CHAPTER 4: INTELLECTUAL PROPERTY AND PATENT REGIMES

by Walter G. Park

Market economies function on the price system and on a system of well-defined property rights. In some regions, this includes the provision of property rights over intangible assets, such as knowledge capital. Through a system of intellectual property laws, individuals and organizations have the right and opportunity to engage in the production, consumption, trade, and exchange of ideas. The nature of intellectual property systems, however, varies across countries, as do legal systems governing real property. In recent years, as more and more of the wealth of nations is in the form of intellectual assets (and as these assets contribute importantly to productivity growth), a concept of property rights that applies only to physical assets is being seen as very limiting.

The purpose of this chapter is to discuss how to measure the strength of property rights protection over *ideas*. Such a measure could be used for academic research, policy evaluation, or comparisons of intellectual property regimes across countries and over time. This chapter focuses on quantifying the level of *patent rights* protection. Patent rights are one form of intellectual property protection (along with copyright protection, trademark rights, geographical indications, and others). Patent rights have received perhaps the most attention because of their close link to economic variables such as investment, technological progress, and productivity growth. However, a more complete picture of a nation's intellectual property regime would need to incorporate the other instruments of intellectual property protection. Though, in most cases, the strength of these individual instruments should be highly correlated, in some cases they may not; that is, in some nations, copyright laws might be strong but patent protection weak. In any event, the methodology presented here for measuring patent protection could be used to quantify the levels of other intellectual property rights. In some cases, intellectual property instruments might all share some common aspects; for example, the same enforcement or judicial mechanisms used to protect patent rights might be available to protect trademark rights.

This chapter is organized as follows: section 2 describes some of the institutional detail behind patent systems. The purpose is to define terms and provide some legal background. Section 3 describes the methodology for constructing an index of patent rights, discusses the possibility of gaps between measured protection and actual practice, and presents some estimates of patent rights for selected countries. Section 4 briefly explores the relationship between patent rights and economic freedom, and section 5 contains some concluding thoughts.

1: INSTITUTIONAL BACKGROUND

The patent is both a scientific and a legal document. It is a scientific document in that it contains a full description of the underlying technology, enabling those persons skilled in the art to make and use the invention. Insufficient technical disclosure is a ground for disqualifying a patent right. The patent document also acts as a legal title (or deed) to a piece of intellectual territory, within which

others may not trespass and utilize without a license. Possession of this territory is temporary (usually 20 years at most), ownership rights must be renewed (through payment of renewal fees), and, like real estate, this intellectual territory can be sold or transferred. This territory of ideas must also be industrially applicable (not consisting of abstract ideas, such as scientific theories, mathematical knowledge, or organizational methods). The boundaries of the intellectual territory given to the patent holder are identified by the "claims" in the granted patent; each of these claims describes what the invention does or can do. The number and breadth of claims implicitly define the extent of the territory.[1]

The logic of why patent systems exist is discussed extensively in the literature.[2] It is therefore best here to clarify a few points. First, in the absence of a patent system, markets for ideas would be "missing" due to the nature of knowledge as a public good. A patent system therefore creates a market that would otherwise not exist. However, since the patent holder is granted *exclusive rights* to exploit the innovation, the market for that innovation is not one of perfect competition. Without the right to exclude, and price at a markup above the competitive price, the innovator might not be able to *recoup* her up-front research and development (R&D) costs over time. By enhancing the ability of the innovator to appropriate the returns to her R&D investments, the patent system generates incentives to innovate and thereby engenders a form of "competition" over time to create ideas. Thus, as the literature suggests, a trade-off exists between technology creation and diffusion: patent systems must provide, on the one hand, adequate incentives for technology creation and, on the other hand, opportunities for competitive diffusion.

This characterization of the patent system can create a few misconceptions. The first is that a patent makes a firm a monopolist in the traditional sense of a single firm in an industry. Rather, it gives the holder the right to exclude others from using the new idea commercially; it does not allow the holder to exclude other firms from entering the industry. A second misconception is that there is a trade-off between technology creation and knowledge diffusion; rather there is a trade-off between the former and the diffusion (or supply) of output embodying the new knowledge. Patents do not restrict the diffusion of knowledge; on the contrary, they help diffuse it. The reason is that, in exchange for patent protection, inventors must (as pointed out earlier) disclose their new knowledge.

How do patent systems work? It is convenient to describe them in roughly the chronological order in which inventors apply for and enforce their patent rights. Table 4-1 presents an outline of the procedures from the *patent application* stage to the *patent enforcement* stage. It is precisely the institutional details governing these procedures that vary across countries and account for the differences in the strength of patent protection among countries.

Patent Application

The inventor must first decide whether to seek patent protection or keep the invention a *trade secret.* By choosing the latter course of action, the inventor risks being imitated and not being able to claim damages but some nations do provide some form of trade secrecy protection (which prohibits the obtaining of company secrets by illegal means). However, trade secret protection does not protect against another inventor independently developing the invention and patenting it, or against reverse engineering.

If the inventor decides to patent, another decision to make is whether to patent nationally only (i.e., in the domestic market only) or internationally (in more than one country). If the inventor decides to patent internationally, there are a number of "routes" in which to seek worldwide protection. One way is simply to file a patent in each country of interest. Obtaining a patent in one country does not automatically grant protection in other countries (unless there exists some specific agreement between countries, as in the case where one country "registers" patents obtained in another country).[3]

Filing patents in each country of interest may be efficient if the inventor is only interested in obtaining protection in a few countries; however, if the inventor is interested in a much broader geographic coverage, separate national filing is cumbersome. Hence an alternative way is to seek a regional patent. A European Patent Office (EPO) patent is one such regional patent. Through a single, centralized filing with the EPO, the applicant can try to obtain a patent in several EPO member

Table 4-1: Patent Application and Enforcement: An Outline of Procedures

(A) Patent Application

1. Pre-Application Choice — Patenting vs. Trade Secrecy?
   - If Choose to Patent, — National or International Patent?
   - If International, which Route — Separate National Filings? PCT Filing? EPO Filing? EPO/PCT Filings? Some Combination of Filings?
2. Pre-Grant Determinations:
   - Priority Date of Application (depending on first-to-file versus first-to-invent, grace periods [if any])
   - Publication of Application (18 months from date of application or upon patent grant [if at all])
   - Patentable Matter (whether "subject matter" restricted: e.g. genetically engineered products, business methods, inventions against public order or morality, etc.)
   - Patentability (search and examination for novelty, non-obviousness, and utility)
   - Duration (length) and Scope (width) of Patent Protection
3. Post-Grant Process:
   - Oppositions (by third parties) against validity of patent grant (where laws allow)
   - Conditions imposed on patent grant (e.g. working; compulsory licensing)
   - Patent Renewal or Maintenance Fees (otherwise, patent rights expire); renewal schedules vary from country to country.

(B) Patent Enforcement

1. Enforcement "Routes":
   - Litigation
   - Arbitration
   - Settlement
2. Statutory Provisions:
   - Preliminary Injunctions
   - Contributory Infringement
   - Burden of Proof Reversals
   - Doctrine of Equivalents
   - Discovery

Note: PCT denotes Patent Cooperation Treaty of the World Intellectual Property Office (WIPO); EPO European Patent Office.

states. Another regional patent is the Patent Cooperation Treaty (or PCT) patent, administered by the World Intellectual Property Office (WIPO). An inventor can file a single PCT application and *designate* as many member states of WIPO as he chooses. Since EPO states are also member states of WIPO, if PCT applicants are also designating a number of EPO countries, the PCT patent has a provision whereby the patent applicant can designate the entire EPO as a block (treated as one member state unit), thus cutting down on those fees that vary with the number of states designated. In that case, the applicant is filing an EPO-PCT patent.[4]

Having decided upon the route for applying for a patent, the inventor goes through the appropriate review and examination. A crucial determination to be made early on is *priority*: who gets to apply for a patent for a particular invention? Is another application pending? In the United States, priority goes to the inventor who is the *first to invent.* In the rest of the world, it is generally the *first to file* an application who gets priority.[5] If someone else has priority, the inventor loses the right to seek a patent for that invention. For inventors filing patents internationally, the *Paris Convention Treaty* allows inventors (of signatory states) up to 12 months to file an application in other signatory countries after first filing in a signatory country. The inventor thus reserves that initial filing date, for 12 months, for purposes of establishing who was first to file. All relevant matters are referred to that filing date (or to the earliest date of priority) for official purposes.

Countries also vary in terms of when to disclose or *publish* information in the patent application. The United States keeps it secret until the patent is granted. If it is not granted, the information is not disclosed to the public. In the EPO and Japan, the application is made public after 18 months from the date of filing, even if the patent is not granted. In most of Africa, it is made public upon acceptance of a complete application. An advantage of early disclosure is that it enables other inventors to build on new and existing knowledge, avert infringement and costly litigation, and avoid duplicative research projects. A drawback is that the procedure may discourage inventors who are risk averse and not certain of successfully obtaining a grant.

Another important part of the patent application process is the determination of patentability. First, the laws generally indicate subject matters that are not patentable, perhaps because certain subjects are not novel, non-obvious, and industrially useful. For example, medical treatment is not considered patentable because it does not yield industrially applicable output. Or, subject matters may be declared unpatentable if they are considered contrary to public order, morality, health, and national security. One area of future controversy and of relevance to the future of the global biotechnology industry is the patentability of genetic innovations, which the United States permits to a limited degree.[6] Prior to 1995, several countries (Argentina, Austria, Denmark, and India) did not even provide pharmaceutical patent protection on national health grounds. Most now permit it.

During the determination of patentability, a crucial conclusion is arrived at concerning novelty. The invention must not be in the pool of existing (prior) knowledge. The inventor therefore disqualifies herself if she publicly discloses the invention before applying for a patent.[7] The United States, however, provides a 12-month grace period, allowing the invention to remain novel if the patent application is made within 12 months of public disclosure. The EPO and Japan permit grace periods of 6 months for certain types of public disclosure only (for example, public demonstrations).

Novelty, non-obviousness, and industrial applicability are determined after extensive search and examination by patent examiners. If, at the end of the process, a patent is granted, a determination of patent "scope" is also made. The scope of protection refers to the size of the protected intellectual territory (i.e., how many claims are accepted or how broadly they are written). If the scope of protection is very broad, competitors must develop inventions with an "inventive step" that is large enough to avoid infringing on the patent holder's rights. Economists have debated whether technological change is better served by a broad or narrow scope (see Merges and Nelson 1994). On the one hand, a broad scope gives more market power to an inventor and might be a strong inducement to invent; on the other hand, it makes it more difficult for competitors to develop new follow-on inventions.

Upon grant, inventors may face opposition from third parties. In the EPO, third-party oppositions occur for a limited time *after* a patent is grant. In Japan, oppositions take place *while* the patent application is being reviewed. In the United States, there are no formal oppositions during or after grant; instead patent validity challenges, if any, occur in court. An advantage of third-party oppositions might be that it helps spread the burden of fully determining patent validity to competitors. A disadvantage is that an expensive obstacle is placed in the path of a patent applicant. Rivals could especially try to delay, if not prevent, the applicant from getting a patent.

After a patent is granted, patent holders may also face conditions regarding working and licensing. Working requirements are essentially requirements that the patent holder practise or exploit the invention by a certain period of time, or else forfeit his patent right or face compulsory licensing. From the point of view of the patent holder, working requirements are restrictive. The patent holder may not be financially able to work the invention or the market may not yet be ready for it. On the other hand, some patent regimes operate on the premise that the purpose of a patent is not to profit inventors but to bring economic value to the community. For this reason, in some countries, if a patent is not worked within a certain time, the patentee is required to give a license to a third party willing and able to work the patent (in exchange for a "reasonable" royalty).

Compulsory licensing may also be imposed if inventions relate to food and medicine or if another patent is being blocked. Blocking patents are patents that contain enough overlapping or related subject matter that manufacturing one item would involve infringing the other. They usually arise when one patent is an improvement over the other. Without a patent, the improver would infringe on the core technology. But, even with a patent, the improver needs a license to use the core technology without which the improvement cannot work. The solution to this dilemma is to have improvers and pioneers approach each other with licensing agreements. Otherwise, if voluntary private bargaining cannot resolve the blocking problem, the authorities in some countries will impose compulsory cross-licensing. Blocking also tends to arise in situations where the scope of protection is too narrow, allowing inventors to patent too closely to one another in "technology space."[8]

Finally, after grant, in order to keep the patent right in force the patent holder must pay renewal (or maintenance) fees. The dates and frequency of renewal vary across countries. In the United States, patent holders must renew three times: three and one-half years after grant, seven and one-half years after grant, and eleven and one-half years after grant. In Japan, patents are renewed annually from the date of application and, in European countries, they are typically renewed annually starting from the third year after the filing date. It should be noted that most patent rights are not held for the full duration that patent holders are entitled to. More than half of patents granted expire voluntarily within 10 years from the date of application.[9]

Patent Enforcement

During the duration of patent protection, the inventor may be required to defend or enforce her patent right. If infringement occurs, and the patent right has not expired, the patent rights holder must largely seek redress through the court system (not through the patent offices). Depending on what enforcement mechanisms are available, the patent rights holder can pursue litigation, arbitration, or outside settlement. (Litigation, however, is costly and lengthy. Combatants typically settle or defer to an arbitration board. Jury trials are relatively infrequent because of the high costs of getting expert testimony and acquiring documents, among other things.) How adequate enforcement mechanisms are, and how well they work, affect the inventor's *ex ante* incentive to innovate (and the imitator's incentive to imitate). Poor enforcement mechanisms have the effect of devaluing patent rights and discouraging patenting. New ideas are more apt to be kept trade secrets.

While litigation, arbitration, and settlement offer different enforcement routes should infringement occur, patent holders may also have recourse to a number of statutory provisions that can aid in enforcement: preliminary injunction, contributory infringement, burden of proof reversal, doctrine of equivalents, and discovery. Preliminary injunctions are pre-trial actions that require the accused

infringer to cease the production or use of the patented product or process during the course of the trial. Preliminary injunctions are a means of protecting the patentee from infringement until a final decision is made in a trial. Contributory infringement refers to actions that do not in themselves infringe a patent right but cause or otherwise result in infringement by others. Examples include the supplying of materials or machinery parts that are essential to the use of a patented invention. Thus, contributory infringement permits third-parties also to be liable if they contribute negligently to the infringement. Burden of proof reversals, in patent process cases, put the onus on the accused to prove innocence (that is, to show that the process used is not the patented one). Under a burden-of-proof reversal, if a certain product is produced by another party, it is assumed that it was produced with the patented process. Given the difficulty patentees have of proving that others are infringing on their patented processes (since there are often several ways of producing the same product), the shift in burden can be a powerful enforcement mechanism. The doctrine of equivalents would find the accused infringer liable if she uses the *essence* of the patented invention but does not *literally* infringe the patent. This is especially helpful if the imitator makes modest changes to an invention and claims by a technicality not to have infringed. According to the doctrine, if the modified invention operates in "substantially" the same way, it is "essentially" an equivalent invention and, therefore, infringes upon the original invention. Lastly, discovery permits the accuser to obtain evidence from the accused, such as documentation. Pre-trial discovery, by compelling parties to exchange information in their possession fully, helps to facilitate settlement as parties develop a more convergent assessment about the likely outcome of a trial.

This concludes a brief overview of what patents are and how patent systems work. The next section shows how to take some of the relevant institutional detail and develop a quantitative measure of the strength of patent systems.

2: Measurement of Patent Rights

The following section is drawn from Ginarte and Park (1997), which developed an index measuring the strength of patent rights across countries and over time. The index scores a nation's patent system from 0 to 5. Higher values indicate stronger levels of protection. Two things should be noted at the outset. First, stronger levels of protection need not necessarily imply "better" (from a social-welfare point of view). It is possible that there exists some optimal level of protection, beyond which higher levels of protection may discourage follow-on innovations or reduce consumer choice.

Secondly, not every patent law or institutional feature can be incorporated into the patent rights index. Some features do not add much variability since almost every country provides them (or does not provide them). Thus a key criterion in designing the index was to select those institutional features that provide maximum variability across countries. Furthermore, in some cases, it is controversial (theoretically or empirically) whether a particular feature of the patent system contributes positively or negatively (or not at all) to the strength of patent rights. For example, *discovery* is an important means of collecting evidence but it burdens both the defendant and plaintiff. *Broad scope* gives strong protection to the patent holder (*ex post*) but may weaken the right of rival inventors to obtain a patent (*ex ante*). In any case, "scope" cannot be measured well, since it is not statutorily addressed. Scope is determined at the examiner level. Third parties or observers (such as social scientists) could dispute whether too many claims (or too few) were granted for an invention. Likewise, the quality of litigation is determined at the trial level (not necessarily by statutes) and can only be assessed case by case. The outcome of a trial could be seen as too favorable (or unfavorable) for the patent rights holder. Thus, to incorporate scope or litigation quality or any other feature of this nature, one would need to obtain further data at the micro-level (e.g. at the examiner level or trial level).

Construction of the Index

Two points that come out of the previous paragraph are: (1) the index is based on "macro" legal features

(and not on micro-level data); (2) the index is "selective," incorporating a subset of legal features in existence. The information used to construct the index is obtained directly from national patent laws.[10]

The index contains five categories: (i) extent of coverage, (ii) membership in international patent agreements, (iii) provisions for loss of protection, (iv) enforcement mechanisms, and (v) duration of protection. Each of these categories (per country, per time period) is given a score ranging from 0 to 1, as discussed below. The unweighted sum of the scores from these categories yields the overall value of the patent rights index. The index, therefore, ranges in value from 0 to 5.

As for how each of these five categories is scored, each category (except duration) consists of several features. A country may have one or more of these features, or none at all. Thus the score in a category indicates the fraction of those features that are available in that country (for that time period). For example, if a country in 1995 has all three features required for strong enforcement, it scores 3 out of 3 and earns a value of 1 for enforcement for that year; if it has only 1 of the features, it receives a score of 1/3 for enforcement for that year. The score for duration is simply the length of protection allowed by authorities as a fraction of 20 years from the date of application (or as a fraction of 17 years from the date of grant, for countries based on a grant-based system). Countries that provide this "standard" length of time or more receive a 1 for duration. Table 4-2 provides a summary of the categories and scoring mechanism.

In what follows, a brief description of the features in each category will be discussed.

Coverage

In this category, the strength of protection is measured by the patentability of the following seven items: pharmaceuticals, chemicals, food, plant and animal varieties, surgical products, microorganisms, and utility models.[11] The value of this category indicates the fraction of these seven elements that were specified as being patentable in the law or were not specifically declared unpatentable.

Membership in International Agreements

By participating in international intellectual property-rights treaties, signatories indicate a willingness and capacity to provide national, nondiscriminatory treatment to foreigners. The three major agreements are: (a) the *Paris Convention* of 1883 (and subsequent revisions); (b) the *Patent Cooperation Treaty (PCT)* of 1970; and (c) the *International Convention for the Protection of New Varieties of Plants (UPOV)* of 1961. Countries that are signatories to all three receive a value of 1 in this category; those that are signatories to just one receive a value of 1/3.

The Paris Convention provides for national treatment to foreign nationals in the provision of patent rights. The main objective of the PCT is to harmonize and simplify administrative procedures. The UPOV confers plant breeder's rights, a form of protection similar to a patent. Unlike the Paris Convention, this treaty requires signatories to adopt uniform standards as national law, helping to make application procedures and laws clear and non-discriminatory.[12]

Loss of Protection

Patent holders may lose their patent rights wholly or partially. This category indicates whether authorities refrain from: (a) working requirements; (b) compulsory licensing; and (c) revocation of patents. These actions have the effect of weakening (or eliminating) a patent right. A country that does not impose any of these measures receives a value of 1 in this category.

As indicated earlier, working requirements refer to the exploitation of inventions. Such requirements restrict the freedom of choice of the patentee. If a country does not require working at any point during the patent term, it receives a value of 1/3. Compulsory licensing requires patentees to share exploitation of the invention with third-parties, and reduces the returns to the invention that the patentee can appropriate (especially if it is imposed within a short time after a patent is obtained). A country receives another 1/3 score if it refrains from imposing compulsory licensing within 3 or 4 years from the date of patent grant or application (the time frame stipulated in the Paris Convention). Finally, countries that do not revoke patents for non-working receive another 1/3 score.

Enforcement

In this category, the selected conditions are the availability of: (a) preliminary injunctions, (b)

Table 4-2: Index of Patent Rights–Categories and Scoring Method

The index of patent rights (IPR) consists of the following five categories and assigns the following values to each criteria:

(1)	**Coverage**	**Available**	**Not Available**
	Patentability of pharmaceuticals	1/7	0
	Patentability of chemicals	1/7	0
	Patentability of food	1/7	0
	Patentability of plant and animal varieties	1/7	0
	Patentability of surgical products	1/7	0
	Patentability of microorganisms	1/7	0
	Patentability of utility models	1/7	0
(2)	**Membership in International Treaties**	**Available**	**Not Available**
	Paris Convention and Revisions	1/3	0
	Patent Cooperation Treaty	1/3	0
	Protection of New Varieties (UPOV)	1/3	0
(3)	**Restrictions on Patent Rights**	**Does Not Exist**	**Exists**
	"Working" Requirements	1/3	0
	Compulsory Licensing	1/3	0
	Revocation of Patents	1/3	0
(4)	**Enforcement**	**Available**	**Not Available**
	Preliminary Injunctions	1/3	0
	Contributory Infringement	1/3	0
	Burden-of-Proof Reversal	1/3	0
(5)	**Duration of Protection***	**Full**	**Partial or No Protection**
		1	$0 < f < 1$

Note*: where *full* duration is 20 years from the date of application (or 17 years from the date of grant, for grant-based patent systems) and *f* equals the duration of protection as a *fraction* of the full duration.

Note: Each category (except for duration) consists of a number of legal criteria relevant to that category. Each category (including duration) is scored out of 1. Thus, the Index of Patent Rights overall varies from 0 to 5. All criteria (or patent law features) within a category are weighted equally so that the value of each criteria is simply equal to its "share" in the category. For example, if a country provides two out of the three enforcement features, it receives a score of 2/3 for enforcement; if it permits patenting in all seven subject areas, it receives a score of 7/7 (or 1) for coverage; if it is not a member of any international treaty and provides for working requirements, compulsory licensing, and revocation of rights, it receives 0 for the second and third categories above; finally, if it provides protection for 12 years from the date of application, it receives a score of 12/20. Overall, this country's IPR value would be = 2/3 + 1 + 0 + 0 + 12/20 = 68/30 or 2.27.

contributory infringement pleadings, and (c) burden-of-proof reversals. A country that provides all three receives a value of 1 for this category. (These legal features were defined in the previous section.)

Duration of Protection

The length of the patent term is important for ensuring adequate returns to innovative activity. Due to cross-country variation in the definition of starting points of patent terms, two scales were established to measure the strength of protection. The scales differ according to whether the start of the patent term is set from the date of application or from the date of grant. For patent terms based on the date of application, the standard is 20 years of protection.[13] Countries that provide 20 years or more of protection receive a value of 1 for this category. Those that provide shorter terms receive a value equal to the fraction of the 20 years that are provided. For example, if a country provides 15 years of protection, it receives a value of 0.75 for this category. The same procedure is applied to patent terms established from the date of grant. The only difference is that the standard duration is 17 years.

Statutory versus Actual Protection

The focus thus far has been on the statutory provisions (that is, "the laws on the books"). In practice, there might be serious gaps between actual and perceived (statutory) protection. If so, the index described above would fail to capture the real strength of patent protection in practice. Determining whether laws are actually enforced is difficult to determine for any legal statute, let alone intellectual property laws. Nonetheless, some indirect evidence is worth considering. The concern is primarily with the measured indexes of the OECD countries rather than those of the less-developed, since the main concern about the latter is the absence of laws.[14] Hence if there is any overestimation of patent protection levels, it should be in the OECD's measures. It would be ideal to examine the execution of laws by studying court cases: the percentage of infringement cases that went to court; attitude of judges and enforcement officials; damages awarded (as to whether they were commensurate with the offense). Unfortunately, no such international database of court records exists.[15]

A second-best approach to studying the execution of laws is to examine *complaints* against the system (its courts, officials, and outcomes). The idea is that a number of complaints would be filed if the system is not working (relative to what the statutes provide). The nature of complaints would indicate whether there are any systematic problems with the execution of laws. Ginarte and Park (1997) have investigated the types of complaints filed by American firms to the *U.S. Trade Representative (USTR)* regarding their protection abroad. If American firms faced these difficulties, it is likely that other foreign agents faced similar treatment in those countries. The authors find, however, that the complaints were largely non-patent related (i.e. related to copyrights or trademarks). Furthermore, the complaints were primarily statutory (rather than enforcement-related)–that is, with the lack of laws in the case of less developed countries, and with procedural law differences in the case of developed nations (concerning coverage, exemptions, application procedures, etc.). Interestingly, there are few complaints about the enforcement of patent rights. Countries like Egypt, Pakistan, and Venezuela have received complaints about inadequate patent enforcement mechanisms while countries like Nigeria, Peru, and the Philippines have received criticisms for the weak execution of enforcement actions that are available under the law. However, no complaints about patent enforcement or execution have been levelled against OECD countries.

In summary, the main complaints are not about the carrying out of patent laws. Rather the subjects of complaints (statutory and institutional differences) are matters that the patent rights index already reflects. Hence, the evidence tends to support a narrow gap between the measured and actual levels of patent protection. This is not to say that there are no problems with the actual execution and administration of the laws, as difficulties do exist even in countries with strong patent systems (the United States, Japan, and the EPO). However, the availability of laws on the books acts as a strong signal to inventors of the strength of patent rights available. "Proof" that the index does help to capture the strength of patent rights in practice is "in the pudding." Numerous empirical studies (including Ph.D. dissertations) have

been conducted with the Ginarte-Park index.[16] These studies find, for example, that the index has a statistically significant effect (as well as the hypothesized effect) on variables like innovation, research and development, patenting, trade, direct foreign investment, licensing, and productivity growth. This is indirect evidence that the index does what it is supposed to do: namely, help reflect the strength of national patent systems. If the index were pure noise, it would not have played any systematic role in explaining these economic phenomena.

Estimates

Tables 4-3A, 4-3B and 4-3C present a sample of the patent rights index for a select group of countries.[17] The countries are grouped according to their income level. The measure of country income used is the average per-capita Gross Domestic Product (GDP) in real 1990US dollars during the period from 1985 to 1995. Table 3 shows figures for the average of 1960–1975, the average of 1975–1990, and 1995.

In general, the high-income nations provide the strongest levels of patent protection and the low-income nations the lowest. Between 1960 and 1975 and 1975 and 1990, the gap in protection levels widened, as high-income nations worked to strengthen their patent systems further, while poor-income nations kept their systems relatively unchanged (or reduced the level of patent rights as in the case of Ecuador, Guatemala, India, and Peru). However, by 1995, a modest convergence in protection levels has taken place as countries began to adopt the provisions of the global TRIPS agreement (*Trade-Related Intellectual Property Agreement*). The agreement calls for the strengthening and harmonizing of intellectual property regimes among signatory states but the period of transition allowed is fairly long (up to 20 years for some countries) so that it will take some time before the agreement is fully implemented worldwide, if at all.[18]

Countries that have significantly strengthened their patent regimes include Korea and Singapore. Korea is now one of the top six patenting nations. Economic development has converted formerly imitating nations into innovating nations and leading proponents of global intellectual property reform. Hong Kong's level of patent rights is not as high as that of other newly industrialized countries and it has been a rather minor player in international patenting (at least until 1995). This may be due to its relative specialization in the financial rather than the technological sector. African countries score relatively high because of their patent registration systems: they have essentially adopted British laws and granted automatic patent protection to British patents. Their lack of enforcement mechanisms have worked to bring their scores below that of the United Kingdom. Among industrialized, OECD economies, Canada has not scored very high due to its previous use of compulsory licensing and non-recognition of pharmaceutical patents. Former socialist economies of Eastern Europe (e.g. Czech Republic, Hungary, Poland, Russia, etc.) have only recently reformed their patent systems along international standards.

Exhibit 4-3A: Index of Patent Rights–High-income nations

	1960-1975	1975-1990	1995
Australia	2.90	3.26	3.86
Austria	3.43	3.95	4.24
Belgium	3.30	3.78	3.90
Canada	2.76	2.76	3.24
Denmark	2.65	3.76	3.71
France	3.08	3.90	4.04
Germany	2.79	3.76	3.86
Hong Kong	2.04	2.46	2.57
Japan	3.24	3.94	3.94
Netherlands	3.33	4.24	4.24
New Zealand	3.10	3.32	3.86
Singapore	2.37	2.57	3.91
Sweden	2.65	3.61	4.24
Switzerland	2.84	3.80	3.80
United Kingdom	2.95	3.57	3.57
United States	3.86	4.41	4.86

Note: Countries are sorted by income group, as measured by average per capita GDP (in 1990 U.S. dollars) during 1985–1995. Source of GDP data: World Bank (1998).

Exhibit 4-3B: Index of Patent Rights–Medium-Income Nations

	1960-1975	1975-1990	1995
Argentina	2.10	2.26	3.20
Brazil	1.61	1.85	3.05
Bulgaria			2.57
Chile	2.19	2.41	2.74
Colombia	1.89	1.12	3.24
Czech Republic			3.19
Greece	2.46	2.42	2.32
Hungary			3.75
Ireland	2.69	2.99	2.99
Israel	3.39	3.57	3.57
Jordan	1.61	1.86	1.33
Korea	2.87	3.61	3.94
Mexico	1.85	1.48	2.52
Poland			3.23
Russia			3.04
South Africa	3.29	3.57	3.57
Thailand	1.51	1.85	2.24
Venezuela	1.35	1.35	2.75

Note: Countries are sorted by income group, as measured by average per capita GDP (in 1990 U.S. dollars) during 1985–1995. Source of GDP data: World Bank (1998).

Thus, no scores are available before 1995. The scores they do receive for 1995 are above average but it remains to be seen whether the actual execution of their laws is consistent with their statutory provisions.

Exhibit 4-3C: Index of Patent Rights–Low-Income Nations

	1960-1975	1975-1990	1995
Bangladesh	1.99	1.99	1.99
Botswana	1.70	1.90	1.90
Chad	2.30	2.71	2.71
Ecuador	1.80	1.54	2.71
Egypt	1.99	1.99	1.99
Ethiopia	0.00	0.00	0.00
Guatemala	1.51	0.97	1.08
Guyana	1.42	1.42	1.42
India	1.68	1.57	1.17
Indonesia	0.33	0.33	2.27
Kenya	2.37	2.57	2.91
Madagascar	1.37	1.86	2.28
Mozambique	0.00	0.00	0.00
Nicaragua	1.35	0.92	2.24
Pakistan	1.99	1.99	1.99
Peru	1.24	1.02	2.37
Romania			2.71
Senegal	2.08	2.46	2.57
Somalia	1.80	1.80	1.80
Sri Lanka	2.60	3.01	3.12
Togo	2.07	2.24	2.24
Tunisia	1.90	1.90	1.90
Zimbabwe	2.37	2.90	2.90

Note: Countries are sorted by income group, as measured by average per capita GDP (in 1990 U.S. dollars) during 1985–1995. Source of GDP data: World Bank (1998).

3: Economic Freedom and Patent Rights

Now that the index of patent rights has been discussed, a question of interest is how patent rights relate to economic freedom, which is the subject of this book. Patent rights pose a quandary to some observers when it comes to economic freedom or competition. On the one hand, some argue that since patent protection restricts competition, an increase in patent rights should reduce economic freedom. On the other hand, in the absence of patent rights, markets for technology may not exist. Thus, patent rights solve a "missing market" problem and should enhance economic freedom. It would be a useful research topic to explore the extent to which intellectual property protection

enhances or restricts economic freedom. For now, as the discussion below will point out, the two measures (patent rights and economic freedom) are positively correlated, indicating that in countries where patent rights are strong, economies tend to be freer. There must be some structural reason why this is the case. Certainly, there is no overlap between the two indexes; that is, there is no feature in one that is in the other that would be driving the correlation. This section provides a first look at the relationship between patent rights and economic freedom. Are there any causal links between the two? The purpose here is not to establish any sound conclusions but rather to stimulate further explorations of what the structural relationship might be.

The level of economic freedom could be interpreted as reflecting the strength of property rights *in general* while the level of patent rights could reflect that of intellectual property *in particular.* The results in this section suggest that from a causal or temporal point of view, economic freedom determines patent rights, not vice versa. An implication is that countries that have high levels of economic freedom are more likely to provide intellectual property protection. A general environment of property rights protection precedes particular kinds of property rights protection.

For this section, a sample of 94 countries was gathered, countries for which both patent rights data and economic freedom data are available for the period from 1980 to 1995.[19] Table 4-4, part A, shows the main sample statistics for these two indexes. "IPR" denotes the index of patent rights and "ECON," the index of economic freedom. The sample statistics indicate that both variables exhibit similar degrees of variability–that is, the coefficient of variation is roughly the same for both variables, although it is slightly higher for IPR. This suggests that the levels of patent rights around the world are slightly more diverse (showing greater extremes between high and low values) than the levels of economic freedom.

The sample statistics also show that the two variables are positively correlated. There are several reasons why this might be the case, one of which is that, if economic freedom represents property rights protection in general, then a high level of intellectual property protection in particular would contribute to a higher general state of property rights protection. Another reason has to do with the overall institutional, cultural, and policy climate. Countries that grant, protect, and enforce private property rights over physical assets such as land, reproducible capital, consumer goods, and so forth, are more likely to be open to the idea of protecting private intellectual assets or creations. Conversely, countries that tend not to protect private property rights (or protect them poorly) are likely to be less sympathetic to the notion of protecting intangible property. Thus, the overall institutional, cultural, and policy environment may play a role as a "third" factor in determining the levels of both economic freedom and patent rights and, hence, generate a correlation between them, even if there were no functional relationship between them.

Nonetheless, it would be of some interest to know if there is a relationship between the two variables in terms of which comes first or which influences which. Table 4-4, part B, presents the results of a simple causality test or test of precedence.[20] The basic idea behind the test is that some variable x causes another variable y if past values of x help to improve predictions for y. For example, consider the following equation for explaining y:

$$y = \alpha_0 + \alpha_1 y(-1) + \ldots + \alpha_n y(-n) + \beta_1 x(-1) + \ldots + \beta_n x(-n) + \varepsilon$$

where the $(-1), \ldots, (-n)$ refer to the variables lagged one period and n periods respectively, α's and β's to the parameters, and ε to the error term. If x does not cause y (in the *Granger* sense), the estimates of $\beta_1, \ldots, \beta_n$ should be zero.

The estimates of the parameters are obtained by statistically fitting the above equation to data from the 94 countries and four time periods (1980, 1985, 1990, and 1995). The first two columns of Table 4, part B represent the case where the lag length is just one period (where time periods are five years apart). That is, the causality test checks to see if data five years ago had an influence on current values. The next two columns represent the case where the maximum lag length is two periods. Longer lags (or data older than 10 years) were tried but found not to be statistically significant.

Table 4-4: Patent Rights and Economic Freedom

(A) Sample Statistics

	IPR	ECON
Mean	2.63	5.90
Standard Deviation	0.90	1.75
Coefficient of Variation	0.34	0.30

Correlation between IPR and MKT = 0.43

(B) Regression Analysis:

	Dependent Variable			
	(1) IPR	(2) ECON	(3) IPR	(4) ECON
Constant	0.072	0.694	0.199	1.170
	(0.079)	(0.199)	(0.119)	(0.264)
IPR (–1)	0.918	–0.004	0.803	–0.529
	(0.034)	(0.063)	(0.128)	(0.347)
ECON(–1)	0.043	0.948	0.132	1.089
	(0.014)	(0.029)	(0.039)	(0.084)
IPR(–2)			0.077	0.501
			(0.138)	(0.361)
ECON(–2)			–0.093	–0.192
			(0.042)	(0.096)
Percentage of Data Explained	88.2%	79.1%	84.9%	78.5%
Number of Observations	282	282	188	188

Note 1: The sample statistics are computed for the period 1980–1995. The regression estimates are obtained for a panel of 94 countries sampled at 1995, 1990, 1985, and 1980.

Note 2: IPR denotes index of patent rights and ECON index of economic freedom. IPR(–1) and ECON(–1) refer to the variables lagged one period (i.e. by five years), and IPR(–2) and ECON(–2) to the variables lagged two periods (i.e. by 10 years).

Note 3: In the regression results, heteroskedastic-consistent standard errors are in parentheses.

The results indicate that it is indeed economic freedom that causes (or precedes) patent rights. The past value of economic freedom positively and significantly influences the current value of patent rights.[21] In other words, economies with a high degree of economic freedom tend to be behind strong patent regimes. In contrast, the past value of IPR does not significantly explain economic freedom. (However, both the past values of IPR and ECON are good predictors of their own current values–i.e., the past value of IPR is a strong determinant of the current level of IPR and likewise for ECON). The coefficient estimates of the variables' respective lagged variables are about 0.9. This shows a high degree of persistence or stability in the values of the indexes. The levels of economic freedom and patent rights are more likely to change gradually over time than abruptly.

Including more historical information (i.e., adding second period lags) does not alter the finding that the lag of ECON explains both ECON and IPR, but that the lag of IPR explains only IPR

(and not ECON). Also, the second period lags–IPR(-2) and ECON(-2)–are insignificant in explaining present values of IPR and ECON, indicating that historical information about levels of economic freedom and patent rights beyond the first lagged period is not statistically important in predicting current levels of freedom and rights. All relevant historical information appears to be summarized in those first period lags.

Overall, the causality tests support the idea that countries with high levels of economic freedom are more likely to adopt and provide strong patent rights protection rather than vice versa. In other words, it is not plausible that strong patent regimes are the driving force for changes in economic freedom; rather, it appears to be the reverse. A policy implication may be that patent reform efforts should start with the strengthening of property rights institutions *in general*, which should help pave the way for *specialized* property protection in the areas of science, technology, and art. Countries that attempt to develop strong intellectual property regimes without developing an environment conducive to property rights protection in general may not succeed.

4: CONCLUSIONS

This chapter has discussed the measurement of patent rights across countries. The measure is country-specific, depending on national institutions, laws, and practices. It is also a measure of the strength of patent rights–not necessarily quality. The quality of patent systems is much harder to estimate. It would depend on what the nation's objectives are. Thus one criterion for measuring quality would be whether the patent system effectively achieves them. But a problem is that certain goals may not necessarily be shared by other nations or cultures. Another is that even if patent policy goals are roughly the same–i.e., to promote technological progress, economic efficiency, and enhance individual inventor liberty–countries differ on what weight they give (or what meaning they ascribe) to different aspects of such progress, efficiency, and liberty. For example, is technological progress identified more with the innovation or with technology diffusion?

In terms of improving the quality of the patent rights index to measure the strength of patent protection, there are a number of extensions that could be made in future work. The first is to incorporate the scope of patent protection. Since countries are granting about the same duration of patent protection (by international agreement), there is less variation in the statutory length of protection than in the breadth of protection. Secondly, as substantive laws converge (due to TRIPS), it would be useful to incorporate procedural law differences across countries, such as WIPO's Patent Law Treaty (PLT).[22] Thirdly, in the enforcement category, it would be useful to incorporate information about punishment for infringement (e.g. fines or sentences) and about the costs of enforcement (e.g. litigation). Fourthly, a limitation with the patent rights index is that it only varies by country, not say by industry. On the surface, this is justifiable. Except for the laws governing coverage (which state whether a particular technology field is patentable), the laws apply the *same* to all potential inventors, regardless of what line of business they are in. But in practice, there may be important interindustry differences in the perceived strength of patent protection. For example, national patent laws may be especially strong for the pharmaceutical industry but lax for the computer industry. Future work could explore the sources of these interindustry differences in the strength of patent rights. One source is *patent pendency* (the time it takes to grant a patent), which depends on the complexity of the innovation; another is scope, which should vary with the type of invention (whether the research field is new or crowded) and with the level of competition in an industry.

Finally, a few remarks about estimating patent rights and dealing with preconceptions. Some readers may find that the patent rights estimates for certain countries conflict with their *a priori* views about the patent systems in those countries. They may have also found that to be the case with the economic freedom index–that the estimates are higher or lower than they had anticipated. The

question is whether to doubt the estimated index or to modify one's prior assumptions. The following are some general comments in defense of indexes.

(1) Utilizing *a priori* views about a regime defeats the purpose of constructing indexes. The approach adopted here is to let the chips fall where they may. Using *a priori* views might sway the collection of information. An independently constructed quantitative index is a valuable supplement to expert opinion and experience, and vice versa.

(2) Indexes help describe the characteristics of a regime, not the outcome or effects of that regime. For example, a common reason people doubt the value of an economic freedom index or a patent rights index is that the value is seen as too high (or too low) for that country's level of economic development. For example, as Table 3 showed, countries that have strong patent systems tend to be the industrialized economies. But there are exceptions: some poor economies have strong patent laws and some rich ones have weak laws. First, this is relatively easy to explain in that there are offsetting factors. The effects of a strong patent regime might be offset by poor fiscal policies; or those of a weak regime be offset by a good education system. Secondly, and most importantly, measures of economic freedom or patent rights are *not* measures of economic development. They help explain development or are determinants of development, but are not themselves indicators of it.

(3) Another source of confusion arises from not recognizing that indexes of economic freedom and patent rights are *flows*, not *stocks*. They reflect the value for a particular year or period and not the entire history of their respective institutions or experiences. This confusion leads some people to expect the more developed economies or countries with a longer history of strong and stable institutions to have higher index values than those with less economic or institutional development. But, it should be recognized that the indexes can change from time to time on a flow basis. As an extreme case, if the United Kingdom were to eliminate its patent system, its patent rights index would be 0 regardless of its past history.

The above remarks are general points. They do not preclude measurement error. In some situations, there might be strong reasons to doubt the validity of the estimates; for example, in the case of patent laws, a huge discrepancy might exist between what the laws state and how authorities behave. Of course, if this discrepancy had persisted, complaints about it would have been widely known (see discussion in section III) and could, therefore, have been incorporated as useful information into the index.

NOTES

(1) Patent applicants who seek broader protection may often try to insert more claims. A kind of "negotiating" or compromising process may take place in which the patent examiner deletes certain patent claims (especially those that seem to extend beyond the scope of the invention or cross into the territory of prior patent holders). Applicants may risk rejection of a patent if their applications contain "too many" claims (especially if the claims are not part of a unifying "inventive" theme). They may be required to file separate patent applications instead.

(2) See, for example, Kaufer (1989).

(3) For example, certain African countries grant patent rights to inventors who obtained a patent in the United Kingdom.

(4) Note, as a technical matter, that these regional patent filings (i.e. EPO or PCT) consist of two stages. In the first stage, the single, centralized filing takes place, which establishes a priority date (see below). Several months later, the applicant undergoes a second stage (known as the "validation" or national phase), where the applicant must eventually file the application in the separate national jurisdictions, meeting local legal requirements and paying local fees. The advantage of the regional patent is in establishing priority and obtaining some extension of time to improve upon the patent application and invention, assess market conditions, and, where applicable, translate the application into the different native languages of the countries designated in the regional patent application.

(5) This difference in priority determination is a source of trade disputes between the United States and the rest of the world and is, thus, a heated subject of international negotiations.

(6) For example, in 1988, Harvard University was issued a patent for an invention that produced a genetically altered mouse susceptible to cancer. Genetically altered animals was considered patentable because they are non-naturally occurring.

(7) Even under a system where priority is based on "first to invent," the inventor must keep the invention undisclosed until an application is filed. This definition of novelty especially affects university researchers who tend to publish their results widely.

(8) In the popular game *Monopoly*, a situation analogous to "blocking patents" can arise. If two or more players each own some of the same colored lots (e.g. blue), then none can build houses. One of them must have all two or three of the same colored lots. Thus, taking the colored lots as analogous to technologies, we can see that, if some product or process cannot be made unless all of its technological components are put to use and if different patent owners own different components, the entire product or process cannot be created unless the gridlock is broken by either private negotiation or compulsory sale. (How the latter is carried out varies by friends and family.)

(9) See Cornelli and Schankerman (1999).

(10) English translations of national patent laws are available at the Library of Congress, Washington, DC.

(11) Utility models refer to relatively minor inventions–i.e., new arrangements or forms introduced or obtained in known objects. Protection is granted only to the new form or arrangement, provided that it results in an improved utilization of the object. The rationale for including utility models is that they help to distinguish the levels of patent protection among developing countries (or countries where innovative activity is relatively low).

(12) Further details about these international treaties can be found in WIPO (1998).

(13) This standard has been recommended by the Intellectual Property Task Force of the United States Chamber of Commerce. See Gadbaw and Richards (1988).

(14) Moreover, in African countries where the measured patent protection levels are relatively high (due to their adoption of British laws), there is as yet very little innovative activity going on. This is the case, despite strong patent laws, because of offsetting factors (e.g. political instability). Thus, with little innovation, there are few patents granted and, as a result, few instances of patent infringement and litigation activity. (There are also few instances of infringement because the imitative capacity of these countries is not very high.) Hence, due to the relative paucity of infringement and litigation activity, there have been few opportunities to "test" the laws and thereby determine whether the patent laws are actually carried out.

(15) As a future research project, it would be very useful to develop a micro-database of international patent cases.

(16) See, for example, Carlton (1996), Connolly (1998), Eaton et al. (1998), Maskus (2000), McCalman (1998), Oxley (1999), Nair (2000), Park and Ginarte (1997), Scalise (1997), Smith (1999), and Yang and Maskus (2000).

(17) The complete data for the period from 1960 to 1995 are available from the author upon request.

(18) If progress in implementation is made, however, the patent rights index will exhibit less and less variability (as national patent standards converge). In that case, to discriminate between regimes the index will have to incorporate: (a) other patent law treaties, for example WIPO's ongoing Patent Law Treaty (PLT), which seeks to reform patent law formalities and procedures; (b) new categories such as punishment, exhaustion (e.g. parallel importing), new subcategories such as the patentability of biotechnological innovations, internet tools, business models, etc., and micro-level features such as patent examination time, length of trial or arbitration, average scope, etc.; and (c) other forms of intellectual property protection such as copyright, trademark, trade secrecy, domain names, geographical indicators, etc.

(19) Data on economic freedom are from Gwartney and Lawson (2000).

(20) This test is referred to as the Granger-causality test. There is some controversy in the economics literature as to whether the Granger-causality test actually tests for causality in the "dictionary sense" of the term (that something is the reason or motive behind an effect or action). There appears to be more of a consensus that it tests for "precedence," that is, whether something precedes another in time (see Maddala 1992). Precedence may be necessary but not sufficient for a causal link between events.

(21) The statistical significance of a variable is judged by how large the ratio of its coefficient estimate is to its standard error. A variable is usually considered statistically important if the ratio exceeds 2 (in absolute value).

(22) Procedural laws govern matters such as notarization, signatures, and other legal formalities; patent filing procedures; renewal payments; and the use of local agent representation (i.e. patent attorneys or agents) for certain tasks.

REFERENCES

Carlton, Dennis W. (1996). A Critical Assessment of the Role of Imperfect Competition in Macroeconomics. *National Bureau of Economic Research*, Working Paper No. 5782.

Connolly, Michelle P. (1998). The Dual Nature of Trade: Measuring Its Impact on Imitation and Growth. Duke University, Department of Economics, Working Paper 97/33.

Cornelli, Francesca and Mark Schankerman (1999). Patent Renewal and R&D Incentives. *Rand Journal of Economics* 50, 2: 197–213.

Eaton, Jonathan, Eva Gutierrez, and Sam Kortum (1998). European Technology Policy: Research Efforts in Europe Matter. *Economic Policy* 27 (October): 403–30.

Gadbaw, R. Michael, and Timothy Richards (eds.) (1988). *Intellectual Property Rights: Global Consensus, Global Conflict.* Boulder, CO: Westview Press.

Ginarte, Juan Carlos, and Walter G. Park (1997). Determinants of Patent Rights: A Cross-National Study. *Research Policy* 26: 283–301.

Gwartney, James, and Robert Lawson (with Dexter Samida) (2000). *Economic Freedom of the World: 2000 Annual Report.* Vancouver, BC: The Fraser Institute:

Kaufer, Eric (1989). *The Economics of the Patent System.* New York: Harwood Academic Publishers.

Maddala, G. S. (1992). *Introduction to Econometrics, Second Edition.* New York: Macmillan.

Maskus, Keith E. (2000). *Intellectual Property Rights in the Global Economy.* Washington, DC: Institute for International Economics.

McCalman, Philip (1998). *Essays on the Multilateral Process.* Ph.D. dissertation, University of Wisconsin, Department of Economics.

Merges, Robert and Richard Nelson (1994). On Limiting or Encouraging Rivalry in Technical Progress: The Effect of Patent Scope Decisions. *Journal of Economic Behavior and Organization* 25: 1–24.

Nair, Usha (2000). Patent Regimes and the Internationalization of Economic Activities: Some Empirical Evidence from US Multinationals. Georgia Institute of Technology, Department of Economics, Working Paper.

Oxley, Joanne (1999). Institutional Environment and the Mechanisms of Governance: The Impact of Intellectual Property Protection on the Structure of Interfirm Alliances. *Journal of Economic Behavior and Organization* 38, 3: 283–309.

Park, Walter G., and Juan Carlos Ginarte (1997). Intellectual Property Rights and Economic Growth. *Contemporary Economic Policy* 15, 3: 51–61.

Scalise, Craig (1997). Natural Intellectual Property Protection Reform: Theory and Evidence, Ph.D. dissertation, University of Chicago, Graduate School of Business.

Smith, Pamela J. (1999). Are Weak Patent Rights a Barrier to US Exports. *Journal of International Economics* 48, 1: 151–77.

World Bank (1998). *World Development Indicators.* Washington, DC: World Bank.

World Intellectual Property Organization (1998). *Intellectual Property Reading Material.* Geneva: WIPO.

Yang, Lili, and Keith E. Maskus (2000). IPR and Licensing: An Econometric Investigation. University of Colorado, Department of Economics, Working Paper.