Patents as Indicators of Technology Output: A Review

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Résumé
Parmi les rares indicateurs de la performance (output) technologique des pays, les comptages de brevets sont sans doute le plus utilisé. En effet, les brevets sont directement issus de l'activité inventive (il n'y a pratiquement pas d'invention majeure qui n'ait pas été brevetée sur les deux derniers siècles). Il semble de plus que les entreprises ont de plus en plus recours au brevet pour protéger l'ensemble de leurs inventions. Cependant les indicateurs fondés sur les brevets ont aussi des limites, et nombre d'indicateurs actuellement publiés sont sujets à des biais statistiques considérables. L'objet de ce document est de présenter les indicateurs de brevet, leur relation avec la performance technologique des pays, les problèmes qu'ils rencontrent, et certaines solutions que des travaux en cours visent à développer.

Introduction

Among the few indicators of technology output, patents are probably the most often used or referred to. They are used notably to assess and compare the inventive performance of countries or firms. Most national S&T publications include a section on patents. Patents are used by business consultants for evaluating the technological achievements of firms. The academic literature on the determinants and impact of inventive activities uses patent data at the aggregate or firm levels. This is due to the widely recognised close relationship between patents and inventive output (see below) and to the relatively easy access to such data.

Patenting activity by firms, but also universities and government laboratories, has been expanding rapidly during the 1990s, although the problems with counting patents tend to blur the picture. To give a rough idea, the number of patents granted in the United States has been about 160 000 in year 2000, whereas it was 90 000 in 1990. A similar (if not as strong in all cases) trend is reported in other countries.

What is a patent?

What is a patent? A patent is a property right over an invention, which gives its owner control over the use of the invention for a limited period of time and in a given country. Patents are granted by national patent offices. The criteria for granting patents are threefold: novelty, inventive step, and industrial applicability. This excludes existing technologies, bright ideas with no substantial contents, and scientific discoveries (with no direct industrial application).

The economic rationale of patents is twofold: the inventor has to be given some monopoly for being compensated for research costs, and disclosure of an invention is beneficial to society as a whole (it allows further progress). That is why any patent document, which is published, must include a description of the discovery complete enough to allow somebody skilled in the art to understand how it works.

The administrative process of patenting is important to remind in order to understand patents statistics. A company seeking protection for an invention files first an application at one national patent office, generally the one from its home country. This application is called the "priority", as it is the first one world-wide for the discovery. This application will be processed by the patent office, then either granted or rejected (processing time varies from 1 year to 8 years, depending on the patent, with large differences between national offices in this respect). During the year following this application, the invention benefits automatically from a protection world-wide. Passed this delay, if the company wants its invention protected in other countries, it has to file an application in these countries, which will be processed in turn, independently by each national

office (an application can be rejected in one country while granted in another). This is the basic process. Since the late 1970s, it has been possible to follow the so-called "PCT route" for international filing. Basically, a PCT (standing for Patent Co-operation Treaty) application is an option for later filing, applied to the WIPO (World Intellectual Property Organisation). It allows the applicant to be protected over 18 to 30 months after first filing (priority), in the set of countries designated in the application. After this delay, the applicant has to decide whether he actually files a patent application or not. A PCT application is cheaper than a patent, and the cost is the same whether the applicant designates 10 or 100 countries: hence its fast growing use over the past two decades. In addition, for patenting in European countries, the national route has been overtaken in the past two decades by the EPO (European Patent Office), which allows to patent an invention at lower cost and stringer protection in about 20 European countries now.

Methodological diversity

Why are patents statistics a complex matter? Patents are a variegated and complex legal object, as exemplified above, reflecting inventive activity which itself is complex, as well as strategic concerns (on the patentee side) and administrative features; they are embedded in (differing) national regulations, follow different and multistage procedures, with a possibility of sharing the ownership and the invention, etc. Different types of patents can be counted, in each type some selection can be made, or not. For instance, one can count all applications in one country, or only patents granted. A patent can be attributed to the applicant (its owner at the time of application) or to the inventor, or to the country where it has been filed first (priority). Regarding the timing, a patent document includes several dates, generated by the underlying administrative process: the date of priority (first application world-wide), the date of application in a given country, the date of publication, or the date of grant.

In this context, there is not yet a standard method for calculating indicators from patents data, which results in a great diversity of the analytical and policy lessons that can be drawn from patent statistics. The diversity of indicators published or used in economic studies can be contrasted with the homogeneity of other S&T indicators such as R&D (based on the Frascati manual) or even scientific publications (based for most of them on a same data base, the Science Citation Index). Depending on the choice that one makes the resulting patents indicators will take substantially different values and support contradictory analytical and policy messages.

The "Patent manual" (published by OECD 1994) marked a first step in the process of clarifying and harmonising patent-based indicators. It presented the legal and economic background which frames patents -- a necessary step before designing statistics -- and listed indicators that could be drawn from patent data bases. It also listed a limited number of methodological issues met when calculating indicators based on patents. However, the Patent manual fell short of analysing precisely these issues and proposing practical solutions. The increasing diversity of patent-based indicators that is correlated with the steady increase in their demand for economic analysis underlines a crucial need for harmonisation.

Patents as indicators of inventive output

Patents are the most widely used source of data for the output of inventive activity. There are good reasons for that:

- Patents have a ***close*** (if not perfect) ***link to invention***. There are very few examples of major inventions which were not patented in the last two centuries (James Watt took a patent on the steam engine, in 1785). Patents cover a broad range of techniques, extending now to biotechnology and software, with first extensions towards services-related inventions (so-called "business methods").

- Patents data are quite ***readily available*** from patent agencies, in computerised form. Hence the cost of processing patents data is lower than survey-based data.

- Patent documents have a ***rich information contents***: the name and address of applicant(s), of inventor(s), the technology category (international classification with more than 60,000 classes), claims, date of priority (close to the date of invention), citation of other patents (which shows the genesis of the invention), etc.

Patents are however subject to certain drawbacks as indicators of inventive activity, which give the ground for certain scholars to dismiss their value for calculating meaningful indicators:

- ***The value distribution of patents is skewed***. Many patents have no industrial application (hence no social value), whereas a few of them have a huge value: with such heterogeneity, counting patents is of limited significance.

- Many inventions are ***not patented***, with a propensity to patent differing across countries and industries (there is evidence of growing propensity to patent since the early 1980s, however). However, most non patented inventions are either small ones, that it would not be relevant to count anyway.

- ***Differences in patent regulations across countries*** make it irrelevant to compare counts of patents applied or granted in different countries. Various biases (due to home advantage or trade flows) tend to bias the foreign country shares within any country.

- ***Changes in patent law***, which have resulted in a substantial strengthening of protection of patentees world-wide since the early 1980s, affect patents time series. Technology covered change over time, making sometimes irrelevant time comparisons. Software and genetic sequences became patentable in the US in the 1990s only

In order to mitigate the above listed sources of noise and bias, and calculate patent indicators that are more meaningful, the OECD has engaged in methodological work. The major steps are as follows.

Counting patents families

The most frequently published indicators are counts of patents taken in a given country, broken down by country of the patentee (the inventor or the applicant). Counting patents applied in a given country by patentees from various countries raises the issue of comparability. Residents in any country have a higher propensity to patent inventions at home than foreigners: protection for smaller inventions is searched on the local market only. The national patent is used as a preliminary protection with no extension abroad if the invention turns out misleading after further investigation of its technological or economic potential. This so-called "home advantage" forbids to compare the home country with others. Moreover, comparability between foreign countries can be limited as well, since patenting is influenced by other factors than technology, such as patenting procedures, trade flows, proximity and other factors.

A second drawback of national patents counts is high heterogeneity in the value of patents. The value of a patent can be roughly defined as the contribution of the invention it protects to the economy: either in technological terms (novelty and fertility of the invention), or in economic terms (return to the patentee). There is broad recognition that the value distribution of patents is very skewed: a few patents have large value, whereas many have very low value. Hence the significance of patents counts is limited, as they put on an equal footing patents of very different values.

It must also be mentioned that many published patent indicators include PCT filings along with actual application. As PCT filings are only an option for possible later application, and only about 50% of PCT do eventually become actual application, counting them on the same footing as actual applications generate further heterogeneity.

"Patent families" are special types of indicators which aim at mitigating these two issues. A patent family is defined as a set of patents taken in various countries for protecting a single

invention, called the "priority". A patent family is the "offspring" of a "priority patent". An inventor seeking protection files a first application world wide (the priority patent), generally in his/her country of residence. As they encompass applications in several countries, patent families are not subject to the "home country advantage". Patent families mitigate this issue as they operate a selection in the whole population of patents. Moreover, filing application in several countries is costly (administrative fees, translation of the document). The patentee does that only if he/she deems it worthwhile, i.e. if the expectation for having the patent granted and the expected return from protection (sales or licenses in designated countries) are high enough. It is then expected that patent families are generally of higher value than patent filed in a single country, which mitigates the heterogeneity issue.

Attributing the right date and country to a patent

The problem in choosing the year to which a patent is ascribed is that every patent document includes several dates, reflecting the patenting process and the strategy of the patentee (see box 3): priority (date of first application in a country world-wide); PCT application date (for an increasing proportion of patents it cannot exceed, and is generally close to, 12 months after the priority date); application to a foreign national or regional office (at most 12 months after the priority date for the direct route, 20 to 31 months after the priority date for the PCT route); publication date (18 months after the priority date); and grant date (for the patents that are granted it takes 3 years on average at the USPTO and 5 years at the EPO, but it can last up to 10 years).

The only date with a clear meaning from a technological or economic point of view is the priority date. It is the closest to the invention time. There is evidence that the companies that choose to patent an invention do it early in the process, keeping the possibility of withdrawing their filing later if the invention turns out deceptive. For assessing the inventiveness of a country at one point in time it is therefore better to use the priority date.

In many statistical publications the application or the grant date are used because they are the most easily accessible (published by national patents agencies or the WIPO), and give the apparently most recent statistics (although they refer to inventions performed some time before). However, these dates are highly dependant on various administrative delays and strategic behaviour of the patentee. The lag between the date of invention and these various dates can differ widely across patents. When one is interested in measuring the inventiveness of countries at one point in time, it is clearly the priority date (the closest to the date of invention) which matters.

Depending on the publication, patent indicators are broken down either by country of residence of the applicant, or by country of the inventor. These various approaches are useful, and a cross look at both is highly relevant. It is of prime importance to understand these notions before interpreting patent-based indicators. The applicant is the owner of the patent at the time of application, most often a firm, sometimes a government body or an individual. Counting patents by applicant means to take the point of view of control (how many patents are controlled by residents of each country). Such indicators reflect the inventiveness of firms of a given country, whatever the location of their research facilities. It remains to be investigated how the value created by the invention is shared between the inventor country, the owner country and other countries (where the multinational firm may have production facilities). For measuring the technological inventiveness of researchers and laboratories located in a country, counting inventors whose residence is in the country is more relevant. A patent generated by, say, an IBM laboratory located in Germany might tell more on Germany's technological capabilities than on US ones.

The future of patent indicators

To summarise the above discussion, getting patent indicators with satisfactory statistical properties and sufficient economic meaning for the purpose of comparing countries technological performance implies to count patent families assigned to the priority year and the country of invention. Such indicators are not published yet, because there are highly complex technical problems to solve for their calculation. The OECD, in co-operation with the European Commission, the National Science Foundation of the United States and the Japanese Patent Office has engaged in a project aiming at making such indicators available soon.