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Policymakers and the R&D-Patent Relationship

Patent-based indicators at the country level are frequently used to assess countries' innovation performances or efforts. Yet they are often said to reflect the propensity to patent rather than actual research productivity. The authors of this article argue that patent-based indicators can rightfully be used to measure research productivity, as witnessed by the influence of several policy tools on the R&D-patent relationship. They also put forward a new counting methodology, less subject to "home" bias.[1]

Research scholars specialising in the empirical analysis of innovation systems generally consider patents as an imperfect indicator of research efforts. Mansfield and Griliches, amongst others, underlined that not all inventions are patentable … and not all patentable inventions are patented.[2] In addition, a patentable invention can be protected with one single patent, several patents, or a large set of overlapping patents (patent thickets), and this "propensity to patent" greatly differs across industries and types of firms. The motivations behind patenting are shifting from the traditional use of protecting one's own innovations to new strategic uses, further complicating the interpretation of patent data.[3] At least, the heterogeneity in propensities to patent casts some doubt on the relevance of patent-based indicators for the measurement of innovation performances. Yet they are commonly used by international organisations to rank countries according to their relative innovation efforts or performances.[4]

As a matter of fact, two components characterise the R&D-patent relationship: a "productivity" effect (the number of inventions generated by each researcher) and a "propensity" effect (the extent to which an invention is protected by one or several patents). In a recent paper, we present empirical evidence suggesting that patent-based indicators also measure the productivity of research, provided an accurate measure of patenting activity is used and the role of several policy tools is accounted for.[5] Below, we present a new patent count methodology based on priority filings. We then investigate the extent to which our indicator correlates with research efforts. It turns out that the design of intellectual property (IP) and sciences and technology (S&T) policies do influence the R&D-patent relationship.

Measuring a Country's Innovative Efforts with Patents

There is no perfect way to assess innovation efforts. Although frequently criticised, the most common indicators are the level of R&D expenses and the number of patents. R&D expenses represent an input into the innovation process, whereas patent counts measure one particular type of output. R&D efforts have a well-accepted measurement method and harmonised yearly series are provided by the OECD.[6] By contrast, there exists no standard methodology for patent data.[7] It is possible to compute a large number of patent-based indicators, each carrying its own meaning.

Assessing a country's patenting performance is more complex than would appear at first sight. Most studies generally rely on patent filings either at the European Patent Office (EPO) or at the US Patent and Trademark Office (USPTO), but this practice induces a strong "home-bias". USPTO filings include domestic priority filings from US firms and filings from abroad. Needless to say many more applications can be expected from US firms than from European firms. The reverse is true of the EPO, where European firms have a much higher propensity to file a patent application than US firms. In addition, EPO filings are generally second filings; they do

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[1] This paper is primarily based on a document authored by G. de Rassenfosse and B. van Pottelsberghe: Policy-makers and the R&D-patent relationship, in: Bruegel Policy Contribution, May 2008. It summarises a Working Paper entitled "A policy insight into the R&D-patent relationship", CEPR Discussion Paper No. 6716, London 2008, which has also been presented at Industry Canada in the Distinguished Speakers in Economics Series, Ottawa, Canada, 18 April 2008.

[2] Cf. E. Mansfield: Patents and Innovation: An Empirical Study, in: Management Science, Vol. 32, No. 3, 1986, pp. 173-181; Z. Griliches: Patent Statistics as Economic Indicators: A Survey, in: Journal of Economic Literature, Vol. 28, No. 4, 1990, pp. 1661-1707.

[3] D. Guellec, B. van Pottelsberghe de la Potterie, N. van Zeebroeck: Patent as a market instrument, in: D. Guellec, B. van Pottelsberghe de la Potterie: The economics of the European patent system, Oxford 2007, Oxford University Press, pp. 85-113.

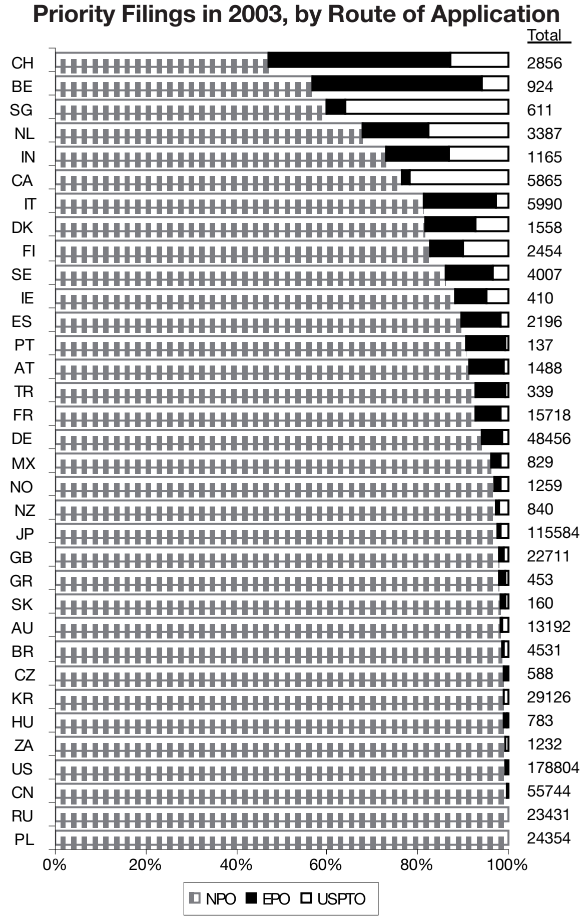
[4] Examples include the IMD World Competitiveness Yearbook (2006); Eurostat: Science, technology and innovation in Europe; or the Economist Intelligence Unit.

[5] G. de Rassenfosse, B. van Pottelsberghe de la Potterie: A Policy Insight ... , op. cit.

[6] See the Frascati Manual published by the OECD for technical information on R&D, and the Main Science and Technology Indicators as well as the ANBERD database for yearly series.

[7] H. Dernis, D. Guellec, B. van Pottelsberghe de la Potterie: Using patent counts for cross-country comparisons of technology output, in: STI Review, No. 27, Paris 2001, OECD, pp. 129-146.

Figure 1
Priority Filings in 2003, by Route of Application

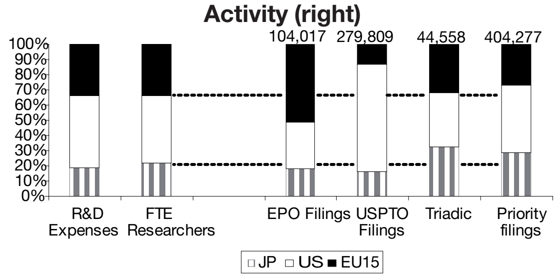


Source: adapted from G. de Rassenfosse and B. van Pottelsberghe: A Policy Insight into the R&D-Patent Relationship, CEPR Discussion Paper No. 6716, London 2008. Note that the number of Japanese priority filings has been divided by 3, as Japanese patents are on average composed of fewer claims (about 8 in 2003, as opposed to 24 in the patents filed at the USPTO). A similar approach has been adopted for South Korean patents. For a discussion, see ibid.

not account for the original priority filings that are made beforehand.[8]

An alternative approach is to rely on the number of priority filings made by the residents of a country. To the best of our knowledge, this counting methodology has rarely been adopted. It is not straightforward to implement, as the firms of a country may choose several routes to file their priority applications. It is particularly true in Europe, where the EPO co-exists with national patent offices, and where firms sometimes first file an application at the USPTO and then transfer it to the EPO. A "correct" (or less biased) methodology would therefore consist in counting the number of priority patents filed at different national or regional patent offices. In the case of the Netherlands, for example, 2,298 priority filings were filed at the national patent office in 2003.[9] During the same year Dutch applicants filed 495 priority filings at the EPO and 594 priority applications at the USPTO. In other words, a total of 3,387 filings were made by firms based in the Netherlands, a net increase of more than 1,000 patents.

Figure 2
Research Efforts (left) versus Patenting Activity (right)



Sources: G. de Rassenfosse and B. van Pottelsberghe: A Policy Insight into the R&D Relationship, CEPR Discussion Paper No. 6716, London 2008; OECD MSTI, USPTO 2003 annual report, EPO 2003 annual report, own computations. Note that the number of Japanese priority filings has been divided by 3, as Japanese patents are on average composed of fewer claims, (about 8 in 2003, as opposed to 24 in the patents filed at the USPTO). A similar approach has been adopted for South Korean patents. For a discussion, see ibid.

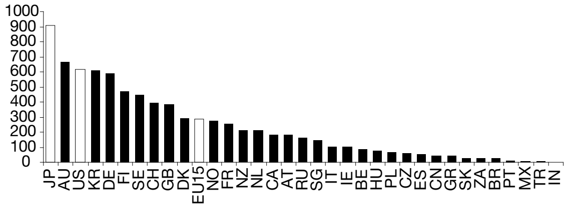
Neglecting EPO or USPTO filings may result in large biases, as Figure 1 demonstrates, especially for Belgium, Canada, India, the Netherlands, Singapore, and Switzerland. The corrected count is reported on the right-hand side of the figure. As compared with the methodology that consists in counting only USPTO or EPO filings, this alternative counting methodology has the advantage of being less subject to the "home" bias, because three routes for priority filings are accounted for (national, EPO and USPTO). An alternative methodology that would also correct the home bias would be to count triadic patents, i.e. patents that have been filed simultaneously at the USPTO, the EPO and the JPO. It is an indicator developed by the OECD that essentially tracks patents with a very high potential value (as they are filed in three patent offices).

Figure 2 shows the results of various counting methodologies (on the right-hand side) compared to two well-known indicators of R&D efforts (on the left-hand side): gross expenditures on research and development (R&D expenses) and the number of full-time equivalent researchers. The home bias clearly appears for patent counts based on EPO or USPTO data. Filings by European (US) applicants are much more important with EPO (USPTO) data than what the number of researchers or the level of R&D expenses would predict. Triadic patents and priority filings are more in line with the two indicators of R&D activities, with Japan being overrepresented in both cases. In other words, patent counts based on the "corrected" number of priority filings or on the number of triadic patents seem to provide a more accurate meas-

[8] Cf. D. Guellec, B. van Pottelsberghe de la Potterie: The economics of the European patent system, op.cit.

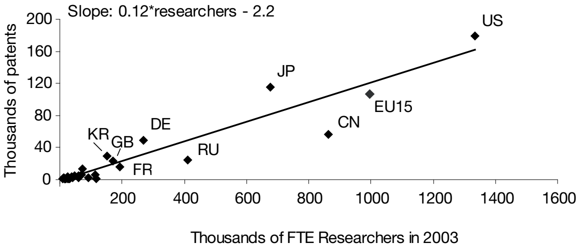
[9] The data come from EPO's PATSTAT database, April 2007.

Figure 3
Corrected Priority Filings per Million Inhabitants



Source: adapted from G. de Rassenfosse and B. van Pottelsberghe: A Policy Insight into the R&D Relationship, CEPR Discussion Paper No. 6716, London 2008.

Figure 4
FTE Researchers in 2003 vs Corrected Priority Filings



Source: adapted from G. de Rassenfosse and B. van Pottelsberghe: A Policy Insight into the R&D Relationship, CEPR Discussion Paper No. 6716, London 2008.

ure of relative research efforts. It is worth noticing that the total number of priority filings generated in Europe, Japan and the USA is around 400,000, whereas the total number of triadic patents is around 44,000, suggesting that about one patent in nine is associated with a high value that justifies a global protection strategy.

Figure 3 shows the corrected count of priority filings per million inhabitants. Germany is the only European country to perform as well as the USA, while the EU15 clearly lags behind. Let us summarise the factors that impact countries' patenting performances.

The "R&D-Patent" Relationship ...

A first glimpse into the R&D-patent relationship is provided by Figures 4 and 5, where the number of full-time equivalent researchers is plotted against the corrected counts of priority filings. A clear positive relationship between the number of researchers and the number of patents applied for appears, but it is subject to a substantial heterogeneity. Countries like the USA, Japan, Germany, South Korea, the UK and Australia are markedly "above" the line. In other words, firms in these countries patent more than their number of researchers would predict. The EU15 is slightly under the line, as are France, Spain, Canada, Russia, India or China. These differences may be due either to varying propensities to patent or to varying productivity levels of research activities.

The extent to which countries apply for relatively more or fewer patents depends on both a research productivity effect and a propensity effect.

In order to test the role of the productivity and propensity effects, we have performed a cross-sectional econometric analysis of 34 countries, representing more than 95% of worldwide priority filings. The results suggest that the two effects explain the observed heterogeneity in the number of patents per researcher, as witnessed by the impact of the design of several policy tools. The most important results are summarised as follows.

... Depends on a Research Productivity Effect

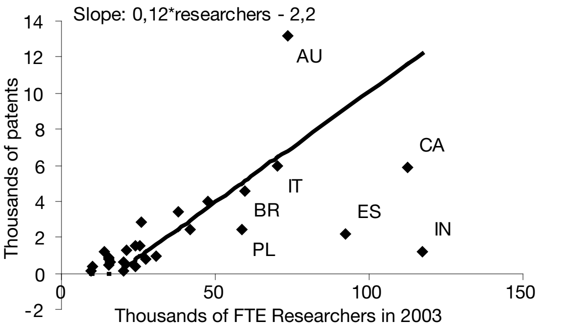
The design of education policies and S&T policies influence the R&D-patent relationship through a "productivity" effect.

- *The higher the human capital index (or the more educated a country)*, the more productive the research efforts. In other words, the countries with a more educated population have more priority filings per researcher. In this respect, Finland, Sweden and Austria score highest, whereas India, China and Turkey score lowest.[10]
- *The number of scientific publications per researcher*, an indicator of research quality, also has a positive impact on the observed number of patents. Switzerland, Italy and the Netherlands have the highest performances, while China, Russia, and Japan lag behind.
- *The gross expenditure on R&D per researcher* is an additional determinant of the productivity of research. It seems that better equipped – or better paid – researchers are more productive in terms of patent filings. Italian, Dutch and Swiss researchers have the highest relative expenditures, as opposed to Russian, Polish and Slovakian researchers.

The three results suggest that patent indicators partly reflect the productivity of research efforts. The design of several policies has a substantial influence on research productivity and therefore affects the R&D-patent relationship.

[10] Please refer to the original article for the complete dataset.

Figure 5 - FTE Researchers in 2003 vs Corrected Priority Filings, Countries with less than 150,000 FTE Researchers



Source: adapted from G. de Rassenfosse and B. van Pottelsberghe: A Policy Insight into the R&D Relationship, CEPR Discussion Paper No. 6716, London 2008.

… and a Propensity Effect

Patent-based indicators also reflect a varying propensity to patent across countries. In particular, intellectual property policies play an important role in fostering the demand for patents.

- *Patenting fees* are a significant determinant of the demand for patents: a reduction of about 10% in patenting fees would result in an increase in patent filings of 3 to 5%. See de Rassenfosse and van Pottelsberghe for an in-depth discussion of the role of fees on patenting behaviour.[11]
- *Stronger patent rights*, such as better enforcement mechanisms, a lower number of restrictions or more patentable subject matters stimulate inventors to file more patent applications. It is measured by the Ginarte-Park index on the strength of patent rights.
- *A country's industrial structure* also matters. For the same level of aggregate R&D intensity, specialisation in the computer or the instrument industry leads to proportionally more patent filings.[12]

The above-mentioned factors are as many pitfalls that make patent-based indicators an imperfect measure of productivity of research: two countries with a similar productivity of their research efforts but with varying IP policies or technological specialisation may exhibit important differences in patenting performances. Nevertheless, patent data also reflect the productivity of research efforts, as witnessed by the impact of education and S&T policies on the R&D-patent relationship.

[11] G. de Rassenfosse, B. van Pottelsberghe de la Potterie: Per un pugno di dollari: a first look at the price elasticity of patents, in: Oxford Review of Economic Policy, Vol. 23, No. 4, 2007, pp. 588-604.

[12] Note that we do not capture specialisation in services. An economy with a large service sector will not have the same patent activity as an economy specialised in high-tech industries. Nevertheless, the service-based economy can be very innovative as well.