The Worldwide Count of Priority Patents: A New Indicator of Incentive Activity

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Abstract

This paper describes a new patent-based indicator of inventive activity. The indicator is based on counting all the priority patent applications filed by a country's inventors, regardless of the patent office in which the application is filed, and can therefore be considered as a complete 'matrix' of all patent counts. The method has the advantage of covering more inventions than the selective Patent Cooperation Treaty (PCT) or triadic family counts, while at the same time limiting the home-country bias of single-country-based indicators (inventors from a particular country tend to file in their own country). The indicator is particularly useful to identify emerging technologies and to assess the innovation performance of developing economies.

JEL Classification: O30, O57
Keywords: patent count, patent indicator, patent statistics, Patstat, priority count, priority filing, worldwide count

1. Introduction

The past decades have seen a sharp increase in the use of patent-based indicators by scholars and policy analysts. Patent data are used across scientific disciplines and for a range of purposes—such as assessing a country's innovation performance, evaluating researchers' mobility or tracking the emergence of new technologies. Yet the abundance of data sources and counting methodologies lead to heterogeneous metrics. Depending on the reference date (priority date vs. application date), the criterion for geographical allocation (inventor vs. applicant), the level of aggregation and several other dimensions, patent counts can vary to a very large extent.[1]

Certain types of patent indicators are more appropriate for certain uses, and careful consideration of the research objective is needed to select the most appropriate indicator. For instance, national data provided by the US Patent and Trademark Office (USPTO) are appropriate for studies of the market orientation of inventive activity. Due to their limited coverage, however, national databases are subject to a geographic bias. For instance, USPTO patent counts are strongly biased in favour of US and Canadian inventors, owing to the high propensity of North American applicants to file patents at that patent office. The ways to avoid the geographic bias are either to count 'international' patents filed under the Patent Cooperation Treaty (PCT), or to count applications filed simultaneously at several national offices (e.g., the 'triadic families' discussed in section 2). These indicators are very exclusive. They count only applications having an international market perspective and, hence, are biased towards inventions of higher value, which are often owned by large firms with a substantial patenting budget. It has long been recognised by scholars that many inventions of local relevance are also of interest for various reasons. They can serve the development of small companies, they witness the presence of absorptive capabilities, and they may be of particular value within developing countries. Overlooking these local patents therefore precludes a full view of the inventive activity of countries.

This paper presents a methodology to build an indicator of priority patent applications using the Worldwide Patent Statistical Database (Patstat) that is maintained and distributed by the European Patent Office (EPO). A priority filing is the *first* patent application filed to protect an invention. It is generally filed in the patent office of the inventor's country of residence, although it may also be filed elsewhere. In some countries the national patent office attracts only a small share of the priority filings made by domestic inventors. A comprehensive measure of inventiveness therefore requires a count of all priority patent applications filed worldwide and their assignment to the country of the inventor's residence (or that of the applicant, depending on the research objective). The aim of this paper is to present a new patent-based indicator that relies on this approach.

The idea of a count of patent priorities is not new *per se*, as it has been done before, notably in the Trilateral yearly reports published by EPO, the Japan Patent Office (JPO), and USPTO. To make this approach operational on a large scale, however, several practical issues need to be resolved. The most crucial one derives from the fact that the Patstat database is plagued by missing information on inventors. A distinguishing characteristic of our contribution is that we present a way to address this problem. In particular, whenever a priority filing has missing information on inventors, we look for any subsequent filing of the

[1] See the OECD Patent Statistics Manual 2009 for an in-depth critical review of existing patent indicators, and Dernis *et al.* (2001) for a first empirical assessment of various counting methodologies.

same invention that may include this information. Validity tests suggest that the proposed retrieval algorithm is highly accurate.

Compared with existing indicators, which mainly focus on higher-value patents, the worldwide count improves the measurement of the inventive activity of small open economies and emerging economies, and reflects the overall innovative dynamism of countries. It is also extremely useful in tracing the geographic location of emerging technologies. With its all-encompassing approach, the indicator measures the 'inventiveness' of countries, as opposed to the inventive 'performance' captured by existing high-value indicators. This being said, the measure of patenting activity developed in this paper is actually the source of all patent series, in the sense that it can be used to generate all existing patent indicators. For instance, to generate the triadic indicator, it would be easy to select only those priority filings that eventually became triadic patents. Thanks to its generality, the worldwide count of priority filings is also particularly appropriate for within-country analysis of inventive activity. It allows scholars and policy analysts to track the population of patents by domestic inventors and informs them of the characteristics of their national system of innovation and exposure to international research.

The paper is organised as follows. The next section reviews the existing patent indicators. Section 3 describes the methodology. A statistical overview of the indicator is provided in section 4. Section 5 studies patenting activity in an emerging field to illustrate the differences with established patent indicators. Section 6 discusses how the patent indicator can be used and offers conclusions.

2. Patent indicators

This section reviews four popular patent indicators in light of six key characteristics: i) the home bias; ii) the existence of a time effect; iii) the timeliness of the statistics; iv) the type of document; v) the level of aggregation; and vi) the value of patents. In the following discussion, it is assumed that the reader has a general knowledge of the patenting process and of patent indicators. [2]

The term *home bias* means that domestic applicants tend to file more patents in their home country than nonresident applicants, relative to their inventive capacity (OECD 2009: 60). By extension, we use this term to refer to how the institutional and geographical characteristics of patent systems affect patent counts. For instance, relying on USPTO patents to assess countries' innovation performance would lead to a biased count in favour of US firms, but also Canadian and Mexican firms due to their geographical proximity to the United States.[3]

The *time effect* is defined as the effect of the passing of time on a patent indicator. One illustration of this effect is provided by de Rassenfosse and van Pottelsberghe (2007), who show that the older members of the European Patent Convention (EPC) have a higher propensity to file applications at the EPO.

Timeliness indicates how quickly a particular class of patent data becomes available.

[2] A good discussion of these topics can be found in Dernis *et al*. (2001) and OECD (2009). Schmookler (1950), Pavitt (1985), and Griliches (1990) provide an extensive discussion of the possibilities and problems of patent indicators.

[3] See Harhoff et al. (2009) for an illustration of how geographical distance affects the propensity to seek patent protection in a country.

The *type of document* refers either to priority filings or second filings. A priority patent application is generally filed at the inventor's home office, although this need not be so. When a priority patent application is subsequently filed in other jurisdictions, with the aim of extending the patent protection to foreign markets, the applications are called 'second filings'.

The *level of aggregation* can be the individual patent level or the family level. A family of patents is a set of patents (or applications) filed in several countries which are related to each other by one or several common priority filings (OECD, 2009: 71).

Even though it is difficult to estimate *patent value*, it is possible to rank some of the indicators according to the presumed average value of the patents that they count. Table 1 displays a comparative description of the main characteristics of existing patent indicators.

Table 1: Comparison of patent indicators

	Home bias		Time effect	Timeliness (months)	Document	Level of aggregation	Value
	Geographic	*Institutional*					
USPTO	Strong	None	N	40	PF & SF	Individual	Low to high
EPO	Medium	None	Y	18	PF & SF	Individual	Med. to high
PCT	Low	None	Y	18	PF & SF	Individual	Varying
Triadic	Low	None	Y	40	-	Family	High
Worldwide[(a)]	None	Medium	N	18	PF	Indiv./Family	Low to high

Notes: PF: priority filing. SF: second filings. Worldwide: the indicator proposed in this paper.
a. The timeliness of 18 months does not apply to patent applications filed at the USPTO, which can remain undisclosed until grant.

A first indicator is the count of the number of patents granted by the USPTO, which has been accessible to researchers for a long time and is extensively used for international comparisons (Merton, 1935; Schmookler, 1954; Soete and Wyatt, 1983). It is argued that a country is more innovative than another if it has a higher share of US patents relative to its size. An advantage of the indicator is that because applicants face a roughly similar patenting cost and are compared under the same patent system, the institutional bias is eliminated. Yet researchers have also long been aware of the limitations of this measure. For instance, Pavitt (1985) explains that 'foreign patenting as a proxy measure of innovative activity has been subjected to […] criticisms […] arguing that there may be systematic, country specific biases in the propensity to patent the output of innovative activities in foreign countries.' Because Canadian and Mexican companies file relatively more patents in the United States than do firms from continental Europe (owing to relative proximity—the so-called geographic bias), comparisons must be made with great care. In addition, until 2001 the USPTO disclosed statistics only on patents granted, rather than on applications, so that that the timeliness of the statistics was subject to the lag between the two events. Certain alleged shortcomings of the US patent system, such as its low inventive requirement, lack of transparency and a lax fee policy, may have led to excessive strategic patenting adding further doubt about the relevance of the indicator. See the evidence provided by van Pottelsberghe (2011) for an international comparison.

A second measure involves counting patent applications filed at the EPO. The EPO was created in 1974 as a regional patent office to provide a single patent filing and grant procedure for member states of the EPC. The EPO is an upper layer in the European patent system and is cost-effective to use if the applicant is targeting more than three European countries for protection. Once a patent has been granted by the EPO, it must be validated and kept in force in each country where protection is desired. Since the EPO is a regional office, the count is not biased toward a single country—at least as far as European countries are concerned—such that statistics on patent filings at the EPO are often assumed to be less biased than those at the USPTO. The count of EPO patent applications nevertheless provides an incomplete picture of patented output, as applicants still have the option to file in their home country or directly at other national patent offices. A recent study by de Rassenfosse and van Pottelsberghe (2007) provides evidence that the transfer rate of national priority patent applications to the EPO varies greatly across EPC member states and is predicted by variables not related to innovation performance, such as the duration of membership of the EPC (direct evidence of the time effect). In other words, the authors find the presence of a systematic bias in the data, casting doubts on the comparability of statistics based on EPO patents. Arguably, however, this bias is bound to vanish as applicants get used to the EPO procedure.

The count of patent applications filed under the PCT is a third, frequently used patent indicator. The PCT is an international treaty that provides a unified procedure for filing patent applications in each of the 145 contracting states (as of May 2012). It makes it possible to seek patent protection by filing an 'international application' at the World Intellectual Property Organization (WIPO). This application must then be validated in each national patent office where patent protection is sought. The PCT route extends the priority period to 31 months instead of the usual 12 months allowed by the Paris Convention, giving the applicant more time to assess the potential value of the invention (OECD, 2009). It is not clear whether PCT applications are of higher value than, say, EPO applications. Indeed, as argued in Guellec and van Pottelsberghe (2000), it might be that inventions with uncertain market potential are filed through the PCT route, whereas those with an unquestionable potential tend to be filed directly at the EPO. Empirical evidence, however, seems to suggest that the PCT route is associated with higher-value patents (van Zeebroeck and van Pottelsberghe, 2011; Jensen *et al*., 2011). Statistics based on PCT applications are less subject to a home bias, even though applicants have made uneven use of the PCT across countries and industries, especially in the treaty's early days. The timeliness of this indicator is good, as PCT applications are published by the WIPO 18 months after the priority date.

A fourth popular indicator is the count of triadic patent families, which is the first statistic based on patent families to become widely used as a measure of the inventive performance of countries.[4] It was developed a decade ago by the OECD to avoid some of the shortcomings associated with other indicators. The aim was to create a measure that selected patents of a certain quality and that would be comparable across countries. According to the OECD definition, the triadic patent family is a set of patent applications that have been filed at both the EPO and the JPO and granted by the USPTO, sharing one or more priority applications. The indicator is robust to differences in patent regulations across countries and changes in patent laws over the years (Dernis *et al*., 2001; Dernis and Khan, 2004). The geographic bias is reduced, since only patents with an international scope are selected. Similarly, triadic patents must be of high value to justify the costs incurred with patent applications in the three patent offices.[5] Analysis by de Rassenfosse and van Pottelsberghe (2009) shows that, among the existing indicators, triadic patents are the least affected by differences in propensity to patent across countries and are particularly reflective of the productivity of research efforts. The count of triadic patents is thus particularly suited for

[4] Other institutions that also report statistics on patent families include the WIPO and the 'four offices' statistics working group (previously known as the Trilateral Office). Frietsch and Schmoch (2010) propose transnational patent families, defined as all patent families with at least a PCT application or an EPO application.
[5] See van Pottelsberghe and François (2009) and de Rassenfosse and van Pottelsberghe (2011) for an assessment of legal and administrative patenting fees at the EPO, the JPO and the USPTO.

international comparison of innovation performance. A major drawback of this indicator, however, is its poor timeliness as a result of the grant lag at the USPTO.[6] While it is possible to mitigate the timeliness issue with 'nowcasting' techniques (i.e., forecasting the recent past), as explained in Dernis (2007), these techniques tend to produce imprecise results for small patenting countries and emerging economies.

The indicator proposed in this paper (labelled 'Worldwide' in table 1) counts priority patent applications filed by inventors from a given country regardless of the patent office of application (as opposed to counting filings at a specific office such as the EPO). This global coverage eliminates the geographic bias (but at the cost of introducing an institutional bias—because we are counting national patents, the peculiarities of each national patent system are likely to affect the count).[7] In addition, because the new indicator involves a count of priorities, it is the closest measure to the date of invention. The methodology adopted to compute the indicator is presented in the next section.

3. Methodology

The counting methodology proposed in this paper is conceptually simple—consisting of selecting the priority patent applications filed worldwide in a given year and assigning them appropriately—though its implementation is quite challenging and requires several working assumptions that need to be discussed.[8] The data come from the EPO Worldwide Patent Statistical Database (Patstat, April 2011 edition), which covers records on patent applications filed in more than 70 patent offices around the world.[9] The issues that must be tackled to build the indicator can be grouped into four categories: i) the choice between the inventor's and the applicant's country of residence; ii) the criteria used to identify priority filings; iii) the choice of a straight count versus a family-based count; and iv) the recovery of missing information.

3.1 The allocation of priority filings to countries

One can assign patents to countries either according to the 'inventor' criterion, or to the 'applicant' criterion. The inventor criterion reflects the origin of the inventive activity and ensures a good match with statistics on research and development (R&D), which specifically relate to the R&D expenditures within a country (OECD, 2009: 63). The inventor count thus captures the output *created* by inventors in a country rather than that *owned* by companies of a country (the applicant criterion). This distinction matters mainly for countries that have a large number of foreign-owned R&D laboratories and where a count based on applicants might underestimate the country's true inventive output. For instance, Guellec and van Pottelsberghe (2001) estimate that more than 30 per cent of the patents from Belgian inventors are applied for by foreign companies. The examples that follow assign patents

[6] In the 2000s, the grant lag was estimated to be about 35 months from filing (USPTO Data Visualization Center, August 2010). However, the grant lag does not take account of the backlog at the USPTO: From 45 per cent to more than 55 per cent of patent applications filed in the early 2000s were still pending in 2010.

[7] The characteristics of the worldwide count, including its institutional bias, are discussed in section 4.

[8] In practical terms, 52 patent offices are included in the analysis: those in OECD countries; those in EPC member states; those of Brazil, Russia, India, China, and South Africa; the EPO; and the WIPO. These 52 offices account for 98.5 per cent of worldwide priority filings in 2005. The MySQL source code used to build the indicator is available upon request from the authors.

[9] Note that the coverage of the Patstat database is incomplete for some patent offices, which affects the accuracy of the indicator (see discussion in Appendix C.4). The coverage of the database should nevertheless be improved with future releases of the database.

according to the country of residence of the inventor(s). The methodology of assigning patents according to the applicant's country of residence is very similar to the methodology presented in this paper, such that we do not discuss it further.

Note that a fractional count methodology is used when a patent has more than one inventor (see the implications of fractional counts in Dernis *et al*., 2001); this ensures that the count is not artificially inflated. An alternative approach, less accurate but frequently used, takes into account only the country of residence of the first inventor listed in the patent application.

3.2 The identification of priority filings

Priority patent applications filed under the Paris Convention and the PCT are considered for the analysis. Particular types of applications were excluded in order to increase international comparability. Specifically, some patent offices have second-tier patents, which are granted generally for a period of up to six years. By contrast, 'standard' patents can be maintained for 20 years (the minimum statutory duration set by the Trade-Related Intellectual Property Rights Agreements, known as TRIPs). The decision was also made to exclude applications that have any type of linkage with other applications, such as a continuation, a continuation in part, or a division. Other specific patents, which can be identified by their 'publication code' in the Patstat database, have also been removed (for instance, plant patents at the USPTO). A list of the excluded publication codes is provided in Appendix A. Note that these patents usually constitute a small fraction of total patent applications, and their exclusion does not affect the count significantly. However, it makes the indicator more homogeneous and easier to interpret.

The USPTO did not publish patent applications until 2001, meaning that only granted patents could be observed—and counted—before that date. With the 1999 Inventor Protection Act, the USPTO aligned to international practices and started publishing patent applications 18 months after the filing date. However, only patent applications that will be filed abroad are automatically published. For patents targeting the domestic market only, it is still possible to avoid publication until the date of grant. Therefore, some applications in the USPTO remain unpublished and hence unobservable.

3.3 Straight count versus family count

Because the proposed indicator counts priority patent applications in many jurisdictions, it is affected by peculiarities of national patent systems (the institutional bias). For instance, it is well known that Japanese patents are more restrictive in scope than those issued elsewhere. As a consequence, Japanese applicants tend to file many more patent applications per dollar of R&D expenditure. As evidence of this institutional difference, patents filed at the JPO had eight claims on average, as opposed to twenty-four claims on average for patents filed at the USPTO in 2005 (de Rassenfosse and van Pottelsberghe, 2012). One way to account for these institutional differences is by counting patent families rather than individual patents. It is indeed often the case that Japanese applicants 'merge' various national priority patent applications when extending their IP right abroad (so that a Japanese second filing usually claims more than one priority document, see Dernis *et al*., 2001). A family count would therefore partially correct for these institutional differences.

Estimating a family count involves weighting each priority filing in a family by the inverse of the number of priority filings in the family, thereby counting the actual number of distinct families.[10] We adopt the extended families definition (Patstat-Inpadoc table), which groups together applications that are directly or indirectly linked through priorities. Martinez (2010) provides a detailed description of the different patent families and how they relate to each other. Note that the family count proposed in this paper aims at harmonizing the notion of invention by counting only distinct sets of patents. By contrast, the family count of triadic patents or the family count proposed by Frietsch and Schmoch (2010) is used as a filtering device to identify valuable patents.[11]

3.4 The recovery of missing information

According to our estimates, Patstat lacks information on the inventor's country of residence for 58 per cent of the priority documents filed from 2000 to 2005. The availability of the information in patent documents varies greatly across patent offices.[12] The country code is missing (almost) systematically for a broad range of patent offices, such as those in Brazil, France, and Japan. The reason for the lack of information is structural: It is due to incomplete provision of data to the Patstat database administrator by patent offices (because of early provision, because the field is not required by certain patent offices, or for other reasons). It is thus important to find a way to recover the missing information. A simplified flowchart of the proposed data-recovery process is presented in Appendix B. The algorithm first selects all the priority filings of a given patent office in a given year. Then, for each filing that has missing information on the inventor's country of residence, the algorithm looks into six potential sources of information (sources 2 to 7—source 1 being the priority document itself, when the information is available). Sources 2 to 6 exploit family linkages, while source 7, the default option when all other retrieval mechanisms fail, considers that the country of residence of the inventor is the country of the patent office of priority application (the 'priority office').

- Source 2: Retrieves information on inventors from the earliest direct equivalent in which the information is available. A direct equivalent is a second filing claiming the priority application in source 1 as sole priority (see Martinez, 2010).
- Source 3: If no information is available in the direct equivalents, the other second filings of the same family are browsed. (The second filings considered in this source claim more than one priority document.)
- Source 4: If the information is missing in source 3, the country of residence of the applicant, as indicated in the priority document, is used to proxy the country of the inventor.
- Source 5: If the country of the applicant is missing, it is searched for in the direct equivalents (source 2).
- Source 6: If no information on the applicant's country was found, it is tracked in all the other second filings of the same family.
- Source 7: Finally, if the information is still missing, the country of the priority office is used for the country of residence of the inventor.

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[10] In the following instance, {$P_{1,1}$, $P_{1,2}$, $P_{1,3}$, $P_{1,4}$, $P_{2,1}$, $P_{2,2}$, $P_{3,1}$}, where the first four priority filings belong to family "1", the next two priority filings to family "2" and the last priority filing to family "3", patents in the first family are given a weight of 0.25, patents in the second family are given a weight of 0.50 and the patent in the third family is given a weight of 1. The sum of weights equals 3, that is, the number of distinct families.

[11] Of course, it is possible to use the family link to filter out low-value patents in the proposed indicator as well. This application exceeds the scope of the paper, but we briefly discuss it in section 4.

[12] The availability of information also varies within patent offices, especially by priority year and filing route. There is usually no systematic difference in data availability in terms of technology fields (IPC classes).

Because country of inventor, country of applicant and priority country do not necessarily match, the algorithm may impute incorrect information. The sources of information are browsed in the proposed order to increase the probability of picking the correct information. For instance, if the information is missing in the original document and the potential second filings, it is likely that the patent was not extended abroad and that it was, therefore, filed by a national inventor, such that the default allocation (source 7) seems quite acceptable. Of course, the imputation rule must be tailored to the research objective. For instance, it is less appropriate to use sources 4–7 if one intends to analyse why some countries offshore R&D.

Table 2 presents the proportion of information recovered, by source of information and patent office. The Canadian, Swiss and Norwegian patent offices are among the 24 countries in our list which provide fairly complete data on inventors: more than 95 per cent of the patent documents contain the inventor's country code (source 1). Patent offices from ten other countries such as Australia, Brazil, France and Japan, on the contrary, provide virtually no information, hence the need to browse second filings. Looking for the missing information in the direct equivalents (source 2) proves to be very useful, yielding the recovery of 56 per cent of the missing information at the French patent office, for example. Looking for information about inventors in other patents of the same family (source 3) makes it possible to recover some additional missing information. Source 4 indicates the share of applicant information that was used for inventors when sources 1 to 3 did not prove successful. This methodology accounts for more than 90 per cent of the information recovered at the Brazilian patent office. Sources 5 and 6 provide little additional information. Finally, the default option of assigning the country of the priority office as the country of the inventor, when no other information could be identified, was used to a large extent for patent offices in seven countries, including Australia, Greece and Japan. The validity of the overall methodology is assessed in detail in Appendix C.

Table 2: Share of information recovered for priority filings, by source of information and patent office

Source:	Inventor			Applicant			
	Priority document	Direct equivalents	Other second filings	Priority document	Direct equivalents	Other second filings	Patent office
	1	2	3	4	5	6	7
Australia	5.64	5.39	1.16	0.03	0.03	0.02	87.73
Austria	46.89	33.12	1.64	18.34	0.00	0.00	0.00
Belgium	45.86	26.16	0.91	26.53	0.00	0.00	0.54
Brazil	0.75	5.68	0.38	90.42	0.00	0.00	2.77
Bulgaria	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Canada	97.08	0.47	0.10	0.65	0.00	0.00	1.70
Chile	0.00	8.49	0.94	90.57	0.00	0.00	0.00
China	99.54	0.03	0.00	0.30	0.00	0.00	0.12
Croatia	96.55	0.46	0.15	1.23	0.00	0.00	1.61
Czech Republic	99.89	0.00	0.00	0.11	0.00	0.00	0.00
Denmark	97.67	0.76	0.11	1.41	0.00	0.00	0.05
Estonia	96.06	0.79	0.00	3.15	0.00	0.00	0.00
Finland	97.01	1.22	0.06	1.19	0.00	0.00	0.51
France	2.29	55.52	3.23	38.47	0.01	0.00	0.48
Germany	96.21	1.15	0.12	2.33	0.00	0.00	0.19
Greece	1.79	15.15	1.37	0.00	0.08	0.00	81.61
Hungary	64.23	2.56	1.61	27.90	0.00	0.00	3.70
Iceland	100.00	0.00	0.00	0.00	0.00	0.00	0.00
India	55.75	11.64	0.87	5.82	0.00	0.00	25.91
Ireland	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Israel	9.10	35.47	5.20	3.71	0.03	0.00	46.49
Italy	18.65	32.07	1.70	22.53	0.12	0.00	24.93
Japan	0.56	10.93	2.69	0.01	0.04	0.01	85.77
Korea	73.53	2.42	0.41	0.00	0.02	0.00	23.63
Latvia	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Lithuania	99.33	0.22	0.00	0.00	0.00	0.00	0.45
Luxembourg	95.19	2.59	0.00	2.22	0.00	0.00	0.00
Mexico	98.00	0.32	0.00	1.61	0.00	0.00	0.07
Netherlands	99.74	0.11	0.00	0.15	0.00	0.00	0.00
New Zealand	1.73	36.30	6.28	0.04	0.08	0.00	55.57
Norway	98.47	0.38	0.06	1.03	0.00	0.00	0.06
Poland	97.44	0.17	0.02	0.40	0.00	0.00	1.97
Portugal	85.57	1.73	0.14	9.81	0.00	0.00	2.74
Romania	98.75	0.00	0.00	0.08	0.00	0.00	1.18
Russia	54.19	0.87	0.20	0.22	0.02	0.00	44.49
Slovakia	97.62	0.10	0.00	0.40	0.10	0.00	1.78
Slovenia	99.46	0.00	0.00	0.46	0.00	0.00	0.08
South Africa	4.58	2.59	0.50	0.88	0.11	0.00	91.34
Spain	99.13	0.23	0.00	0.44	0.00	0.00	0.19
Sweden	23.87	59.74	3.16	12.67	0.35	0.00	0.21
Switzerland	99.09	0.44	0.07	0.34	0.00	0.00	0.07
Turkey	97.70	0.29	0.07	0.43	0.07	0.00	1.44
United Kingdom	25.18	24.73	8.17	0.18	0.05	0.01	41.68
United States	99.51	0.19	0.00	0.15	0.00	0.00	0.14
Average	*41.67*	*8.11*	*1.70*	*1.78*	*0.03*	*0.01*	*46.71*

Notes: Rows add to 100 per cent. Statistics based on priority filings for the years 2000 to 2005. See main text for explanation of the algorithm.

4. Overview of the worldwide indicator

As observed in the introduction, patent indicators serve a variety of purposes, and certain types of patent indicators are better suited than others for certain uses. This section illustrates the information content of the new indicator. A ranking of countries is provided, and the salient features of the indicator are illustrated and discussed. The actual values for the worldwide priority count are available in Appendix D.

Table 3 presents the ranking of countries according to their relative patent count, as measured by different patent indicators standardised by the number of full-time-equivalent researchers—that is, the number of patents per researcher. Some of the many differences in countries' rankings between the various patent counts are particularly striking. As compared with the 'international' indicators (USPTO, EPO, PCT, and triadic), the worldwide priority count improves the ranking of developing economies, where companies mainly target their local markets. Brazil, Russia and China, for instance, gain more than 15 positions when the priority count is used in lieu of the triadic count.

The institutional bias of the worldwide indicator is clearly visible with Japanese and Korean inventors, who are ranked first and second, with more than 500 patents per thousand researchers, far ahead of German inventors, who, with 155 patents per thousand researchers, are the closest followers. The patent systems of these two countries encourage a large number of narrow patents (Kotabe, 1992), giving their residents a quantitative edge over residents of other countries that allow for broader patents.

The geographical bias that affects USPTO and EPO counts is also clearly visible. Canadian inventors, for instance, rank 17th in the worldwide priority count, but jump to the 7th position in the count of USPTO patents. Similarly, inventors from the Netherlands and Switzerland rank 14th and 6th in terms of priority filings but 3rd and 1st when EPO patents are counted.

The columns labelled 'Dev.' report the deviation coefficients with respect to the worldwide count. For instance, the deviation of the count of USPTO patents by inventors from country *i* is computed as $DEV_{USPTO,i} = (USPTO_i/USPTO_{tot})/(Worldwide_i/Worldwide_{tot})$. It measures the proportion of USPTO patents obtained by inventors from country *i*, relative to the proportion of total priority filings obtained by inventors from country *i*. A coefficient greater than one means that the country fares better using the USPTO count than the worldwide count. Austrian inventors, for instance, are listed in 41 per cent more US patents than what their worldwide count would predict (coefficient of 1.41). By contrast, inventors from less-advanced but fast-developing countries usually have fewer USPTO patents. Slovenian inventors, for instance, have half as many patents in the United States as what their worldwide count would predict (coefficient of 0.47). The deviation coefficients can be directly compared across patent indicators. For instance, Austrian inventors file three times as many applications at the EPO as at the USPTO (4.13/1.41). The deviation coefficients clearly illustrate the extent of the geographic bias for small, open economies (as shown, for example, by the coefficient for Dutch and Belgian inventors at the EPO) as well as the bias against less-advanced countries (as seen in the coefficients for inventors from Brazil, China and Russia).

Table 3: Comparison of patent indicators by inventor country, priority year 2000

	Worldwide			USPTO		EPO		PCT		Triadic	
	Count	Per '000 researchers	Rank	Rank	Dev.	Rank	Dev.	Rank	Dev.	Rank	Dev.
Australia (*)	1,108	17	34	18	3.53	20	5.01	16	9.95	17	4.63
Austria	1,568	73	10	9	1.41	**5**	4.13	7	3.11	6	2.45
Belgium	1,154	38	22	16	2.09	9	6.24	17	4.39	10	3.99
Brazil	3,156	43	18	40	0.00	40	0.01	37	0.05	40	0.00
Bulgaria	118	12	35	37	0.09	37	0.12	39	0.13	37	0.06
Canada	5,029	47	17	7	2.78	19	1.83	19	2.81	19	1.46
Chile (*)	10	2	42	28	5.43	32	5.27	35	6.71	31	2.18
China	22,538	32	25	42	0.00	42	0.00	41	0.00	42	0.00
Croatia	206	30	26	32	0.10	29	0.40	34	0.36	27	0.27
Czech Republic	544	39	21	27	0.24	26	0.66	26	1.00	26	0.23
Denmark (*)	640	33	23	11	2.91	7	8.28	**5**	9.03	9	4.80
Estonia	20	8	38	31	0.51	30	1.51	27	4.44	28	0.92
Finland	2,800	80	7	13	1.18	11	2.79	6	3.14	12	1.73
France	13,306	77	8	15	1.04	10	3.00	15	2.22	7	2.24
Germany	40,099	155	**3**	**4**	1.02	**2**	3.02	**4**	2.09	**3**	2.03
Greece	336	23	31	30	0.20	27	0.91	30	1.00	30	0.22
Hungary	873	61	13	24	0.27	25	0.75	24	1.33	24	0.44
Iceland	21	12	36	21	3.93	16	9.27	20	9.70	16	7.01
India (*)	636	5	41	39	0.04	39	0.12	40	0.20	38	0.08
Ireland (*)	258	30	27	17	2.32	15	4.39	18	5.28	21	1.68
Israel	2,062	-	-	-	2.45	-	2.79	-	4.65	-	2.17
Italy	9,175	139	**4**	10	0.71	**4**	2.38	14	1.25	13	0.97
Japan	333,185	515	**2**	**2**	0.41	13	0.36	22	0.21	**4**	0.61
Korea	70,614	652	**1**	**5**	0.21	21	0.10	21	0.17	15	0.15
Latvia	98	26	29	29	0.21	36	0.09	36	0.16	36	0.04
Luxembourg	110	67	11	12	1.44	8	4.08	9	3.21	8	2.59
Mexico	268	12	37	26	1.26	33	0.61	28	2.31	29	0.49
Netherlands	2,455	58	14	6	2.26	**3**	7.72	**1**	7.72	**2**	5.83
New Zealand	448	41	19	19	1.37	18	2.14	13	4.32	20	1.45
Norway	1,459	76	9	20	0.70	17	1.51	11	2.59	18	0.97
Poland	2,231	40	20	36	0.05	35	0.11	32	0.31	34	0.06
Portugal	107	6	39	33	0.46	28	2.15	33	1.92	35	0.35
Romania	517	25	30	22	1.66	23	2.39	12	7.18	22	1.99
Russia	16,856	33	24	41	0.00	41	0.00	42	0.00	41	0.00
Slovakia	220	22	32	34	0.13	34	0.28	29	1.10	33	0.11
Slovenia	213	49	15	23	0.47	22	1.30	23	1.85	25	0.54
South Africa	276	19	33	38	0.03	38	0.05	38	0.10	39	0.02
Spain	2,069	27	28	25	0.60	24	2.12	25	1.94	23	0.98
Sweden	2,692	63	12	8	2.07	6	4.66	**2**	6.69	**5**	3.18
Switzerland	2,223	85	6	**3**	2.36	**1**	6.73	**3**	4.26	**1**	5.10
Turkey	131	6	40	35	0.38	31	1.90	31	4.00	32	0.48
United Kingdom	21,537	126	**5**	14	0.69	12	1.54	8	1.70	14	1.05
United States	62,029	48	16	**1**	5.55	14	2.80	10	4.14	11	3.12

Notes: 'Rank' is the country's rank in terms of patents per full-time-equivalent researcher. Ranks 1–5 are shown in boldface type. The columns labelled 'Dev.' report the deviation coefficients with respect to the worldwide count (see main text for details). * Indicates coverage problems (see Appendix C.4 for details).
Sources: OECD Statistical Extracts (http://stats.oecd.org), UNESCO Institute for Statistics and authors' computations.

The following sections discuss the salient features of the new indicator.

No filter on patent value

Table 4 presents the correlation coefficients between the various indicators. The USPTO, EPO, PCT and triadic counts are highly correlated with each other. This is hardly surprising, given that all triadic patents are filed at the EPO and the USPTO, and many PCT applications eventually become triadic patents. The worldwide count of priority filings is the least correlated with the other indicators, suggesting that it captures different dimensions of inventive activity.

Table 4 : Correlation coefficients

	USPTO	EPO	PCT	Triadic
USPTO	-	-	-	-
EPO	0.87*	-	-	-
PCT	0.97*	0.92*	-	-
Triadic	0.89*	0.95*	0.85*	-
Worldwide	0.50*	0.62*	0.39*	0.80*

Notes: Data for priority year 2000. N = 44 countries.
* Indicates significance at the 10 per cent probability threshold or less.

Using the data presented in this paper, Danguy *et al.* (2009) estimate a patent production function at the industry level for a set of OECD countries over the period 1987–2005. They find that the elasticity of the worldwide count with respect to R&D expenditure is 0.118. Interestingly, the elasticity of the triadic count with respect to R&D expenditure is 0.110. Thus, their result suggests that the worldwide count is at least as strongly correlated with R&D expenditures as is the triadic count.

The worldwide indicator counts all priority filings, regardless of their value. It is well-known that the distribution of patent value is highly skewed to the left, with a majority of low-value patents (see, for example, Trajtenberg, 1990; Harhoff *et al.*, 2003). International patent indicators, in particular triadic patents, have been specifically designed to filter out low-value patents. As a result, international indicators put developing economies at a disadvantage, since more of their inventions are incremental (Puga and Trefler, 2010) and do not make it through the strict filters of the international patent system. In addition, companies from emerging countries are less likely to target foreign markets or may be impeded by the high cost of patenting. In short, international indicators mask the local and entrepreneurial natures of inventive activity. The worldwide count, by contrast, puts no filter on value and, in all logic, should better capture these dimensions, although at the cost of counting patents of uneven value across countries.

Table 5 presents the correlation of the ratio of the worldwide count with a given patent count (such as worldwide/USPTO) with a series of indicators of economic activity. A positive correlation coefficient indicates that the worldwide count indicator is high vis-à-vis the given patent indicator. The data suggest that the worldwide count better reflects the inventive activity of developing countries and countries with a strong entrepreneurial base. The first row presents the correlation coefficients with the gross domestic product (GDP) per capita. The lower the GDP per capita, the higher the share of priority filings that do not target foreign markets. This is a clear illustration that international indicators, particularly the triadic count, reflect the advantage of the most advanced economies in terms of high-value inventions, and, inversely, that the worldwide count of priority filings increases the score of developing economies. The next four rows of the table represent correlations with measures of entrepreneurial activity: 'Business creation rate' (number of new enterprises as a percentage of the population of active enterprises with at least one employee); 'New firms' share in employment' (number of persons employed in newly born enterprises, as a percentage of persons employed); 'High-growth firms as share of all firms' (number of high-growth enterprises with at least ten employees as a percentage of the population of active enterprises with at least ten employees); and 'Gazelles as share of all firms' (number of gazelles with at least ten employees, as a percentage of the population of active enterprises with at least ten employees).[13] All the indicators are positively correlated with the relative counts, suggesting that countries with a higher entrepreneurial activity have relatively more priority filings.

Table 5: Correlation coefficients between indicators of economic activity and patent indicators

		Patent count relative to the worldwide count			
	N	USPTO	EPO	PCT	Triadic
GDP per capita	45	-0.38*	-0.31*	-0.31*	-0.30*
Business creation rate	24	0.18	0.21	0.23	0.21
New firms' share in employment	19	0.49*	0.38	0.35	0.40*
High-growth firms as share of all firms	18	0.38	0.43*	0.47*	0.43*
Gazelles as share of all firms	13	0.75*	0.80*	0.74*	0. 80*

Notes: Year 2000. Values for patent indicators are defined relative to the worldwide count. For example, 'USPTO' = Worldwide count/USPTO count. * Indicates significance at the 10 per cent probability threshold or less.
Sources: OECD Statistical Extracts (http://stats.oecd.org), UNESCO Institute for Statistics (GDP per capita).

In a nutshell, the worldwide count reflects the 'inventiveness' and entrepreneurial orientation of countries, while the other indicators, owing to their high selectivity, reflect the inventive 'performance' of countries. However, as we have already stressed, the worldwide count is an all-encompassing measure, in the sense that it can be used to generate all the other indicators (because all patents are either priority filings or claim a priority filing). For example, in order to generate the triadic indicator, one filters the worldwide count to obtain only priority filings that became triadic patents. Similarly, the count of priority filings can be weighted by patent value indicators, such as the size of the patent family, to reflect national inventive performance.

Institutional bias

The worldwide count is subject to an institutional bias when countries with heterogeneous patent systems are directly compared against each other, as in Table 3. Although patent laws tend to converge over time, there are still some strong institutional differences, as illustrated by Park (2008) for enforcement mechanisms and by de Saint-Georges and van Pottelsberghe (2011) for transparency and stringency. The biggest differences are likely to be observed between developed and developing economies, because the latter usually have lower novelty thresholds and weaker patent laws. For instance, before the 2009 patent reform, the Chinese patent office searched only national prior art, rather than worldwide prior art.[14]

[13] Data for the manufacturing industry. Gazelle companies are a subset of high-growth firms that achieve a required level of growth in the first five years of their founding (see The Eurostat-OECD Manual on Business Demography Statistics available on the OECD website).
[14] Ronald A. Cass, "Patent reform with Chinese characteristics", *Wall Street Journal Asia*, February 10, 2009.

One can think of various ways to correct for the institutional bias. One would be to count patent families rather than individual patents, as explained in section 3.3. For instance, if four priority patent applications filed in the same patent office belong to the same patent family (perhaps because a second filing in another jurisdiction claims these four patent documents), these four patents would count as just one in a family count. Another way of correcting for institutional bias involves estimating a 'conversion rate' of patents between patent offices, and using it to weight the raw count of priority filings.[15] Such a conversion rate can be obtained by computing the average number of priorities claimed by second filings at a reference office. For instance, if the EPO is taken as the reference office, the weight for, say, Japan is defined as the average number of priority filings from the JPO claimed by second filings at the EPO. Thus, if three Japanese priority filings are usually merged together to produce one patent at the EPO, the conversion rate is three, and the count of Japanese patents is therefore divided by three. Other normalisation techniques can be used. For instance, section 5 presents a new way to normalise patent count which is appropriate for cross-country comparison of the patenting activity in a specific technology field.

Table 6 presents correlation coefficients between the corrected worldwide counts and the 'international' counts. Since international counts are not affected by the institutional bias, a correction is deemed successful at reducing the institutional bias if the correlation coefficient has increased as compared with the uncorrected count. The first row of Table 6 is taken from the last row of Table 4 and provides the benchmark coefficients (raw count). The second row presents the correlation coefficients with the family-corrected count. Correlation coefficients are similar to the first row, suggesting that the family count does not reduce the institutional bias. With hindsight, the family count does not offer a strong enough correction because of the high number of singletons. Since many priority filings are their unique family member, the family count is always very close to the raw count. The last row of Table 6 presents the correlation with the count weighted by the conversion rate. The conversion rate was computed for the period 1999–2001, taking the EPO as the reference office. The largest weight is obtained for Japan. On average, 1.34 priority filings at the JPO are combined into one second filing at the EPO. Interestingly, the correlation is stronger, suggesting that the method corrects the institutional bias to some extent. The correction is not perfect, however, since the patents filed at the EPO are a highly select group and may not be representative of the population of 'national-only' patents.

Table 6: Correlation coefficients

	USPTO	EPO	PCT	Triadic
Worldwide (no correction)	0.50*	0.62*	0.39*	0.80*
Worldwide (family-corrected count)	0.50*	0.62*	0.39*	0.80*
Worldwide (weighted by conversion rate)	0.52*	0.66*	0.43*	0.83*

Notes: Data for priority year 2000. N = 44 countries. 'Worldwide (weighted by conversion rate)' is the worldwide indicator multiplied by the ratio of the average number of priority filings per second filing at the EPO during the period 1999–2001. * Indicates significance at the 10 per cent probability threshold or less.

Note that the worldwide count is not subject to the institutional bias when growth rates in patents are of interest, when countries with homogenous patent systems are compared or when patents from a single country are tracked over time.

[15] Millot (2009) developed a similar methodology for trademark data.

Elimination of the geographic bias

The worldwide indicator eliminates the geographic bias by construction, since it counts patents filed in all patent offices. Table 7 presents the breakdown of the patent count by destination of priority filings. It indicates the jurisdictions in which priority applications by inventors from a specific country are filed.

Table 7: Destination of priority patent applications, by country of inventor

Country of inventor	Home	Europe	EPO	USPTO	ROW
Australia (*)	72.41	5.52	0.64	17.32	4.11
Austria	55.35	34.71	6.23	3.07	0.63
Belgium	22.23	35.03	33.97	7.93	0.85
Brazil	97.98	0.59	0.21	1.02	0.20
Bulgaria	94.76	2.96	0.00	1.13	1.15
Canada	54.60	3.74	0.32	40.64	0.71
Chile (*)	10.33	69.02	0.00	10.33	10.33
China	98.68	0.20	0.15	0.58	0.39
Croatia	94.81	2.28	0.00	2.91	0.00
Czech Republic	90.91	4.95	1.17	2.11	0.86
Denmark (*)	46.00	27.20	15.54	9.65	1.61
Estonia	69.42	16.53	1.65	2.48	9.92
Finland	83.53	6.22	3.73	6.02	0.50
France	89.88	3.47	3.87	2.12	0.66
Germany	91.67	1.53	4.89	1.46	0.44
Greece	93.91	3.18	0.99	1.22	0.69
Hungary	92.09	3.88	1.20	2.40	0.43
Iceland	32.81	9.38	4.69	43.75	9.38
India (*)	51.25	7.34	2.60	34.67	4.15
Ireland (*)	29.83	34.47	11.15	23.64	0.91
Israel	65.76	2.99	1.09	29.40	0.76
Italy	86.69	3.24	7.87	1.35	0.85
Japan	99.36	0.07	0.07	0.38	0.13
Korea	99.31	0.07	0.05	0.31	0.26
Latvia	88.91	8.56	0.00	1.30	1.24
Lithuania	86.76	6.71	1.32	0.00	5.22
Luxembourg	42.87	23.62	16.86	15.02	1.62
Mexico	69.33	0.87	0.00	28.35	1.44
Netherlands	61.04	15.63	14.12	6.87	2.34
New Zealand	90.82	4.06	0.00	3.59	1.52
Norway	87.17	9.10	1.11	2.37	0.25
Poland	98.63	0.88	0.10	0.26	0.12
Portugal	74.12	15.43	7.01	1.56	1.87
Romania	99.54	0.16	0.00	0.30	0.00
Russia	99.06	0.30	0.03	0.32	0.28
Slovakia	86.44	11.95	0.00	0.24	1.37
Slovenia	86.45	8.62	0.94	2.35	1.64
South Africa	79.00	8.50	1.18	7.88	3.44
Spain	83.37	8.43	4.66	2.32	1.22
Sweden	76.04	7.71	6.10	8.89	1.25
Switzerland	20.02	37.35	33.86	5.70	3.08
Turkey	87.44	8.67	0.76	1.92	1.21
United Kingdom	94.55	0.67	1.55	2.88	0.35
United States	96.90	1.22	0.46	-	1.42

Notes: Rows add up to 100 per cent. Data for priority year 2000. 'Europe' stands for EU-27. 'ROW' stands for 'rest of the world'. * Indicates coverage problems (see Appendix C.4 for details).

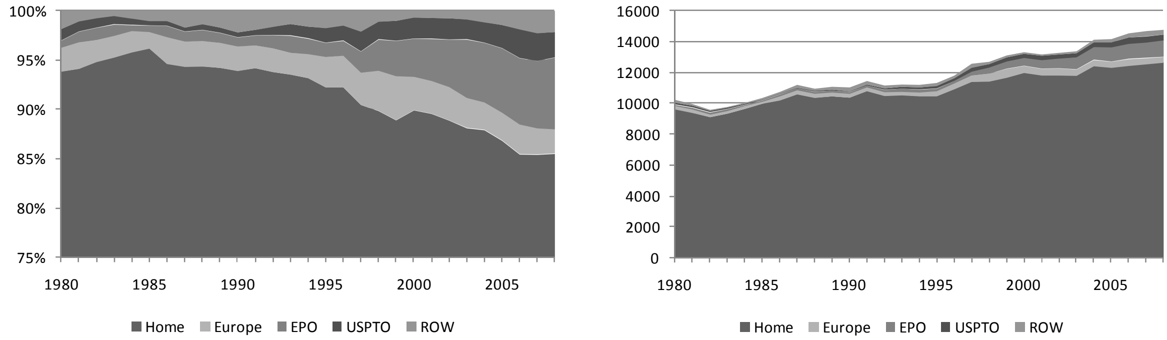
In most cases, the home office attracts the majority of priority filings. This is true for patents by inventors from developing countries such as Brazil, China and Russia, but also from large developed economies such as Japan, the United Kingdom and the United States. By contrast, many patents by inventors from small, open economies such as Belgium, the Netherlands and Switzerland are first filed abroad, notably at the EPO. Similarly, the USPTO attracts more than half of the priority patent applications filed by Canadian and Israeli inventors. In light of these figures, the favourable rankings shown in Table 3 for Dutch inventors at the EPO, for example, and Canadian inventors at the USPTO, comes as no surprise. The high degree of heterogeneity in the destination of priority filings highlights the interest of the global measure of patenting put forward in this paper. Restricting the count to a single patent office (be it the EPO, the USPTO or the national patent office) typically provides a biased picture.

Figure 1 provides a dynamic view of the data presented in Table 7 for patents by French and Dutch inventors in the period 1980–2008. The top-left panel shows that the French patent office attracts a decreasing share of priority filings by domestic inventors, although French inventors still file more than 80 per cent of their priority applications at the French patent office (down from 95 per cent in 1985). This situation mostly benefits the EPO, where the time effect mentioned in section 2 is clearly visible. Interestingly, the absolute number of priority patent applications filed by French inventors at their home office is still rising, as shown in the top-right panel of Figure 1. It has been increasing at a rate of 1 per cent annually.

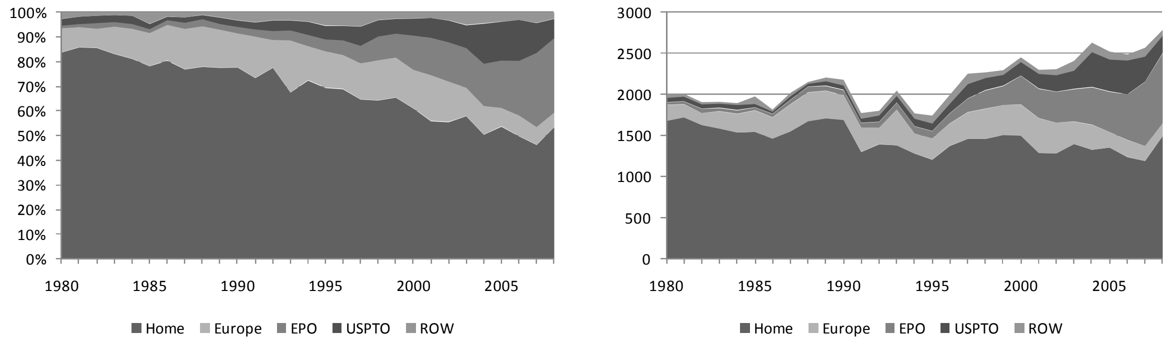
A different trend is observed for patents by Dutch inventors. The bottom-left panel also shows a relative decline in the attractiveness of the home office (which received only 53 per cent of total priority applications by Dutch inventors in 2008, down from 83 per cent in 1980), but the decline is carried over to the absolute number of priority filings as well. Priority filings at the home office shrunk at a rate of 0.85 per cent annually. These graphs clearly illustrate that patent practices are changing over time, but in different ways from country to country. They represent additional evidence of the shortcomings of collecting data at a single patent office.

Figure 1: Evolution of the destination of priority patent applications, by country of inventor

France



Netherlands



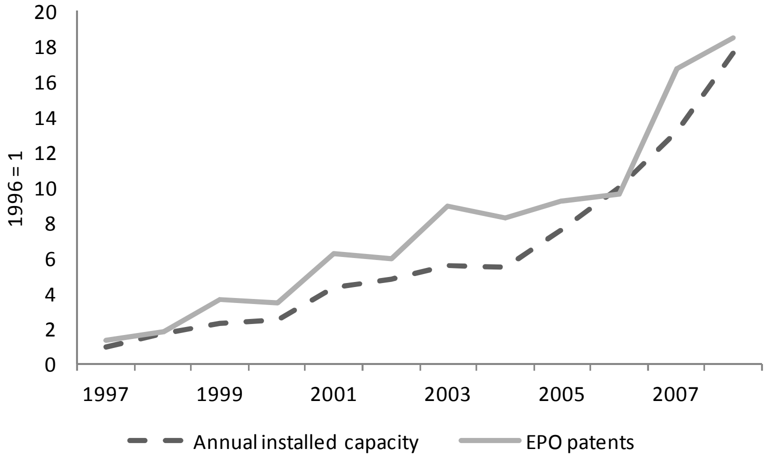
Notes: The left panels depict the relative share, while the right panels depict the absolute number, of priority filings. 'ROW' stands for 'rest of the world'.

5. An application of the new indicator: The wind-power industry

This section presents an overview of patenting activity in a specific field to further illustrate key aspects of the worldwide count and illustrate its uses. As previously mentioned, the worldwide priority count is useful for identifying emerging technologies and assessing the innovation performance of developing economies. The example of the wind-power industry, which has been experiencing unprecedented growth since the early 2000s and is now booming in China, meets these two criteria. As a sign of the industry's growth, the global cumulative installed capacity, the industry standard for market size, grew from 7,600 MW in 1997 to 120,291 MW in 2008 according to data by the Global Wind Energy Council.

The industry's growth is also apparent in the rising number of patents filed at the EPO, which closely tracks the growth in installed capacity, as illustrated in Figure 2. The number of patents filed went from 26 in 1997 to 352 in 2008. The number of US patents granted follows a similar trend. Wind-power patents are identified by their IPC codes, following Popp *et al.* (2011).

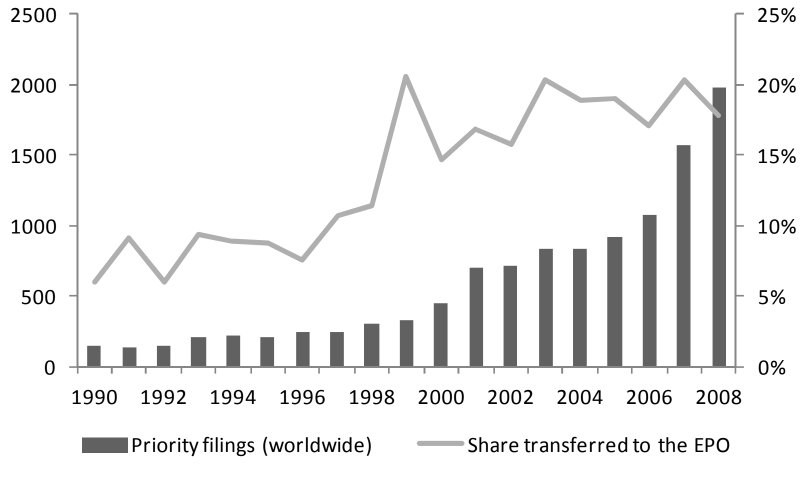
Figure 2: Growth in global installed capacity and patent applications at the EPO, 1997–2008



Sources: Global Wind Energy Council, Global Wind Report 2010 and Patstat (EPO patents by priority year).

Although the correlation between the two series is remarkable, the growth in patenting activity at the EPO is difficult to interpret. It may reflect either a genuine increase in inventive output or greater globalisation of the industry. As the market is expanding from a limited number of pioneering countries into a global one, firms now have more incentives to seek patent protection at international levels. Figure 3 shows the number of priority patent applications filed worldwide (left axis) and the percentage share of those patents transferred to the EPO either directly as priority filings or indirectly as second filings (right axis). Approximately 20 per cent of priority filings were transferred to the EPO in the late 2000s, up from 10 per cent in the 1990s.

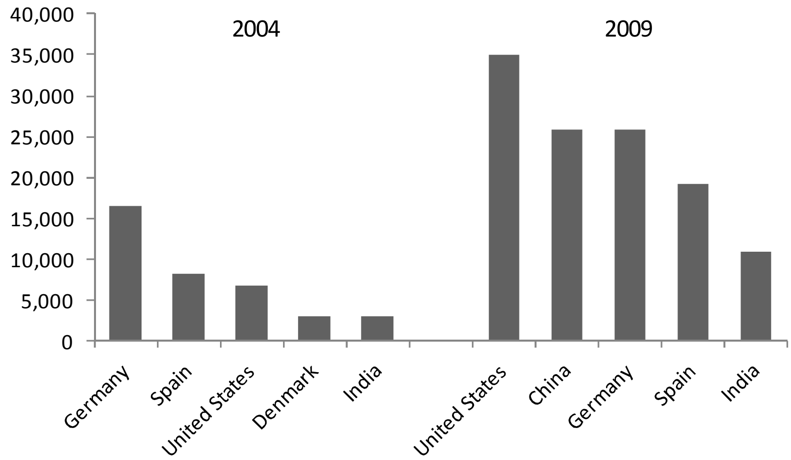
Figure 3: Worldwide count of priority patent applications and share transferred to the EPO, 1990–2008



Two observations can be made from Figure 3. First, the worldwide number of priority filings was close to 2,000 in year 2008, as opposed to 352 patent applications filed that same year at the EPO (not reported). Thus, the global count captures a much larger set of patented inventions—in fact, the widest possible set. (Triadic patents were in the order of 40 in the early 2000s, approximately 5 per cent of global output, making them irrelevant for a detailed technology analysis.) Second, the number of priority filings is indeed growing, suggesting a global increase in the supply of wind power technologies. However, it grew by a factor of 8 from 1997 to 2008, whereas EPO filings grew by a factor of 18 over the same period. This suggests that the growth in EPO patents observed in Figure 2 is driven both by a global increase in technology output and by a greater propensity to seek protection at the EPO.

The next figure provides an overview of the largest countries in terms of installed capacity. Germany was the leading market in 2004, with an installed capacity of 16,629 MW, well ahead of Spain and the United States, the second and third largest markets, respectively. Figures for the year 2009 show the sharp rise of China, which became the second-largest market, with 25,805 MW of installed capacity. China outpaced the United States in 2011, and it is now the largest market for wind turbines (not reported).

Figure 4: Installed capacity for wind power generation in MW, 2004 and 2009



Source: Global Wind Energy Council, Global Wind Report 2010.

Table 8 shows the market share of the largest manufacturers of wind turbines for the years 2004 and 2009. Five companies from Denmark, the United States, Germany and Spain controlled approximately 80 per cent of the market in 2004. Interestingly, these four countries are also the largest markets in terms of installed capacity (Figure 4), evidence of the importance of home markets for building global champions. The ranking for the year 2009 illustrates the rise of Chinese companies, with three companies in the top ten. These companies have benefited from the strong growth in the Chinese market depicted in Figure 4.

Table 8: Installed capacity for wind power generation and share of wind turbine market, 2004 and 2009

2004			2009		
Name	Country	Share	Name	Country	Share
Vestas	Denmark	22.0	Vestas	Denmark	13.5
GE Wind	United States	18.3	GE Wind	United States	13.5
Enercon	Germany	15.9	Sinovel	China	9.6
Gamesa	Spain	14.6	Enercon	Germany	8.9
NEG Micon	Denmark	9.8	Goldwind	China	7.7
			Gamesa	Spain	7.2
			Suzlon Energy	India	6.9
			Siemens	Germany	6.4
			Dong Fang	China	5.8
			REpower	Germany	3.0

Source: 'The Global Wind Industry: Competitive Dynamics & Industry Trends', presentation by IHS Emerging Energy Research, Chicago, United States, 31 March 2004; and 'China Builds Global Wind Turbine Competitiveness', presentation by IHS Emerging Energy Research, Beijing, China, 23 June 2010.

Table 9 provides the ranking of countries according to the number of wind-power patents they have produced. The top ten countries are reported for two time periods and three patent indicators. Patents from these countries account for between 78 and 89 per cent of total wind-power patents filed, depending on the time period and indicator used. The columns labelled 'Worldwide' present a normalised count of priority filings (with the raw count in parentheses). The number of worldwide priority patent applications for country *i* is normalised as follows:

$$Worldwide_i = \left[\frac{WIND\_PAT_i}{TOT\_PAT_i/_{GERD_i}}\right]\left[\frac{TOT\_PAT_{ref}}{GERD_{ref}}\right]$$

The first bracketed term controls for the institutional bias of the worldwide indicator by dividing the number of wind patents by inventors of country *i* by the number of priority filings over the gross R&D expenditure of the country (the denominator can be seen as a measure of the propensity to patent in the country). The normalisation is needed to control for institutional characteristics that affect the raw patent count, such as the strength of patent protection, the level of fees and other aspects of the design of patent systems (such as the fact that patent systems in some countries favour numerous but narrow patent applications—as in Japan and Korea—or that some patent offices do not publish all patent applications—such as the USPTO—which lowers the patent count). The second term in brackets expresses the number of wind-power patents relative to a reference country. The reference country chosen is the United States, without loss of generality. This second term does not change the final ranking, nor does it change the relative differences between countries (indeed, the second term is similar for all countries). Thus, the normalised worldwide count of priority filings can be interpreted as revealing the relative importance of wind-power patents in country *i*, expressed in the US equivalent. The columns labelled 'EPO' and 'USPTO' count both priority filings and second filings in these offices. Normalisation is not needed for these indicators, since the restriction to a single office eliminates institutional biases.

Table 9: Average yearly number of wind-power patents by country of residence of inventor

1999–2003						2004–2008					
Worldwide (raw number)		EPO		USPTO		Worldwide (raw number)		EPO		USPTO	
Germany	37 (101)	Germany	50	United States	32	United States	92 (92)	Germany	85	United States	87
United States	32 (32)	Japan	12	Germany	29	Germany	58 (172)	Denmark	30	Germany	57
Denmark	19 (13)	Denmark	9	Japan	16	Denmark	52 (41)	United States	30	Denmark	28
Japan	18 (219)	United States	5	Denmark	8	Spain	42 (37)	Spain	19	Japan	22
Spain	14 (13)	Netherlands	5	Canada	5	**China**	41 (268)	Japan	14	Spain	14
Canada	12 (14)	France	4	Netherlands	3	Japan	22 (234)	Netherlands	8	Taiwan	9
France	10 (16)	Spain	3	Great Britain	3	Canada	18 (20)	Great Britain	6	Great Britain	8
Russia	9 (50)	Belgium	3	Taiwan	3	France	15 (26)	France	5	Netherlands	7
Brazil	9 (9)	Sweden	3	Belgium	2	Great Britain	13 (34)	Norway	4	China	7
Netherlands	8 (8)	Great Britain	2	France	2	Russia	13 (79)	Sweden	4	Canada	6

Notes: The columns labelled 'worldwide' present a normalised worldwide count of priority filings. The figures in parentheses are the raw counts of wind patents (variable WIND_PAT). See main text for details.

The ranking is globally consistent across the three patent indicators. The top four countries in the first time period are always Denmark, Germany, Japan and the United States, while the top three countries in the second time window are always Denmark, Germany and the United States. Interestingly, even though the patent systems of Germany/Denmark, Japan and the United States are all very different from each other, the ranking generated by the normalised worldwide count is very similar to that generated by the more established patent indicators. This suggests the adequacy of the normalisation implemented. Note that the raw patent numbers are shown in parentheses next to the normalised figures. For instance, German inventors produced an average of 101 priority patent applications per year over the period 1999–2003, although the normalised count amounts to 37. This strong difference reflects the fact that German inventors produced 623 patents per billion R&D dollars over that period, whereas US inventors produced 229 patents per billion R&D dollars.

Two countries that rank particularly high with the worldwide priority count but not with the ‘international’ counts are Spain during the first time period and China during the second. Spain ranks fifth in the worldwide count in the period 1999–2003 without even placing in the top ten at the USPTO. Interestingly, Spain entered the top five in the 2004–2008 period for both the EPO and the USPTO indicators, suggesting that the worldwide count was not off the mark in the first period. This is also apparent from the market figures presented above: Spain was the second-largest market in terms of installed capacity in 2004, and Gamesa, a Spanish company, was the fourth-biggest player in the world market. China shows a similar pattern in the period 2004–2008. It is ranked fifth by the worldwide count but does not even enter the top ten at the EPO. One may argue that the worldwide count does not control for the quality of patents. Chinese patents may arguably be of lower quality than, say, US or German patents. However, the figures reflect a real rise of China, both in terms of installed capacity (Figure 4) and large players (Table 8), suggesting that the worldwide count has successfully identified emerging trends in the wind-energy market.

To sum up, the overview of the wind-power industry validates the worldwide indicator and suggests ways in which it can be used. First, it helps to put international indicators in perspective by providing an additional dimension. The observed increase in the number of international wind-power patents is driven by both an increase in the technological output and a greater globalisation of technologies. Second, it made it possible to identify emerging trends in the wind-energy market. Chinese leadership during 2004–2008 was apparent only from the worldwide indicator, much like the Spanish leadership during 1999–2003. Finally, the overview illustrates a normalisation technique that can be used to control for the institutional bias of the worldwide count.

6. Discussion and concluding remarks

This paper proposes a methodology for building a patent-based indicator which involves a worldwide count of priority filings. The indicator is based on counting all the priority patent applications filed by a country’s inventors, regardless of the patent office in which the applications are filed. The methodological contribution of the paper relies on exploiting patent-family linkages (direct equivalents and other second filings) to recover missing information on the countries of residence of inventors. The methodology proves to be highly reliable for some countries where almost no information is reported in the priority applications available in the Patstat database. Because priority patent applications are published after 18 months, the timeliness of the indicator is good in theory, although coordination between patent offices and the EPO (the database administrator), as well as the frequency of releases of the database, can delay the availability of data by another 18 months.

The indicator captures patent applications and not patents granted.[16] This methodological feature ensures better timeliness and homogeneity of the data, as they are not affected by varying grant delays and standards across patent offices. It goes without saying that the count of patents granted can easily be computed from the present data.

The count put forward in this paper does not substitute for existing international patent indicators but rather complements them in various ways. First, counting priority applications by country of the inventor can put international indicators into perspective. It provides a benchmark value against which those indicators can be compared. For example, Slovenian and Hungarian inventors file about the same number of triadic patents (1.87 vs. 1.88 per thousand researchers in 2000), but Hungarian inventors file almost 25 per cent more priority patent applications (61 vs. 49). Inversely, although Spanish and Romanian inventors have about the same propensity to file priority applications (27 vs. 25 per thousand researchers in 2000), inventors from Romania file almost twice as many triadic patent applications (3.55 vs. 1.88). Such data inform policy makers about the innovation potential and the quality of research in their country.

Second, the paper illustrates that the worldwide count indicator improves the measurement of the inventive activity of small, open economies (because it has no geographic bias) and emerging economies (because it has no filter on patent value). The count of priority applications provides an important index of technological development and reflects the entrepreneurial dynamism of a country.

Third, although the indicator is not designed to direct comparisons of inventive performance across countries with heterogeneous patent systems, it actually represents a complete matrix of patent counts, in the sense that it can be used to generate all other existing counts (because all patent applications are either priority filings or claim a priority filing). For example, to generate the triadic indicator, one needs only select those priority filings that became triadic patents. Similarly, the exhaustive count of priority filings provides the grounds for novel selection criteria and weighting rules (for example, counting only priorities with at least one application abroad—see Chan, 2010). The preceding section has also illustrated that normalisation techniques can be designed to make possible meaningful cross-country comparisons.

Fourth, the indicator is also particularly appropriate for within-country analysis of inventive activity. It allows scholars and policy analysts to track the population of patents applied for by national inventors and provides information about the 'attractiveness' of the national patent office. A telling example of this is provided by the breakdown of data on the destination of patent applications. Inventors from countries such as Switzerland and Canada tend not to file at their home patent office but, rather, prefer the EPO and the USPTO, respectively. More generally, the geographic data inform policy makers about the characteristics of their national innovation system and the level of exposure to international research. For instance, more than 50 per cent of patents by Israeli inventors are first filed at the USPTO, providing evidence of the strong ties between the two countries. Similarly, the broad coverage of the indicator and the retrieval algorithm are of significant interest in studies aimed, for instance, at investigating technology diffusion and patterns of international trade.

[16] With the notable exception of the United States, where not all patent applications are published.

The patent count proposed in this paper has already been used, in a simplified form or in its present form, in work by several authors. We will briefly discuss these applications in order to further illustrate the indicator's possibilities. The worldwide indicator was used by Danguy *et al*. (2009) to show that the boom in patent applications (the so-called 'global patent warming') could be observed only with international patents and not with priority patent applications. The authors adduced this result as evidence that the burst in patent applications does not reflect an increase in inventive activity but rather an effect of globalisation. Turlea *et al*. (2011) used the worldwide indicator to study the patenting activity of the information and communications technology industry across the world. Picci (2010) and Picci and Savorelli (2011) use it together with a set of measures of the internationalization of R&D effort. Finally, de Rassenfosse and Wastyn (2012) have matched the patent indicator to Belgian firms to show that a count of patents at just one reference office such as the EPO leads to selection bias. The characteristics of firms that file their patents at the EPO differ from those that file their patents at the national office, which affects econometric estimates of invention production functions. The majority of empirical innovation studies limit data collection to highly selected patents (such as EPO or triadic patents), whereas the use of a more comprehensive set, including all priority filings, would paint a more complete picture of inventive activity. The authors recommend using the worldwide indicator described here to improve identification of a country's innovation through its patented output.

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References

Chan, H. 2010. The determinants of international patenting for nine agricultural biotechnology firms. *The Journal of Industrial Economics* 58(2), 247–278.

Danguy, J., de Rassenfosse, G., and van Pottelsberghe de la Potterie, B. 2009. The R&D-patent relationship: An industry perspective. *European Investment Bank Papers* 14(1), 170–196.

de Rassenfosse, G., and van Pottelsberghe de la Potterie, B. 2007. Per un pugno di dollari: A first look at the price elasticity of demand for patents. *Oxford Review of Economic Policy* 23(4), 588–604.

de Rassenfosse, G., and van Pottelsberghe de la Potterie, B. 2012. On the price elasticity of demand for patents. *Oxford Bulletin of Economics and Statistics* 74(1), 58–77.

de Rassenfosse, G., and van Pottelsberghe de la Potterie, B. 2009. A policy insight into the R&D-patent relationship. *Research Policy* 38(5), 779–792.

de Rassenfosse, G., and Wastyn, A. 2012. Selection bias in innovation studies: A simple test. ZEW Discussion Paper 12-012, Center for European Economic Research, Germany.

de Saint-Georges, M., and van Pottelsberghe de la Potterie, B. 2011. A quality index for patent systems. ECARES Working Paper 2011-10, Université libre de Bruxelles, Belgium.

Dernis, H, 2007. Nowcasting patent indicators. *OECD STI Working Papers* 2007/3, OECD, Paris.

Dernis, H., Guellec, D., and van Pottelsberghe de la Potterie, B. 2001. Using patent counts for cross-country comparisons of technology output. *Science Technology Industry Review* 27, 128–146.

Dernis, H., and Khan, M. 2004. Triadic patent families methodology. *OECD STI Working Papers* 2004/2, OECD, Paris.

Fink, C., Khan, M., and Zhou, H. 2011. The surge in worldwide patent applications. Document prepared for the PCT Working Group, Geneva.

Frietsch, R., and Schmoch, U. 2010. Transnational patents and international markets. *Scientometrics* 82(1), 185–200.

Furman, J., Porter, M., and Stern, S. 2002. The determinants of national innovative capacity. *Research Policy* 31(6), 899–933.

Ginarte, J., and Park, W. 1997. Determinants of patent rights: A cross national study. *Research Policy* 26(3), 283–301.

Griliches, Z. 1990. Patent statistics as economic indicators: A survey. *Journal of Economic Literature* 28(4), 1661–1707.

Grupp, H., and Schmoch, U. 1999. Patent statistics in the age of globalisation: new legal procedures, new analytical methods, new economic interpretation. *Research Policy* 28(4), 377–396.

Guellec, D., and van Pottelsberghe de la Potterie, B. 2000. Applications, grants and the value of patent. *Economic Letters* 69(1), 109–114.

Guellec, D., and van Pottelsberghe de la Potterie, B. 2001. The internationalisation of technology analysed with patent data. *Research Policy* 30(8), 1256–1266.

Harhoff, D., Hoisl, K., Reichl, B., and van Pottelsberghe de la Potterie, B. 2009. Patent validation at the country level—The role of fees and translation costs. *Research Policy* 38(9), 1423–1437.

Harhoff, D., Scherer, F., and Vopel, K. 2003. Citations, family size, opposition and the value of patent rights. *Research Policy* 32(8), 1343–1363.

Jensen, P., Thomson, R., and Yong, J. 2011. Estimating the patent premium: Evidence from the Australian Inventor Survey. *Strategic Management Journal*, forthcoming.

Kotabe, M. 1992. A comparative study of US and Japanese patent systems. *Journal of International Business Studies* 23(1), 147–168.

Martinez, C. 2010. Insight into different types of patent families. *OECD STI Working Papers* 2010/2, OECD, Paris.

Merton, R. 1935. Fluctuations in the rate of industrial invention. *Quarterly Journal of Economics* 49(3), 454–474.

Millot, V. 2009. Trademarks as indicator of product and marketing innovations. *OECD STI Working Papers* 2009/6, OECD, Paris.

Organisation for Economic Co-operation and Development. 2009. *OECD Patent Statistics Manual*. Paris.

Park, W. 2008. International patent protection: 1960–2005. *Research Policy* 37(4), 761–766.

Pavitt, K. 1985. Patent statistics as indicators of innovative activities: Possibilities and problems. *Scientometrics* 7(1-2), 77–99.

Picci, L. 2010. The Internationalization of inventive activity: A gravity model using patent data. *Research Policy* 39(8), 1070–1081.

Picci., L., and Savorelli, L. 2011 The structural transformations of internationalized R&D activities: An analysis of patent data. Unpublished paper, University of Bologna, Italy.

Popp, D., Hascic, I., and Medhi, N. 2011. Technology and the diffusion of renewable energy. *Energy Economics* 33(4), 648–662.

Puga, D., and Trefler, D. 2010. Wake up and smell the ginseng: International trade and the rise of incremental innovation in low-wage countries. *Journal of Development Economics* 91(1), 64–76.

Schmookler, J. 1950. The interpretation of patent statistics. *Journal of the Patent Office Society* 32(2), 123–146.

Schmookler, J. 1954. The level of inventive activity. *Review of Economics and Statistics* 36(2), 183–190.

Soete, L., and Wyatt, S. 1983. The use of foreign patenting as an internationally comparable science and technology output indicator. *Scientometrics* 5(1), 31–54.

Trajtenberg, M. 1990. A penny for your quotes: Patent citations and the value of innovations. *Rand Journal of Economics* 21(1), 172–187.

Turlea, G., Nepelski, D., De Prato, G., Simon, J.-P., Sabadash, A., Stancik, J., Szewczyk, W., Desruelle, P., and Bogdanowicz, M. 2011. *The 2011 Report on R&D in ICT in the European Union*. Institute for Prospective Technological Studies, Joint Research Centre, European Commission.

van Pottelsberghe de la Potterie, B. 2011, The quality factor in patent systems. *Industrial and Corporate Change* 20(6), 1755–1793.

van Pottelsberghe de la Potterie, B., and François, D. 2009. The cost factor in patent systems. *Journal of Industry, Competition and Trade* 9(4), 329–355.

van Zeebroeck, N., and van Pottelsberghe de la Potterie, B. 2011. Filing strategies and patent value. *Economics of Innovation and New Technology* 20(6), 539–562.

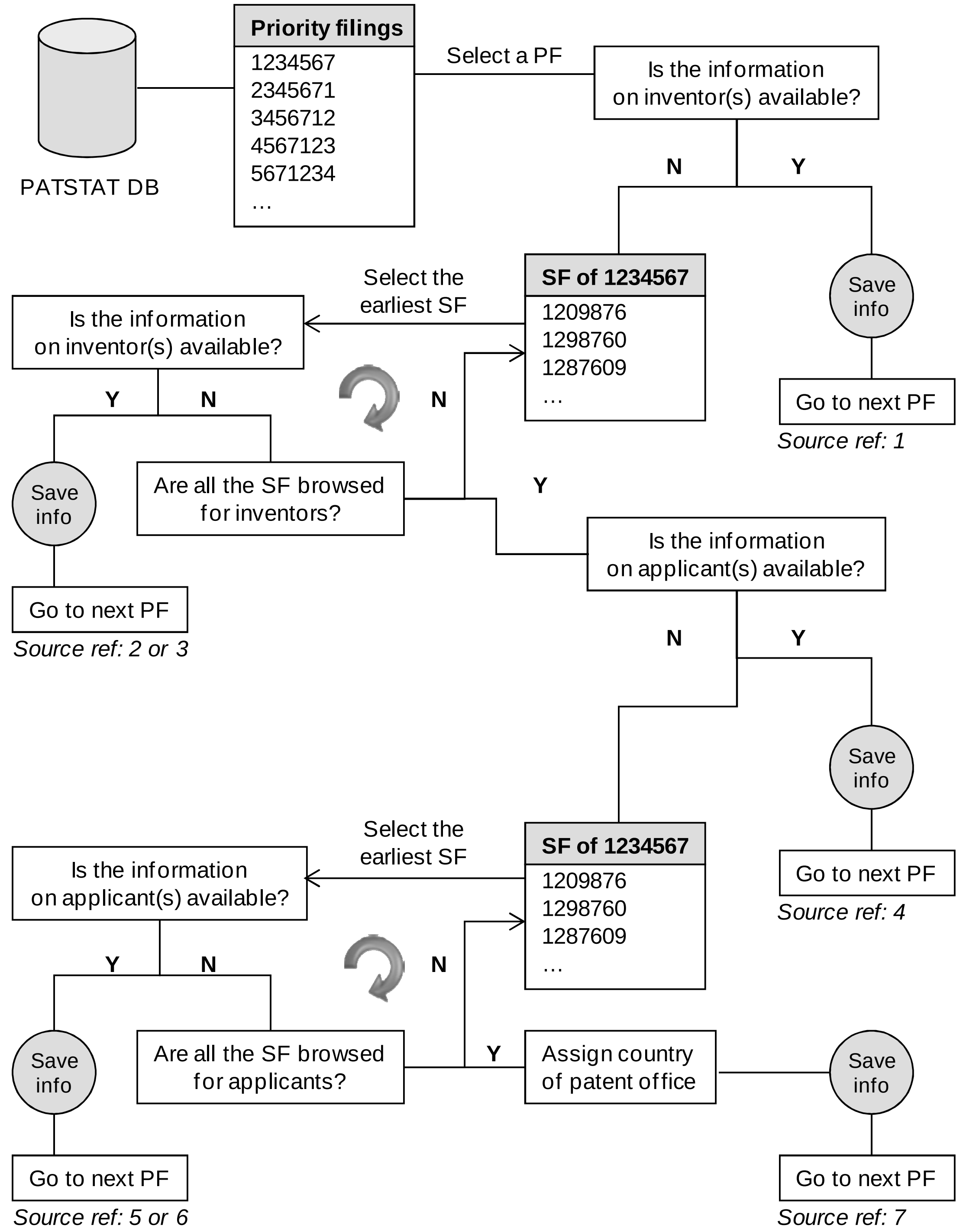
Appendix A—List of excluded patent types

Patents with the following publication codes were excluded from the analysis:

Patent office	Publication code(s)	Description
Australia	A3, B3, B4, C1, C4, D0	Petty patents
Belgium	A6, A7	Six-year patents
France	A3, A4, A7	Certificate of utility
Ireland	A2, B2	Short-term patents
Netherlands	C1	Six-year patents
Slovenia	A2	Short-term patents
United States	E, E1, H, H1, I4, P, P1, P2, P3, S1	Plant and design patents

Notes: These codes correspond to the field publn_kind in table tls211_pat_publn.

Appendix B—Flow chart of the data recovery process



PF and SF stands for priority filing and second filing. The symbol means that a first loop is executed for the direct equivalents (source ref 2 or 5), then a second loop is executed for the other second filings (source ref 3 or 6).

Appendix C—Validity tests

Four tests were performed to ensure the validity and robustness of the methodology adopted to recover missing information. The first compares the information recovered for priority applications filed at the French patent office and reported in the Patstat database (inventor information on inventors is missing in 85 per cent of cases, see Table 2) with the actual data obtained directly from the French patent office. The second test ignores the information on inventors contained in the patent document itself (that is, the first source of information is bypassed) and compares information recovered using the methodology with the ignored information. It does so for a set of patent offices that attract a large proportion of patents for inventions by foreign inventors. The third test, similar to the second, is performed for patent offices that receive a high number of so-called singletons (that is, patents that are not extended abroad). The fourth test is concerned with the coverage of the Patstat database. It compares counts of patent applications by national inventors at their home office with WIPO data.

C.1 Detailed analysis for the French patent office

Patstat records of priority applications filed in the French patent office lack information on the inventor's country of residence. To test the robustness of our methodology for recovering missing information, we compared the information retrieved with data obtained directly from the French patent office. The test was performed on a random sample of 3,000 French priority patent applications filed between 2000 and 2005. The results are presented in Table C.1.

Table C.1: Overview of the accuracy of the information recovered for priority applications filed at the French patent office

Total number of priority applications compared	3,000
Total number of applications for which country of inventor was correctly identified	2,921
Of which French inventors correctly identified	*2,817*
Of which foreign inventors correctly identified	*104*
Applications for which country of inventor was wrongly assigned	79

The results are highly satisfactory: 97 per cent of the information recovered by the methodology turns out to be accurate. Only 79 of 3,000 priority applications filed at the French patent office were assigned to a wrong country, less than 3 per cent of the sample. A closer look at the type of allocation errors (not reported) reveals that 60 per cent of the allocation errors relate to allocation to a French inventor when the true inventor is foreign; 28 per cent concern allocation to a foreign inventor when the true inventor is French; and 12 per cent concern allocation to an inappropriate foreign inventor.

This encouraging result may be driven by the low international profile of priority applications filed at the French patent office, where less than 5 per cent of the priority patent applications originate from foreign inventors. Thus, assigning patents to French inventors by default would have led to 95 per cent accuracy. The next test looks at patent offices that attract many priority filings by foreign inventors.

C.2 Detailed analysis for the Canadian, German and US patent offices

The second robustness test consists of ignoring source 1 and comparing the result of the missing-information algorithm with the ignored information (Table C.2). The test was performed on 3,000 randomly chosen applications filed in each of three national patent offices that receive many applications from foreign inventors.

Table C.2: Overview of the quality of the information recovered for priority applications filed at the Canadian, German and US patent offices

	Canada	Germany	US
Total number of priority applications tested	3,000	3,000	3,000
Total number of applications for which country of inventor was correctly assigned	2,900	2,902	2,656
Of which national inventors correctly identified	*2,319*	*2,740*	*2,299*
Of which foreign inventors correctly identified	*581*	*162*	*357*
Applications for which country of inventor was wrongly assigned	100	98	344

The results obtained for the Canadian and the German patent offices are very similar to those obtained for the French patent office, with 97 per cent of applications correctly allocated. At the USPTO, only 88 per cent of the applications were correctly allocated. Note that this exercise constitutes a very strong test, since it deliberately bypasses the source of correct information (source 1). The quality of the actual indicator is therefore much higher than the results of this test might imply, because source 1 is used whenever possible.

The distribution of allocation errors is reported in Table C.3. No pattern emerges, suggesting that there is no systematic bias in the allocation error. While the majority of allocation errors at the Canadian patent office involve applications from foreign inventors being wrongly allocated to other foreign inventors, the most common allocation error at the German patent office concerns applications from German inventors wrongly allocated to foreign inventors. At the US patent office, the allocation of applications from foreign inventors to US inventors is the most common type of allocation error.

Table C.3: Distribution of allocation errors (%)

	But the application was allocated to:					
The correct country is:	Canada	FOR	Germany	FOR	US	FOR
Canada/Germany/US	—	23	—	55	—	20
FOR	27	50	36	9	71%	9

Note: ‘FOR’ = foreign inventor.

C.3 Detailed analysis for the Chinese, Korean and Russian patent offices

The third robustness test is similar to the previous one, except that it is performed on patent offices that receive a high number of singleton applications. Missing data for such applications cannot be collected from direct equivalents and other second filings. Our methodology will recover it from the applicant’s country of residence (source 4) or from the country of the priority office (source 7). The quality of the information recovered using the methodology is very high, with 98 to 99 per cent of the applications correctly allocated (Table C.4). Again, the distribution of allocation errors presented in Table C.5 does not exhibit any particular pattern.

Table C.4: Overview of the quality of the information recovered for patents filed at the Chinese, Korean and Russian patent offices

	China	Korea	Russia
Total number of priority applications tested	3,000	3,000	3,000
Total number of applications for which country of inventor was correctly assigned	2,976	2,966	2,943
Of which national inventors correctly identified	*2,901*	*2,926*	*2,879*
Of which foreign inventors correctly identified	*75*	*40*	*64*
Applications for which country of inventor was wrongly assigned	24	34	57

Table C.5: Distribution of allocation errors (%)

	But the patent was allocated to:					
The correct country is:	China	FOR	Korea	FOR	Russia	FOR
China/Korea/Russia	—	69	—	32	—	5
FOR	31	0	53	15	84	11

Notes: 'FOR' = foreign inventor.

C.4 Coverage of the Patstat database

The accuracy of the new patent indicator is as good as the coverage of the Patstat database, which ultimately depends on the quality of the data provided by individual patent offices. Assessing the coverage of the Patstat database is not straightforward. Ideally, the patent counts from Patstat would be compared with data obtained from national patent offices. Unfortunately, patent offices do not report homogeneous statistics: Some report only granted patents, some provide information only on applicants (instead of inventors), and others do not distinguish priority filings from second filings. One way to check the validity of the results involves comparing the patent counts with WIPO statistics on filings by national residents. The WIPO compiles homogeneous statistics on patent filings using survey data collected annually from patent offices around the world.

The WIPO data differ from ours in four important ways. First, the WIPO data consider total applications, including second filings as well as priority filings. As a result, the WIPO counts will necessarily be higher than those presented in this paper. Second, the WIPO distinguishes between filings from residents and filings from nonresidents, and the former do not match perfectly with the series developed in this paper. Third, statistics are reported for applicants rather than for inventors. Fourth, the WIPO series captures all applications, whereas the Patstat database includes only published applications. For these reasons, counts generated from Patstat records will tend to be lower than those of the WIPO, but the figures should nevertheless be in a similar range and exhibit a similar trend.

We matched every Patstat patent series with its WIPO equivalent and found that the quality of the Patstat coverage was high for most countries.[17] Coverage problems were found for five countries: Australia, Chile, Denmark, India and Ireland. Patent counts for these countries must be used with caution.

[17] See also Fink *et al*. (2011) for an in-depth analysis of the Patstat coverage.

Appendix D—Worldwide priority count

Worldwide count of priority filings by country of inventor 1982–2008

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Australia (*)	1,108	1,111	984	1,200	1,792	1,894	1,707	1,795	1,736
Austria	1,568	1,727	1,712	1,863	1,928	2,123	2,220	2,252	2,209
Belgium	1,154	1,136	1,158	1,197	1,216	1,147	1,199	1,327	1,313
Brazil	3,156	3,341	3,331	3,703	3,971	3,941	3,949	4,063	3,654
Bulgaria	118	137	130	207	289	265	200	128	68
Canada	5,029	5,233	5,129	5,163	5,342	5,507	5,420	5,003	4,457
Chile (*)	10	8	27	43	64	24	20	106	91
China	22,538	27,066	37,544	51,918	61,905	84,016	108,201	133,189	169,591
Croatia	206	230	233	227	258	215	189	198	217
Czech Republic	544	516	513	606	583	591	622	751	753
Denmark (*)	640	625	653	709	660	714	717	832	865
Estonia	20	30	24	25	31	32	47	58	50
Finland	2,800	2,962	2,718	2,558	2,728	2,553	2,672	2,578	2,628
France	13,306	13,180	13,283	13,383	14,115	14,158	14,553	14,683	14,784
Germany	40,099	39,171	37,591	37,862	39,905	39,881	40,209	41,237	42,389
Greece	336	419	419	448	437	517	602	652	685
Hungary	873	962	895	819	813	777	762	783	769
Iceland	21	13	21	18	16	13	18	8	5
India (*)	636	792	914	1,041	969	697	820	1,012	1,233
Ireland (*)	258	276	290	269	288	308	362	358	449
Israel	2,062	2,057	1,942	1,872	1,982	1,408	2,205	2,316	1,897
Italy	9,175	9,321	7,115	3,183	10,311	10,633	12,368	11,830	6,904
Japan	333,185	333,574	316,260	306,762	308,843	306,796	286,108	274,496	269,340
Korea	70,614	76,767	80,908	93,397	102,537	100,951	105,176	107,226	110,042
Latvia	98	102	133	73	93	100	114	123	136
Lithuania	76	66	88	72	86	77	73	71	101
Luxembourg	110	90	89	83	97	105	99	88	96
Mexico	268	547	534	534	583	496	513	627	717
Netherlands	2,455	2,298	2,316	2,417	2,643	2,525	2,496	2,574	2,792
New Zealand	448	550	423	468	461	417	468	402	247
Norway	1,459	1,313	1,325	1,184	997	1,257	781	751	760
Poland	2,231	2,029	2,150	2,148	2,212	1,944	2,040	2,263	2,227
Portugal	107	141	148	170	130	205	252	325	349
Romania	517	489	558	361	383	363	300	265	154
Russia	16,856	19,546	21,314	23,183	22,078	22,687	25,396	24,783	26,009
Slovakia	220	193	196	158	170	148	183	200	154
Slovenia	213	214	235	256	286	286	269	309	300
South Africa	276	280	355	303	457	398	411	317	310
Spain	2,069	2,172	2,258	2,272	2,545	2,739	2,703	2,825	2,473
Sweden	2,692	2,423	2,116	2,090	2,374	2,545	2,604	2,809	2,746
Switzerland	2,223	2,269	2,245	2,288	2,519	2,548	2,520	2,263	2,624
Turkey	131	141	225	242	297	424	536	841	1,151
United Kingdom	21,537	21,437	20,854	20,414	19,248	18,122	17,967	18,099	17,433
United States	62,029	73,874	73,416	72,913	72,527	73,326	70,006	67,641	60,503

Note: * Indicates coverage problems (see Appendix C.4 for details).

Worldwide count of priority filings by country of inventor 1982–2008 (continued)

	1991	1992	1993	1994	1995	1996	1997	1998	1999
Australia (*)	443	563	471	403	403	414	421	398	608
Austria	1,349	1,392	1,453	1,378	1,240	1,402	1,499	1,540	1,611
Belgium	713	739	857	810	817	915	1,021	1,099	1,252
Brazil	2,258	1,957	2,382	2,230	2,686	2,595	2,884	2,562	2,879
Bulgaria	648	350	246	158	174	143	194	129	137
Canada	3,094	3,164	3,453	3,557	3,596	3,888	4,614	4,787	4,788
Chile (*)	6	2	1	6	11	16	14	7	4
China	6,489	8,757	10,458	9,652	8,846	9,948	10,834	11,987	14,201
Croatia	1	141	170	124	132	160	155	173	158
Czech Republic	6	26	719	652	560	551	548	590	561
Denmark (*)	1,129	1,239	1,238	501	508	518	537	604	638
Estonia	0	94	454	314	245	79	25	29	15
Finland	2,101	2,022	2,189	2,316	2,137	2,283	2,505	2,608	2,481
France	11,445	11,164	11,230	11,208	11,334	11,811	12,581	12,681	13,098
Germany	24,328	25,833	26,276	27,260	28,117	30,886	33,542	36,066	38,251
Greece	221	286	127	211	286	305	301	291	319
Hungary	2,261	1,568	1,188	1,156	1,064	826	754	730	774
Iceland	31	19	30	12	23	24	20	27	19
India (*)	729	885	961	1,343	1,327	670	650	711	545
Ireland (*)	270	221	189	201	227	203	226	248	216
Israel	1,203	1,275	1,400	1,530	1,654	1,575	1,832	1,786	1,989
Italy	7,522	7,237	7,091	7,420	7,650	8,100	8,549	8,770	8,877
Japan	311,992	311,777	303,387	290,527	301,882	304,502	312,643	318,180	314,196
Korea	7,572	9,595	12,559	15,873	26,653	31,265	32,282	42,350	53,809
Latvia	0	103	162	159	204	177	143	173	88
Lithuania	0	54	175	107	106	99	122	126	89
Luxembourg	69	68	83	60	59	79	89	107	99
Mexico	429	664	170	74	217	327	210	82	109
Netherlands	1,776	1,801	2,053	1,771	1,741	2,009	2,258	2,279	2,298
New Zealand	326	302	321	320	335	310	285	360	441
Norway	930	963	1,037	1,060	1,123	1,384	1,304	1,339	1,387
Poland	3,089	2,676	2,226	2,445	2,421	2,269	2,225	2,231	2,136
Portugal	98	71	101	104	90	101	97	115	114
Romania	1,159	735	831	1,022	1,161	1,178	1,057	784	559
Russia	36	3,320	10,566	8,102	8,300	12,235	12,080	13,296	15,121
Slovakia	5	10	228	189	188	151	192	185	182
Slovenia	15	115	172	132	180	161	147	172	159
South Africa	412	359	377	409	428	471	444	435	336
Spain	1,439	1,283	1,364	1,284	1,350	1,514	1,683	1,784	1,984
Sweden	1,539	1,587	1,758	1,956	2,148	2,460	2,651	2,591	2,602
Switzerland	1,961	2,026	2,034	1,985	1,853	1,876	2,134	2,188	2,208
Turkey	62	73	62	52	64	94	101	82	130
United Kingdom	17,624	17,741	17,373	16,954	17,400	17,226	17,694	19,463	20,512
United States	41,229	42,971	44,376	47,379	51,869	55,520	60,595	62,309	61,216

Notes * Indicates coverage problems (see Appendix C.4 for details).

Worldwide count of priority filings by country of inventor, 1982–2008 (continued)

	1982	1983	1984	1985	1986	1987	1988	1989	1990
Australia (*)	924	770	516	448	406	549	634	307	366
Austria	1,318	1,301	1,408	1,347	1,269	1,282	1,248	1,238	1,236
Belgium	328	577	465	528	679	573	595	633	632
Brazil	2,015	2,195	1,963	2,022	1,914	2,306	2,266	2,204	2,346
Bulgaria	1,450	1,620	1,605	1,666	1,751	1,678	1,359	1,201	800
Canada	3,159	3,291	3,326	3,319	2,710	2,353	2,340	2,630	3,148
Chile (*)	3	4	5	4	7	4	9	5	7
China	12	12	18	4,660	3,133	3,594	4,121	4,177	5,309
Croatia	0	0	0	0	0	0	2	1	1
Czech Rep.	3	5	3	1	1	1	1	4	10
Denmark (*)	562	1,138	946	866	953	1,061	1,245	1,173	1,258
Estonia	0	0	0	0	0	0	0	0	0
Finland	1,502	1,701	1,738	1,673	1,723	1,828	1,928	1,901	2,036
France	9,592	9,777	10,052	10,352	10,761	11,216	10,965	11,074	11,017
Germany	24,408	24,967	25,013	24,245	23,875	23,463	24,061	23,554	22,865
Greece	1,452	1,319	1,451	1,274	1,335	1,597	304	261	261
Hungary	1,766	2,241	2,245	2,186	2,077	2,257	2,306	2,089	2,639
Iceland	19	27	23	10	17	11	17	12	18
India (*)	702	632	585	560	575	570	741	1,006	687
Ireland (*)	980	1,059	1,387	1,435	1,532	1,502	1,833	1,855	916
Israel	826	795	827	931	940	1,047	1,122	1,284	1,220
Italy	6,053	5,937	5,827	5,715	5,833	7,198	7,653	7,837	7,548
Japan	210,264	226,676	254,803	270,165	280,031	296,695	291,612	297,522	311,567
Korea	496	574	886	1,275	1,917	2,661	3,061	4,119	5,437
Latvia	0	0	0	0	0	0	0	0	0
Lithuania	0	0	0	0	0	0	0	1	1
Luxembourg	100	88	60	98	88	77	69	65	58
Mexico	141	206	175	150	218	207	172	178	134
Netherlands	1,907	1,912	1,899	1,977	1,819	2,020	2,152	2,209	2,183
New Zealand	321	371	354	411	331	365	336	323	328
Norway	425	399	469	468	725	855	968	1,081	972
Poland	4,301	4,563	4,988	4,980	4,588	5,521	5,997	3,783	3,567
Portugal	82	94	103	87	81	72	87	90	95
Romania	1,781	1,920	2,092	2,535	2,535	2,679	3,125	2,963	1,489
Russia	3	2	0	3	1	5	2	8	21
Slovakia	0	0	0	0	0	0	1	2	7
Slovenia	0	0	0	0	0	0	0	0	1
South Africa	494	476	464	349	259	1,929	801	299	375
Spain	1,307	1,201	1,393	1,770	1,288	1,564	1,660	1,943	1,914
Sweden	1,891	1,947	1,767	1,814	1,724	1,735	1,581	1,563	1,534
Switzerland	2,121	2,213	2,214	2,233	2,145	2,157	2,174	2,172	2,011
Turkey	59	66	77	61	71	69	61	43	57
United Kingdom	4,524	17,219	16,294	16,892	17,642	17,789	18,577	17,899	17,883
United States	30,978	29,227	29,470	30,179	30,546	33,916	37,237	39,234	41,719

Note: * Indicates coverage problems (see Appendix C.4 for details).