ON THE ABUSE OF PATENTS AS ECONOMIC INDICATORS

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Patents have a long history as a proxy for inventive activity. Although these data lost ground in the early 1960s to other measures of technical innovation, they have once again become fashionable in the last decade. There are many reasons to justify their use, ranging from their availability to the fact that they are by definition related to inventiveness and that they appear to be based on an objective and only slowly changing standard. There are, however, many empirical issues and problems in drawing inferences from these data, some well-known, others rarely mentioned. It is the purpose of this article to demonstrate that these drawbacks are major and that consequently patent data give, at best, a very partial and misleading picture of innovation and technical change.

The use of patent data as a proxy for economic and inventive activity is not new. Such data have been used in numerous studies of the relationship between firm size on the one hand and the volume of investment or the rate and direction of innovative activities on the other. They have also been used as indicators in studies on a wide range of topics, e.g., long-run development, long wave theories, and the relationship between economic and technological change have been studied in this way. Comparative studies of industries and countries have also been undertaken using patent data as indicators (Basberg 1987; Cooper 1991b).

Although they lost ground in the early 1960s to other measures of technical innovation such as product count, research and development (R&D) spending, number of skilled personnel and Standard Industrial Classification (SIC) information, patents have once again become fashionable among scientometrists (Callon et al. 1992), economic historians (MacLeod 1988; Sokoloff 1988), economists (Jaffe et al. 1992; Jaffe and Palmer 1996; Lanjouw et al. 1996; OCDE 1996) and economic geographers (Ceh 1997) in the last two decades. It is no wonder that the idea that something interesting might be learned from patent data tends to be rediscovered in each generation, for in the desert of good measures of technical progress, as one economist puts it, "patent statistics loom up as a mirage of wonderful plentitude and objectivity . . . [they] are available; they are by definition related to inventiveness, and they are based on what appears to be an objective and only slowly changing standard" (Griliches 1990, p. 1661).

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The use of patent statistics rests, of course, on the assumption that they reflect inventive activity and innovation.

> After all, a patent does represent a minimal quantum of invention that has passed both the scrutiny of the patent office as to its novelty and the test of the investment of effort and resources by the inventor and his organization into the development of this product or idea, indicating thereby the presence of a non-negligible expectation as to its ultimate utility and marketability. (Griliches 1990, p. 1669)

Other economists have added:

> Among measures of the extent of innovation patents are unique in both the richness of the information they contain and in the breadth of their coverage. Patent documents contain detail on the characteristics of individual innovations (e.g., its technological area, or its citation to related innovations) and their inventors (both the inventor *per se* and the owner or the assignee of the patent) not available elsewhere. Moreover, unlike R&D expenditure data, which is at best available for a subset of larger firms, patent data is available for all firms and individuals over a very long time period. . . . These features of patent data make it possible to use them to study the efficacy of policies tailored to particular technological areas or specific types of firms, the cross country flows of benefits from the patent system, externalities in the knowledge generation process, and many related phenomena. (Lanjouw et al. 1996, pp. 1–2)

There are, however, many problems, most of them well-known, in using these sorts of data, although they are rarely dealt with in a serious manner by those using them. For example, there are a number of methodological problems in the collection of patent statistics. Some people will claim patents for a variety of reasons that are not related to the practical use of a given innovation. Another major problem is that there are most certainly many more people who have not gone through the trouble of seeking patents for their innovations than there are recognized patent holders. All in all, it can probably be said that, taken as a whole, what comes out of a patent office is at best representative of the technological potential of a given number of innovations, but certainly not of their technological actuality.

Although most researchers using patents—or for that matter most indicators of technological change—are quick to point out that these data are only indirect measures, "the data are used as if real reservations had not been made" (Basberg 1987, p. 138). In doing so, most researchers follow Schmookler's famous dictum (1966, p. 56): "We have a choice of using patent data cautiously and learning what we can from them, or not using them and learning nothing about what they alone can teach us."

Austrian economists, on the other hand, have long been hostile to the use of economic statistics and to the patent system (Oakman 1986; Rothbard 1993). There is no need, however, to invoke Austrian theory to oppose the use of dubious economic indicators such as patent data because, even on strictly empirical grounds, the case against these statistics is nothing short of overwhelming. It will therefore be argued that, no matter what the corrective strategies adopted by the researcher, patent data do not provide a reliable measurement of economic and inventive activity and have nothing in particular to teach us.

This article will first deal with the traditional rationales for and against the patent system, so as to put the data in perspective. It will then cover the main problems associated with patent data as a proxy for inventive activity by looking at a number of findings from older studies dealing directly or indirectly with the patent system. Even though the purpose of this article is not to deal with the functioning of the patent system or with its rationale, overlaps with these topics cannot be avoided.

The Patent System in Theory and Practice

The Theoretical Nature of Patents

In theory, a patent is an official document that confers proprietorship (i.e., the exclusive right to make, use, or sell) of an invention on the recipient. It is granted by an official of the State in accordance with patent law and is enforceable in the courts. Grant of a patent is preceded by examination of applications by the patenting authority, but the final responsibility for validating or invalidating a patent lies with the courts. If a patent is granted, a public document is created containing information about the inventor, his employer, and the technological antecedents of the invention. Among this information are claims that serve, along with "references" and "citations," the legal function of delimiting the scope of the property right that the patent constitutes. The right embedded in the patent can be assigned by the inventor to somebody else, usually his employer, or it can also be sold to or licensed for use by somebody else. In order to be eligible for patent protection in America, an invention must be: (1) new and not obvious; (2) not previously achieved by someone else; (3) useful and important; and (4) not injurious to public morals and health. Patents may be obtained on machines, manufactures, compositions of matter and processes, as well as on combinations of these. In addition, patents can also be obtained on certain designs and on genetically engineered organisms.

A patent grants its owner the right to exclude others from making, using, and selling the invention for a period of 20 years from the filing date. There are special circumstances where a patent owner cannot use his own invention because it would infringe on the patent rights of others.[1] In return for the right to exclude those who copy the invention and those who independently discover the same thing, the inventor must disclose the invention to the public at the time of the patent's issue. This disclosure, contained in the patent itself, must be sufficiently detailed so that those "ordinarily skilled in the art" may copy and utilize the invention after the patent's expiration or without undue experimentation (this is known as "enablement"). While the patent is in force, however, the inventor is given the right to control the use of his knowledge. It should be noted here that some American states allow a person who invented something patented independently and before the patentee, to continue applying the invention for which the patent was issued (this practice is usually known as "prior user right").

[1]For example, inventor Jones patents a device comprised of components A, B, and C. Inventor Smith improves on Jones's invention by adding D. Smith *can then get a patent* on the new device with components A, B, C, and D. Inventor Smith can prevent everyone from using the device with components A, B, C, and D, however, Smith cannot use it either because it infringes on Inventor Jones's patent. On the other hand, Jones cannot add component D to his patented device because that would infringe on Smith's patent. What results then is a cross-license between the original and improvement patent owners.

The Case for the Patent System

The rationale for the patent system is completely utilitarian. Intellectual property is said to be property no less than a house or a car and, as most will acknowledge, property rights are a critical prerequisite for economic growth. Supporters of the patent system usually argue that it is an important incentive to entice the inventor to put in the work required to produce an invention. Without it, it is said, there would be no suitable way for the innovator to appropriate a decent part of the social benefits of his invention.

To put it briefly, the social returns from innovative activities are held to be very high, but it does not necessarily follow from this that the private returns (i.e., the returns to the innovating firm or individual) are also high. Once new information is produced, it is deemed to have become what most economists call a free or a public good (i.e., its use does not diminish its stock and it cannot be appropriated by individuals). If information about inventions is made available as soon as it is discovered, there might then be no incentive for anyone to take the risks involved in spending money on necessary research and development. Inventors can not therefore reap the benefits of their work without special safeguards, because once their inventions have been implemented or otherwise disclosed, they can be freely copied by others in the absence of protection. Why then should an inventor devote time or money on developing a better mousetrap if a competitor who does not need to recoup the R&D costs can undercut him? The absence of a patent system, it is therefore argued, adversely affects the development of inventions.

The stated purpose of patents is thus to encourage innovation and technical progress by providing a temporary monopoly for the inventor and by forcing the early disclosure of the information necessary for the production of an item or the operation of a new process. It is argued that any welfare losses due to the restrictions in disseminating an invention are outweighed by the incentive to invention they provide. It is therefore commonly said that patents promote technological ingenuity, enrich nation's economies, offer a proper measure of the technological and economic state of a society, and compensate deserving individuals for their hard work (Silberston 1967; Taylor and Silberston 1973; Walker and Bloomfield 1988).

Rosegger (1986, pp. 146–47) has summed up the main economic arguments usually put forward by proponents of the patent system: (1) well-defined and protected property rights are essential to a market economy in which rational self-interest guides the behavior of individuals; (2) although patents confer monopoly rights, the fact that the technological bases for these rights are made public contributes to the body of generally accessible information; (3) the patent system provides the necessary incentives for further investment in technological advancement; (4) even in the age of large-scale corporate inventing, patent protection is essential, because many modern technologies require large investments and long time periods for the development and commercialization of new ideas; (5) to the extent that patents cover successful process innovations, lower costs of production and lower market prices will result even if the patentee behaves like a rational monopolist (i.e., short-run profit is maximized); and (6) the patent laws encourage the development of improved products, because they allow firms to extend their monopoly positions through improvement patents.

The Case Against the Patent System

There has always been a set of thorny questions about the patent system. Historian of technology George Basalla (1990, p. 120) has stressed the most frequent ones: (1) Who is to judge if an invention is truly novel, useful, or important?; (2) On what grounds should these judgments be made?; (3) Should we accept the inventor's word about originality in evaluating an invention?; (4) Are patents inherently elitist, monopolistic, and therefore antidemocratic?; and (5) Are some discoveries—scientific laws, mathematical theorems—truly unpatentable?

Rosegger (1986, pp. 147–48) has also summed up the traditional economic arguments against the patent system: (1) patents create monopolies, and all monopolies involve a misallocation of society's resources; (2) in a socially optimal system of knowledge production must reflect the fact that the marginal cost of using existing information is zero and therefore the creation of "artificial" property rights is wasteful; (3) patent holders may capitalize on inventions by suppressing their development, even though these inventions would benefit the public; (4) patents lead to waste by inducing others to invent around or "patent around"[2] protected monopoly positions; (5) because there is no legal presumption of the validity of a patent, the equal burden of proof falling upon patentee and alleged infringer is anything but equal in economic terms. It must be pointed out that there is in fact a legal presumption of validity of patents; and (6) patent protection is unnecessary as an incentive for technological effort, because inventors can rely on other technical and institutional factors to achieve quasi-rents.

Analytical and historical examinations of patents and their meaning for technology and economic growth are generally deemed inconclusive. The general conclusion is that we must be cautious about accepting at face value the many flattering assessments of the modern patent system, because patents do not play anything like a dominant role among the various mechanisms by which returns from innovation are captured. A number of studies conducted by several authors over a span of more than 40 years (1957 to the present) have asked whether inventors find patents useful for excluding imitators and/or capturing royalty income. The answer uniformly found was that patent grants are not useful for either purpose in most industries (Svetos 1996; Hippel 1988).

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[2]Winter (1989, pp. 48–49) has defined *patenting around* in the following way:

> At the benign extreme, this term may simply mean providing through independent inventive activity an effective functional substitute for the patented process or product, so that the patent does not block the achievement of some larger innovative goal. The knowledge borrowed from the prior inventor's contribution could be limited to, at most, the insight that the function in question is a useful one to perform. Nothing remotely approaching patent infringement may be involved. At the other extreme, however, the new solution skirts the edges of the existing patent's scope with just enough room to spare to make a successful infringement action unlikely—and the judgment about what is enough room may invoke assessment not only of the legal scope of the existing patent, but also of the strategic stakes, resources, alertness, and litigation-proneness of the patent holder. In between these extremes there lies a broad interval where the borrowing from the prior inventor is very real but probably noninfringing under prevailing patent law.

As is well-known, most important inventions will be patented *around* long before their patents expire (Mansfield 1987).

In general, while the results vary by industry, the imitation-cost increases caused by patents are quite modest, and the speed of imitation is fairly rapid even with patents. Also, most patented products and processes would have been introduced even without patent protection. The only industry that appears to be a real exception to the rule that patents are relatively unimportant is the pharmaceutical drug industry. The most frequently cited reasons for that state of affairs are that unusually strong patents are obtainable in the chemical field, of which pharmaceuticals is a part, and that it is often difficult to invent around a pharmaceutical patent. The fact that the pharmeceutical industry is by far the most heavily regulated of all makes the importance of patents in it understandable (Hippel 1988; Winter 1989; Svetos 1996). This issue will be explored further in the following section.

Skeptics concerning the true effect of the patent system also point toward a number of factors, such as the inefficient allocation of resources due to the patent system, the prominent role of "patenting around," changes in the allocation of research funds, increased secrecy, substantial legal and administrative costs, an arbitrary incentive to focus on the sorts of research which are patentable, and differential effects depending on the stage of industry development. Besides, as will be shown in more detail, all innovations are not patented and conversely not all patents are innovations.

PATENTS AS ECONOMIC AND INNOVATION INDICATORS

There is an impressive array of studies using patent statistics as a proxy to the process of innovation and technical change. The main advantages of patent data for quantitative analysis are fairly obvious: they are easily available and relatively cheap; they provide plenty of technical and geographical information about the invention, the inventor and his employer; and, they come in nice time-series that can go back to the middle of the nineteenth century (even further back for some countries). In fact, it is readily acknowledged by most practitioners that the current popularity of patent data probably owes much more to the growing availability of machine readable data files and on-line databases, and to the easy statistical treatments they allow, than to a newfound value in their validity as measures of innovative outputs (Statistique Canada 1985; Basberg 1987; Griliches 1990; OCDE 1994).[3] But there are still many problems with the use of patent statistics as economic and innovation indicators that were identified long ago. They are usually classified under two broad categories of problems: *identification* and *intrinsic variability*.

Problems of identification are those that are related to the correct measurement of a phenomenon, in all places and at all times. In the particular case of patents, these problems are generally viewed as twofold: one, not all innovations are patentable; and not all patentable innovations are patented (Statistique Canada 1985). We will, however, add two other considerations under this umbrella: there are strong biases in the delivery of patents related to the type of innovation under consideration, the size of the firm that produced the innovation, and the industry of origin of the innovation; and second, there are important data gathering and classification problems that are not corrected within patent data.

[3]For a detailed survey of these databases, see OCDE (1994).

Problems of intrinsic variability refer to the fact that patents differ considerably in their technical and economic significance and can therefore not be "weighted" appropriately. There are a number of drawbacks here: (1) some patents prove to have some economic value, whereas others will not be worth anything; (2) the purpose of some patents is purely defensive; and (3) patent requirements have evolved drastically over time and geographical space. Most authors using patent statistics usually acknowledge some of these problems and have come up with a variety of answers, ranging from the classic response that "patents are the best indicator available" to postulating a statistical relationship between the numbers of patents emitted and the true number of innovations in a given economy (Statistique Canada 1985; OCDE 1996). We will now look more closely at these various problems.

Many Inventions are Not Patentable

The boundary between what is and what is not patentable is sometimes fairly arbitrary and in some cases seems to reflect what can be feasibly administered by a patent office. Criteria will vary between countries, but the principle generally holds good that an invention can be patented only to the extent that it has a particular application in what economists normally think of as production.[4] Thus there can not be a patent upon an abstract philosophical principle, a mathematical algorithm, or a computer program, though a chip with a particular program coded into it might be patented. In Canada, scientific principles, theorems, simple ideas, ways of doing business, computer programs as such and medical treatments cannot be patented (OPIC 1994). Some very innovative things that can turn out to be of great economic value are therefore not patentable. This is especially true with new technologies where there might be some uncertainty as to the patentability of new inventions or innovations (Basberg 1987).

It has already been mentioned that a patent must theoretically be a description of an invention that is fully workable without further assistance from the patentee. This usually means that a patentable invention must be a physical result or a physical means of attaining some result, not a purely human means of attaining it. This brings in the question of local conditions and of tacit knowledge and technical know-how in innovative work. It is now well-known that the details of a process may vary greatly with the local conditions under which it operates or the purpose for which it is used, and that it is not always clear that an advance of knowledge can be put into words within the constraints of a patent application. Taylor and Silberston were thus told by many firms in the engineering fields that patent clearance on its own is seldom worth much compared with unpatented expertise:

> In most specific cases of selectivity in these fields that we investigated from the licensor's point of view, secret know-how or highly specific technical skills emerged as the effective barriers to imitation, and patents were rarely if ever a critical factor. (Taylor and Silberston 1973, p. 185)

As Winter also reminds us:

> Improvements in this sort of knowledge can occur, at the individual level, without conscious awareness of how improvement has been achieved or perhaps even of the

[4]As we have already seen, machines, manufactures, and compositions of matter, or combinations of these, as well as certain designs and genetically engineered organisms are patentable.

> fact that improvement has occurred. Similarly, coordination improvements in organizations may occur for reasons that are imperfectly and diversely understood by the participants therein. Knowledge advances of these types fall outside the realm of statutory subject matter for patents. Furthermore, the requirement that a patent application contain "a written description of the invention . . . in such full, clear, and concise terms as to enable any person skilled in the art to which it pertains . . . to make and use the same" (35 U.S.C. sec. 112) is an extremely demanding requirement when even moderately severe difficulties in articulation are present. In effect, it demands that the application be a complete instruction book for a "person skilled in the art." The fact that instruction books are not generally an efficient means of conveying improvements in skills is resoundingly attested by the fact that how-to books have not yet rendered firsthand instruction obsolete. (The exclusion from protection of processes that require "a mental step to be performed" is another quite explicit bar to the protection of tacit knowledge.) (Winter 1989, p. 51)

It must, however, be kept in mind that "numerous inventions depending substantially for their implementation on unpatented know-how *are* patented and this represents a departure in practice from the law's intention" (Taylor and Silberston 1973, p. 8).

Most Inventions are Not Patented

An invention is likely to be protected in one way or the other if it is thought to have some economic value, but there are at least two alternatives; patenting and secrecy. And as Taylor and Silberston (1973, p. 186) put it long ago: "At the risk of undue generalization, we would say that the existence of unpatented manufacturing know-how seems an overwhelming factor." In short, not all patentable inventions are patented. Some inventors can rely on other technical and institutional factors to earn a return on their investment. In these situations, the cost of patents, the fear of litigation, risk of disclosure, and the ease of inventing around a patent all play a role. Other inventors might simply want their new product in the public domain as quickly as possible in order to set a new standard and to establish themselves as leaders in their branch of industry.

There are a number of ways by which inventors can protect their innovations. The most obvious one is through secrecy, especially when the risk of disclosure and patenting around are high. A product or process improvement can be kept secret through ordinary steps, such as placing the process off limits to non-employees and then limiting in various ways the security hazard inherent in the access provided to employees. Trade secrecy protection theoretically lasts indefinitely and does not require a costly registration process. Of course, no inventions will remain forever secret; in time, reverse engineering or employees changing jobs will put an end to this situation. Despite this, there are still a number of ways to try to slow down that process. Companies thus routinely require provisions in employment contracts that preclude employees from disclosing the companies' proprietary information, both during and after employment; publications by employees can be screened to prevent disclosure of proprietary information, etc. Probably the most famous example of trade secret protection is the formula for the syrup for Coca-Cola, which has been held secret for many decades.

But secrecy is not everything. In cases where technological advances are very rapid, difficult to police, or costly to copy, patent protection may not seem worthwhile.

In many industries technology might in fact be progressing too rapidly and the lives of new products might prove to be so short that they may well be obsolete before a patent is issued. In this situation, inventions go unpatented because the patents would be literally valueless when issued. The *head start* of the inventor may be quite adequate to deter copyists, especially where industrial application of the invention is a relatively complicated matter. Other considerations, such as customers' *brand loyalty* or economies of scale, can also play a role in these situations.

The fact that firms in newly-developed and growing-product markets do not play a zero-sum game for some fixed amount of total sales is also well-known. Thus until the late 1980s, Digital Equipment Corp. (DEC) encouraged other companies to use its technology to make add-on products that would raise demand for its computer (Coy et al. 1993). The patent holder for a superior new product might also confront resistance from industrial customers who do not want to rely on a single supplier. Automobile manufacturers were thus unwilling to make the modifications to wheel rims necessary for adopting tubeless tires as long as such tires were available only from the original patentee, B.F. Goodrich. Only by conceding the invention to its competitors could B.F. Goodrich generate any demand for its new product (Rosegger 1986, p. 141).

There is also another important reason why some firms will not want to patent their innovations. As was mentioned earlier, a patent gives a patentee the right to exclude others from using it, but it does *not* give him the right to use it if it infringes on the patents of others. Hippel has argued that not patenting an innovation is usually a better option.

> For example, Fairchild Semiconductor has a patent on the so-called planar process, an important process invention used in the manufacture of integrated circuits. If firm *B* invents and patents an improvement on that process, it may not use its improvement invention without licensing the planar process from Fairchild and in turn that firm may not use the improvement either without licensing it from firm *B*. Thus, in rapidly developing technologies where many patents have been issued and have not yet expired, it is likely that any new patent cannot be exercised without infringing the claims of numerous other extant patents. Given this eventuality, the benefit of a particular patent to an inventor would very probably be diminished because the patentee might be prevented from using his own invention or might be forced to cross-license competitors holding related patents in order to practice his invention. (Hippel 1988, pp. 51–52)

Many social scientists relying heavily on patent data to study technical change have, however, come up with various results showing that the propensity to patent patentable inventions is rather high (OCDE 1996). Based on a survey of 100 firms, Mansfield (1987) has thus argued that between 66 and 87 percent of patentable inventions were filed for patents. A survey done by *L'Office européen des brevets* on European firms of up to 1000 salaried workers has shown that a quarter of these firms were trying to patent more than 90 percent of their patentable inventions, whereas another quarter were trying to patent between 50 to 90 percent of their patentable inventions. The PACE survey[5] has come up with results showing that 15 percent of firms try to patent between 80 and 100 percent of their product innovations, whereas 37 percent were doing so for less than 19 percent of theirs (OCDE 1996, p. 25).

[5]The European and Japanese follow-up to the Yale survey.

It might, however, be argued that it is doubtful that these figures have any meaning whatever, because of the subjectivity involved in determining what is a *patentable invention*. Actually, it is possible to file any number of patents on the same invention as long as you file *terminal disclaimers* along with them so as not to extend the terms. There are also many things that are patentable but that are commercially worthless, so no one ever considers filing for patent protection. It is also the impression of this writer that far less than the amount of inventions that companies' employees come up with are patented, if only because the shop floor worker who comes up with an innovation in a company usually doesn't get the credit for it (for example, the engineer in charge of production will put his name on the patent instead of the name of the true originator).

A different kind of research on innovation also illustrates the problem. Through a number of interviews in the residential construction industry, Slaughter (1991; 1993) has documented all significant innovations relating to a single technology, the stressed-skin panel.[6] Of the 34 innovations[7] sampled, 28 were made by users and 6 by manufacturers. Eight of these user innovations in stressed-skin panels were commercialized by manufacturers, while 20 were not. More interestingly though, only 5 of the 34 innovations sampled were or would possibly be under patent protection. These were: a modified air-compression nailgun, a clip connection system, a cam-lock joint, a rolled steel joint, and the insecticide-impregnated foam core (Slaughter 1993, p. 85). In a similar type of reserarch on Silicon Valley's semiconductor industry, Rogers (1982, p. 118) has found that most of his respondents considered that "much technological information is not patented by private firms."

Bias in the Propensity to Patent

Many inventions are not or cannot be patented. There are, however, a number of biases in the propensity to patent which can be related to the type of invention that is patented, the size of the firm that is patenting, and the industry of the firm that is patenting.

Type of Invention: It is generally agreed that process innovations (i.e., mostly production methods and special techniques) are much less likely to be patented than product innovations, secrecy being deemed much more efficient to protect process innovation than the patent system (Statistique Canada 1985, p. 20; OCDE 1996, p. 44). Respondents to the Yale survey of R&D executives have thus pointed out that with a single exception (petroleum refining), patents were rated more effective in preventing product duplication than process duplication. On a seven point scale, two-thirds of the scores in the product column were above the midpoint level of 4 ("moderately effective"), while roughly two-thirds of those in the process column were below that level (Winter 1989, p. 48). The results of the PACE survey (OCDE 1996, p. 24) were even more drastic; according to this study, only 7 percent of the surveyed firms said that they frequently used patents for

[6]A stressed-skin panel is a *sandwich* of a solid core of plastic insulative foam laminated to the facing materials, where the facing materials or "skin" carry some portion of the building load. The panel acts similarly to an I-beam to distribute the load. The facing materials can be made of plywood, other structural wood sheets, gypsum board, or metal. The plastic foam core is not only a connecting web between the facing sheets to distribute the load, but is also a thermal insulating material.

[7]In this study, an innovation is defined as anything new actually used in a project (Slaughter 1993, p. 85).

process innovations, whereas 57 percent said that only in very rare occasions would they try to patent process innovations.

Size of the Firm: The size of the firm is also an important factor in the propensity to patent. Although some authors have argued that patenting underestimates the innovation output of big firms, which appear to show a lower propensity to patent than their smaller counterparts[8] (Mansfield 1987), it is widely recognized that the patent system does not do much to encourage the lone inventor or the small firm and that it instead tends to make industry structures more rigid than they would otherwise be. There are many reasons for this situation, ranging from the huge amounts of money needed to use the patent system successfully (to file applications, to manage a portfolio of patents in many countries, to renew patents, to engage patent agents, and to sue alleged infringers in courts) and to the fact that small firms or lone inventors, unlike large firms, do not employ patent lawyers and other personnel solely for that purpose. Many simply cannot afford these costs or consider the expected return on their investment as uncertain or lower than the costs incurred.

As one critic has put it:

> There are many issues involved with the transfer of intellectual property. One is the time it takes to get a patent, the legal hassles, and the other negotiations that have to take place in any kind of intellectual property scenario. The intellectual property process often intimidates and impedes the entrepreneurial process and seemingly takes forever. (Ball 1992, p. 58)

One principal argument supporting this claim is the growth of patents held by corporations which rose in the United States from 18 percent at the turn of the century to more than 60 percent in the early 1970s (Silberston 1967). Recent studies also show that fewer than 700 firms in the United States now claim more than 60 percent of patents (OCDE 1996). Many critics have thus argued that patents are usually nothing more than *license to litigate* or even *protection money*. Although this is undoubtedly true in some instances, it should be pointed out that most of the evidence suggests that most firms do their best to avoid the cost of litigation.[9] There are a number of reasons for that, ranging from the large scope for compromise to the unlikelihood of achieving outright victory,[10] to the time and cost of a court hearing.[11]

Industry of Origin[12]: Besides differing according to firm size, the propensity to patent also differs across industries. This is mostly related to the possibility of "inventing around" patents and to the pace of innovation in a given industry, where an invention might be obsolete before the patent is granted. For example, it

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[8]For example, small Canadian enterprises typically patented one invention per $275 million (in sales) in 1975. Large Canadian inventive enterprises usually patented one invention per $131 million (in sales) in 1975 (Ceh 1997, p. 69).

[9]This issue is more thoroughly dealt with in the section "Defensive Nature of Many Patents."

[10]During the 1960s and 1970s, 72 percent of all litigated patents were declared in various courts to be invalid (Edson 1993, p. 25).

[11]Legal fees in patent-infringement suits can run a half-million dollars or more, and long delays are common.

[12]It should, however, be pointed out that there are a number of problems with the usual industrial classification. This topic will be addressed in more detail in the subsection "Methodological Problems in Patent Data."

appears that patents in chemicals are much stronger than in those of mechanical inventions (Hippel 1988; Winter 1989; Edson 1993).[13] These sectoral biases are not new, although there have been a number of changes in the industries which were better covered by the patent system (MacLeod 1988).

These days the pharmaceutical industry comes out on top in every study of the propensity of industries to patent, while fields where technology is changing rapidly, especially in the area of electronics, are ranked at the bottom (Taylor and Silberston 1973; Winter 1989; OCDE 1994 and 1996). Thus according to a survey of 100 firms covering the years from 1981 to 1983 inclusively, but excluding very small firms, patent protection was judged to be essential for the development or introduction of 30 percent or more of the inventions in only two industries, pharmaceuticals and chemicals (Mansfield 1987). In another three industries (petroleum, machinery, and fabricated metal products), patent protection was estimated to be essential for the development and introduction of about 10 to 20 percent of their inventions. In the remaining seven industries (electrical equipment, office equipment, motor vehicles, instruments, primary metals, rubber, and textiles), patent protection was estimated to be of much more limited importance. Indeed, in office equipment, motor vehicles, rubber and textiles, the firms were unanimous in reporting that patent protection was not essential for the development or introduction of any of their inventions. The PACE survey has similarly shown that 54 percent of firms in the pharmaceuticals industry try to patent more than 80 percent of their product innovations, whereas virtually no firm in the basic metal sector has anything to do with patents (OCDE 1996, p. 43). Furthermore, 77 percent of all firms surveyed only try to patent between zero and 19 percent of their product innovations; and the percentage of firms surveyed that never use patents is estimated to be 10 percent in Germany, 15 percent in Italy and in small European countries, and 17 percent in the United Kingdom (OCDE 1996, p. 44). It can also be pointed out that public institutions such as universities and research laboratories used to show a much lower propensity to patent than private institutions such as firms and private laboratories, but that they have in recent years become much more active players in that respect (OCDE 1996; Svetos 1996).

Methodological Problems in Patent Data

There are a number of methodological problems in the supposedly neutral information contained within patent data. There is about no consistent practice with respect to the names to which corporate patents are assigned. As was pointed out, corporate patents can be signed by a designated lawyer or engineer, not by the actual inventor (who may be a shop floor worker). The location of the origin of an invention is also problematic. For example, when patent statistics are used to analyze the spatial distribution of innovative activity, a locational problem typically arises; namely, the risk that patents generated in the area analyzed may be granted to firms or subsidiaries in other locations and that patents granted to a firm located in a specific area may actually be related to innovations generated elsewhere. The risk is especially significant when large multi-plant corporations are concerned (Antonelli 1986).

[13]There have, of course, been a number of exceptions. The Polaroid and the xerography processes are cases in point.

Another serious problem has to do with industrial classification and the inter-industrial flow of knowledge. One aspect of the problem here is that firms frequently change their principal Standard Industrial Classification from one census year to the next, depending on which of the many products they make were in greatest demand at the time of the most recent census. The other is that many, if not most, technologies are linked across industries. Such inter-industry linkages mean that advances in one industry will depend on progress in a second and will set conditions for the evolution of a third.

If squeezing a firm into a somewhat arbitrarily defined industrial sector is often problematic, it usually pales in comparison with the classification of patents by industry. To put this succinctly, patent classification and industry classification are not comparable in any direct way. The industry of origin for a patent is not known by the patent office, because neither the inventor nor the firm for which he works (if any, of course) is asked to identify themselves by industry. All that the patent office usually knows is the technical nature of the invention. The United States Patent Office classifies patents into about 400 main classes with about 100,000 subclasses. This classification system is based primarily on technological and functional principles and is only rarely related to economists' notions of products or well-defined industries.[14] As Jacob Schmookler noted long ago:

> [A major] deficiency arose from the fact that I could not assign many inventions to a single industry. In part this resulted from my own ignorance, but often it reflected the interindustry character of technology. Thus, a given improvement in the diesel engine may be used in generating electricity or driving a locomotive, a given bearing may be used in a shoemaking machine or a lawn mower, and a given knife may be used in harvesting or in kitchens. In consequence, the patent statistics used below generally do not include power plant inventions, electric motors, bearings, or other instruments or materials whose industry of origin was either multiple or simply not evident. Unfortunately, this means that the railroad data do not include inventions in the field of the steam or diesel engines, and that neither the farm nor the construction data include inventions on tractors. (Schmookler 1966, p. 23)

Griliches (1990, p. 1666) also adds some examples of his own. Thus a subclass dealing with the dispensing of liquids contains both a patent for a water pistol and for a holy water dispenser. Another subclass relating to the dispensing of solids contains patents on both manure spreaders and toothpaste tubes.

The problem of classification is thus real. Before any classification is attempted, the investigator has to face the inherent ambiguity of the task. Does he want to assign the invention to the industry in which it was made (industry of origin), to the industry that is likely to produce it (producing industry),[15] or to the industry that will use the resulting product or process and whose productivity may thereby benefit (destination or industry of use)?

> Consider, as an example, the case of a new plow invented in a chemical firm's research laboratory as part of its project on new combined fertilizer and tillage systems. It

[14] Griliches (1990, p. 1666) even adds that the economist's notion of a well-defined industry "may be a mirage anyway."

[15] Perhaps the most valiant attempt at attributing an industry of origin to patents is Scherer (1987a).

> depends on what question is to be asked of the data. If we want to study the returns to R&D expenditures we may wish to count it in the chemical industry whence the money came to develop it. If we want to analyze the impact of technological change on the rate of investment, on the sale of new equipment, we may wish to count it in the farm equipment industry. If we are interested in its effects on measured productivity we are more likely to count it as being relevant to agriculture. This difference in questions reflects itself also in different classification strategies pursued by different researchers. (Griliches 1990, p. 1666)

There has always been a number of strategies to deal with this problem, but most of these have proven to be arbitrary and lead to a number of serious problems, most notably double counting (OCDE 1996). It can, however, be noted that for the last 25 years the Canadian patent office has compiled data on the "potential industries of use" for each patent. But to quote a respected writer on this topic: "most of the basic questions of classification still remain to be answered" (Griliches 1990, p. 1667).

Problems of Intrinsic Variability

As was mentioned earlier, besides problems of identification, there are also a number of problems of intrinsic variability with the use of patents as economic indicators. The study of Thomas Edison's patents will afford a first illustration. Israel and Rosenberg (1991) have compared the information available about Edison's inventions from artifacts and notebooks with the timing and descriptions of those inventions in patent specifications. They made the following observations: (1) Edison described and drew things that he could not construct; (2) he did not always patent aspects of his work that seem significant in retrospect; (3) the nature of the patent examination process could lead to very misleading claims in the issued patent without recourse to the full patent application record[16]; (4) Edison did not himself create his applications in their final forms and sometimes his attorneys "garbled almost to incoherence" several of his specifications; and (5) the patent application process can also lead to incorrect assumptions regarding time of inventive activity—even the date of filing[17] and execution[18] (when the inventor

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[16]Israel and Rosenberg (1991, p. 1096)

> In Edison's application for a siphon recorder for his automatic telegraph he initially claimed that the device would minimize the use of chemicals, a key feature of this instrument. On being notified that this claim had been registered for a previously patented device, Edison changed his claim to cover the placement of the receiving wires. This aspect of the invention allowed him to minimize the use of chemicals but had been only mentioned in passing in the original application. The patent as issued consequently tells the reader nothing about the real purpose of the instrument.

[17]Edison's attorneys sometimes held an application for months before filing, for no obvious reason. The modern tale of Stanley Cohen and Herbert Boyer, usually referred to as the modern fathers of biotechnology, can also illustrate this point. While collaborators at Stanford, they came up with inventions with regard to the recombinant DNA process in unicellular organisms and products made by recombinant DNA techniques. These inventions were developed without thought as to their patentability and it was nearly too late to file when an administrator at Stanford read about their research and contacted Cohen (Svetos 1996).

[18]Israel and Rosenberg (1991, p. 1098)

> Although Edison rushed to his patent attorney to cover the development of his electromotograph on the day he realized its uniqueness, he executed the application for his universal private-line printer, a fairly successful instrument, a full year

signs the application) have sometimes proven deceptive. The Edison case, although admittedly an ancient one, is a cautionary tale, and many of the same problems are still present in today's patent data.

In the remainder of this section, we will look more closely at the most serious problems of intrinsic variability: some patents prove to have some economic value whereas others will not be worth anything, the purpose of some patents is purely defensive, and patent requirements have evolved drastically over time and geographical space, making international and historical comparisons impossible.

Heterogeneous Economic Value of Patents

Obviously, if patent data are to have any practical value as indicators of technological change, it is necessary to show that the number of patents which indeed do lead to innovations is significant. But the fact that patents differ greatly in terms of their positive economic significance (i.e., the capacity of the innovation they describe to create true wealth) is well acknowledged and has been addressed in a number of ways (Griliches 1990, p. 1679; OCDE 1996, p. 25). The problem here, however, is that there are still no satisfactory measures of the significance of individual patents. Taken as a whole, patents are at best representatives of technological potential and not of technological achievement. It is therefore not an overstatement to say that most patents are almost valueless and that they end their lives unused in the files of corporations, patent offices, or lone inventors. To quote one strong believer in the use of patents as economic indicators: "Evidence . . . shows that the vast majority of patents is worth very little and that the bulk of the inventive system is based on a relatively small number of very valuable patents" (Griliches 1990, p. 1699). In 1869, United States Commissioner of Patents Samuel S. Sparks estimated that 10 percent of all patents had commercial value. Although nearly a century later economist Jacob Schmookler estimated the figure was 50 percent, many modern commentators still agree that Sparks's estimate holds true even now (Basalla 1988, p. 69). Some even write that the true number of economically worthless patents is probably closer to 95 percent (Poirier 1997).

There is, however, a more general issue at stake here, which is the true nature of the human creative process and its relation to the patent system. In short, it might be true that some inventions form the basis of entirely new industries or radically change existing technologies. These are very rare occurrences and may prove nothing more than an arbitrary selection of a basic intellectual breakthrough which remained for a long period afterwards far from a state of technical feasibility. Others provide small improvements in minor devices. The remaining, and largest, group have little or no economic impact (Basalla 1988, p. 115).

A point that is now well taken by most analysts of technological change is that innovation does not proceed through major breakthroughs by specific individuals, but through small and cumulative improvements that yield over time novel and useful artifacts (Rosenberg 1982). The patent system, however, is built on an

after beginning commercial production. The reasons for the difference between these two cases are fairly clear—the former was an unexpected, potentially important new development, whereas the latter was developed under a contract with a company that controlled nearly all patents in printing telegraphy and was thus virtually immune to danger from other inventors. Between these extremes, though, are many instances of patent applications and caveats executed weeks or even months after Edison recorded their conception or development in his notebooks.

entirely different view of technological change. Within it, an invention is uniquely identified with its inventor and its associations with existing artifacts are obscured. All of patent law is based on the assumption that an invention is a discrete and novel entity that can be assigned to the individual who is determined by the courts to be its legitimate creator. Thus, the patent system converts the continual stream of made things into a series of distinct entities and has historically led a number of well-known inventors such as Samuel Morse, Eli Whitney, and Thomas Edison to lie in court about the true nature of their inventions (Basalla 1988, pp. 60–61). But despite its intellectual underpinning, the patent system cannot entirely obscure the true nature of technological change. F.M. Scherer thus noted that: "as the bleary-eyed reviewer of some 15,000 patent abstracts in connection with research . . . [he] was struck by how narrowly incremental (adaptive?) most 'inventions' are" (Scherer 1987b, p. 124). Even the *Canadian Intellectual Property Office* had to confess that 90 percent of all patented inventions are minor improvements on existing patented devices (OPIC 1994, p. 8). And even though many technical people might believe what they have been told, i.e., that in the past there were revolutionary changes, it usually doesn't accord with their experience.

> Spokesmen in a number of firms said that in recent years there have been no technical developments of real importance in their fields from which patents have barred them. Several ventured the view that the era of the "master" or "basic" patent has largely gone and, although others (particularly in chemicals) would not agree entirely with this, it seemed commonly accepted among engineering and electronics firms that basic patents of great commercial significance (comparable to Western Electric's transistor patents in the 1950s or, on a lesser scale, the pre-war patents on xerography) are nowadays extremely rare.
>
> A second and not unrelated answer was encountered typically among manufacturers of plant and machinery: this was that in lines of activity where the basic technology is well established and has passed into the public domain, firms attempt to secure recognition for their products through variations in design and minor improvements which are either not patentable, or if patented, can be easily circumvented. (Taylor and Silberston 1973, p. 184)

Defensive Nature of Many Patents

Most social science studies that refer to patent use or to patents as a proxy of innovative activity typically do not emphasize what might be termed the *defensive* uses of patents, i.e., that patents can be used as bargaining chips or as means of reducing competition. It is thus well-known that many corporations protect the technology they are currently utilizing by accumulating hundreds of patents that form a *protective fence* around their products and processes. They are supposed to make it increasingly difficult for competitors to invent around, but the real goal of these patents, whose vast majority will remain undeveloped, is often to provide a shield behind which a corporation can retreat and protect itself from the potential threat of innovating competitors.

James Watt, for example, held a patent that covered noncondensing engines "wrought by the force of steam only." This claim effectively blocked the development of a high-pressure engine, even though Watt himself firmly opposed this and did not plan to develop one (Mokyr 1990, p. 247). Nineteenth-century bicycle manufacturer Albert Pope sought from the outset monopolistic protection by purchasing virtually every patent connected with the bicycle, some dating from the velocipede craze of the 1860s. By 1881 he had secured a patent monopoly that would not begin to deteriorate until 1886. Until he lost his patent position, Pope extracted a fee of $10 per bicycle from other manufacturers. When he first began selling bicycles, two other firms also made high-wheelers, yet his patent monopoly helped drive both companies out of business (Hounshell 1991, p. 199). The patent conflict between Thomas Edison's and Alexander Graham Bell's patents is well-known[19]; actually Western Union had encouraged the then young Edison "to patent as many different designs as possible in order to block rival companies from exploiting the systems of other inventors" and had on that occasion given him financial support to build his new laboratory at Menlo Park in the spring of 1876 (Gorman and Carlson 1990, p. 147). Indeed, the rise of almost all industrial research laboratories has been closely related to patent struggles between corporate rivals (Basalla 1988, pp. 124–29).

To understand the defensive nature of many patents an important feature must first be pointed out. The patent system places the burden of detecting infringers and suing for redress on the patentee. It is probably fair to say that such suits are notoriously long and expensive and that both defendants and plaintiffs tend to avoid them assiduously. It has been pointed out that although 11,962 patents were granted in the United Kingdom between 1770 and 1850, only 257 patent cases came before the courts (Dutton 1984, p. 71). Hippel (1988, p. 53) has described what he perceives to be a typical "avoid the courts" situation:

> Firm A's corporate patent department will wait to be notified by attorneys from firm B that it is suspected that A's activities are infringing B's patents. Because possibly germane patents and their associated claims are so numerous, it is in practice usually impossible for firm A—or firm B—to evaluate firm B's claims on their merits. Firm A therefore responds—and this is the true defensive value of patents in industry—by sending B copies of "a pound or two" of its possible germane patents with the suggestion that, although it is quite sure it is not infringing B, its examination shows that B is in fact probably infringing A. The usual result is cross-licensing, with a modest fee possibly being paid by one side or the other. Who pays, it is important to note, is determined at least as much by the contenders' relative willingness to pay to avoid the expense and bother of a court fight as it is by the merits of the particular case.

It must, however, be pointed out that Hippel's statement was first written in a journal article in the early 1980s, when courts were much more hostile to the patent system than they have become in recent years. It has subsequently been argued that the more recent pro-patent sentiment and the legal climate of American courts have made patents more valuable in a company's asset inventory (Edson 1993).

There have historically been a number of drawbacks to a system where patents challenged in court were likely to be held valid, especially following the radical shift in the granting of patents from inventors to corporations. A classic argument is that one person or corporation may gain control over a large number of patents, and then attempt to acquire others in order to dominate an industry, excluding competitors from the field by preventing them from using alternative processes.

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[19]The legal battle was, however, waged between Western Union and the American Bell Telephone Company.

Another means whereby large firms may gain control through patents is to acquire licenses on the patents of weaker firms by threatening to oppose the grant of their patents or even to petition for their revocation in the courts. The expense of such an action is often beyond the means of small firms—and certainly of the vast majority of lone inventors—who feel compelled to grant the licenses concerned. Other devices with monopolistic consequences are the accumulation of patents through time in order to perpetuate the exclusive position of a company even after the original important patents have expired.[20]

It is thus widely believed that the cost of patent litigation is often enough to intimidate lone inventors and small businesses or drive them out of the field regardless of the merit of their infringement case. It has often been said that for every inventor who prevailed in court against a big firm, or even got to plead his case, hundreds have lacked the stamina or finances to wage the arduous, expensive, and risky battle required. Many inventors over the years have also reportedly given up their court battles in frustration and many victories by the lone inventors have proven to be Pyrrhic, with litigation costs exceeding settlements.[21] Among the famous inventors who were destroyed by patent litigation were the flying shuttle's inventor John Kay, the engineer Jonathan Hornblower, and Charles Goodyear, the inventor of the rubber vulcanization process. Eli Whitney's patent wars over the cotton gin led to his arrest by his opponents and almost bankrupted him. The Foudrinier brothers, who introduced mechanical papermaking into Britain, went bankrupt in 1810 and spent much of the rest of their lives in prolonged and expensive patent litigation (Mokyr 1990, p. 249).

The relationship between the small inventor or firm and big corporations deserves closer examination. Taylor and Silberston who studied this question most carefully have given a balanced picture.

> Very few of those [big firm managers] consulted could recall instances of inventions submitted from individuals or very small firms that had been accepted, although one or two isolated cases were mentioned to us, but all said they were ready to welcome promising cases. Most of the inventions submitted are relatively simple-minded, although some show genuine technical expertise or ingenuity, and the main reasons for refusing to take them up are either that the idea is an old one or that it is simply not a commercial proposition. So far as we could tell, there seems no substance at all to the claim that the small man receives scant attention from the large firm, much less that the large firm attempts to pirate the small man's inventions after showing him the door. (Taylor and Silberston 1973, p. 322)

Taylor and Silberston (1973, p. 102) also mentioned that "the adverse publicity that tends to attach to a large company involved in a court action, especially where its opponent is an individual or a very small firm" always acts as a powerful deterrent against unethical behavior.

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[20]It is worth noting that under United States laws, building a protective fence through a company's own R&D efforts is legal, whereas buying up other firms' patents may be considered a violation of the law (Rosegger 1986, p. 145).

[21]A famous case in the United Kingdom was *Killick v. Pye*, where the winner went bankrupt after her action (Taylor and Silberston 1973, p. 327).

If it is true that most large firms use their patents in a somewhat legitimate manner, there have undoubtedly been cases where large firms have abused the system at the expense of small firms. The reverse is also true, although it is doubtful that these cases are very numerous.[22] It must, however, be noted that the number of actions between giant firms has soared in the last decades, especially between American and European firms on the one hand and their Japanese competitors on the other. Thus following its winning lawsuits against Korean and Japanese semiconductor companies, Texas Instruments has been receiving millions of dollars in licensing fees on patents that the company never developed into products of its own (Auriol and Pham 1993; Coy et al. 1993; Edson 1993).

Evolution of Patent Requirements over Time and Space

The Evolution of National Patent Systems: Patent systems vary greatly across countries and, to a large extent, over time because of judicial, geographical, economical, and cultural factors.[23] Even the OCDE has to conceded that international comparisons of the number of patents delivered in each country are meaningless (OCDE 1994, p. 17).

Edison's patents will once again afford an illustration. In the nineteenth century, British and Canadian patent law allowed far broader coverage in a single patent than did American law. Consequently, Edison applied for system-wide protection for his quadruplex telegraph and electric lighting with specifications that revealed the relations of components that he had to patent separately in the United States. It has also been pointed out that foreign patents also may be indicative of differences in competitive environments. Edison thus patented a telephone switchboard in Britain, but not in the United States (Israel and Rosenberg 1991, p. 1100).

Generally in terms of costs and procedures, the Japanese patent system is designed to encourage innovators to disclose strategic information sooner than the American system. On the other hand, American patents used to be much more detailed than their Japanese counterparts due to the fact that until recently the Japanese filed *single claim* patents, whereas in other countries each patent contains several claims. United States protection is broader than in most other countries, particularly Japan, partly due to the doctrine of equivalents, which can broaden protection beyond the claims in the patent according to similarity of function (Ordover 1991; Scotchmer 1991; Callon et al. 1993; OCDE 1994). And although there is a European Commission on Patents, there are still important differences between European countries (Auriol and Pham 1993). As one Italian researcher has put it: "Italy belongs to the group of countries where the Patent Office's examination is essentially based on formal aspects and not on the evaluation of the novelty of the invention" (Sirelli 1987, p. 158).

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[22]These actions by small firms or inventors are facilitated by "first-to-invent" patent system. Many authors have also written about "submarine patents," i.e., legal torpedoes issued to obscure inventors who convince the Patent Office that they had an idea first and then sock corporate giants for millions in royalties. To be more specific, a submarine patent is one that an inventor files, say, in 1950, and for which he keeps spawning continuations and divisionals to keep it alive, but secret for decades, while in the meantime industry independently develops and implements these ideas. Much later, say 1980, the patent finally issues, and surfaces like a submarine to make it now illegal to practice what has been done for many years.

[23]For a brief comparison of the European, American, and Japanese patent systems, see OCDE (1994).

A major philosophical difference between patent systems is the first-to-file versus the first-to-invent provision. The United States, along with Jordan and the Philippines, have a first-to-invent system under which an individual applicant for a patent must prove that he had the idea first, not simply that he won the race to the courthouse. He can assert this priority to the invention at any time. He is entitled to a patent if thereafter he has not suppressed, abandoned, or concealed the invention. This philosophy, which has guided the United States patent system since Jefferson, was established to protect the inventor who lacks the resources to keep up a stream of patent applications merely to invoke their priority (Edson 1993). The rest of the world has, however, adopted a first-to-file system on the contention that it better serves the public because it is simpler and conforms with the systems in almost all other countries. Moreover, it is argued that it spurs inventors to file for patents earlier and to disclose their inventions sooner, thus speeding the progression from idea to finished product. There are, of course, a number of drawbacks to this system, for example, the unlikely possibility of someone stealing the profits of an invention from the true inventor by beating him to the courthouse steps.[24] A more likely outcome is that patents will be put in very general terms in order to cover as much ground as possible.[25] The most plausible result, though, is an astronomical number of defensive patents and the litigation or licensing that will result from this.

There are also a number of other differences between countries having to do with pre-grant disclosure (i.e., the requirement that a patent "lay open" for a length of time after filing), pre-grant opposition (i.e., third parties can oppose the granting of a patent before it is delivered), licensing, royalties, etc. (Ordover 1991). Other arrangements are also possible. For example, in the pharmaceutical realm, Indian officials only grant patents on processes and not on products (Eswaran and Gallini 1994). There can also be differences that are cultural and not technical. For example, Japanese business culture is said to have valued patents much more than elsewhere in the post-war decades.

The filing and granting rates vary considerably between countries for a variety of reasons. In Japan in 1990, 380,000 patents were filed, while there were only

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[24]An interesting historical case is that of Guglielmo Marconi who, upon moving to England in 1896, "immediately and dramatically [applied and received] a patent on a method of transmitting signals by means of electrical impulses." This patent, the first issued anywhere in the world for radio telegraphy, encompassed virtually the entire technological application of the scientific work of Maxwell and Hertz. Marconi brought little that was new or original to the patent, but he was the first to claim existing methods, equipment, and circuits as *property*. Under British law this claim was all that was needed to justify his right to a broad patent covering electromagnetic signaling (Basalla 1990, p. 100). More recently, a biotechnology firm, Agracetus, has been given patents on all genetically engineered cotton and soybeans, regardless of the process used to engineer them or the traits engineered (Svetos 1996).

[25]As one British patent specialist in a pharmaceutical firm put it more than a quarter of a century ago:

> It is rare for the complete [specification] to contain a really full and adequate disclosure for commercial operations but this is not because of secretiveness. Rather it is an inevitable result of the "first to file" system. Under this, it is essential to obtain an early priority date and invariably commercial exploitation will not take place for three or four years, and in the pharmaceutical field often five to ten years. (Taylor and Silberston 1973, p. 95)

160,000 in the United States the same year (Auriol and Pham 1993). The granting rate has been over 90 percent in France (until the mid-1970s), about 80 percent in the United Kingdom, and only about 35 percent in Germany. It has varied in the United States from a low of 58 percent in 1965 to a high of 72 percent in 1967 (Griliches 1990, p. 1663). As we have seen, this can also be explained by differences in the procedures and resources of the various patent offices, therefore implying differences in the average quality of a granted patent across countries and periods. In short, these numbers don't mean anything.

Historical Changes in Patent Systems: A patent is granted if it passes certain minimal standards of novelty and potential utility. These standards, however, can change over time, both as a result of changes in perception of what is an innovation and because of changing applications pressure on a relatively fixed number of patent office workers.[26] Basberg (1987, p. 135) has pointed out that three conditions must be met for a long and complete time-series of patents to have any value: first, the quality of an average patent must remain more or less unchanged; second, the relationship between patents and inventions in a chosen area must remain constant; third, attitudes as to the use of the patent system must remain substantially constant. It is doubtful that these preconditions are often met.

In discussing the incestuous relationship between the Munn & Co. Patent Agency—which was also the owner of *Scientific American*—and the United States Patent Office in the middle of the nineteenth century, noted historian of technology Eugene Ferguson has pointed out that:

> *Scientific American* soon became the leader and chief member of the patent lobby, bringing whatever pressure it could command for more examiners and less rigorous examination of applications. The law that reformed the Patent Office in 1836 gave examiners no clear guidance in their decisions regarding the merits or novelty of an invention. (Ferguson 1989, p. 56)

Moreover, a change in the resources of the Patent Office or in its efficiency will typically introduce changes in the lag structure of grants behind applications, and may produce a rather misleading picture of the underlying trends. It has thus been argued that the decline in the number of American patents granted in the 1970s was almost entirely the result of the fluctuations in the Patent Office, culminating in the sharp dip in 1979 due to the absence of a printing budget for the approved patents (Griliches 1990, p. 1690). It has also been pointed out that due to understaffing, the officials of the United States Patent Office have had a tendency to interpret the usefulness criterion so loosely that patent applications have rarely been turned down for failure to meet the requirement. In fact, it has been said that only the idea for a perpetual-motion machine would likely to be turned down (Rosegger 1986, p. 131).

The use of patent data as a proxy for inventive activity has a long history. There are many reasons to justify their use, from their availability to the fact that they are, by definition, related to inventiveness and that they appear to be based on an objective and only slowly changing standard. There are, however, a host of identification and intrinsic variability problems in these statistics. For example, it is highly plausible that patent counts in a field of industry may decline while the

[26]For a more detailed introduction to this topic, see Cooper (1991a).

underlying innovative activity may be increasing; or on the contrary, that the number of patents issued in one field of industry may rise because a small number of firms are building their patent war chest. To sum up the main deficiencies in the use of patent data as economic and innovation indicators: (1) not all innovations are patentable; (2) not all patentable innovations are patented; (3) there are strong biases in the propensity to patent depending on the industry of origin, the size of the firm and the type of invention; (4) there are important reliability problems in patent data; (5) some patents prove to have an economic value, but most do not; (6) many patents are of a purely defensive nature; and (7) patent requirements have evolved drastically over time and geographical space. As was mentioned, most studies using patents as economic and innovation indicators treat very lightly the key problems in those statistics.

A number of ways of improving patent statistics have been suggested over the years,[27] but in the eyes of this writer, none has been able to overcome the subjectivity involved in assessing the quality of a patent. There are also other important problems in the data used in these studies, most notably that typically only large firms (or more specifically people in charge of patenting in these firms) or atypical creative geniuses are thoroughly studied. Innovation done in small firms or by more typical inventors who cannot afford the cost of a patent is therefore usually left out.

Austrian economists have long been hostile to the use of economic statistics (Rothbard 1993), but their epistemological claims have not been echoed in the mainstream of the profession which, for a number of reasons, has always been fond of patent statistics. The purpose of this article was therefore to demonstrate that, even on strictly empirical grounds, the drawbacks associated with patent statistics are nothing short of major and that even in the best circumstances, these data only give us a partial picture of the technological potential of a small number of innovations. Doing empirical studies of innovation is a worthy goal, but this does not justify the use of bad indicators on the grounds that they are the only ones that fit well with the dominant methodologies.

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