.0	0.0	6.5	6.1	1.0	0.0	3.5
Chemicals	50.5	16.0	5.0	48.0	28.9	7.0	0.0	24.0	61.0	7.0	0.0	50.0	12.7	3.0	0.0	10.0
Telecommunications	24.7	4.5	1.0	27.0	16.8	2.0	0.0	8.5	23.6	0.0	0.0	1.0	4.6	0.0	0.0	4.5
Basic metals	11.7	5.0	0.0	15.5	6.0	1.0	0.0	7.0	12.9	0.0	0.0	3.0	2.6	1.0	0.0	3.0
Construction	6.2	1.0	0.0	9.0	7.0	0.0	0.0	3.0	29.0	0.0	0.0	57.0	2.7	0.0	0.0	4.0
Rubber, plastics, minerals	23.7	8.0	1.0	21.0	16.1	3.5	0.0	11.0	22.8	1.0	0.0	24.0	6.4	1.0	0.0	6.0
Finance & insurance	23.7	5.0	1.0	22.0	16.9	5.0	1.0	21.0	11.1	0.0	0.0	2.0	5.7	1.0	0.0	7.0
Electrical equipment	40.8	6.0	1.0	49.0	23.8	4.0	0.0	22.0	45.0	0.0	0.0	14.0	9.1	1.0	0.0	6.0
Publishing & broadcasting	19.4	10.0	3.0	20.0	7.5	2.0	0.0	7.0	3.7	0.0	0.0	2.0	3.2	1.0	0.0	3.0
Food products	69.9	21.0	6.0	78.0	27.0	9.0	1.0	26.0	94.1	9.0	2.0	96.0	16.4	2.0	0.0	14.0
Other manufactures	86.9	25.0	12.0	77.0	26.5	14.0	6.0	34.0	55.6	3.0	0.0	18.0	12.5	5.0	0.0	15.0
IT services	18.5	6.0	1.0	16.0	4.7	2.0	0.0	5.0	4.0	0.0	0.0	1.0	2.9	0.0	0.0	2.0
Textiles & apparel	31.3	3.0	0.0	13.0	11.9	0.0	0.0	8.0	48.9	3.5	0.0	42.0	8.3	1.0	0.0	2.0
Computers & electronics	21.9	6.0	1.0	19.0	11.3	2.0	0.0	8.0	13.2	0.0	0.0	4.0	4.4	0.0	0.0	2.0
Pharmaceuticals	65.3	6.5	1.0	34.0	28.1	2.0	0.0	27.0	35.8	0.0	0.0	17.0	14.6	0.5	0.0	8.0
Scientific R&D	15.2	7.0	2.0	22.0	4.5	1.0	0.0	4.0	5.1	0.0	0.0	1.0	4.5	1.0	0.0	4.0
All firms	**30.3**	**7.0**	**1.0**	**23.5**	**14.9**	**2.0**	**0.0**	**13.0**	**22.7**	**0.0**	**0.0**	**7.0**	**6.6**	**1.0**	**0.0**	**4.0**

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014.

Appendix 2:

Distribution of TM applications at IP AUS by Nice class, by companies' headquarter location, 2010-12

	USA	EU28	JPN	KOR	CHN	RoW
1-Chemical goods	3.6	5.1	3.4			4.4
2-Paints and colorants	1.2					
3-Cleaning products	6.7	9.9	2.8			1.7
4-Oils and fuels					3.0	
5-Pharma products	13.0	20.6	14.5		1.3	24.2
6-Metals	1.3	1.3			2.4	1.5
7-Machineries	2.4	3.9	5.0	4.7	17.3	2.6
8-Hand tools					4.0	
9-Instruments & computers	20.4	11.5	19.5	59.0	26.8	15.4
10-Medical instruments	9.0	6.3	2.3			5.1
11-Lightening and heating	1.6	2.5	1.9	11.4	2.9	2.2
12-Vehicles	2.0	5.3	8.7	11.9	19.0	
13-Firearms						
14-Precious goods						5.1
15-Musical instruments						
16-Papers and packaging	2.1	1.6	1.7			2.1
17-Rubber and plastics		1.7	1.3			1.1
18-Leather and complements						
19-Building material		1.5			1.2	
20-Furniture						
21-House utensils		1.1				
22-Fibrous products						
23-Yarns and threads						
24-Textiles						
25-Clothing and footwear		1.2	1.1			
26-Decorations						
27-Carpets and floor covers						
28-Games	4.9	1.2	6.2			
29-Food	1.4		2.1			2.2
30-Condiments and cereals	3.3	1.3	1.1			3.9
31-Animals and grains						
32-Low and non alcohol drinks			6.0			
33-Alcoholic drinks		1.5	4.7			
34-Tobaccos	3.2					
35-Business and advertising	2.8	2.4	2.3	1.8	1.4	4.0
36-Insurance and finance		1.3				5.6
37-Building services	1.1	1.9	1.8	1.5	10.3	
38-Telecommunications	1.0	1.3		1.3		1.4
39-Transport and packaging					1.2	
40-Treatment of materials						
41-Education and sport	2.9	2.0	2.3	1.3		3.8
42-R&D and software	5.7	3.6	3.0	1.1	1.5	2.9
43-Food, drink and accommodation						
44-Medical and hygiene services	1.0					2.1
45-Legal and personal services						

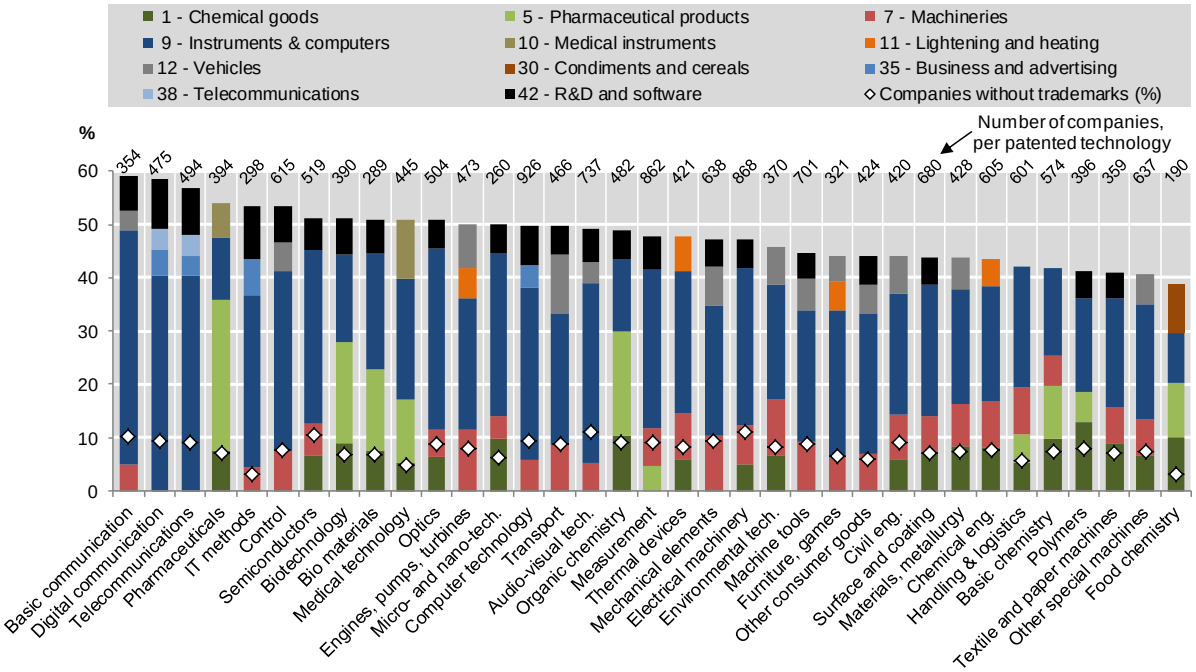
Note: Trademark counts by international classes are based on the application date and the location of the applicant's headquarters, using fractional counts. Blue bars and percentages correspond to the distribution of Nice classes in the trademark applications of the region considered. Only percentages higher than 1% are displayed. Grey cells correspond to classes with no applications from the region/office considered.

Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; and OECD Trademark database (internal), 2014.

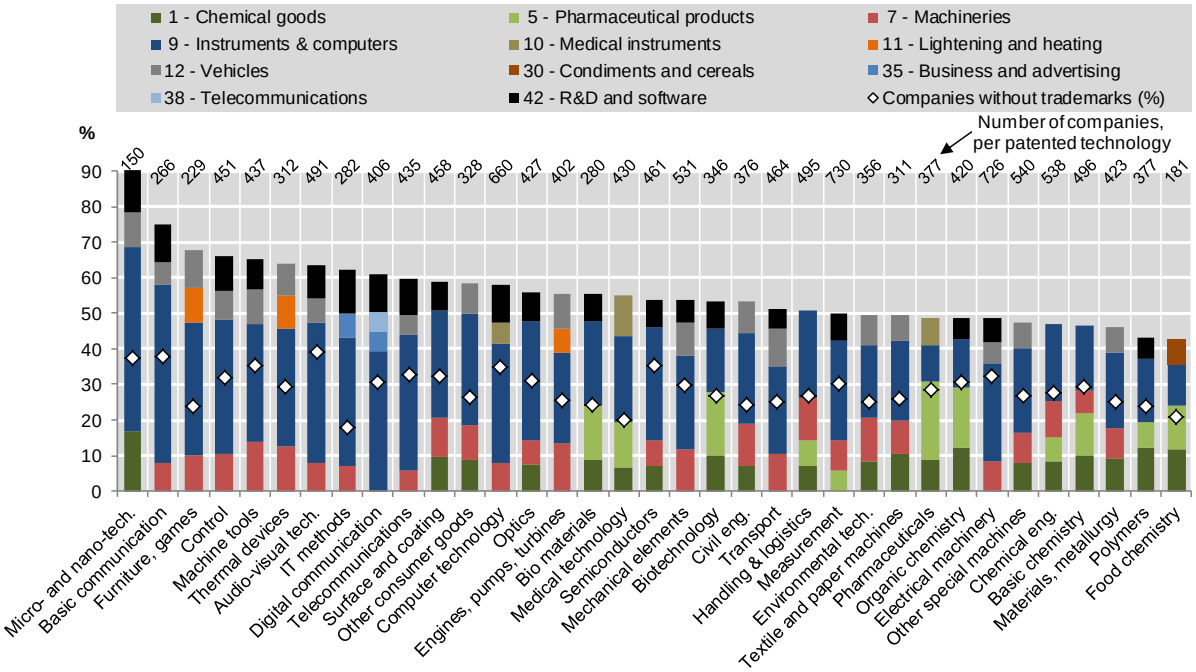
Appendix 3:

Composition of patenting companies' trademark portfolio, 2010-12

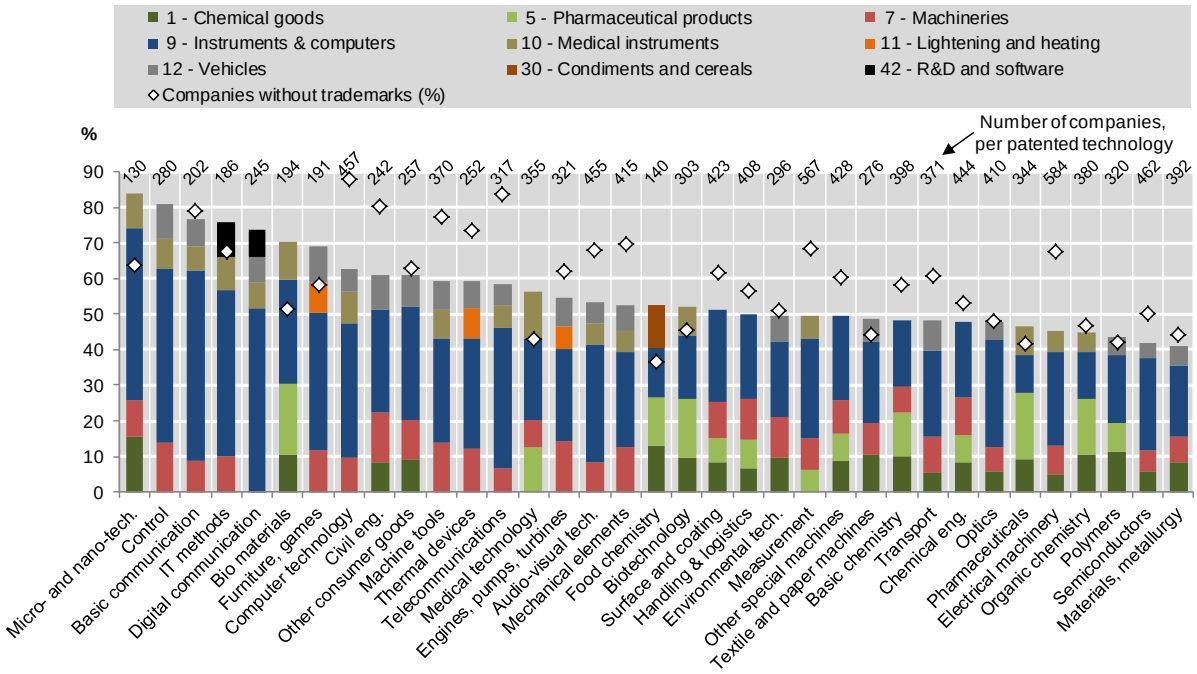
A3.1 Top 4 trademark classes associated with patented technologies, USPTO



A3.2 Top 4 trademark classes associated with patented technologies, EPO & OHIM



A3.3 Top 4 trademark classes associated with patented technologies, JPO



Source: IPTS-OECD, calculations based on EU R&D Scoreboard data, 2013; the Worldwide Patent Statistical Database, EPO, December 2014 and OECD Trademark database (internal), 2014.

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