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Patents

A patent is the legal right of an inventor to exclude others from making or using a particular invention. This right is sometimes termed an 'intellectual property right' and is viewed as an encouragement for innovation. This article gives a brief history of patenting, and discusses the legal and administrative process for obtaining a patent in the major world jurisdictions. Evidence on patent effectiveness in encouraging innovation is surveyed, and the article concludes with a discussion of the use of patent data in economic analysis.

A patent is the legal right of an inventor to exclude others from making or using a particular invention. This right is customarily limited in time, to 20 years from the date of the application submission in most countries. The principle behind the modern patent is that an inventor is allowed a limited amount of time to exclude others from supplying or using an invention in order to encourage inventive activity by preventing immediate imitation. In return, the inventor is required to make the description and implementation of the invention public rather than keeping it secret, allowing others to build more easily on the knowledge contained in his invention.

The economics of patents has two distinct components, one normative and one positive. The first is directed towards questions of optimal patent policy, the existence and strength of patents, and the design of the patent system. The second uses patent data as an indicator of inventive activity, relying on the fact that patent offices attempt to apply fairly uniform standards of novelty and inventive step when granting patents, so that counts based on them should reflect the innovative activity in a society or in a particular industrial or technology sector. The advantage of patent data is that they are available in great detail over a wide range of time periods, geographic areas, and technological sectors (Griliches, 1990). Nevertheless, all patents are not equal, and it is important to understand the operation of patent systems throughout their history in order to make effective use of these data.

This article begins with a brief history of patents, followed by a discussion of the legal and administrative processes for obtaining a patent in the three major patent offices, the United States, European, and Japanese. Then the evidence on patent effectiveness in encouraging innovation is surveyed. The final section discusses the use of patent data in economic analysis.

Brief history

Patents have a long history, although some of the earliest patents are simply the grant of a legal monopoly in a particular good rather than protection of an invention from imitation. Early examples of technology-related patents are Brunelleschi's patent on a boat designed to carry marble up the Arno, issued in Florence in 1421, the Venetian patent law of 1474, and various patent monopolies granted by the English crown between the 15th and 17th centuries. The modern patent, which requires a working model or written description of an invention, dates from the 18th century, first in Britain (1718) and then in the United States (1790), followed closely by France (in both the latter two cases one of the consequences of a revolution). Many other Continental European countries introduced patents during the 19th century, as did Japan. During the 20th century, the use of patent systems became almost universal.

The French patent law of 1791 emphasizes the property right aspect of the patent rather than its use in promoting the useful arts: 'All new discoveries are the property of the author; to assure the inventor the property and temporary enjoyment of his discovery, there shall be delivered to him a patent for five, ten or fifteen years' (Ladas and Parry, 2003). In contrast, the Japanese law of 1959 states that its goal is to encourage 'inventions by promoting their protection und utilization and thereby to contribute to the development of industry' (JPO, 2006). Patents are enshrined in the US constitution with the sentence 'Congress shall have power ... to promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries' (Article 1, Section 8, clause 8), which implicitly recognizes both goals of a patent system, namely, reward to the inventor and the promotion of inventive progress.

In 1883 the Paris Convention for the Protection of Industrial Property ensured national treatment of patent applicants from any country that was a party to it. Its most important provision gave applicants who were nationals or residents of one member state the right to file an application in their own country and then, as long as an application was filed in another country that was a member of the treaty within a specified time (now 12 months) to have the date of filing in the home country count as the effective filing date in that other country (the 'priority date'). This is an important feature of the patent system, and enables worldwide priority to be obtained for an invention originating in any one country, in addition to ensuring that in principle all inventors are treated equally by the system, regardless of the country from which they come.

Legal and administrative

Although the process for granting a patent varies slightly according to the jurisdiction for which protection is desired, the adoption of the agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) in 1995 ensures that it is approximately the same everywhere in the world. This agreement requires its member countries to make patent protection available for any product or process invention in any field of technology with only a few specified exceptions. It also requires them to make the term of protection available for not less than a period of 20 years from the date of filing the patent application.

The World Intellectual Property Organization (WIPO) has almost 200 member states and lists an equivalent number of national patent offices and industrial property offices on its website. In general, the patent right extends only within the border of the jurisdiction that has granted it (usually but not always a country). An important exception is the European system, where it is possible to file a patent application at the European Patent Office (EPO) that will become a set of national patent rights in several European countries at the time of issue (EPO, 2006). A similar situation exists with respect to the African Regional Intellectual Property Organization (ARIPO). The exact number and choice of countries is under control of the applicant. Patents granted by the EPO have the same legal status as patents granted by the various national offices that are party to the European Patent Convention (EPC).

The Patent Cooperation Treaty (PCT) came into existence in 1978, and now has 133 countries as contracting signatories. Any resident or national of a contracting state of the PCT may file an international application under the PCT that specifies the office which should conduct the search. The PCT application serves as an application filed in each designated contracting state. However, in order to obtain patent protection in a particular state, a patent needs to be granted by that state to the claimed invention contained in the international application. The advantage of a PCT application is that fewer searches need to be conducted and the process is therefore less expensive. In fact, 87 per cent of the PCT applications go to one of three patent office for search: those in the United States, Europe, and Japan. Most of the other systems rely on them for the search process and follow them in a number of other areas. Therefore the brief account that follows focuses on these three major systems.

EPO patent grants are issued for inventions that are novel, mark an inventive step, are commercially applicable, and are not excluded from patentability for other reasons (Article 52, EPC). The statutory requirements for patentability in the United States are similar: 'any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof' may be patented (35 US Code 101-103 and 112). By itself, this definition does not create a subject matter restriction, although it has long been held that laws of nature, physical phenomena, and abstract ideas are not patentable subject matter.

The origins of the Japanese patent system date back to the Meiji Era (1868–1912). Early patent laws in 1885 and 1899 were modeled on French, US, and then German patent law. In 1899, Japan acceded to the Paris Convention for the protection of industrial property. The patent law was completely revised in 1909, 1921, and 1959. Today, in Japan, patent rights are still protected by the Patent Act of 1959, frequently amended since then (JPO, 2006; Kotabe, 1992). Two important recent changes were the introduction of a product patent in 1976 and the switch to allowing multiple claims in a patent in 1987, both of which have the effect of bringing the system closer to those in Europe and the United States (Nagaoka, 2006).

US patent applications must be filed within one year of the invention's public use or publication – this year is called the 'grace period', intended to allow researchers some ability to publish their results in a timely manner without losing the possibility of patenting them. In Europe and other jurisdictions, there is no grace period. Alone among the world's patent offices, the US Patent and Trademark Office operates a 'first-to-invent' rather than a 'first inventor-to-file' system. In either case, the applicant must be the inventor (except in certain special cases such as death or mental incapacity), but in the US system priority is assigned to the inventor who can show that he reduced the invention to practice first. Also unique to the United States is the fact that patent applications are not made public automatically. Ordinarily patent applications are published 18 months after their priority date, but in the United States an applicant may request exemption from this rule if he files an application on the equivalent invention only at the United States Patent and Trademark Office (USPTO) and in no other jurisdiction.

Many patent offices have a provision for challenging patents following their issue. In the United States, any third party may request re-examination of a patent during its lifetime, although for various reasons related to potential subsequent litigation this opportunity is rarely taken up. In Europe and Japan, robust patent opposition systems with limited time frames operate, and these systems are often used by rival firms as an alternative to more expensive litigation (Hall et al., 2003). In Europe this avenue of challenge is particularly attractive because it is the last opportunity to attack a patent at the European-wide level rather than in individual national courts.

Patents are valuable only if they can be enforced and this fact has a number of implications for their use. First, the ability of the courts to reach the 'correct' verdict with respect to infringement and validity will matter; in situations or jurisdictions where there is a great deal of uncertainty about the outcome, and even if both parties agree as to the merits of the case, it may be worth pursuing the issue further or in some cases, reaching a private financial settlement to avoid a random outcome in the courts. Second, the costs of litigation will matter: parties with deep pockets can threaten those with less access to resources, or where the opportunity cost of paying attention to a patent suit is high. On the other hand smaller parties with less to lose can also hold up firms with large sunk investments that they might lose. Finally, the threat of litigation may discourage firms from even entering certain areas, thus providing a disincentive rather than an incentive for R&D. Lerner (1995) documented this phenomenon for biotechnology. The degree to which these kinds of threats matter depends to a great extent on the costs and extent of litigation, both of which tend to be higher in the United States than in many other countries.

Research on patent litigation is difficult because of the data collection problem (it frequently requires accessing the records of courts in several different jurisdictions) but in recent years there have been series of studies of US patent litigation (Moore, 2000; Lanjouw and Schankerman, 2001; Bessen and Meurer, 2005) and at least one of the German system (Cremers, 2004). All of these studies document the fact that litigated patents tend to be the more valuable. The US studies also show that only about five per cent of such suits go to trial, with the remainder being settled before going to trial. They also show that whether patent litigation has increased depends on whether it is measured in aggregate or per patent. That is, the increase in patent litigation has roughly paralleled the increase in patenting, at least in the United States.

Economics of patents

The economic view of patents is that they offer a bargain between society and the inventor: in return for a limited period of exclusivity, the inventor agrees to make his invention public rather than keeping it secret. Therefore, one of the central questions that arises when patents are used a policy tool to encourage innovation is whether this tool is effective. The theoretical literature in this area produces somewhat ambiguous results. In the simplest case, where a patent corresponds to a single product and knowledge is not cumulative, clearly patents do encourage innovation. In fact, the early theoretical industrial organization literature on patent races seemed to suggest that patents produced too much innovation (Wright, 1983; Reinganum, 1989). However, models that incorporate the cumulative nature of innovation or the fact that production of something new frequently relies on patents held by a large number of entities produce more ambiguous results (Judd, 1985; Bessen and Maskin, 2006).

This question has also proved exceedingly difficult to answer empirically, largely because of the absence of real experiments. Some researchers have looked at historical eras when there were changes to the system and examined the consequences for subsequent innovative activity, measured either by patenting in a jurisdiction not affected by the changes to the system or by invention counts obtained independently (Lerner, 2002; Moser, 2005). A second widely used approach is to survey firms and ask about their patent use (Levin et al. 1987; Cohen et al. 2002; Arundel, 2003). Using these kinds of survey data matched to R&D spending and innovation outcomes, more structural approaches have been pursued by Baldwin, Hanl and Sabourin, 2000; Arora, Ceccagnoli and Cohen, 2003; and Bloom, Van Reenen and Schankerman, 2005, among others.

A few conclusions emerge from this body of work. First, introducing or strengthening a patent system (lengthening the patent term, broadening subject matter coverage or available scope, improving enforcement) unambiguously results in an increase in patenting and also in use of patents as a tool of firm strategy (Lerner, 2002; Hall and Ziedonis, 2001). It is much less clear that these changes result in an increase in innovative activity, although they may redirect such activity toward things that are patentable and are not subject to being kept secret within the firm (Moser, 2005). Sakakibara and Branstetter (2001) studied the effects of expanding patent scope in Japan in 1988 and found that this change to the patent system had a very small effect on R&D activity in Japanese firms.

The survey evidence from a number of countries shows rather conclusively that patents are not among the important means to appropriate returns to innovation, except perhaps in pharmaceuticals (Levin et al., 1987; Cohen et al., 2002; Arundel, 2003). More important means of appropriation are usually superior sales and service, lead time, and secrecy. Patents are usually rated as important only for blocking and defensive purposes. Thus, if there is an increase in innovation due to patents, it is likely to be centred in the pharmaceutical and biotechnology areas, and possibly specialty chemicals. Arora, Ceccagnoli and Cohen (2003) found that increasing the patent premium, which they describe as the difference in payoffs to patented and unpatented inventions, does not increase R&D much except in pharmaceuticals and biotechnology. Using aggregate data across 60 countries for the 1960–90 period, Ginarte and Park (1997) found that the strength of the patent system is positively associated with R&D investment in countries with high median incomes (that is, G-7 and others), but not in lower-income countries.

Recently it has been suggested that the existence and strength of the patent system affects the organization of industry by allowing trade in knowledge, which facilitates the vertical disintegration of knowledge-based industries and the entry of new firms that possess only intangible assets. The argument is that, by creating a strong property right for the intangible asset, the patent system enables activities that formerly had to be kept within the firm because of secrecy and contracting problems to move out into separate entities. Although limited, research in this area supports this conclusion in the chemical and semiconductor industries (Arora, Fosfuri and Gambardella, 2001; Hall and Ziedonis, 2001).

Economic analysis has also been used to address the optimal design of the patent system. The seminal work in this area was Nordhaus (1969), which considered two policy instruments: the length of the patent term and the breadth of the patent, that is, the range or scope of the inventions covered. The broader the scope of a patent, the larger the number of competing products and processes that will infringe the patent, and the larger the market power of the patentholder. Later work by Gilbert and Shapiro (1990) and Klemperer (1990) built on and extend his method of analysis. Unfortunately, even though all three sets of authors simplified the problem by assuming that a patent corresponds to a product and that there is no uncertainty, the welfare conclusions still turn on assumptions about the nature of the product market and the existence of close substitutes for the patented product. The main conclusion from this line of work is that optimal patent design is likely to depend on the nature of the product market and the technology, which is inconsistent with long-standing practice and policy in most patent systems. Historically, the only important exception to the homogeneous treatment of technologies is the extreme one of excluding some of them (such as pharmaceutical products, medical practices, or disembodied software) completely from the system.

Recent theoretical and empirical work on the patent system has focused on a set of questions that have increased in importance because of the complexity of modern technology and the growth in patent use in sectors that traditionally had paid relatively little attention to them. Briefly described, the new setting is one where a single product involves hundreds of patents, and where one innovation builds directly on many others. Neither feature is really new, but both have assumed increasing importance in a number of technology areas such as information technology and biotechnology. At a theoretical level, Scotchmer (1991; 2005) was the first to identify the problem that cumulative innovation creates for the patent system, in the sense that it is difficult if not impossible to set incentives at the correct level for both the first and subsequent innovators.

When development of an innovative product requires multiple patent inputs, Heller and Eisenberg (1998) have argued forcefully that the licensing solution may fail because of transactions costs if a large number of patentholders are involved. One consequence of this fragmentation threat may be increased defensive patenting by the product developer. Empirical evidence for this proposition has been provided by Ziedonis (2004) in the context of the semiconductor industry.

Using patent data

Researchers into the economics of innovation and technical change frequently find themselves in need of measures of innovative output or success, preferably classified by sector or technology. Many would also like measures of knowledge flow between individuals and firms, given the potential importance of spillovers in the production of knowledge. In recent years, the growth in importance of the knowledge economy worldwide has lead to an increased interest in such measures. As was noted long ago by such pioneers in the field as Schmookler (1966), patent data can be very helpful in constructing them. The primary advantage of patent data is that they are available over a wide range of countries and years, for detailed technology classes, and they contain information on inventor, geographic area, and owner (if there is one other than the inventor). Together, these data provide information on the locus and type of newly created knowledge. The second advantage is that they provide information on links between different quanta of knowledge via the citations to other patents and non-patent documents that they contain (see Jaffe, Trajtenberg and Fogarty, 2000, for further justification of the use of patent citations to model knowledge flow and for the limitations of the measure). With the possible exception of data on scientific paper publication, no other data source comes even close to providing this level and quantity of information about the creation and dissemination of new knowledge.

The use of patent data as a proxy for innovation output in the economic analysis of technological change dates back to the path-breaking analyses of Schmookler (1966) and Scherer (1965). An overview is given in OECD (1994). The availability of information from the US patent office in machine-readable form in the late 1970s enabled research using these data with much larger samples of firms; the resulting early work is reported in Griliches (1984) and then surveyed by Griliches, Pakes and Hall (1987) and Griliches (1990). At the same time, Schankerman and Pakes (1986) pioneered the use of renewal data from the patent offices of several European countries to estimate the value distribution of patents; at the time, such data were not available for the United States owing to the absence of renewal fees in that country.

The results of this early work were, first, to demonstrate a strong correlation between the size of a firm's R&D effort and its patenting output, with little evidence that smaller programmes and firms yielded more output per unit of input, once selection was controlled for. Second, the renewal data, along with pieces of evidence from some specific sectors such as pharmaceuticals (Grabowski and Vernon, 1994) and medical devices (Trajtenberg, 1990), suggested that the value distribution of patents was very skewed, with a few patents worth a lot and most patents worth nothing. Third, there was little evidence that patent outcomes added much predictive power to sales, profits, or market value equations in the presence of R&D expenditure (Griliches, Hall and Pakes, 1991).

With the advent of the personal computer and the increased access to computing power on the part of economic researchers, it became feasible to construct data-sets containing patent citations in the late 1980s, leading to a second wave of research. Similarly to a research paper, the patent document contains a set of references to earlier patents and scientific literature on which it builds; a typical patent referenced approximate five earlier patents in the 1980s, and an increasing number as time passes. These citations can be used to give an indication of the impact of a patented invention on the inventions in subsequent patents and to investigate an additional set of questions related to the flow of knowledge across time, space and organizational boundaries.

However, it is important to note that differences exist in citation practice between the US and other patent systems (see Webb et al., 2005, and Harhoff, Hoisl and Webb, 2006, for further discussion of this issue), and most of the validation of this methodology has been done using US data.

Researchers have used these data to explore questions involving spatial spillovers (for example, Jaffe, Trajtenberg and Henderson, 1993), knowledge flows among firms in a research consortium (for example, Ziedonis, Ziedonis and Silverman, 1998), and spillovers from public research (for example, Jaffe and Trajtenberg, 1996; Jaffe and Lerner, 2001). In using citations as evidence of spillovers, or at least knowledge flows, from cited inventors to citing inventors, it is clearly a problem that many of the citations are added by the inventor's patent attorney or the patent examiner, and may represent inventions that were wholly unknown to the citing inventor. On the other hand, in using citations received by a patent as an indication of that patent's importance, impact or even economic value, the citations that are identified by parties other than the citing inventor may well convey valuable information about the size of the technological 'footprint' of the cited patent.

Beginning with Trajtenberg's (1990) study of the welfare impact of CAT scanners, there are by now number of studies that 'validate' the use of citations data to measure economic impact, by showing that citations are correlated with non-patent-based measures of value. Hall, Jaffe and Trajtenberg (2005) investigated the use of citations as an indicator of private invention value in a large sample of publicly traded US manufacturing firms and confirmed that, although patent yield conveys little information beyond that conveyed by R&D spending, citation-weighted patents are strongly related to market value in a nonlinear way, with very highly cited patents worth a great deal more than those with less than average citation.

Recent work by Lanjouw and Schankerman (2004) also uses citations, together with other attributes of the patent (number of claims and number of different countries in which an invention is patented) as a proxy for patent quality. They find that a patent 'quality' measure based on these multiple indicators has significant power in predicting which patents will be renewed and which will be litigated. They infer from this that these quality measures are significantly associated with the private value of patents. Similarly, Harhoff et al. (1999) surveyed 962 holders of German patents that had a priority date of 1977, asking them to estimate at what price they would have been willing to sell the patent right in 1980, about three years after the date at which the German patent was filed. They find both that more valuable patents are more likely to be renewed to full term and that the estimated value is correlated with subsequent citations to that patent. As in Hall, Jaffe and Trajtenberg (2005, p. 23), the most highly cited patents are very valuable, 'with a single U.S. citation implying on average more than $1 million of economic value'.

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See also innovation; intellectual property

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World Intellectual Property Organization