USING PATENT COUNTS FOR CROSS-COUNTRY COMPARISONS OF TECHNOLOGY OUTPUT

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I. INTRODUCTION

A patent is an intellectual property right relating to inventions in the technical field. A patent may be granted to a firm, individual or public body by a national patent office. An application for a patent has to meet certain requirements: the invention must be novel, involve a (non-obvious) inventive step and be capable of industrial application. A patent is valid in a given country for a limited period (generally 20 years). Box 1 describes the patenting process in detail.

Among the few available indicators of technology output, patent-based indicators are probably the most frequently used. Most national S&T publications include a section on patents. The scientific literature on the determinants and impact of innovative activities increasingly uses patent data at the aggregate (national) or firm levels. This is because the close relationship between patents and innovative output is widely recognised and because patents are such a rich source of information. However, there is no standard method of calculating indicators from patent data, with the result that the analytical and policy lessons that can be drawn from patent statistics are widely divergent. The wide variety of indicators published (Box 2) or used in economic studies can be contrasted with the homogeneity of other S&T indicators such as R&D (based on the F*rascati* M*anual*) or even references to scientific publications (most of which are based on the same database, the Science Citation Index). Since the messages drawn from the various patent-based indicators differ widely and are often contradictory, it seems necessary to improve standardisation in this field. This is all the more necessary at a time when patenting activity by firms, but also universities and government laboratories, has been expanding rapidly, increasing the "noise" (lack of precision) and sometimes biases (misleading information) as well as the information conveyed by patent statistics.

Why are patents statistics so complex? As legal instruments, patents are a complex mix that reflect inventive activity, which is itself complex: they are governed by different national regulations, follow different, multistage procedures, and may allow for co-owners, co-inventors, etc. Counts can be made of different types of patents, within each type, and some selectivity may or may not be exercised. For instance, one can count all applications in one country, or only patents granted. A patent can be attributed to the applicant (the patentee at the date of application) or the inventor or the country where it has been filed first (priority

Box 1. **The patenting process**

This box describes the patenting process from filing an application through to granting of a patent or denial of the application. Thorough familiarity with this process is necessary in order to be able to interpret statistical indicators for patents. More detailed information is given in the "OECD Patent Manual" (OECD, 1994).

1) G*eneral procedure*. When the owner of a new technology (an individual, company, public body, university, non profit-making organisation) decides to protect an invention, the first step is to file an application with a national patent office (generally the national office of the applicant's country). The first application filed (in any patent office) and the date of filing are known as the "*priority application*" and the "*priority date*". The patent office then begins examining the application in order to check whether a patent may be granted or not, *i.e.* that the invention is, in fact, novel, inventive and capable of industrial application. The application is published 18 months after it is filed (*publication date*), except in the United States, where an application is published when the patent is granted and only if it is granted. The lapse of time between filing and granting or denial of a patent ranges from two to ten years, with significant differences from one country to another.

2) EPO (E*uropean Patent Office*). The EPO is a regional office which examines patent applications for 19 European countries. When it grants a patent, the rights of the applicant are protected in all of the countries of Europe that the applicant has designated in the application. This procedure is used by applicants who wish to protect their inventions in several countries of Europe (it is cheaper than filing separate applications with the national patent office of each individual country).

3) I*nternational application*. Since 1883, when procedures were standardised under the Paris Convention (which now has over 100 signatory countries), applicants who wish to protect their invention in more than one country have 12 months from the priority date to file applications in other Convention countries.

Another procedure for protecting a patent in several countries is to file an application under the Patent Co-operation Treaty (the PCT), which has been in force since the beginning of the 1980s) with the World Intellectual Property Organization (WIPO). The PCT procedure is an intermediate step between the priority application and filing for patent protection abroad. It is more of a way of keeping the option to file future applications open than an actual patent application. It gives the applicant time to decide whether or not to file an application in other PCT contracting countries, and protects the invention in the meantime. When filing a PCT application, the applicant designates any of the 100 PCT contracting countries in which he may wish to patent the invention. If the applicant designates countries covered by the EPO, the application is known as a "Euro-PCT" application.

Box 1. **The patenting process** (*cont.*)

The first stage in the PCT procedure (the Chapter I procedure), is to send a copy of the application to a body authorised under the PCT to conduct international searches for prior art. This body, the International Searching Authority (ISA), may be a regional or international patent office. The EPO, for instance, carries out more than half of all worldwide searches [other ISAs are the United States Patent and Trademark Office (USPTO), the Japanese and Swedish patent offices, etc.]. PCT applications are published by the WIPO 18 months after the priority application (as in the other offices). The international search report, published at the same time, gives the applicant some indication of whether or not a patent may be granted. Once the ISA has made its report, the applicant has three options, namely: to extend the application to the national and regional patent offices he has designated (entering the national or regional phase); to request a preliminary international examination; or, to withdraw the application. If the applicant opts for the regional phase and designates the EPO, the application is then termed an *extended* E*uro*-PCT *application*.

An applicant who opts for an international preliminary examination (as in most cases) enters the second phase of the PCT procedure (the Chapter II phase). The International Preliminary Examining Authority (IPEA) is the same as the ISA. The findings of the examination are not legally binding on the patent offices designated in the national or regional phase. Nevertheless, the EPO does take account of the outcome of the preliminary examination during the regional phase – in other words, if the Euro-PCT application is effectively extended to the EPO. The Chapter II procedure enables the applicant to delay the national or regional phase by up to 31 months from the priority date: the patentee may then decide to extend the application to any or all of the countries he has designated or to withdraw the application.

application). Regarding the attribution of dates, a patent has several of them: the priority date (first application worldwide), the date of application in a given country, the date of publication, or the date of grant. Depending on the selection made, the resulting indicators will give substantially different results.

The "Patent Manual" (OECD, 1994) marked a first step in the process of clarifying and harmonising patent-based indicators. It described the legal and economic background to patents – a necessary step before designing statistics – and listed indicators that could be constructed from patent databases. It also listed a limited number of methodological problems encountered when calculating indicators based on patents. However, the "Patent Manual" fell short of analysing these very problems and proposing practical solutions. The increasing diversity of

Box 2. **A sample of recently published patents statistics**

Australia (1996)

- Foreign patent applications, date of application, by inventor.
- USPTO grants, date of grant, by inventor.

European Commission (1997)

- EPO applications, date of priority, by inventor, including non-extended Euro-PCT since 1989.
- EPO applications, date of publication, by inventor, including non-extended Euro-PCT.
- USPTO grants, date of priority, estimates since 1992.
- USPTO grants, date of grant.
- Triad applications (patents which, in addition to the country of origin, are filed in at least two foreign markets in two different triad regions).

Germany, BMBF (1998)

- Triad applications (patents which, in addition to the country of origin, are filed in at least two foreign markets in different triad regions), figure I/15.

France, OST (1998)

- EPO applications, date of application, by inventor, including non-extended Euro-PCT for the last few years.
- USPTO grants, date of grant, by inventor.

Japan, STA (1996)

- JPO applications, and grant.
- Domestic (resident) patent applications (including PCT), and domestic grants.
- Foreign applications (including PCT) and grants.

The Netherlands (1994)

- EPO grants, date of priority.

OECD, MSTI (2000)

- Applications from OECD Member countries, resident and non-resident applications, by date of application/ or publication, by country of residence of the applicant.

Box 2. **A sample of recently published patents statistics** (*cont.*)

United States, NSF (1998)

- USPTO grants, date of grant, by inventor.
- Grants in large countries, date of grant, by inventor.
- Patent families for certain technology areas, by priority date, by priority country.

Sources: BMBF (1998), Bundesministerium für Bildung und Forschung, *Facts and Figures* 1998.
Department of Industry, Science and Technology (1996), *Australian Business Innovation – A Strategic Analysis*.
European Commission (1998), *Second European Report on* S&T *Indicators*, 1997 – *Appendix*.
Japanese Science and Technology Agency (1996), *Indicators of Science and Technology*.
Het Nederlands Observatorium van Wetenschap en Technologie (1994), *Wetenschap – en technologie – Indicatoren*, 1994.
NSF (1998), *Science and Engineering Indicators*, 1998.
OECD (2000), *Main Science and Technology Indicators*, 2000-2, Paris.
OST (1998), *Science et Technologie – Indicateurs* 1998, Paris.

patent-based indicators in response to the steady increase in demand for indicators for economic analysis, coupled with a distinct improvement in data supply (databases are a richer source of information and more widely available), underlines a crucial need for harmonisation.

This article addresses basic methodological problems associated with patent counts. Its aim is to propose rules and methods for calculating higher-quality patent-based indicators of the technology produced and used by countries. A range of issues relating to the counting process are addressed: choice of patent office, choice of a reference date, choice of country of attribution, and choice of the set of patents to be counted (domestic patents and patent "families").

II. PATENTS AS A SOURCE OF STATISTICAL DATA

The information content of patent documents

A patent applicant files a document with the patent office of the country in which he is seeking protection for his invention. The patent document is a rich

source of information on the invention it covers; information that can be used directly in constructing statistical indicators. This article looks only at information that is currently used for indicators – in the full knowledge that data that is currently "silent" for statisticians could well prove pertinent and useful tomorrow thanks to progress in this area – primarily the patent specification, which can run to dozens of pages.

A first set of information relates to the *technical features* of the invention:

- The list of "claims" describes the innovative content of the given invention thus defining the patent's field of coverage.
- The technical classification to which the invention belongs. There are different classifications, the principal being the International Patent Classification (IPC) kept by the World Intellectual Property Organization, which contains more than 60 000 sub-divisions.
- Cited patents (each patent lists prior art relevant to the invention, which is usually described in other patents).
- Scientific papers cited.

A second set of information relates to the "development" *of the invention*:

- The list of inventors (individuals), their address and country of residence.
- The list of applicants, who will have legal title to (be the owners of) the patent if it is granted. In the vast majority of cases, the applicants will be companies and the inventors their employees. Their address and country of residence is supplied.

A third set of information relates to the *history of the application*:

- Priority date (date of first filing worldwide).
- Date of filing in the country concerned.
- Date of publication (18 months after the priority date).
- Date of denial or withdrawal.
- Date of grant.
- Date of termination (non-payment of renewal fee).

Lastly, by cross-referencing information from different national patent offices, it is possible to determine the countries in which protection is being sought, since prior art worldwide must be cited (priority number).

Patent-based indicators

The most commonly used indicators are counts of patents that share a number of common elements. For instance, statistics from a count of patents by inventors resident in Korea and by inventors resident in Japan will be used to compare

the innovative output of both countries. At a more general level, one can also calculate the share of each country in the OECD area and observe trends in these shares over time. The count can also be confined to specific fields of technology. In all of these cases, patent counts by inventor resident in a given country are considered to reflect a country's innovative output.

As well as straightforward counts, more complex indicators can be constructed. For instance, the count can be restricted solely to patents applied for abroad or to a given patent "family" (all patent applications relating to the same invention in a number of different countries). Then, there are weighted counts, which allocate different weightings to each patent – instead of the uniform values used in straight counts – in order to reflect characteristics which are considered to reflect patent quality, such as number of citations, number of claims, or renewal period.

Advantages and limitations of patent counts

Patents are the source of data most widely used to measure innovative activity. There are good reasons for this.

- Patents have a ***close*** (if not perfect) *link to invention*. There are very few examples of major inventions that have not been patented in the last two centuries (James Watt patented the steam engine in 1785).
- Patents cover *a broad range of technologies* on which there are sometimes few other sources of data (biotechnology, nanotechnology, etc.).
- The contents of patent documents are a *rich source of information*: on the applicant, inventor, technology category, claims, etc.
- Patent data are quite *readily available* (now by electronic means) from national and regional patent offices and the marginal cost for the statistician is much less than when conducting surveys.

However, patents are subject to certain drawbacks as indicators of innovative activity:

- T*he value distribution of patents is skewed*. Many patents have no industrial application (hence, are of no value to society), whereas others are of substantial value: with such heterogeneity, patent counts that assume all patents to be of equal value actually tell us very little.
- Many inventions are *not patented*. The propensity to patent differs across countries and industries (there is evidence of a growing propensity to patent since the early 1980s, however). Non-patented inventions are either small ones, whose value does not warrant the costs of patenting, or inventions that are protected by other means (trade secrecy, lead-time on the market, reputation).

- D*ifferences in patent regulations across countries* make it difficult to compare counts of patents applied or granted in different countries – a Belgian patent cannot be compared with a Korean patent, for example. Moreover, it is difficult to draw comparisons between countries of invention based on patent applications filed in any given country: various biases (due to home advantage or trade flows) tend to bias the foreign country shares within any country.
- C*hanges in patent law* over the years make it difficult to analyse trends over time. The protection afforded to patentees worldwide has been stepped up since the early 1980s, with the result that companies are more inclined to patent than before. The list of technologies covered has grown longer over time and in some countries now includes software and genetic sequences, which had been excluded until recently.

Patent counts should not be discarded as a statistical indicator just because of these limitations. Many statistical indicators, including the most widely utilised, such as GNP (gross national product) also have flaws, sometimes major ones. Secondly, appropriate statistical methods can do much to correct any flaws. The rest of this article addresses these methods.

III. WHERE AND WHEN? ATTRIBUTING A COUNTRY AND DATE TO PATENTS

Attributing a country: inventor, applicant or priority country

Depending on the indicators used, patents can be classed by the country of residence of the applicant or the inventor, or by country of priority application (country where the patent was first filed before being extended to other countries). These are all useful approaches and a comparative study of all three is informative. However, it is important to have a thorough grasp of these concepts before interpreting the indicators.

The applicant is the patentee at the date of the application. In most cases this is a firm, sometimes a government body or individual. Patent counts by applicant concentrate on "ownership" (*i.e.* the number of patents owned by residents of each country). Indicators of this type reflect the innovative performance of a given country's firms, regardless of where their research facilities are located. For measuring the innovative performance of laboratories and researchers in a given country, a count of resident inventors is more meaningful. Finally, a count by priority country tells us more about the attractiveness of that country's patenting process: quality of intellectual property regulations, reputation of the patent office (rules, cost of patenting) and general economic features (size of the market). The latter can be a decisive factor: it is well known, for instance, that large Canadian firms

often patent directly in the United States before eventually filing an extension of their patent in Canada.

How does the choice of count criteria affect patent-based indicators? Table 1 reports OECD country shares in applications to the European Patent Office (EPO) using different count criteria. Depending on the criterion used to obtain a

Table 1. **Differences in patent counts depending on the reference date selected, 1990**[1]

Reference date	Number of patents				Shares in OECD			
	Grant		Application		Grant		Application	
	Priority	Grant	Priority	Applic.	Priority	Grant	Priority	Applic.
Australia	167	92	361	361	0.45	0.41	0.60	0.57
Austria	462	297	652	678	1.23	1.33	1.08	1.08
Belgium	314	224	512	627	0.84	1.00	0.85	1.00
Canada	324	173	550	628	0.86	0.77	0.91	1.00
Czech Republic	0	0	0	0	0.00	0.00	0.00	0.00
Denmark	242	109	325	321	0.64	0.49	0.54	0.51
Finland	287	81	429	401	0.76	0.36	0.71	0.64
France	3 379	2 345	4 916	5 107	9.00	10.48	8.17	8.13
Germany	7 866	5 756	11 490	12 810	20.96	25.73	19.10	20.39
Greece	8	0	27	25	0.02	0.00	0.04	0.04
Hungary	30	59	70	91	0.08	0.26	0.12	0.15
Iceland	3	0	9	5	0.01	0.00	0.01	0.01
Ireland	37	12	68	67	0.10	0.05	0.11	0.11
Italy	1 281	691	2 246	2 410	3.41	3.09	3.73	3.84
Japan	8 961	3 679	12 914	13 189	23.87	16.45	21.47	20.99
Korea	74	3	118	64	0.20	0.01	0.20	0.10
Luxembourg	25	19	41	26	0.07	0.08	0.07	0.04
Mexico	8	1	14	14	0.02	0.00	0.02	0.02
Netherlands	1 000	757	1 519	1 696	2.66	3.38	2.52	2.70
New Zealand	12	10	23	39	0.03	0.04	0.04	0.06
Norway	89	56	128	174	0.24	0.25	0.21	0.28
Poland	9	12	20	18	0.02	0.05	0.03	0.03
Portugal	3	2	8	5	0.01	0.01	0.01	0.01
Spain	118	55	256	255	0.32	0.24	0.43	0.41
Sweden	686	514	933	959	1.83	2.30	1.55	1.53
Switzerland	1 144	928	1 684	1 884	3.05	4.15	2.80	3.00
Turkey	1	0	4	5	0.00	0.00	0.01	0.01
United Kingdom	1 924	1 418	3 546	3 937	5.13	6.34	5.89	6.27
United States	9 081	5 079	17 298	17 035	24.19	22.70	28.75	27.11
OECD	37 534	22 371	60 160	62 831	100	100	100	100

1. Number of patent applications and patents granted, by inventor, fractional counts.

breakdown of patents by country, a country's share can differ (in relative terms) by more than 10% for large countries and more than 20% for smaller countries.

- The average discrepancy between counts by applicant and counts by inventor (in absolute value) was 10% in 1994 (when restricted to the 18 countries with more than 100 EPO applications). For counts by inventor, the United Kingdom's share was 5.7% in 1994, falling to 5.0% for applicant counts. For the Netherlands, the figures were 2.4% and 3.2% respectively. For the United States, they were 29.7% and 31.3%. In other words, some countries like the United States and the Netherlands have more applicants than inventors, while the reverse is true for countries like the United Kingdom. This asymmetry reflects the internationalisation of research (location of research facilities by multinational firms, see Guellec and van Pottelsberghe, 2001). These data can be used for analysing patterns of research internationalisation.
- The average discrepancy between counts by priority and counts by inventor (in absolute value) was 33% in 1994 (when restricted to the 18 countries with more than 100 applications). In the United States, the United Kingdom and to a lesser extent Germany, the total number of patents filed in the patent office is higher than the number of patents filed by resident inventors and applicants. The preference of some foreign firms for these countries is probably due to the reputation of their national offices and their market size. It is common for instance for Austrian firms to file a priority application in Germany and Canadian firms in the United States.

Attributing a date: priority date, application date, grant date

The problem in choosing the year to which a patent is attributed is that every patent document includes several dates, reflecting the patenting process and the strategy of the patentee (see Box 1): priority (date of first application in any country worldwide); PCT application (for an increasing proportion of patents, filed 12 months after priority application); application to national or regional agency (at most 12 months after the priority date for the traditional, direct procedure; 20 to 31 months after the priority date for the PCT procedure); publication (18 months at least after the priority date); and grant date (for the patents that are granted it takes three years on average at the USPTO and five years at the EPO, but can take up to ten years).

The only clearly meaningful date from a technological or economic point of view is the priority date. It is the closest to the date of invention. There is evidence that companies which choose to patent an innovation do so early in the process, so that they have the option of withdrawing their filing later if the invention turns out to be disappointing. For assessing a country's innovative performance at a particular point in time, it is therefore better to use the priority date.

Table 2. **Country shares in EPO applications with various criteria of attribution**
Inventor country, priority office or applicant country; by priority year; in %

	Priority country		Inventor country		Applicant country	
	1985	1994	1985	1994	1985	1994
Australia	0.00	0.01	1.13	0.71	1.07	0.65
Austria	1.23	0.89	1.37	1.10	1.21	0.96
Belgium	0.46	0.60	0.92	1.22	0.79	0.88
Canada	0.00	0.00	0.98	1.10	0.88	0.98
Czech Republic	0.00	0.00	0.00	0.04	0.00	0.03
Denmark	0.49	0.63	0.54	0.72	0.51	0.71
Finland	0.40	1.08	0.42	1.11	0.42	1.14
France	8.63	7.95	8.68	8.09	8.42	7.78
Germany	22.38	21.01	21.97	20.26	21.57	19.75
Greece	0.01	0.04	0.02	0.05	0.01	0.04
Hungary	0.00	0.00	0.27	0.07	0.27	0.05
Iceland	0.11	0.10	0.01	0.02	0.00	0.00
Ireland	0.07	0.09	0.09	0.13	0.07	0.15
Italy	3.33	3.53	3.44	3.78	3.28	3.40
Japan	15.54	16.81	15.57	16.58	15.45	16.33
Korea	0.26	0.27	0.04	0.57	0.04	0.56
Luxembourg	0.22	0.04	0.08	0.04	0.19	0.10
Mexico	0.11	0.05	0.00	0.02	0.00	0.01
Netherlands	2.30	1.33	2.73	2.41	3.42	3.18
New Zealand	0.50	0.26	0.10	0.10	0.10	0.10
Norway	1.07	0.68	0.30	0.29	0.29	0.31
Poland	0.01	0.01	0.05	0.03	0.04	0.02
Portugal	0.01	0.02	0.01	0.02	0.01	0.02
Spain	0.24	0.51	0.29	0.62	0.25	0.52
Sweden	2.19	2.12	2.25	2.14	2.20	2.20
Switzerland	3.09	2.40	3.54	2.77	4.06	3.44
Turkey	0.06	0.05	0.00	0.01	0.00	0.00
United Kingdom	8.69	6.51	7.58	5.72	7.15	4.99
United States	28.61	33.01	27.37	29.74	28.06	31.30
OECD	100	100	100	100	100	100

Source: OECD.

In many statistical publications the application or the grant date is used as these are the most readily available (published by national patent offices or the WIPO) and, ostensibly, the most recent statistics (although they in fact relate to inventions that go back some time). However, these dates are highly dependent on various administrative delays and the strategic behaviour of the patentee. The lapse of time between the date of invention and these various dates can differ widely from one patent to another. If one wants to measure the innovative perfor-

mance of countries at a given point in time, it is clearly the priority date (the closest to the date of invention) which matters. Table 2 illustrates how the choice of date influences the indicators:

- The total number of patents granted to OECD countries in 1990 is 22 371, if the date of grant is taken as the reference date and 37 534 if the priority date is taken as the reference date.
- The average discrepancy between counts by priority date and counts by application date was 4% in 1994 (when restricted to the 18 countries with more than 100 patent applications). For grants (difference between counts taking 1990 as the priority date and 1990 as the grant date), the discrepancy was 25%.
- The statistics for patents granted by the EPO to inventors in the United States and Germany show the impact of the choice of date on cross-country comparisons. If computed with 1990 as the priority year, the United States has the largest share (24.2%). If computed taking 1990 as the year of grant, the United States falls into second position (22.7%) and is overtaken by Germany (25.7%).

The reason for these discrepancies is twofold: country shares by priority year fluctuate over time, and the delay between priority and application – or grant – dates differs across countries. While European countries are more likely to file their priority application with the EPO itself (making the priority and application dates the same), the United States and Australia make extensive use of the PCT procedure (giving a time lapse of 30 months between the priority application in the national office and the EPO application) whereas Japan does not. There is little doubt that the best choice for most purposes is the priority date. However, this raises the issue of timeliness in the availability of indicators.

IV. PATENT FAMILIES

National patent counts: statistical biases

Most national statistical directories publish counts of patents filed in the country concerned. Thus we compare the number of patents filed with the national industrial property agency in country "A" by inventors resident in country "A", country "B", and so on. The advantage of this approach is that it allows us to assess the relative share of various countries in innovation on a given national technology market, in this case country "A's" market. Since patents only protect an invention in the country of filing, any technology used or sold in country "A" must be patented there (at least in reasonably large countries) and national authorities are interested in this domestic aspect of technology competition. However, this approach is not sufficient for international comparisons of technology perfor-

mance: the performance of countries is not fully reflected by their share of patents in any given country.

Nationals of country "A" will file more patents – proportionate to their innovative activity – in their home country than will nationals of other countries. When an inventor invents a new technique, he generally first patents it in his own country, which automatically protects it worldwide for one year. After one year, if he wishes to continue protecting it worldwide, he must file patent applications in the relevant countries (the process can be more complicated than this if he uses the PCT procedure, see Box 1). An inventor will only do so if the invention: *i*) has international commercial potential; and *ii*) is still commercially promising one year after first filing for a patent. Filing abroad therefore suggests that there are two criteria that will be met by only some of a country's national patent applications. Consequently, patent applications in country "A" by its own residents and by residents of other countries are not comparable, since the latter meet some criteria that some of the former group of applications does not meet. This is known as the "home advantage" and leads to over-representation of country "A" residents in that country's patent total. For instance, the share of United States residents in patents granted by the USPTO is between 55% and 60%, while the share of Japanese residents in patent applications filed with the Japanese Patent Office (JPO) is of the order of 85%.

A second source of bias in national statistics stems from the fact that patent protection is operative only on one market and that other countries may or may not be so interested in protecting their inventions on any given market. A key factor in patenting is commercial strategy: if one wants to sell the new product on a given market, then patent protection is needed. If not, protection is less important. Consequently, international patent filings are influenced by trade flows. Korean inventors have more of an incentive to seek protection in Japan (they accounted for 4.3% of patents filed with the JPO by non-residents in 1998) than in Germany (1.1%), for instance.

To avoid the biases of purely national statistics, we can turn to international applications. One approach to international comparisons is to look at the number of patents taken out abroad by different countries. This also raises a few problems. First of all, it means counting individual inventions several times, as many times as it is patented in any country. In other words, the count for an invention patented in 100 countries will be 50 times higher than for an invention patented in only two. Second, all of the countries concerned are treated in the same way, regardless of size.

The indicator we are looking for would ideally:

- Select patents of a certain quality standard.
- Count patents fairly whatever the country of innovation.

The indicator that comes closest to meeting the above criteria is "patent family" counting.

Family counts

A patent confers national property rights in that it protects an invention only in the country in which it was granted. Inventors seeking international rights therefore have to file applications in each country in which they want patent protection.

A "patent family" can be defined as all patent documents filed in different countries to protect the same invention. At its most basic, the family comprises a "priority patent application" and all "subsequent patent applications" that relate to it. The priority patent application is the first application filed to protect the invention, generally in the inventor's country. Subsequent patent applications are filed one year after the priority application in other countries in order to extend the geographical coverage of protection.

Advantages of the "patent family" for statistical purposes

- It improves the *international comparability* of patent-based indicators. Only patents applied for in the same set of countries are included in the "family", thus eliminating *home advantage* and the influence of geographical location.
- Patents in the family are *high-value patents* (the value of a patent can roughly be defined as the contribution of the invention it protects to the economy, either in technological terms or in economic terms). The patentee will take on the additional costs related to the extension of the protection to other countries only if he/she deems it worthwhile: *i.e.* if the expectation of having the patent granted and the expected return from protection (sales or licences in designated countries) are high enough.

Some methodological choices have to be made before conducting patent family counts:

- *Geographical coverage*: there are over 100 national industrial property agencies worldwide, not counting regional agencies (such as the EPO in Europe). Which agencies should be taken into account in constructing a patent family? In other words, with which agencies does a patent have to be filed in order to be considered part of a family? In the shorter term, we opted for the "triad". The "triad family" is a patent family that has one "member" in Europe, one in Japan and one in the United States.
- *Defining the family*: the relationships in the patent family as outlined above (a priority application, plus subsequent related applications) can sometimes be a little more complex in real life. First, a number of patent applications made in one country can be grouped together under a single patent in

another country. Applications citing multiple priority applications are particularly common for Japanese patents, which often cite between five and 30 priority applications for a single European or US patent. Then there are patents that have "common priorities", where a single patent is cited as the priority application for two or more subsequent applications. So, some patent families are related to each other by common priorities and the problem is then where to draw the line between them. The choice we made here was to define the family as all patents with one or more common priority.

Table 3. **Triad patent families (patents filed with the EPO, JPO and USPTO)**
By priority year and country of invention

	Number of families		Share in world total	
	1990	1995	1990	1995
Australia	135	148	0.43	0.46
Austria	159	194	0.51	0.60
Belgium	205	319	0.66	0.99
Canada	242	345	0.77	1.08
Czech Republic	7	3	0.02	0.01
Denmark	98	160	0.31	0.50
Finland	134	253	0.43	0.79
France	1 894	1 775	6.05	5.54
Germany	3 918	4 267	12.51	13.31
Greece	3	1	0.01	0.00
Hungary	29	15	0.09	0.05
Iceland	1	6	0.00	0.02
Ireland	27	20	0.09	0.06
Italy	622	557	1.99	1.74
Japan	9 699	8 601	30.97	26.83
Korea	62	313	0.20	0.98
Luxembourg	18	11	0.06	0.03
Mexico	7	11	0.02	0.03
Netherlands	687	719	2.19	2.24
New Zealand	8	13	0.03	0.04
Norway	41	79	0.13	0.25
Poland	4	3	0.01	0.01
Portugal	1	2	0.00	0.01
Slovak Republic	0	2	0.00	0.01
Spain	70	86	0.22	0.27
Sweden	383	649	1.22	2.03
Switzerland	769	693	2.46	2.16
Turkey	1	1	0.00	0.00
United Kingdom	1 355	1 303	4.33	4.06
United States	10 503	11 162	33.54	34.81
European Union	9 574	10 316	30.57	32.17
OECD Total	31 083	31 711	99.27	98.90
World	31 312	32 064	100.00	100.00

Source: OECD patent database.

In other words, when two sets of patents are "inter-related", they are regarded as forming a single family (this is the method used for the INPADOC database maintained by the EPO). The family therefore consists of a set of priority applications and any subsequent related applications in the triad countries.

Table 3 gives the number of triad patent families by country of invention for priority years 1990 and 1995, constructed in accordance with the above rules.

V. CONCLUSION

Patent-based indicators are extremely useful for comparing and monitoring trends in the technology output of different countries. However, we have to follow some methodological rules in constructing them if we are to avoid certain statistical biases. The proposals on patent families, priority years and county of invention outlined in this article are a step in that direction. Work to further this approach is either currently in progress or is to begin shortly. It primarily involves: nowcasting families so as to have more up-to-date statistics (currently, with the PCT and USTPO procedures for granting applications, it can take around five years before information is made available); improving the correlation of patent-based indicators to the activity of firms (using a table correlating patent technology classifications with industrial activity classifications); and lastly, better reflecting patent value in the indicators, using supplementary information such as citations, claims or renewals.

REFERENCES

Guellec, D. et B. van Pottelsberghe (2001),
"Patents and the Internationalisation of R&D", *Research Policy*, forthcoming.

OECD (1994),
"The Measurement of Scientific and Technological Activities. Using Patent Data as Science and Technology Indicators – Patent Manual", OECD, Paris.