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Probabilistic concordance schemes for the re-assignment of patents to economic sectors and scientific publications to technology fields

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1 Introduction

In this paper, we describe the creation of an (updated) probabilistic concordance between industry sectors on the one hand and technology fields on the other. In an earlier publication (Neuhäusler et al., 2017) we have already provided an early version of this scheme, thereby focusing on the re-allocation of R&D expenditures by technology fields. Here, we apply an update to this earlier work by switching the focus to the re-allocation of patents to industry sectors[1] and by building on a broader database. In addition to the updated concordance lists for patents, we will here further extend the focus by describing a concordance between scientific disciplines and technology fields. While patent/sector concordances based on different approaches are relatively common in the literature, this is one of the first attempts to re-allocate scientific publications by technology fields on a larger scale.

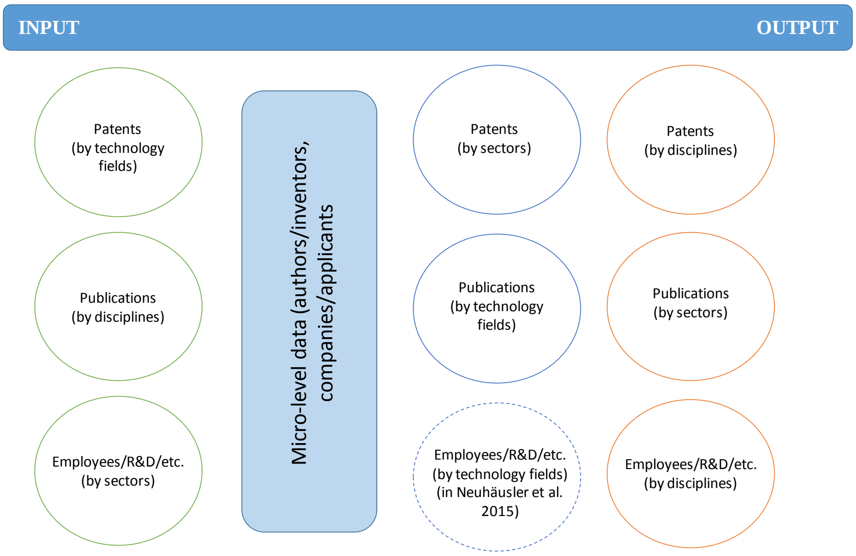
The background for this re-allocation of different indicators is that many indicators commonly used in innovation research at the meso-level to measure the output of parts of innovation systems are measured at different scales. Economic indicators, i.e. indicators geared towards measuring the aggregate financial output of companies like value added but also employment, R&D expenditures etc., are only available at the level of economic sectors, mostly in terms of the NACE Rev. 2 classification. Indicators related more directly to innovation in the industrial sector like patents or related to the innovative output of science systems like scientific publications, on the other hand, are measured via different classifications. For patents, for example, technology field classification schemes based on IPC classes, like the very common WIPO list of 35 technology fields (WIPO35) (Schmoch, 2008) are applied. When it comes to measuring the innovative output of the science system, the classification is geared towards classifying scientific disciplines, be it at the level of journals or at the level of single articles, which are provided by the large database providers Web of Science (Wos) and Scopus.

In order to assess the effects of innovation indicators like scientific publications or patents on output related measures like employment or value added, however, the classifications have to be brought to a common denominator. This will be attempted within this paper regarding patents (which are classified at the level of technology fields by the International Patent Classification (IPC) and aggregates thereof like the WIPO35 list), scientific publications (which are classified at the level of scientific disciplines within Scopus) as well as economic indicators (which are classified alongside industrial

1 This has basically also been possible with the earlier concordance tables.

sectors according to several existing sector classifications with the NACE classification being one of the most common). A schematic representation of the re-allocations that are enabled by applying the probability matrices that will be provided within this paper can be found in Figure 1.

Figure 1: Schematic representation of the conversion



Source: Own compilation.

Though several options arise with the help of combining the data at hand, we will here focus on the re-allocation of patents by sectors and the re-allocation of publications by technology fields (the blue circles in Figure 1). A re-allocation of R&D expenditures as well as further economic indicators by technology fields using a similar methodology as applied here has been more deeply described in earlier works of the authors (Frietsch et al., 2017; Neuhäusler et al., 2017). The circles marked green in Figure 1 mark the classifications in which the described indicators typically are classified, while the circles marked in red show potential ways of further re-classifying the data, which, however, cannot be performed with the data and methodology at hand.

The basic approach to re-allocate patents by sectors as well as publications by technology fields is to apply probabilistic concordances. Towards this end, we will combine the respective data at the micro level, i.e. the level of patent applicants/companies in the case of the conversion of patents to sectors and the level of authors/inventors for the conversion of publications by technology fields. Upon this link of data at the micro level, we aggregate the patents at the level of sectors, e.g. at a 2-digit NACE Rev. 2 level in the case of patents or at the level of 35 WIPO fields (Schmoch, 2008) for scientific publications, which results in a matrix of patent shares per technology field and sector and a matrix of publication shares per discipline and technology field. Based on these concordance matrices, patent/publication data can be transferred to the respective other classification at the macro level, also when using other data sources in future analyses.

Within the following sections, we will first describe some earlier approaches and concordances and briefly discuss their specific strengths and weaknesses. In section 3, the different data sources used for the analyses are depicted. In this section, we also discuss which methods have been applied to link the different data sources at the micro level. Section 4 describes how the probabilistic concordances have been generated, including some exemplary results of the conversion. Section 5 provides a brief summary and discussion.

2 Earlier approaches & existing concordance schemes

With regard to the link of technological and sectoral classifications, there have been several approaches in the literature so far. One of the most popular and widely used approaches was suggested by Schmoch et al. (2003), who used a microdata approach to match technological fields to sectors. They provided a concordance matrix to assign patent counts to sectors, which basically resembles the approach applied here. They collected patent data according to 4-digit classes of the International Patent Classification (IPC) for 44 technological fields and then developed the matrix, which contained the shares of sectors per technological field. This concordance matrix, however, has certain drawbacks due to the fact that it was established about 14 years ago. It used IPC7 as the basis for the technological classification, which is no longer being used as a classification scheme, with the new scheme differing considerably in certain aspects (e.g. new IPC fields for certain new and emerging technologies, no more main and secondary classes). Furthermore, the assumed relation between sectors and technologies as empirically defined by Schmoch et al. (2003) is most probably no longer accurate as new actors have entered the scene, others left, merged and so on.

Upon this concordance, Schmoch and Gauch (2004) followed up with a method that suggested a simplified version of the 44 technological fields used in the earlier study and assigned them directly to sectors. They provided a list of 19 sectors and the corresponding IPC 4-digit classes. The concordance thus made a 1:1 assignment of individual IPC classes to individual sectors, rather than assigning a probability (or fractional) as was the case in Schmoch et al. (2003). This classification thus resembled more or less an intellectual concordance but not an empirical one.

In 2002, Johnson (2002) provided a concordance that was based on assignments of SIC (Standard Industrial Classification) codes made by patent examiners at the Canadian Intellectual Property Office (CIPO). He also applied a probabilistic approach for his concordance and used the distinction between sector of invention and sector of use, which was made during the examination at the CIPO. Johnson thus suggested a concordance between IPC and SIC/ISIC sectors, including a differentiation by sector of invention and sector of use. The OECD also used this approach for their statistics and patent analyses in the first half of the 2000s. Unfortunately, the CIPO did not continue the sector distinction in the 1990s and therefore no updated data was available. Subsequently, the OECD then also switched to the concordance suggested by Schmoch et al. (2003).

Earlier approaches in the 1980s and 1990s also existed. Though they followed slightly different methodologies, they all employed intellectual assignments of IPC classes to sectors – either made by the researchers themselves or also by referring to the distinctions made by the Canadian patent examiners (Evenson and Putnam, 1988; Verspagen et al., 1994).

A more recently suggested approach came from Lybbert and Zolas (2012), who argued that direct (100%) assignments of IPC classes to sectors are not adequate as companies as well as sectors are technologically heterogeneous. This follows up on the argumentation already made by Schmoch et al. (2003). Consequently, the concordance proposed by Lybbert and Zolas (2012) was not a deterministic but a probabilistic assignment. They used a keyword-based algorithm to make a probabilistic matching of patents to sectors, which leads to a probabilistic assignment. The procedure, however, is rather complex and time consuming. The application of keywords makes it also necessary to constantly update the assignment since new or emerging fields, where the wording and use of terms are in flux, are not covered. In continuation of this work, Lybbert, Zolas and Bhattacharyya (2014) further proposed a data mining and semantic matching approach based on keywords (Algorithmic Links with Probabilities (ALP)) to also construct a probability match of trademark data to economic data (as trademarks also follow their own classification scheme, the NICE classes) .

One of the most recent available assignments was suggested by van Looy, Vereyen and Schmoch (2014), who provided an updated version of the concordance established in 2003 by Schmoch et al. in a publication edited by Eurostat, which intends to apply it to its patent statistics. Eurostat was one of the most intensive and long-term users of the Schmoch et al. (2003) concordance, but the above mentioned shortcomings made an update (or alternative) necessary. Van Looy et al. (2014), updated the 44 technology definitions and checked the assignments and groupings of each of the IPC

4-digit codes. In particular, they were able to take the new NACE 2 classification into account, while previous concordances had to rely on NACE 1.1. However, their work also resulted in a direct 1:1 assignment of individual IPC classes to individual sectors and is not – like the approaches in Schmoch et al. (2003) or Lybbert and Zolas (2012) – a probabilistic concordance. The advantage of the 1:1 assignment is its applicability and ease of implementation. The shortcoming, as already stated above, is that it is not able to take into account the heterogeneity of sectors in terms of technologies.

Finally, Dorner and Harhoff (2017) have proposed a further probabilistic concordance based on linked inventor-employee patent data for Germany. The employment micro-data from linked inventor-establishment data was used to identify the industry of origin of inventions and to combine them with technology classifications from the inventors' patents. This was the basis for their concordance tables.

As for the case of the concordance from scientific disciplines to technology fields, there have up to now only been few attempts. There have been several attempts to identify scientific publications that were cited by patents in so-called non-patent literature (NPL) citations (Callaert et al., 2006; Callaert et al., 2012; Callaert et al., 2014). This establishes a link of patents and scientific literature at the level of single patents and publications, which could potentially be used to generate a concordance of scientific disciplines to technology fields. Besides the fact that a large share of NPL citations actually do not refer to scientific papers (but other literature, etc.) (Callaert et al., 2014), this link only provides information on the publications that were actually cited in patents. More recently, Maraut and Martínez (2014) published a paper in which they described the linkage of Spanish authors from Scopus to inventors from PATSTAT in order to identify academic patents and researchers. This methodology builds at least partly on the works of Dornbusch et al. (2013) that has also been applied in Dornbusch and Neuhäusler (2015). A similar approach is also employed as the basis for the re-allocation of scientific disciplines to technology fields within this paper. However, Maraut and Martínez (2014), as well as Dornbusch et al. (2013), did not provide a concordance table based on this linkage, as is proposed in this paper. Another assignment was suggested by Ikeuchi et al. (2016). They also linked scientific authors to Japanese inventors named on patent filings at the Japan Patent Office (JPO). For publications, they also used Scopus as a starting point. For patents, however, they employed the IIP database of Japanese patents described in Goto and Motohashi (2007). Upon this basis, they came up with a concordance table of scientific disciplines to technology fields that is similar to the one proposed in this paper. However, it is centred on the Japanese innovation system, which has major differences compared to Western Europe systems or the system in the United States.

3 The data

The basic data that has been used for the study comes from three sources, which will be presented in more detail below. All these input data was used in conjunction to create the concordances.

3.1 Patent data

The necessary patent data for the study was extracted from the "EPO Worldwide Patent Statistical Database" (PATSTAT), which covers information about published patents from more than 80 patent authorities worldwide, dating back to the late 19th century. PATSTAT includes all information stated on a patent application, i.e. application authorities (patent offices), several patent relevant dates (priority, filing, publication date), inventor and applicant addresses, patent families (INPADOC and DOCDB), patent classifications (e.g. IPC and ECLA), title and abstract of a patent filing, technical relations and continuations, citations to patents and to non-patent literature and information on legal events (PRS file). With the addition of OECD's REGPAT database, PATSTAT also includes a regionalization of applicants and inventors by NUTS codes.

For the differentiation of technology fields, we apply the list of 35 WIPO fields (Schmoch, 2008). All the patents used for the analysis are counted according to their year of worldwide first filing, what is commonly called the priority year. This is the earliest registered date in the patent process and is therefore closest to the date of invention. Throughout the analyses, we follow the concept of "transnational patents" suggested by Frietsch and Schmoch (2010). In detail, all filings at the World Intellectual Property Organisation (WIPO) under the Patent Cooperation Treaty (PCT) and all direct filings at the European Patent Office (EPO) without precursor PCT filing are counted. This excludes double counting of transferred PCT filings to the EPO. Put more simply, all patent families with at least a PCT filing or an EPO filing are taken into account. This approach is able to overcome the home advantage and unequal market orientations of domestic applicants, so that a comparison of technological strengths and weaknesses between countries becomes possible. In addition, it provides full cohort data 18 months after filing without having to take into account transfer quota or the event of PCTs entering the national phase. This approach, next to the comparability of the technological competitiveness of nations, also shows the highest correlation with national R&D expenditures (see Frietsch et al., 2017) as well as high correlations with international trade data (Blind and Frietsch, 2006; Frietsch et al., 2014).

3.2 Bibliometric data

For the analysis of scientific publications, an offline version of Elseviers' Scopus was employed. Scopus provides information on articles published in about 22,000 journals worldwide. It mainly covers journals in science, technology and medicine, but also social sciences and humanities – though the latter areas are not covered to the same extent. Based on this database, a detailed analysis of scientific publications and citations is possible for any country in the world. Fraunhofer ISI has – as a member of the "Kompetenzzentrum Bibliometrie", funded by the German BMBF – implemented an Oracle-SQL version of this database and systematically added further data and information to the database. Among the extensions are regionalisation (NUTS1, NUTS2, and NUTS3) of EU-member countries. In addition, we are able to apply definitions of disciplines/areas or of the science system in general. The Scopus database mainly covers journal articles. We therefore analyzed the following document types: articles, letters, notes, and reviews.

3.3 Company data

The company data used for the analyses, i.e. the assignment of companies to NACE sectors, originates from the Orbis company database provided by Bureau van Dijk (BvD), meanwhile owned by Moody‘s. It is one of the largest company databases in the world, covering approximately 150 million companies, almost exclusively from the private sector, with a focus on Europe and North America, as well as a number of companies from Asia and other parts of the world. Orbis offers structural information on the sector, number of employees, turnover and ownership of a company etc. The implemented Orbis version provides structural information about the industry (NACE Rev. 2), number of employees (last available year), turnover and ownership of companies (Global Ultimate Owner) as well as the description of the economic activity. Orbis has been merged with PATSTAT at the level of company/applicant names based on a string matching algorithm (a variant of the Levenshtein distance). In total, approximately 160,000 companies of ORBIS have been matched to patent applicants in PATSTAT.

3.4 Database links

In order to generate the concordances, we first have to set up links between the respective datasets, i.e. a link between patent data and company data (PATSTAT and Orbis) as well as a link between patent and bibliometric data (PATSTAT and Scopus). The details of these two linkages will be described in the next two subsections.

3.4.1 The link between PATSTAT and BvD Orbis

For the matching of PATSTAT and Orbis, the information on the name of the patent applicant from PATSTAT and the company name from Orbis were used. The aim is to identify information on patent applicants that corresponds to an observation within Orbis or has a high similarity with it. For this purpose, the similarity between the applicant names in PATSTAT and each company entry in Orbis (snapshot from 2016) was calculated. This was done with the help of a variant of the Levenshtein distance, which calculates how many edits are needed in order to align two text-strings. If a certain similarity value between the text strings is exceeded, the respective pair of entries is interpreted as a "match".

Before this matching could be performed, however, the names in both datasets were harmonized to have a "clean" name for the matching.[2] The entire text was converted to lower case letters, special characters, umlauts, number, punctuation etc. were removed or replaced. Furthermore, all occurrences of multiple spaces were replaced by a single space. In a final step, the legal form of the companies - e.g. "Corp", "Ltd", "Limited", "AG", "S.p.a." - was removed from the names. After the name cleaning, the calculation of similarity scores was performed. In addition to the similarity calculation, we further introduced a country-, as well as a ZIP-code criterion (first three digits), given that a country/ZIP-code was available for the entries in both datasets, to decrease the probability of false positive matches.

In a final step, the entries that are selected as real "matches" had to be determined. For this purpose, a threshold value t was defined. We hereby resorted to the calculation of an F-Score, i.e. the harmonic mean between recall and precision values based on a "gold-standard" of 1,000 manually matched patent applicant/company pairs. The higher the recall and precision, the better the matching (Baeza-Yates and Ribeiro-Neto, 2011; Raffo and Lhuillery, 2009). We used an F-Score of 0.86 as the threshold value for the matching, as this value proved to be the optimal compromise between precision and recall based on the test of the matching against the "gold-standard". All matches whose similarity value exceeded 0.86 were interpreted as a real match and used for further analyses. This matching now allows us to assign a NACE code to each applicant in the PATSTAT database.

2 This was done on top of the already harmonized applicant names provided in the EEE-PPAT table from the K.U. Leuven: Du Plessis et al. (2009); Magerman et al. (2009); Peeters et al. (2009).

3.4.2 The link between PATSTAT and Scopus

For the creation of the link between PATSTAT and Scopus, a slightly different approach had to be followed, i.e. we used the names of authors from Scopus to match them to the names of inventors in PATSTAT, instead of resorting to the matching of applicants with author affiliations. This method has been applied earlier to identify what has become known as "academic patents", i.e. patented inventions where university researchers were involved, but the university was not named as the patent applicant. A large share of patent filings from universities is registered by companies and the university staff only appears as an inventor. Simply looking at the applicant names leads to an underestimation of patents from academia. In order to correct for that, the names of scientific authors (research-active university staff) were linked with inventor names from the PATSTAT database (compare Dornbusch et al., 2013). This link between Scopus and PATSTAT has also been applied here to connect the two databases. This has been accomplished for the German universities and public research organizations (PROs), which were identified within Scopus. The author names from these organizations were matched with inventor names from patent filings at the European Patent Office (EPO) of all German inventors between 2000 and 2015.

To ensure a high precision, the matching was not only performed on the basis of author/inventor names but complemented with additional selection criteria, especially to avoid homonyms, i.e. different people having identical names. Besides looking at the match of full strings of last and first names, a time-lag between the priority year of the patent filing and the publication year was applied. Furthermore, it was checked whether the author and inventor were located in the same NUTS region and published within a similar field (compare Dornbusch et al., 2013).

On this basis, it is possible to assign a list of IPC-codes as well as a list of scientific disciplines to an author/(academic) inventor, which can in aggregate be used to generate shares of patent filings by scientific disciplines or, and this is the focus of this analysis, the shares of publications by IPC classes.

4 Setting up the probabilistic concordances

4.1 The concordance of sectors and technology fields

To set up the concordance between technology fields and sectors, we use the matched data set of PATSTAT and BvD's Orbis. The link at the level of patent applicants/companies contains information on the sector of each applicant (from BvD Orbis). Due to the match with PATSAT, we can also calculate a technological profile of each of the matched companies, i.e. numbers and shares of patents by technological fields of each company. The aggregation of the technological profiles of all companies for a given sector then provides us with a technological profile of the respective sector, i.e. we can generate the shares of each particular technology field within each sector, or, the other way around, we can generate a profile of sector-specific patents by technology field (the shares of patents of each sector within a given technology field).

In more detail, the working steps involved in setting up the new probabilistic concordance scheme are as follows.

1. The list of 35 WIPO fields (Schmoch, 2008) is used to define technology fields based on IPC classes. On this basis, patent data can easily be collected by other researchers and the matrix can be applied by them to generate their own re-allocation of patents by industry sectors.
2. We collect the most recent patent data for each of the companies. Here, we use transnational patent filings for 2014 to 2016 (aggregate) as these can best be used for international comparisons.
3. The patents of the companies are aggregated at the level of industrial sectors (NACE Rev. 2, 2-digit).
4. The shares of patents per technology field across each of the sectors is calculated, which results in a vector of field-specific patents across sectors or, in other words, a technology profile of each sector is generated. An exemplary conversion is depicted in Figure 2. Here, "NACE sector 3" is responsible for 45% of all patents in technology field "WIPO35F01" while "NACE sector N" is responsible for 55% of all patents in the respective field (the remaining sectors have a share of 0%). Patents in this technology field, i.e. WIPO35 field 1 ("WIPO35F01"), consequently are assigned to sectors according to this distribution. The number of patents in sector 1 (or 2 or 3) then simply is the sum of patents across all technologies. In our example, we split up the 500 patents from "WIPO35F01" to sectors according to the given probability distribution, and do the same for "WIPO35F02", "WIPO35F03" etc. The sum of patents across all fields then provides us with the number of patents in "NACE sector 1", i.e. 1,550 patents.

Figure 2: Exemplary application of the probability matrix to assign patents to NACE sectors

Patents by WIPO35 field in country X	2016
WIPO35F01	500
WIPO35F02	1000
WIPO35F03	1500
...	...
WIPO35F35	1000
Sum	**4000**

x

Matrix of patent shares by NACE sectors

NACE/Field	WIPO35F01	WIPO35F02	WIPO35F03	...	WIPO35F35
NACE Sector 1	0%	20%	90%		0%
NACE Sector 2	0%	40%	0%		0%
NACE Sector 3	45%	0%	0%		80%
...	...	...	...		...
NACE Sector N	55%	40%	10%		20%
Sum	**100%**	**100%**	**100%**		**100%**

=

Patents by NACE/Field	WIPO35F01	WIPO35F02	WIPO35F03	...	WIPO35F35	Sum
NACE Sector 1	0	200	1350	...	0	1550
NACE Sector 2	0	400	0	...	0	400
NACE Sector 3	225	0	0	...	800	1025
...	...	...	0	...	...	...
NACE Sector N	275	400	150	...	200	1025
Sum	**500**	**1000**	**1500**	**...**	**1000**	**4000**

Source: Own compilation.

This final matrix can then be applied to any patent data collected using the WIPO35 classification (Schmoch, 2008). In addition, we have generated matrices for all the described concordances also at the level of IPC 3-digit classes.[3] However, national matrices might also be of interest, since this better resembles the industrial structure of a given country. Tests have shown that the country-specific matrices are similar to the matrix based on transnational patents, yet there are country-specific idiosyncrasies. Testing a matrix for China, which follows a targeted international patent strategy with regard to choosing patents to file at an international level and others to file only nationally leads, for example, to differences in the matrix of patent shares by industry. For other Western industrialized countries like the U.S. or Germany, however, these differences are minor.

3 The full matrices can be downloaded here: https://www.isi.fraunhofer.de/content/dam/isi/dokumente/ccp/innovation-systems-policy-analysis/2019/Concordance_tables_for_download_060519.xlsx or are available upon request at peter.neuhaeusler@isi.fraunhofer.de.

The concordance matrices at the level of WIPO35 fields are depicted in the annex. Together with the matrices at the level of 3-digit IPC classes, they are also available for download.[4]

4.2 The concordance of technology fields and scientific disciplines

To set up the concordance between scientific disciplines and technology fields, we resort to the above discussed link of data from Scopus and PATSTAT at the level of German authors/inventors. For these authors, a link has now been generated between the discipline of their scientific papers as well as their patent's IPC classes. This enables us to generate a technological profile of the publications of these authors, i.e. numbers and shares of publications by disciplines and technological fields of each author (similar to PATSTAT-BvD Orbis link). The aggregation of the technological profiles of all authors for a given discipline then provides us with a technological profile of the respective discipline, i.e. we can generate the shares of each particular technology field within each discipline. We could also generate a profile of discipline-specific patents by technology field (the shares of patents of each field within a given technology field). This is basically doable with the data at hand, yet is out of the scope of this paper

In more detail, the working steps involved in setting up the new probabilistic concordance scheme are as follows.

1. The Scopus ASJC (All Science Journals Classification) list of 27 scientific disciplines is used to define scientific disciplines based on Scopus journal classifications. On this basis, publication data can easily be collected by other researchers and the matrix can be applied to generate their own re-allocation of publications by technology fields.
2. We collect publication data for each of the author/inventor pairs for 2014 to 2016 (aggregate). We limit the publication types to articles, letters, reviews and notes. Conference proceedings are highly discipline-specific and therefore excluded.
3. The publications of the author/inventor pairs are aggregated at the level of the 35 WIPO technology fields.
4. The shares of publications per discipline across each of the technology fields is calculated, which results in a vector of discipline-specific publications across technology fields or, in other words, a technology profile of each discipline is

4 The full matrices can be downloaded here: https://www.isi.fraunhofer.de/content/dam/isi/dokumente/ccp/innovation-systems-policy-analysis/2019/Concordance_tables_for_download_060519.xlsx or are available upon request at peter.neuhaeusler@isi.fraunhofer.de.

generated. An exemplary conversion is depicted in Figure 3. Here, "WIPO35F01" is responsible for 20% of all publications in discipline 1 ("Disc. 1") while "WIPO35F03" is responsible for 30% of all publications in the respective field and "WIPO35F035" is responsible for 50% (the remaining sectors have a share of 0%). Publications in discipline 1 are thus assigned to WIPO35 technology fields according to this distribution. The number of publications in WIPO35 field 1 (or 2 or 3) then simply is the sum of publications across all disciplines. In our example, we split up the 2,000 publications from "Discipline 1" to technology fields according to the given probability distribution, and do the same for " Discipline 2", " Discipline 3" etc. The sum of publications across all disciplines then provides us with the number of publications in "WIPO35F01", i.e. 1,800 publications.

Figure 3: Exemplary application of the probability matrix to assign publications to WIPO35 technology fields

Publications by discipline in country X	2016
Disc. 1	2000
Disc. 2	1500
Disc. 3	4000
...	...
Disc. 27	500
Sum	**8000**

X

Matrix of publication shares by WIPO35 fields

Field/Discipline	Disc. 1	Disc. 2	Disc. 3	...	Disc. 27
WIPO35F01	20%	0%	25%	...	80%
WIPO35F02	0%	90%	25%	...	0%
WIPO35F03	30%	10%	25%	...	0%
...	...	...	...	...	...
WIPO35F35	50%	0%	25%	...	20%
Sum	**100%**	**100%**	**100%**	**...**	**100%**

=

Publications by field	Disc. 1	Disc. 2	Disc. 3	...	Disc. 27	Sum
WIPO35F01	400	0	1000	...	400	1800
WIPO35F02	0	1350	1000	...	0	2350
WIPO35F03	600	150	1000	...	0	1750
...	...	...	...	...	...	...
WIPO35F35	1000	0	1000	...	100	2100
Sum	**2000**	**1500**	**4000**	**...**	**500**	**8000**

Source: Own compilation.

This final matrix can then be applied to any bibliometric data collected using the classification of 27 scientific disciplines. In addition to the matrices per WIPO35 classes, we have generated matrices also at the level of IPC 3-digit classes, which are available upon request. As in the case of patents, also national matrices might be of interest since this better resembles the industrial structure of a given country. However, we only have a matching of Scopus and PATSTAT available for Germany. This might lead to biases when collecting international data and using the matrix provided in this paper. However, though certain countries have their focuses in certain disciplines, we can still assume that there is no systematic bias as it is in the case of patents.

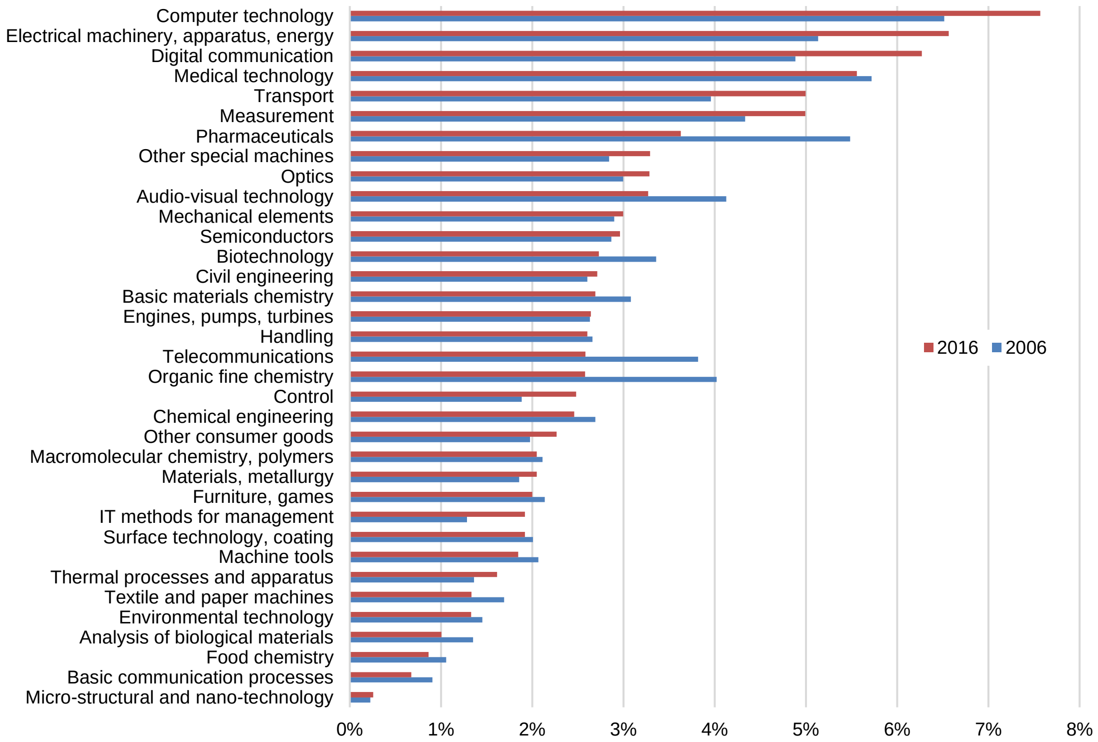
The concordance matrices at the level of WIPO35 fields and sectors are depicted in the annex. Together with the matrices at the level of 3-digit IPC classes they are also available for download. [5]

4.3 Results of the concordances

In this section, we can take a closer look at the results of the concordances. In Figure 4 the shares of transnational patent filings by WIPO35 fields in total filings in 2006 and 2016 are depicted. This is what can be achieved by solely analyzing patent data, no concordance is needed. As can be seen from the figure, the shares of filings are rather stable across time. The largest growth in shares between 2006 and 2016 can be found in electronics, i.e. electrical machinery and apparatus, computer technology and digital communication. In addition, the shares of transport as well as measurement technologies have grown. In pharmaceuticals, organic fine chemistry, telecommunications and audio-visual technology we can observe the largest declines in shares. However, this comparison becomes more interesting when the patent filings by economic sectors are compared. This is displayed in Figure 5. Already at first sight it becomes clear that the distribution of patent filings by sectors is more skewed than in terms of technology fields. The largest share of filings come from firms in the manufacturing of computers and electronic devices sector, followed by machinery, chemicals, motor vehicles and electrical equipment. Companies from these five sectors are responsible for 60% of all transnational patent filings, with 27% alone being filed from the manufacturing of computers and electronic devices sector.

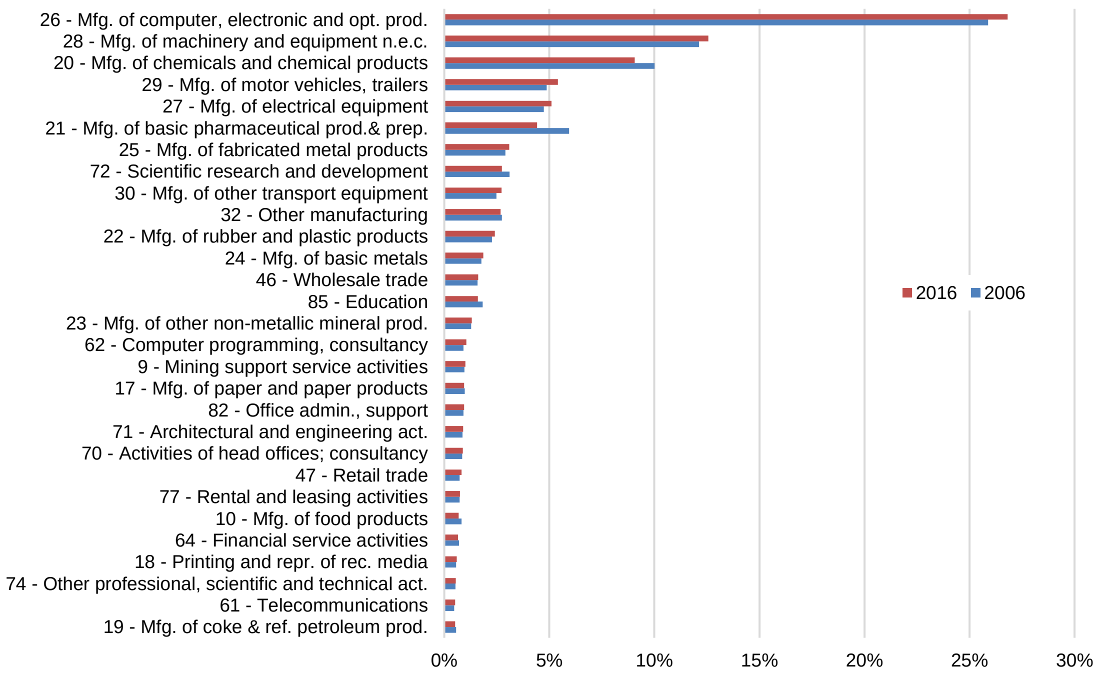
5 The full matrices can be downloaded here: https://www.isi.fraunhofer.de/content/dam/isi/dokumente/ccp/innovation-systems-policy-analysis/2019/Concordance_tables_for_download_060519.xlsx or are available upon request at peter.neuhaeusler@isi.fraunhofer.de.

Figure 4: Shares of transnational patent filings by WIPO35 fields



Source: EPO - PATSTAT

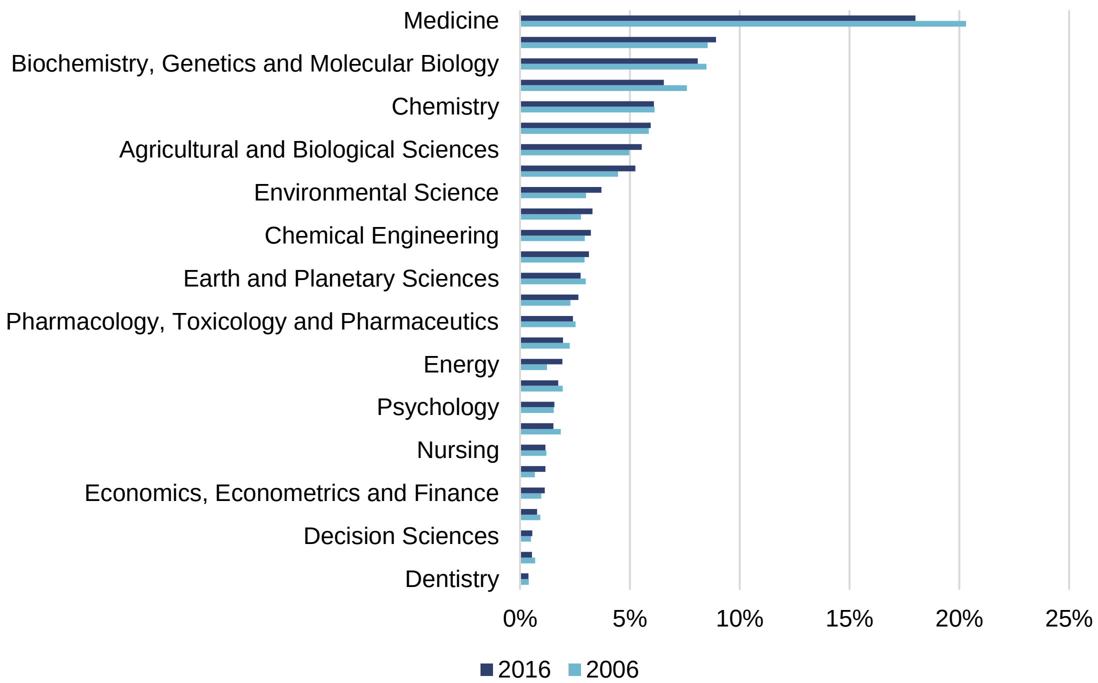
Figure 5: Shares of transnational patents by NACE sectors (2-digit)



Source: EPO - PATSTAT, BvD ORBIS. Note: Only the sectors with shares above 1% are shown

What can also be found is that these shares are rather stable over time, although slight changes that also have been found in the distribution across technology fields can be found in the sectors, i.e. decreasing shares within chemicals and pharmaceuticals and growing shares in electronics and, to a certain extent, also machinery. We thus do see an electronification of industry, i.e. a rise in electronics and IT related technologies in the industry 4.0 era. What also can be found is that many patented inventions concentrate in the electronics sector but seem to spread across technology fields. Firms from the computer technology sector thus do file patents in various technology fields, which confirms the results found in Gehrke et al. (2014).

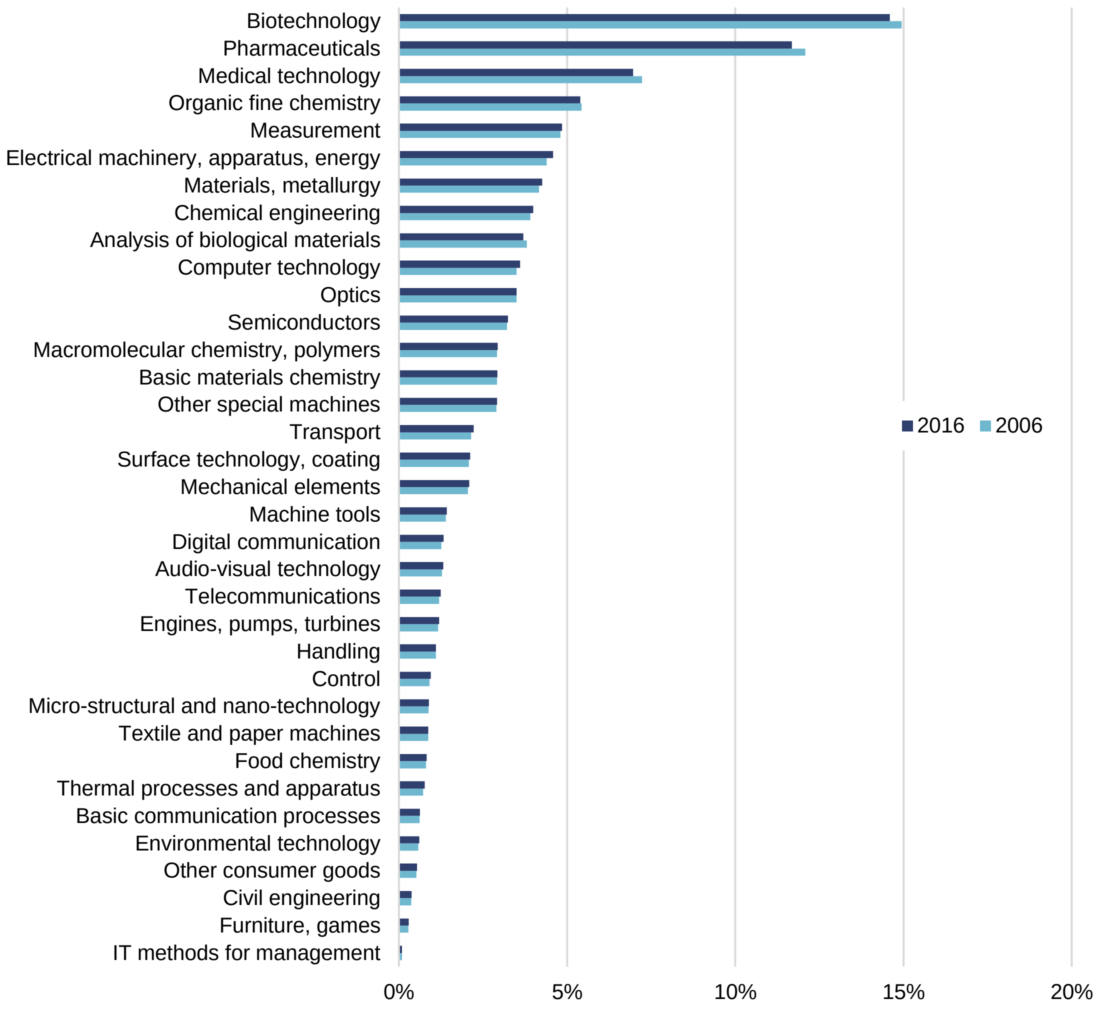
Figure 6: Shares of publications by scientific disciplines



Source: Elsevier - Scopus.

As for the bibliometric indicators, the shares of publications by scientific disciplines in 2006 and 2016 are provided in Figure 6. Medicine is by far the largest field in terms of scientific publications, although the shares have decreased since 2006. It is followed by engineering, biochemistry, physics and astronomy, chemistry and materials science. In sum, a similar trend as for patents can be found, i.e. a decrease in publications especially in medicine, as well as chemistry related fields (mostly biochemistry) and increasing shares in engineering, computer science, environmental science, agricultural and biological sciences but also social sciences. The more interesting question however is, how this translates to the shares of publications by technology fields, which is displayed in Figure 7. Here, it can be found that the largest shares of publications are in the fields of biotechnology, pharmaceuticals, medical technology and organic fine chemistry, though the shares in these fields have slightly decreased over the years. The next largest fields are measurement, electrical machinery, materials and chemical engineering, where there has been an increase in publications in the last ten years. The smallest technology fields in terms of publications are IT methods for management, furniture, civil engineering and other consumer goods.

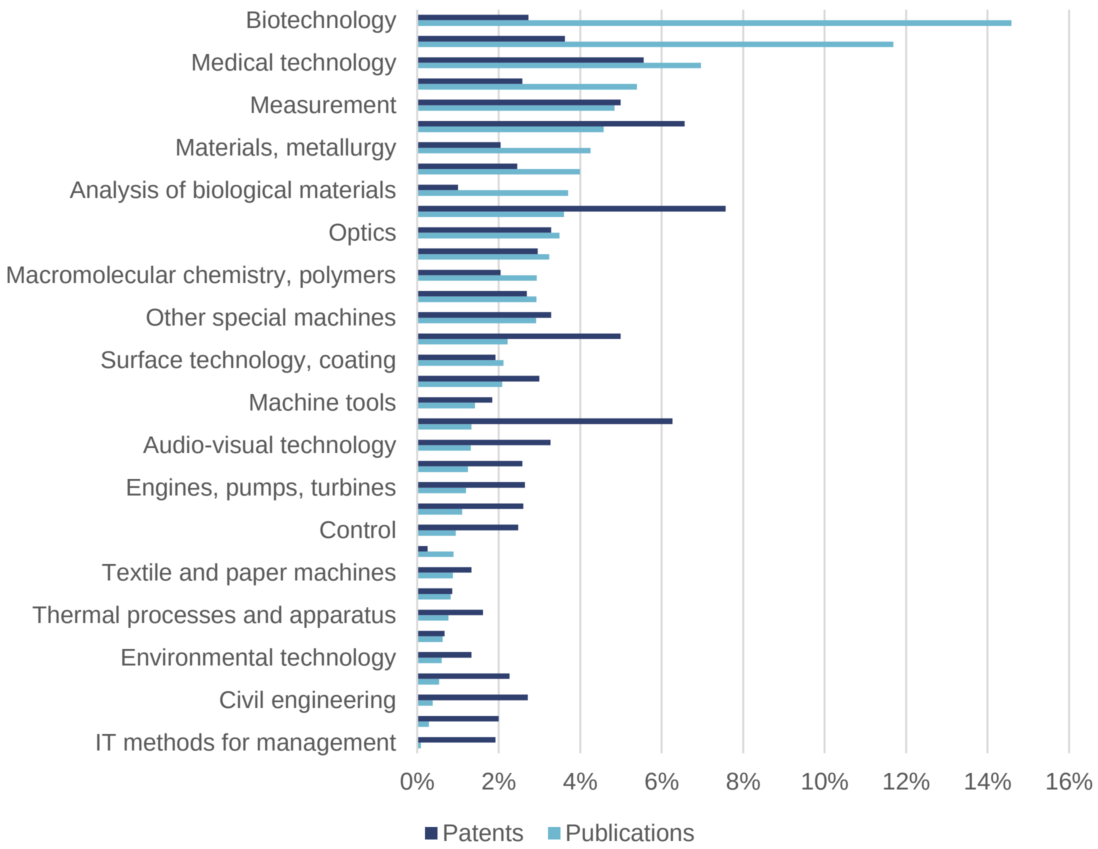
Figure 7: Shares of publications by WIPO35 classes



Source: Elsevier - Scopus, EPO - PATSTAT

In sum, it can be found that there are rather distinct profiles when it comes to publishing and patenting, which becomes clearer when looking at the WIPO35 profiles of patents and publications depicted in Figure 8. While publications are to a large extent located in the fields of biotechnology, pharmaceuticals and medical technology - about 33% of all publications are located within these three fields - patents are most often located in computer technology, electrical machinery and equipment, digital communication and transport.

Figure 8: Shares of publications and patents by WIPO35 classes, 2016



Source: Elsevier - Scopus, EPO - PATSTAT

5 Summary & discussion

In this paper, we provided a probabilistic concordance between industry sectors and technology fields on the one hand and scientific disciplines and technology fields on the other. Innovation researchers often are confronted with the problem of different classification schemes for different innovation related indicators, which makes it hard to compare these indicators, especially at the meso-level. In this paper, we thus try to address a part of this problem, which enables us to measure publications and patents as well as patents and further economic indicators at the same level.

The probabilistic concordances provided in the paper are based on micro-level links between relevant and commonly used datasets in innovation research, i.e. PATSTAT in the case of patents, Scopus in the case of publications and BvD's Orbis in the case of company data. The concordances between the three indicators are provided at the level of 35 technology fields as well as IPC 3-digit classes. These final matrices can then be applied to any patent data collected using the WIPO35 classification as well as publication data using the Scopus classification.

The concordance matrices are only available at the worldwide scale, which does not take into account national peculiarities with regard to science and industry structure. Tests have shown the country-specific matrices are similar to the matrix based on transnational patents, yet there are country-specific idiosyncrasies. This should be kept in mind for the further interpretation of the results.

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7 Annex

Table 1: List of IPC classes (3-digit)

IPC Code (3-digit)	Description
A01	Agriculture; forestry; animal husbandry; hunting; trapping; fishing
A21	Baking; equipment for making or processing doughs; doughs for baking
A22	Butchering; meat treatment; processing poultry or fish
A23	Foods or foodstuffs; their treatment, not covered by other classes
A24	Tobacco; cigars; cigarettes; smokers' requisites
A41	Wearing apparel
A42	Headwear
A43	Footwear
A44	Haberdashery; jewellery
A45	Hand or travelling articles
A46	Brushware
A47	Furniture; domestic articles or appliances; coffee mills; spice mills; [...]
A61	Medical or veterinary science; hygiene
A62	Life-saving; fire-fighting
A63	Sports; games; amusements
B01	Physical or chemical processes or apparatus in general
B02	Crushing, pulverising, or disintegrating; preparatory treatment of grain for milling
B03	Separation of solid materials using liquids or using pneumatic tables or jigs; [...]
B04	Centrifugal apparatus or machines for carrying-out physical or chemical proc. [...]
B05	Spraying or atomising in general; [...]
B06	Generating or transmitting mechanical vibrations in general
B07	Separating solids from solids; sorting
B08	Cleaning
B09	Disposal of solid waste; reclamation of contaminated soil
B21	Mechanical metal-working without essentially removing material; punching metal
B22	Casting; powder metallurgy
B23	Machine tools; metal-working not otherwise provided for
B24	Grinding; polishing
B25	Hand tools; portable power-driven tools; handles for hand implements;
B26	Hand cutting tools; cutting; severing
B27	Working or preserving wood or similar material; [...]
B28	Working cement, clay, or stone
B29	Working of plastics; working of substances in a plastic state in general
B30	Presses
B31	Making paper articles; working paper
B32	Layered products
B41	Printing; lining machines; typewriters; stamps
B42	Bookbinding; albums; files; special printed matter
B43	Writing or drawing implements; bureau accessories
B44	Decorative arts
B60	Vehicles in general
B61	Railways
B62	Land vehicles for travelling otherwise than on rails
B63	Ships or other waterborne vessels; related equipment

IPC Code (3-digit)	Description
B64	Aircraft; aviation; cosmonautics
B65	Conveying; packing; storing; handling thin or filamentary material
B66	Hoisting; lifting; hauling
B67	Opening or closing bottles, jars or similar containers; liquid handling
B68	Saddlery; upholstery
B81	Micro-structural technology
B82	Nanotechnology
C01	Inorganic chemistry
C02	Treatment of water, waste water, sewage, or sludge
C03	Glass; mineral or slag wool
C04	Cements; concrete; artificial stone; ceramics; refractories
C05	Fertilisers; manufacture thereof
C06	Explosives; matches
C07	Organic chemistry
C08	Organic macromolecular compounds; [...]
C09	Dyes; paints; polishes; natural resins; adhesives; [...]
C10	Petroleum, gas or coke industries; [...]
C11	Animal or vegetable oils, fats, fatty substances or waxes; [...]
C12	Biochemistry; beer; spirits; wine; vinegar; microbiology; [...]
C13	Sugar industry
C14	Skins; hides; pelts; leather
C21	Metallurgy of iron
C22	Metallurgy; ferrous or non-ferrous alloys; [...]
C23	Coating metallic material; coating material with metallic material; [...]
C25	Electrolytic or electrophoretic processes; apparatus therefor
C30	Crystal growth
C40	Combinatorial technology
C99	Section C Other - Chemistry; metallurgy
D01	Natural or artificial threads or fibres; spinning
D02	Yarns; mechanical finishing of yarns or ropes; warping or beaming
D03	Weaving
D04	Braiding; lace-making; knitting; trimmings; non-woven fabrics
D05	Sewing; embroidering; tufting
D06	Treatment of textiles or the like; laundering; [...]
D07	Ropes; cables other than electric
D21	Paper-making; production of cellulose
E01	Construction of roads, railways, or bridges
E02	Hydraulic engineering; foundations; soil-shifting
E03	Water supply; sewerage
E04	Building
E05	Locks; keys; window or door fittings; safes
E06	Doors, windows, shutters, or roller blinds, in general; ladders
E21	Earth or rock drilling; mining
F01	Machines or engines in general; engine plants in general; steam engines
F02	Combustion engines; hot-gas or combustion-product engine plants
F03	Machines or engines for liquids; wind, spring, or weight motors; [...]
F04	Positive-displacement machines for liquids; pumps for liquids or elastic fluids
F15	Fluid-pressure actuators; hydraulics or pneumatics in general
F16	Engineering elements or units; [...]

IPC Code (3-digit)	Description
F17	Storing or distributing gases or liquids
F21	Lighting
F22	Steam generation
F23	Combustion apparatus; combustion processes
F24	Heating; ranges; ventilating
F25	Refrigeration or cooling; combined heating and refrigeration systems; [...]
F26	Drying
F27	Furnaces; kilns; ovens; retorts
F28	Heat exchange in general
F41	Weapons
F42	Ammunition; blasting
G01	Measuring; testing
G02	Optics
G03	Photography; cinematography; analogous techniques; [...]
G04	Horology
G05	Controlling; regulating
G06	Computing; calculating; counting
G07	Checking-devices
G08	Signalling
G09	Educating; cryptography; display; advertising; seals
G10	Musical instruments; acoustics
G11	Information storage
G12	Instrument details
G21	Nuclear physics; nuclear engineering
G99	Section G Other - Physics
H01	Basic electric elements
H02	Generation, conversion, or distribution of electric power
H03	Basic electronic circuitry
H04	Electric communication technique
H05	Electric techniques not otherwise provided for

Source: WIPO (https://www.wipo.int/classifications/ipc/ipcpub/).

Table 2: List of NACE Rev.2 codes (2-digit)

Sector 2-digit Code	Description
1	Crop and animal production, hunting and related service activities
2	Forestry and logging
3	Fishing and aquaculture
5	Mining of coal and lignite
6	Extraction of crude petroleum and natural gas
7	Mining of metal ores
8	Other mining and quarrying
9	Mining support service activities
10	Manufacture of food products
11	Manufacture of beverages
12	Manufacture of tobacco products
13	Manufacture of textiles
14	Manufacture of wearing apparel
15	Manufacture of leather and related products
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
17	Manufacture of paper and paper products
18	Printing and reproduction of recorded media
19	Manufacture of coke and refined petroleum products
20	Manufacture of chemicals and chemical products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
22	Manufacture of rubber and plastic products
23	Manufacture of other non-metallic mineral products
24	Manufacture of basic metals
25	Manufacture of fabricated metal products, except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment n.e.c.
29	Manufacture of motor vehicles, trailers and semi-trailers
30	Manufacture of other transport equipment
31	Manufacture of furniture
32	Other manufacturing
33	Repair and installation of machinery and equipment
35	Electricity, gas, steam and air conditioning supply
36	Water collection, treatment and supply
37	Sewerage
38	Waste collection, treatment and disposal activities; materials recovery
39	Remediation activities and other waste management services
41	Construction of buildings
42	Civil engineering
43	Specialised construction activities
45	Wholesale and retail trade and repair of motor vehicles and motorcycles
46	Wholesale trade, except of motor vehicles and motorcycles
47	Retail trade, except of motor vehicles and motorcycles
49	Land transport and transport via pipelines
50	Water transport
51	Air transport

Sector 2-digit Code	Description
52	Warehousing and support activities for transportation
53	Postal and courier activities
55	Accommodation
56	Food and beverage service activities
58	Publishing activities
59	Motion picture, video and television programme production, sound recording and music publishing activities
60	Programming and broadcasting activities
61	Telecommunications
62	Computer programming, consultancy and related activities
63	Information service activities
64	Financial service activities, except insurance and pension funding
65	Insurance, reinsurance and pension funding, except compulsory social security
66	Activities auxiliary to financial services and insurance activities
68	Real estate activities
69	Legal and accounting activities
70	Activities of head offices; management consultancy activities
71	Architectural and engineering activities; technical testing and analysis
72	Scientific research and development
73	Advertising and market research
74	Other professional, scientific and technical activities
75	Veterinary activities
77	Rental and leasing activities
78	Employment activities
79	Travel agency, tour operator and other reservation service and related activities
80	Security and investigation activities
81	Services to buildings and landscape activities
82	Office administrative, office support and other business support activities
84	Public administration and defence; compulsory social security
85	Education
86	Human health activities
87	Residential care activities
88	Social work activities without accommodation
90	Creative, arts and entertainment activities
91	Libraries, archives, museums and other cultural activities
92	Gambling and betting activities
93	Sports activities and amusement and recreation activities
94	Activities of membership organisations
95	Repair of computers and personal and household goods
96	Other personal service activities
97	Activities of households as employers of domestic personnel
98	Undifferentiated goods- and services-producing activities of private households for own use
99	Activities of extraterritorial organisations and bodies

Source: European Commission (http://ec.europa.eu/competition/mergers/cases_old/index/nace_all.html)

Table 3: List of scientific disciplines (27 fields)

Discipline Code	Discipline name
1	Agricultural and Biological Sciences
2	Arts and Humanities
3	Biochemistry, Genetics and Molecular Biology
4	Business, Management and Accounting
5	Chemical Engineering
6	Chemistry
7	Computer Science
8	Decision Sciences
9	Dentistry
10	Earth and Planetary Sciences
11	Economics, Econometrics and Finance
12	Energy
13	Engineering
14	Environmental Science
15	Health Professions
16	Immunology and Microbiology
17	Materials Science
18	Mathematics
19	Medicine
20	Multidisciplinary
21	Neuroscience
22	Nursing
23	Pharmacology, Toxicology and Pharmaceutics
24	Physics and Astronomy
25	Psychology
26	Social Sciences
27	Veterinary

Source: Elsevier - Scopus

Table 4: List of WIPO35 fields (35 fields)

WIPO35 Code	WIPO35 field name
W35F01	Electrical machinery, apparatus, energy
W35F02	Audio-visual technology
W35F03	Telecommunications
W35F04	Digital communication
W35F05	Basic communication processes
W35F06	Computer technology
W35F07	IT methods for management
W35F08	Semiconductors
W35F09	Optics
W35F10	Measurement
W35F11	Analysis of biological materials
W35F12	Control
W35F13	Medical technology
W35F14	Organic fine chemistry
W35F15	Biotechnology
W35F16	Pharmaceuticals
W35F17	Macromolecular chemistry, polymers
W35F18	Food chemistry
W35F19	Basic materials chemistry
W35F20	Materials, metallurgy
W35F21	Surface technology, coating
W35F22	Micro-structural and nano-technology
W35F23	Chemical engineering
W35F24	Environmental technology
W35F25	Handling
W35F26	Machine tools
W35F27	Engines, pumps, turbines
W35F28	Textile and paper machines
W35F29	Other special machines
W35F30	Thermal processes and apparatus
W35F31	Mechanical elements
W35F32	Transport
W35F33	Furniture, games
W35F34	Other consumer goods
W35F35	Civil engineering

Source: Schmoch (2008)

Table 5: Shares of transnational patents in WIPO35 fields by NACE Rev.2 sectors (2-digit), 2014-2016

NACE/ WIPO35	W35 F01	W35 F02	W35 F03	W35 F04	W35 F05	W35 F06	W35 F07	W35 F08	W35 F09	W35 F10	W35 F11	W35 F12	W35 F13	W35 F14	W35 F15	W35 F16	W35 F17	W35 F18	W35 F19	W35 F20	W35 F21	W35 F22	W35 F23	W35 F24	W35 F25	W35 F26	W35 F27	W35 F28	W35 F29	W35 F30	W35 F31	W35 F32	W35 F33	W35 F34	W35 F35
1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	3%	1%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
6	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	1%	0%	0%	1%	0%	2%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%
7	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
8	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
9	0%	0%	0%	0%	0%	1%	0%	0%	0%	4%	1%	1%	0%	0%	0%	0%	0%	0%	3%	1%	0%	0%	0%	1%	0%	0%	1%	0%	0%	0%	1%	0%	0%	0%	17%
10	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	1%	0%	0%	1%	4%	2%	1%	25%	1%	0%	0%	0%	1%	0%	2%	0%	0%	0%	1%	0%	0%	0%	1%	0%	0%
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26	26%	56%	68%	75%	66%	53%	27%	53%	47%	32%	20%	26%	33%	4%	9%	4%	6%	2%	7%	8%	17%	40%	12%	9%	11%	8%	5%	22%	9%	10%	5%	6%	14%	16%	3%
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NACE/ WIPO35	W35 F01	W35 F02	W35 F03	W35 F04	W35 F05	W35 F06	W35 F07	W35 F08	W35 F09	W35 F10	W35 F11	W35 F12	W35 F13	W35 F14	W35 F15	W35 F16	W35 F17	W35 F18	W35 F19	W35 F20	W35 F21	W35 F22	W35 F23	W35 F24	W35 F25	W35 F26	W35 F27	W35 F28	W35 F29	W35 F30	W35 F31	W35 F32	W35 F33	W35 F34	W35 F35
31	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	1%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	4%	0%	0%
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41	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
42	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
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45	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
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NACE/ WIPO35	W35 F01	W35 F02	W35 F03	W35 F04	W35 F05	W35 F06	W35 F07	W35 F08	W35 F09	W35 F10	W35 F11	W35 F12	W35 F13	W35 F14	W35 F15	W35 F16	W35 F17	W35 F18	W35 F19	W35 F20	W35 F21	W35 F22	W35 F23	W35 F24	W35 F25	W35 F26	W35 F27	W35 F28	W35 F29	W35 F30	W35 F31	W35 F32	W35 F33	W35 F34	W35 F35
70	1%	0%	0%	1%	0%	0%	1%	0%	0%	1%	1%	1%	1%	0%	0%	0%	1%	1%	1%	1%	1%	0%	1%	1%	1%	1%	0%	1%	1%	2%	1%	1%	4%	3%	2%
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77	1%	2%	1%	1%	1%	2%	1%	0%	0%	0%	0%	1%	0%	1%	1%	0%	1%	3%	0%	0%	0%	1%	0%	0%	1%	0%	0%	0%	1%	0%	0%	0%	1%	1%	0%
78	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
79	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
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81	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
82	2%	1%	1%	1%	1%	1%	2%	1%	0%	1%	2%	1%	0%	1%	2%	1%	0%	0%	0%	1%	1%	1%	1%	0%	1%	1%	0%	1%	1%	1%	0%	1%	0%	1%	1%
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88	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
90	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
91	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
92	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
93	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
94	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	1%	0%	1%	1%	0%	1%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
95	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
96	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
97	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
98	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
99	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: EPO - PATSTAT

Table 6: Shares of publications in scientific disciplines by WIPO35 fields, 2014-2016

WIPO35/Scientific discipline	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
W35F01	3%	4%	2%	4%	5%	6%	6%	2%	4%	5%	5%	19%	7%	6%	2%	2%	7%	5%	2%	5%	3%	4%	2%	7%	4%	5%	4%
W35F02	1%	3%	1%	2%	1%	1%	4%	3%	1%	1%	2%	1%	2%	1%	3%	1%	1%	2%	1%	2%	1%	1%	0%	2%	2%	3%	1%
W35F03	1%	2%	0%	2%	0%	0%	4%	1%	1%	1%	2%	1%	2%	1%	1%	1%	1%	3%	1%	2%	1%	2%	0%	1%	1%	3%	0%
W35F04	1%	2%	0%	2%	0%	0%	6%	1%	1%	1%	2%	0%	2%	1%	1%	1%	1%	4%	1%	1%	1%	2%	0%	1%	1%	4%	0%
W35F05	0%	0%	0%	0%	0%	0%	2%	0%	1%	1%	0%	0%	2%	0%	0%	0%	1%	1%	0%	1%	0%	1%	0%	1%	1%	2%	1%
W35F06	3%	8%	2%	4%	1%	1%	14%	7%	1%	3%	2%	1%	4%	2%	7%	2%	2%	11%	3%	3%	2%	3%	2%	3%	3%	7%	3%
W35F07	0%	0%	0%	1%	0%	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
W35F08	2%	3%	2%	3%	2%	4%	3%	1%	1%	5%	5%	4%	4%	2%	2%	2%	6%	4%	2%	4%	2%	4%	1%	6%	3%	4%	2%
W35F09	2%	4%	2%	3%	1%	2%	5%	4%	2%	5%	5%	1%	4%	3%	3%	2%	5%	6%	2%	4%	2%	4%	1%	8%	6%	5%	5%
W35F10	3%	6%	3%	6%	3%	3%	8%	8%	4%	6%	5%	5%	8%	5%	7%	3%	6%	8%	3%	5%	4%	3%	2%	8%	5%	5%	5%
W35F11	4%	4%	7%	1%	3%	3%	1%	2%	4%	3%	3%	2%	2%	4%	4%	6%	2%	2%	6%	4%	5%	4%	5%	2%	4%	2%	4%
W35F12	0%	1%	0%	1%	0%	0%	3%	3%	0%	1%	1%	1%	2%	1%	1%	0%	1%	3%	0%	0%	0%	1%	0%	1%	1%	2%	1%
W35F13	7%	6%	7%	2%	4%	3%	4%	2%	20%	4%	5%	1%	5%	6%	18%	7%	4%	3%	14%	6%	13%	10%	7%	5%	7%	6%	13%
W35F14	6%	4%	7%	3%	10%	13%	2%	4%	4%	5%	5%	6%	2%	5%	3%	4%	5%	3%	5%	4%	5%	7%	11%	4%	6%	3%	5%
W35F15	24%	16%	25%	5%	10%	8%	5%	11%	14%	14%	14%	3%	5%	16%	14%	30%	5%	7%	23%	20%	20%	18%	20%	8%	18%	10%	19%
W35F16	17%	12%	19%	3%	7%	8%	3%	5%	15%	10%	9%	2%	3%	9%	10%	20%	4%	4%	20%	13%	19%	21%	29%	6%	10%	8%	14%
W35F17	3%	1%	3%	2%	5%	7%	1%	2%	4%	4%	4%	3%	2%	2%	2%	2%	6%	2%	2%	4%	2%	2%	3%	3%	4%	2%	2%
W35F18	4%	0%	1%	0%	1%	1%	0%	1%	1%	0%	0%	0%	0%	1%	1%	2%	0%	0%	1%	1%	1%	2%	1%	0%	0%	1%	1%
W35F19	3%	2%	3%	2%	6%	7%	1%	1%	6%	3%	3%	3%	2%	3%	2%	2%	4%	2%	2%	3%	3%	2%	4%	2%	3%	2%	2%
W35F20	2%	4%	2%	6%	8%	8%	2%	4%	3%	4%	4%	11%	5%	5%	2%	2%	11%	3%	2%	3%	2%	2%	2%	6%	4%	3%	4%
W35F21	2%	2%	1%	5%	3%	4%	1%	2%	1%	2%	2%	6%	2%	3%	1%	1%	4%	2%	1%	2%	1%	1%	1%	3%	2%	1%	1%
W35F22	1%	1%	1%	1%	2%	2%	0%	0%	0%	1%	1%	2%	1%	1%	0%	1%	1%	1%	1%	1%	1%	1%	0%	1%	1%	1%	0%
W35F23	3%	2%	4%	2%	16%	9%	2%	1%	2%	4%	3%	7%	3%	7%	2%	3%	5%	3%	3%	3%	2%	3%	3%	3%	4%	2%	2%
W35F24	0%	0%	0%	0%	1%	1%	0%	0%	0%	1%	0%	1%	1%	3%	1%	0%	1%	1%	0%	0%	0%	0%	0%	1%	0%	1%	0%
W35F25	1%	1%	1%	3%	1%	0%	3%	3%	1%	1%	1%	1%	2%	1%	1%	0%	1%	2%	1%	1%	2%	0%	0%	1%	1%	1%	0%

WIPO35/Scientific discipline	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
W35F26	1%	1%	1%	4%	1%	1%	2%	4%	2%	2%	1%	1%	3%	2%	1%	1%	2%	2%	1%	1%	1%	1%	0%	2%	1%	2%	1%
W35F27	1%	1%	1%	2%	1%	1%	1%	2%	1%	1%	0%	4%	2%	2%	3%	0%	1%	2%	1%	1%	1%	1%	0%	2%	1%	2%	1%
W35F28	1%	1%	0%	9%	1%	0%	1%	3%	1%	1%	1%	1%	2%	1%	1%	0%	1%	1%	0%	0%	0%	0%	0%	1%	1%	1%	0%
W35F29	2%	1%	2%	8%	3%	3%	3%	6%	3%	3%	4%	3%	5%	3%	2%	2%	5%	3%	2%	2%	2%	1%	2%	4%	3%	4%	2%
W35F30	1%	1%	0%	1%	1%	1%	1%	1%	1%	1%	1%	4%	1%	2%	1%	0%	1%	2%	0%	0%	0%	0%	0%	1%	1%	1%	0%
W35F31	1%	2%	1%	6%	1%	1%	3%	7%	1%	2%	3%	2%	5%	2%	2%	1%	3%	4%	1%	1%	1%	1%	1%	3%	1%	3%	2%
W35F32	1%	3%	1%	4%	2%	1%	4%	3%	1%	3%	4%	3%	5%	2%	1%	1%	2%	4%	1%	1%	1%	1%	1%	3%	1%	4%	2%
W35F33	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	1%	0%	0%	0%	1%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	1%	0%
W35F34	0%	1%	0%	1%	0%	0%	1%	3%	1%	0%	0%	0%	1%	1%	1%	0%	1%	1%	0%	1%	0%	0%	0%	1%	1%	1%	0%
W35F35	0%	0%	0%	1%	0%	0%	1%	0%	0%	2%	1%	0%	1%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	1%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Elsevier - Scopus, EPO - PATSTAT