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Strengthening Protection
of Intellectual Property
in Developing Countries

A Survey of the Literature

Wolfgang E. Siebeck, editor
with
Robert E. Evenson,
William Lesser, and
Carlos A. Primo Braga

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ABSTRACT

Will developing countries benefit economically from strengthening their protection of intellectual property? They have been repeatedly urged to do so by developed nations, most recently in the ongoing Uruguay Round of Multilateral Trade Negotiations. In search of the answer to this questions the authors have reviewed a substantial body of economic literature, theoretical and empirical, covering the economics of patents and other instruments of intellectual property.

The vast majority of studies conducted to date have focused on industrial economies. This important body of research suggests that increases in intellectual property protection generate research and development activity sufficient to offset the social cost of the limited monopoly granted to patentees, copyright holders, and other owners of intellectual property. For developing countries, unfortunately, similar research is lacking.

The paper proposes a research agenda that includes an assessment of intellectual property protection in developing countries, the incentive effects on local R&D, foreign direct investment and technology licensing, and the potential benefit to developing countries of "petty patents" and plant breeders' rights.

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— The Authors

CONTRIBUTORS

Robert E. Evenson, Ph.D., Professor of Economics, Yale University, New Haven, Connecticut.

William Lesser, Ph.D., Associate Professor of Agricultural Economics, Cornell University, Ithaca, New York.

Carlos Alberto Primo Braga, Ph.D., Assistant Professor of Economics, University of Sao Paulo, Brazil, and Visiting Professor, Center for Brazilian Studies, School of Advanced International Studies, Johns Hopkins University, Washington, D.C.

Wolfgang E. Siebeck, Special Advisor to the Vice-President for Development Economics, The World Bank, Washington, D.C.

ACRONYMS AND ABBREVIATIONS

ARIPO	African Intellectual Property Organization
BIRPI	United International Bureaux for the Protection of Intellectual Property
CGIAR	Consultative Group for International Agricultural Research
EC	European Community
EPC	European Patent Convention
FAO	Food and Agricultural Organization (United Nations)
GATT	General Agreement on Tariffs and Trade
INPI	National Institute of Industrial Property (Brazil)
NICs	Newly industrialized countries
NIEO	New International Economic Order
NTBs	Nontariff barriers
OAPI	Organisation africaine de la propriété intellectuelle
OECD	Organization for Economic Cooperation and Development
PBRs	Plant Breeders' Rights
PCT	Patent Cooperation Treaty
R&D	Research and development
TNCs	Transnational corporations
TRIPs	Trade-related aspects of intellectual property rights
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UPOV	International Union for the Protection of New Varieties of Plants
USDA	United States Department of Agriculture
WIPO	World Intellectual Property Organization

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I. INTRODUCTION

Wolfgang E. Siebeck

Should developing countries step up their protection of intellectual property and strengthen laws and institutions necessary to enforce such protection? By doing so, would they gain better access to technology from industrial countries, develop more indigenous research and development, and attract more foreign investment?

Economic science has probed many of the effects that protecting intellectual property has on welfare gains and losses. But little concern has been shown for the interests of developing countries. And, one should add, until recently little interest has been shown by developing countries in these issues.

There are several reasons for this neglect. First, strong intellectual property protection is widely seen as a prerogative of advanced countries, something not required until relatively late in the development process. Second, the issue has not generally received the serious attention it deserves: Suggestions that developing countries could be better off protecting intellectual property are often interpreted as attempts to deprive the developing world of the benefits of technological advances.

The current Uruguay Round of multilateral trade negotiations includes intellectual property among its fifteen negotiating subjects. This step was taken at the instigation of the United States and over long and strong resistance from developing countries. During the first phase of the negotiations, until the mid-term review in Montreal in December 1988, developing countries effectively refused to negotiate on the subject of intellectual property. In Montreal, however, a compromise stipulating that rules and principles of intellectual property protection should be worked out without prejudging who would later administer such rules and principles (the GATT or the World Intellectual Property Organisation) has since allowed substantive discussions to take place in the Negotiating Group on Trade-Related Aspects of Intellectual Property (TRIPs). Agreement in this group is widely seen as critical for a positive outcome of the Uruguay Round.

The purpose of this report is to provide an overview of the economic literature on intellectual property. Our main interest in preparing it was to determine whether the literature provides answers to the questions developing-country policy makers are likely to raise when faced with the need to decide on the introduction of stricter intellectual property rules.

The report is organized into seven chapters. To help the casual reader, chapter 2 provides a primer on the major instruments of intellectual property protection and the international conventions governing them. It also sketches the current scope of protection in individual countries. Unfortunately, a systematic appraisal of the scope and effectiveness of the protection offered by individual developing countries is lacking.

Chapter 3 reviews the economic literature on intellectual property. Although substantial, this literature is overwhelmingly devoted to the impact of intellectual property protection in industrial economies. The chapter recounts the traditional analyses of 19th century economists, the major reviews undertaken in the 1950s, and the more recent attempts to capture the welfare effects of and the trade-offs between encouraging research through the grant of a temporary monopoly and the diffusion of new knowledge and technology. Some analyses raise doubts about the welfare gains from intellectual property protection. Others conclude that optimal protection would have to provide for differential terms of protection instead of the standard fixed term offered in most countries. More recent analyses have been concerned with the use or misuse of intellectual property instruments to gain and control market share.

Only recently have the effects of differential protection of intellectual property by industrial and developing countries received attention. Studies have tried to gauge whether developing countries will be better off free-riding on knowledge appropriated from industrial countries, or protecting it along with their own knowledge production.

Chapter 4 reviews the limited empirical literature and published evidence on the effects of intellectual property protection. While the literature shows that developing countries widely underinvest in research, it does not provide conclusive evidence that higher returns and investments occur in those developing countries which offer stronger protection of intellectual property.

Chapters 5 and 6 deal with the specialized literature in four sectors in which intellectual property appears to matter most. These are (a) pharmaceuticals and chemicals, where patents are generally considered critical for protecting inventions and recouping high research and development expenditures; (b) information technology, where advances have given rise to calls for better protection than patents and copyrights can provide; (c) the audio, video, and publishing industries, where developing countries have a strong interest both as producers and consumers; and (d) seeds and plants, long excluded from intellectual property protection, where a stronger role for private-sector breeding in developing countries may require some form of protection of breeders' rights.

Chapter 7 examines the costs and benefits that strengthened intellectual property protection could entail for a developing country. The costs of introducing and enforcing intellectual property systems, of higher royalty payments, and of losses from closing down "pirating" activities, as well as the opportunity costs of higher research investment, have to be weighed against the potential benefits deriving from higher domestic research efforts and more access to foreign technology and foreign investment. The threat of trade retaliation, once introduced into the cost/benefit analysis, will affect the trade-off faced by countries with significant trade links with industrial countries.

The current state of economic analysis provides few of the answers a developing country policy maker would need in order to make an informed decision on whether to strengthen intellectual property and enforce its protection. Chapter 8 summarizes the findings of this survey and suggests that research resources be shifted to a number of tasks of priority interest to developing countries.

To quote one of the first scholars who addressed the concerns of the developing countries (Vernon, 1957: 24): "These nations can hardly be expected to see the extensive grant of patent monopoly rights to foreigners as being unqualifiedly consistent with their own national aspirations. A bridge between our conceptions and theirs in this regard will need a kind of understanding which we have so far rarely displayed in international patent negotiations." We hope that this survey will serve as a block in the building of this bridge.

Two cautionary remarks are required. First, the survey does not claim to be exhaustive. Its authors have attempted to reflect the broadly accessible literature on the subject. By necessity, they have left out important contributions that have appeared in other than economic publications, as well as many publications written in languages other than English. For a subject as international in its ramifications as intellectual property, we only reluctantly agreed to this shortcut. Secondly, while it has been our intention to review the effects of all instruments of intellectual property protection, patents have assumed a predominant position in the discussion. To a large extent this reflects the prevailing focus in the literature, but also the fact that patents as the prime tool for protecting inventions dominate the discussion on knowledge transfer between industrial and developing countries.

II. AN OVERVIEW OF INTELLECTUAL PROPERTY SYSTEMS

William Lesser

Instruments of Intellectual Property Protection

Intellectual property and the body of law developed for its protection falls into five major classes: patents, plant breeders' rights, copyrights, trademarks, and trade secrets. *Patents*, or utility patents as they are more formally known, are applied to product and process inventions. Some countries have a lesser form of patent protection, known as the utility model or petty patent, that provides weaker protection for more modest and typically adaptive inventions. Another variant, often but not exclusively used in centrally planned economies, are inventors' certificates, a form of nonexclusive patent.¹ Applying only to the plant kingdom, *plant breeders' rights* (PBRs) are a patent-like form of protection originally intended to cover traditionally bred plant varieties. *Copyrights* protect creative works such as books and music. They have also been used in recent years to protect computer programs (some applications of which, in some countries, can be accorded patent protection). Some countries protect the work of performers, phonogram producers, and broadcasters through copyrights or specific rights called "neighboring rights." *Trademarks* reserve a portion of the language (e.g., Ford, Chevrolet, Dodge, all originally family names) or symbols (McDonalds' "Golden Arches" or Gucci's stylized G) for the identification of a particular product or service. *Trade secrets* do not apply to specifically identified products but protect a firm or individual from the unauthorized disclosure of proprietary information.² Less common types of protection include the plant patents available in the United States to protect

¹ Patents, which generally allow the inventor or patent holder to prohibit or exclude others from using the invention, may be exclusive or nonexclusive. Inventor's certificates are not exclusive.

² More extensive discussions of the forms of intellectual property protection are provided by Benko (1987); Crespi (1988); and Sherwood (1990b).

inventions of asexually bred plants, and design patents, by which shapes such as the original Coca-Cola bottle can be protected.

This chapter provides a brief overview of the major characteristics of these forms of intellectual property protection. It does not, however, offer specific information about legislation in individual countries and therefore should not be construed as a legal interpretation of comparative intellectual property systems. Any such interpretation, if it were to be useful to more than a narrow audience, would have to encompass other aspects of law (e.g., trade secrets and contract law) and deal with important extralegal considerations such as administrative and business practices that, to the extent they differ from country to country, can profoundly affect the level of protection offered an invention or other element of intellectual property.

Patents

Patents, which bar others from the unauthorized use, sale, or manufacture of the product or process claimed by the patentee, are intended to protect embodiments of inventive activity rather than abstract thoughts. Therefore most national patent laws exclude from protection abstract or nonembodied ideas and statements such as formulas and methods of conducting business. Some exclude items offensive to public morals. Others exclude particular products or technologies, often out of concern for public welfare. This explains the large number of countries that prohibit patents for pharmaceutical products and other medical applications. Still other systems exclude agricultural applications in total, or living organisms such as seeds and animals. Appendix 1 reveals the major differences among countries in the length and scope of patent protection.

In its strongest form, a patent protects its holder against subsequent discovery of another way to produce or use the patented product. Thus it provides what may be called negative rights, the right to exclude others from using the invention. The patent holder is entitled to enforce that right against unauthorized use, e.g., by means of legal proceedings. However, virtually all national patents systems limit the patentee's right of exclusion through a device known as the "compulsory license." The characteristics of compulsory licenses vary substantially. Most developing countries subject patents to a working requirement test, meaning that unless the holder uses the patent in domestic production others will be granted licenses to do so. In some cases an unexploited patent may simply lapse (for examples, see Gadbow and Richards, 1988; McLeland and O'Toole, 1987).

Typically a patent is granted for 17 to 20 years, although for some products in a few countries the period is as short as five years (see appendix 1). Once issued, it can be traded or licensed like other forms of personal property. Many employers (including universities to an increasing extent) require in employment contracts that inventions made by employees become the property of the employer. However, patent laws generally require that the individual inventor(s) be identified on the patent.

Generally, a patentable invention must have three characteristics: novelty (it must be new), utility (it must do what it is intended to do),³ and nonobviousness (it must not be a trivial extension of the existing state of the art). It is the degree of the invention's nonobviousness, or the size of its "inventive step," that determines the scope of protection. In most industrial countries patent applications are examined for obviousness, although under so-called registration systems patents are granted after only pro forma examination. In such cases, the scope and validity of a patent cannot be determined until the patent is challenged in court. The examination process means that patents may not be issued until two or more years after the application has been filed.

Patent offices rarely test a product, accepting instead the reasonable claims of the applicant and allowing competitors to challenge irregularities and deficiencies in court. However, an invention must be described "completely" in the application; when that cannot be done in writing, as is often the case with living matter, the written disclosure may be supplemented by the deposit of a sample. The required description, which constitutes the "disclosure" or "enablement" requirement for patentability, provides the technical teaching function of a patent. Disclosure enables others, at least in theory, to extend the newly created knowledge, thereby hastening the appearance of competing products and processes.

One of the complexities of patent law is its application to goods produced in Country A using a process patented in Country B but not in Country A. Because patents, like other forms of intellectual property, are territorial (protection applies only in countries in which a patent is held), firms are free to use technology patented elsewhere. The situation changes when a firm attempts to export manufactured goods into a territory where the process used in manufacture is protected by a patent. Many national patent laws restrict the importation of the direct products of a patented process.⁴ Recent U.S. legislation goes further, permitting restrictions on indirect products of patented processes.⁵ Such import restrictions will prove especially important in biotechnology, where patented processes may figure early in the creation of internationally traded high-value products.

Petty patents differ from utility patents in three ways: (a) they are of shorter duration (4 to 7 years typically), (b) they are seldom examined, and (c) there is little or no inventive step required.⁶ For these reasons, petty patents are typically inexpensive and quick to be issued. They usually apply to adaptive inventions and are predominantly held by nationals of

³ Utility does not mean that the invention must be practical in an economic or engineering sense, although it must have potential applications. Under intellectual property law, it is the market, not the patent office, that decides what is commercially viable.

⁴ For example, the European Patent Convention states in Article 64(2) that "the protection conferred by the patent shall extend to the products directly obtained by such a process."

⁵ Section 337 of the Tariff Act of 1930, as amended by the 1988 Omnibus Trade and Competitiveness Act.

⁶ A petty patent may be issued even if it provides no more than a modest improvement on existing products.

the country in which they are issued (Evenson, Evenson, and Putnam, 1987; Juma and Ojwang, 1989).

Another variation on patents is the industrial design or, in the United States, the design patent. This form of protection applies to an invention's shape or form, provided these do not serve solely to obtain a technical result. The requirement for protection is novelty or originality of appearance, and virtually all countries use a registration system (WIPO, 1988a: 48).

Plant Breeders' Rights (PBRs)

PBRs are next in complexity to patents, the major differences being the scope of protection and the limitations on the rights of the holder. To obtain protection, the applicant must show that the submitted plant variety is (a) stable (that it reproduces true to form over repeated propagations), (b) homogenous (that important characteristics are uniform across a single planting) and, most important, (c) clearly distinguishable from existing varieties, but again, not necessarily in an economic or agronomic sense. Most national variety-protection authorities (but not those in the United States) plant varieties and perform statistical tests to determine "distinguishability" (Lesser, 1987a and Murphy, 1979). Protection is granted for a minimum of 15 years. A longer period applies to trees and vines.

PBRs are subject to what are known as the farmers' exemption and the research exemption. The farmers' exemption gives users the right to retain part of the harvest for subsequent planting as seed. The research exemption permits breeders to use a protected variety in subsequent breeding and to apply for protection of the outcome as long as repeated use of the protected variety is not required.⁷ For these reasons many plant breeders believe that PBR protection is not as strong as patent protection (Lesser, 1986b).

Copyrights

Copyrights protect original materials, including original compilations of previously published materials, from unlicensed copying. In contrast to the procedure followed for patents, the originality of the copyrighted material is not determined prior to issuance of the copyright. In fact, the Berne Convention requires that copyrights be issued without examination. Thus challenges to copyrights generally must be raised in court. The duration of a copyright varies, but it typically extends for the lifetime of the author plus 50 years. Copyrights may be assigned.

⁷ A proposed revision to the UPOV Convention calls for substantial changes in PBRs by requiring a dependency license for some derivative varieties. See UPOV (1989b). Some patent laws do not have explicit research exemptions, although they are often interpreted to allow a broad exemption. For the case of the United States, see Bent (1989).

Unlike patents, copyrights are generally nonexclusive; the holder cannot prohibit others from using the work but can demand compensation in the form of a royalty. Of much debate in this era of the ubiquitous photocopying machine is the "fair use" of copyrighted materials: How many copies may be made before a royalty is owed, and how extensively may a document be quoted before an infringement occurs?

Trademarks

Trademarks are intended to protect a product's image as vested in a name (brand) or image (logo). Customers are offered the assurance of purchasing what they intend to purchase (Nelson, 1978). There are few limitations on trademarked words and logos other than that they not be from a restricted list and that they not be so similar as potentially to confuse the customer. Trademarks can endure virtually indefinitely provided they remain in use.

Trade Secrets

In most countries, trade secrets are not defined by law or subjected to specific formal requirements as are patents and other forms of intellectual property. Rather, they are protected by physical measures of secrecy and by restrictive contracts entered into with employees, users, and others to whom the secrets may be revealed. Judicial interpretations of what can be protected as a trade secret have changed from time to time and from country to country. At its broadest, a trade secret is anything that is secret and that confers upon its owners a competitive advantage (Crespi, 1988: 173). Inventions and writings are just part of what might be withheld as trade secrets; customer lists would also qualify. Once a secret is lost, however, no protection applies, unless it can be shown that the secret was improperly acquired. This is also true if valuable information can be deciphered by examining products in which the information is used, a process known as reverse engineering. Trade secret law does, however, apply sanctions to those who improperly reveal or acquire trade secrets. For example, the law may be used to protect confidential information held by an employee hired by a competitor. Sherwood (1990b) observes three ways in which national laws protect trade secrets: as legal property (United States); as a contract; or as an aspect of ethical business practices (Germany).

Because they do not perform the teaching function of patents, made possible by the requirement of full disclosure, trade secrets are sometimes referred to as the antithesis of patents. Because trade secrets need never be revealed and because they do not have an expiration date, they can be virtually perpetual, as with the secret for Coca-Cola syrup, provided, of course, that the secret is not discovered independently by another.

Some Misperceptions

A common concern about patents and other forms of intellectual property protection is that an invention already disclosed may be patented by someone other than the inventor.

Under law, only the inventor and the inventor's successors in title have the right to a patent. In the United States, the inventor can still obtain a patent within one year of initial disclosure ("first to invent" rule), whereas in most other systems, the inventor forfeits the right to a patent if the invention is disclosed by another in a prior application (the "first to file" principle). In cases of fraud or error, a patent may be invalidated in court. Similarly, only authors and composers and their legal successors (including publishers) enjoy copyright protection. The discoverers of the Dead Sea Scrolls, for example, could not copyright their discovery.

A frequent but unfounded concern is that material already in the public domain may be patented or otherwise protected. That is generally not the case. Patents and PBRs do indeed allow protection for some forms of discoveries (as opposed to inventions) but only if the discovery requires a notable input of human effort and ingenuity. In the case of discovered microorganisms, for example, the organism must be identified and isolated from the natural environment to produce a pure sample. "Discovered" plant varieties must be described and their distinctiveness, uniformity, and stability established before protection can be granted.⁸ Furthermore, patents granted on plants and animals apply only to the unique characteristics claimed in the application. For example, the holders of the only animal patent granted to date (the "Harvard mouse") have patented mice exhibiting certain characteristics, not all mice as a genus.

Perhaps the major misperception is that intellectual property law in and of itself constitutes an effective system of protection. In reality numerous other components—including a legal, political, and economic system conducive to private business activity and the protection of private property in general—must be in place if intellectual property is to be reliably protected. Chief among these is the requirement for a fair and impartial court system for the resolution of disputes. The court need not be technically competent—technical expertise can be obtained from consultants—but it must be perceived as being even-handed or the system will not function. Protection also requires an active defense strategy on the part of the intellectual property owner. Only if the owner successfully pursues his or her legal rights will the system provide protection.

Another common misperception is that intellectual property rights are routinely used to prevent the exploitation of new technology. Although such use is not unheard of, in general the patent holder has an economic incentive to utilize the invention as widely as possible. Commonly, this is done through technology licensing, which may provide for the use of the invention in other countries. In cases where an invention represents an improvement to previously patented technology, patent holders may issue "cross licenses" to enable all parties to use the most current technology available (Barton, Dellenbach, and Kunuk, 1989).

⁸ These are minimum requirements. However, not all discoveries that meet the minimum requirements will satisfy the nonobviousness requirement for a patent or certificate of plant breeders' rights.

International Agreements

Intellectual property, like other forms of property, is territorial. Thus it is in no way a violation of one nation's intellectual property laws to make, use, or sell in another nation an item protected in the first nation. For this reason, inventors, authors, and artists are obliged to file for protection in each nation in which a significant market is sought or anticipated. Such filings are supported and facilitated by the network of international conventions described in this subsection.

International agreements for the protection of intellectual property at the world and regional levels have existed for over a century. The principal worldwide agreements are the Paris Convention of 1883 covering patents and trademarks, the Berne Convention of 1886 on copyrights, and the International Union for the Protection of New Varieties of Plants (UPOV), dating to 1961. Several regional conventions exist, especially in Africa and Europe. The practical significance of the agreements listed in appendix 2 varies considerably; most observers agree that the Paris, Berne, and UPOV conventions are the most important in their scope and impact.

Paris Convention

The Paris Convention, with 98 signatory nations, including many developing countries, has two major provisions: (1) "national treatment," i.e., equal treatment of nationals and non-nationals (article 2, Stockholm text), and (2) the granting of priority rights when filing for the same patent or trademark in any signatory nation within one year (article 4).⁹ Apart from these two principles, the convention allows signatories flexibility in setting national laws on patents and trademarks. For example, a member state may offer no patent protection for certain product groups, provided that the absence of protection applies equally to nationals and non-nationals.

Countries that are exporters of technology benefit from the Paris Convention's system of "national treatment." Conversely, for technology importers, the Paris Convention effectively neutralizes the option of selectively refusing to grant patents or trademarks. Even in the presence of the convention, however, nations retain considerable latitude in excluding products from protection and issuing compulsory licenses. See, for example, Richards' (1988) description of the patent act of Brazil, a member state. Schiff (1971) discusses the

⁹ "National treatment" requirements in international treaties bar signatory nations from discriminating against foreigners by offering them weaker patent protection than the protection accorded nationals. "Priority rights" allow an inventor to file for protection in any other member country within a year of first filing in a member country. Subsequent filings will carry the same application date as the original national filing, a provision that is of particular significance in countries that deem the first applicant to be the true inventor. This system of national filings accompanied by priority rights allows inventors to obtain protection at the lowest possible cost while awaiting the verdict of the market on the commercial viability of the invention.

case of Switzerland, which for many years offered trademark protection under the Paris Convention but no patent protection. Moreover, members are free to grant nationals certain other forms of preferential treatment including subsidies, and tax abatements.

Berne Convention

Like the Paris Convention, the Berne Convention is based on the principle of equal treatment regardless of nationality, but it goes further in setting substantive minimum standards. The convention also protects translation rights.

Because the Berne Convention sets more specific standards than the Paris Convention, national copyright legislation is more widely harmonized than patent legislation. Copyright protection under the convention is extended without the formalities of applications or examinations. The minimum protection period is the lifetime of the author plus 50 years.

International Convention for the Protection of New Varieties of Plants (UPOV)

UPOV covers plant varieties only. The protection conferred is known as plant breeders' rights (PBRs), as described above. No developing country is presently a member of the union.

Unlike the Paris Convention, UPOV requires its members to adopt its standards and scope of protection as national law. However, there remain considerable differences, notably between the United States and Europe, in the way national laws are applied (Lesser, 1987b: 358, and 1986b). For instance, the United States has not adopted UPOV's exclusion of "double protection" (articles 2 and 37), thus allowing an invention to qualify simultaneously for a patent and a certificate of plant breeders' rights.

Other Conventions

Another international agreement facilitates administrative procedures. The Patent Cooperation Treaty (PCT) of 1970 allows for a single application and a worldwide literature search¹⁰ in all 40-odd member countries. The search procedures can be used for a modest fee paid to patent offices. Commercial services, such as the International Patent Documentation Center in Vienna, provide similar assistance.

The recently concluded Treaty on the Protection of Layout-Designs (Topographies) of Microchips (1989) requires signatory nations to protect certain rights of the creators of microchip designs, provided that the chip is "original" and "not commonplace" (article 3). However because major chip-producing nations—including the United States, Japan, and the

¹⁰ The search is a review of documents and other sources conducted to determine whether the invention is novel and to assist in the determination of its non-obviousness.

members of the European Community—have declined to sign the treaty, its fate is uncertain.¹¹

Regional Conventions

The major regional patent convention is the European Patent Convention of 1973, under which a single application may result in the grant of up to 11 European national patents. This offers procedural facility and other economies for national patent offices and applicants alike, which explains the rapid rise in applications to the European Patent Office.

In the developing world two active regional offices exist, both in Africa. The African Regional Property Organization (ARIPO), headquartered in Harare, Zimbabwe, serves the English-speaking countries of East Africa. The Organisation Africaine de la Propriété Intellectuelle (OAPI) with headquarters in Yaoundé, Cameroon, serves French-speaking nations. Together, the two incorporate a total of over 30 member countries. The laws under which both regional organizations function are uniform across their member states (Straus 1989; Juma and Ojwang, 1989).¹² Despite the apparent advantages in centralizing these offices and providing a degree of homogeneity in protection, the level of patent activity appears to be low.

Administration of Agreements

Most of the international treaties on intellectual property and copyrights are administered by the World Intellectual Property Organization (WIPO). WIPO, with headquarters in Geneva, was established by a convention signed in 1967 and brought into force in 1970. It became a specialized agency of the United Nations in 1974. The objectives of WIPO are:

- (a) to promote the protection of intellectual property through cooperation among states and, where appropriate, in collaboration with other international organizations;
- (b) to encourage the development of new treaties and the modernization of those treaties it presently administers.

¹¹ The United States has national legislation protecting such products. The U.S. law offers reciprocal rights to nationals of countries providing similar protection. See chapter 5.

¹² According to Juma and Ojwang (1989: 23-24), OAPI member states have a uniform patent law similar to the French system. ARIPO provides for regional patents having the effect of national patents in all designated member states (quoted in Straus 1989: 9). Individual ARIPO countries also maintain national systems that fall into three categories: (a) automatic conferral of South African patents (Botswana, Lesotho, and Swaziland); (b) re-registry of British patents (The Gambia, Ghana, Kenya, Seychelles, Sierra Leone, Tanzania and Uganda); and (c) various other national laws, including the WIPO Model Law (Liberia, Malawi, Mauritius, Nigeria, Sudan, Zambia, and Zimbabwe).

To developing countries, WIPO provides assistance in gaining access to patented foreign technology, increasing competitiveness in trade, and locating technological information. Much of this assistance is provided in the form of advice, training, documents, and equipment (WIPO, 1989). WIPO lacks an enforcement mechanism, relying instead on national courts.

UPOV operates as a sister organization to WIPO, sharing the same secretary-general and headquarters building.

Scope of Protection

The scope of protection in OECD countries is uniformly high. Appendix 1 summarizes the status in individual countries.

Finland, Norway, and Spain still do not protect pharmaceutical products and processes. However, under pressure from its pharmaceutical and computer industries, the United States recently introduced retaliatory trade provisions (Section 301 of the 1988 Trade and Competitiveness Act) that make it possible to levy retaliatory tariffs on imports from countries that do not protect the intellectual property of U.S. nationals. The EC is adopting similar policies. The U.S. Protection of Semiconductor Chip Products Act (Chip Protection Act) insists on reciprocal standards for the protection of semiconductor technology.

In the current Uruguay Round of Multilateral Trade Negotiations, one negotiating group has been asked to devise rules and principles for protection of intellectual property. This could lead to a harmonization of intellectual property standards at a level above those obtaining in individual countries or required under existing treaties.

The protection afforded intellectual property in developing countries varies widely, and many products are excluded from protection. Pharmaceuticals, for example, are explicitly excluded by 28 of 81 countries. Living organisms are excluded by 30 of 81. The patent term varies from 5 to 20 years.

Many countries provide for compulsory licensing based on "inadequate use." This is commonly interpreted as lack of domestic manufacture¹³ and is seen as contributing, paradoxically, to a low average patent use rate of 5 to 10 percent in developing countries, compared to 10 to 30 percent in industrial countries (Greif, 1987; Vaitos, 1972; Taylor and Silberston, 1973: 20; Nogués, 1990a). If domestic manufacture of the product is economically not viable and its importation is prohibited, the patent will simply lie unused.

¹³ WIPO (1988a: 10-12) classifies the national provisions for compulsory licenses according to their basis: nonworking, public interest, abuse of monopoly, and other grounds.

Conclusion

Legal protection of intellectual property in developing countries is generally considered to be weaker than in OECD countries.¹⁴ However, detailed assessments and rankings have not been performed. Nor has the question of differential interpretation, administration, and enforcement of identical or similar legal provisions been satisfactorily addressed. Additional research would make it possible to probe whether countries with stronger protection are more successful in gaining access to technology, a question reviewed in chapter 4.

¹⁴ See Gadbow and Richards (1988) and McLeland and O'Toole (1987).

III. GUIDANCE FROM ECONOMIC THEORY

Carlos Alberto Primo Braga

This chapter reviews the economic literature on intellectual property—most of it concerned with the economic implications of patents. Most of the studies were produced in developed countries and their direct relevance for the concerns of developing countries is unclear. However, this review serves the purpose of defining the current boundaries of the theoretical debate on intellectual property rights.

Early Analyses

Early economic views of intellectual property developed in the context of a broader debate on the implications of monopolies. Machlup and Penrose (1950) provide an excellent summary of this debate, which was particularly fierce in the second half of the 19th century. The main arguments for patent protection at that time were the "natural law" thesis, the "reward by monopoly" thesis, the "monopoly profit incentive" thesis, and the "exchange for secrets" thesis (Machlup, 1958: 21).

Some of these arguments are based on purely philosophical grounds. Hughes (1988) presents an elegant discussion of the "Lockean labor theory" (which in his view underlies Anglo-Saxon jurisprudence on intellectual property rights) and of the "Hegelian personality theory" as alternative philosophical arguments for intellectual property rights. The Hegelian justification—that "an idea belongs to its creator because the idea is a manifestation of the creator's personality or self" (Hughes, 1988: 330)—could be used to explain the "natural law" thesis. The "Lockean labor theory" in its normative form—that "the unpleasantness of labor

should be rewarded with property" (Hughes, 1988: 303)—in turn can be thought of as providing the ethical or moral imperative behind the "reward by monopoly" thesis.¹⁵

Although they are still inherent in the contemporary debate, these arguments have long been replaced by more utilitarian perspectives, such as the ones expressed in the "monopoly profit incentive" and "exchange for secrets" theses. The former assumes that if special incentives such as patents were not available, "inventors and their capitalist backers" would engage in a lower level of R&D activity than would be socially desirable. The latter holds that patents serve to disclose technological secrets that otherwise might "die with their inventors and forever be lost to society" (Machlup, 1958: 21). In this view, the patent is presented not as a privilege but as the result of a bargain between the inventor and society in the spirit of Rousseau's social contract (Machlup and Penrose, 1950).

The history of national intellectual property systems suggests that such utilitarian views, and even economic expediency, have usually dominated considerations of morality and fairness. The Constitution of the United States, for example, empowered the Congress in 1787 "To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries" (art. I, sec. 8, cl. 8). Although some authors have tried to construe this provision as a recognition of the natural right of the inventor or author, most analysts interpret it as an attempt to foster social goals: to promote industrialization by providing favorable conditions for "working new inventions locally" (Anderfelt, 1971: 13) and to stimulate writing. It is true that the natural law argument was explicitly mentioned in the French patent law of 1791. This argument, however, has often been ridiculed on the grounds that most instruments of intellectual property have a set term: "If property in ideas was a 'natural right,' it was asked, how could it be limited to 14 or 17 years instead of being recognized for all time?" (Machlup, 1958: 22; based on Coquelin, 1873).¹⁶ Anderfelt (1971: 19), in turn, suggests that the notion of inherent rights is difficult to reconcile with "systems in which examination (as to novelty, inventiveness, etc.) precedes the patent grant."¹⁷

¹⁵ The Lockean justification leaves unresolved a distinction with important public policy consequences. Is the reward offered for the past labor of the inventor (in which case it should be proportional to the inventor's private investment), or is it a reward for saving the future labor of others (in which case it should be proportional to the social benefits of the invention)? The Lockean theory seems to underlie the former, while economic efficiency favors the latter.

¹⁶ Hughes (1988: 291) notes that Denmark and Norway recognized perpetual rights in intellectual property between 1741 and 1814.

¹⁷ The argument alleging the incompatibility of examination with natural rights is as follows: If the right applies to a manifestation of the creator's personality or self, the "natural right" of the first individual to "manifest" the invention would not in any logical way cancel the "natural rights" of individuals subsequently manifesting the same aspect of self. In contrast to patent law, copyright law in fact endows each creator with property rights, even if their creations are identical, provided they are created independently of each other.

The evolution of modern copyright protection is also illustrative of the power of interests over ideals to the extent that it can be described, at its origins, as "a saga of publishing interests attempting to protect a concentrated market and a central government attempting to apply a subtle form of censorship to the new technology of the printing press" (Hughes, 1988: 291). In the case of England "a printing guild was formed, and censorship [by the monarch] was permitted by printers in exchange for an exclusive monopoly on the right to print" (Benko, 1987: 21). By the early 18th century, however, England had already established the basis for modern copyright law with its Statute of Anne (1710) substituting "a statutory rule of law for a regime of royal favor" (Ginsburg, 1990: 10). Its main objectives were to discourage "piracy," while encouraging "Learned Men to Compose and Write useful Books."

Of course, utilitarian arguments that the benefits to society of protecting intellectual property exceed its costs have not been spared criticism. Typically, such criticisms have suggested that the costs of protecting intellectual property are higher than the supporters of protection acknowledge. The impairment of competition among firms and the negative impact on the diffusion of knowledge have often been mentioned in this context. As Machlup and Penrose (1950) describe it, there were moments in the second half of the 19th century when the antipatent movement seemed close to obtaining a decisive victory, reflecting the strength of the "free-trade crusade" in several European countries. On the other hand, John Stuart Mill argued persuasively that the "condemnation of monopolies ought not to extend to patents"; he criticized attempts "to impugn the principle of patents altogether ... which, if practically successful, would enthrone free stealing under the prostituted name of free trade...." (Mill, [1848] 1965: 928-29).

Some virulent advocates of free trade were among the early supporters of intellectual property rights protection. Friedrich List, for instance, argued that the "granting of patent privileges offers a prize to inventive minds. The hope of obtaining the prize arouses the mental powers, and gives them a direction towards industrial improvements" (List, [1841] 1966: 307).

Despite the inconclusiveness of the academic debate, the forces favoring intellectual property rights protection finally prevailed, and by the end of the 19th century, the Netherlands was the only industrial nation without patent laws.¹⁸ The victory was not won without compromise, however, as attested by the adoption in many countries of rules for compulsory "working" and licensing of patents.

The 1950s witnessed a revival of interest in the economics of intellectual property. Two important contributions were the works of Penrose (1951) and Machlup (1958), which stressed the economic ambiguity of patents under many circumstances. These analyses, however, remained basically descriptive; their major contribution was to call attention to the

¹⁸ The Netherlands had no patent system from 1869 to 1912. Switzerland introduced a "rudimentary" patent system by 1888, but comprehensive patent protection was not adopted until 1907 (Schiff, 1971).

historical roots of the debate, to summarize the main arguments for and against protecting intellectual property, and to combat the mythicizing of its benefits.

The theoretical terms of the economic debate on intellectual property rights in the first half of this century were not significantly different from those used by earlier analysts. Actually, as Machlup (1958: 25) points out, economists had ceased to see the patent question as a burning issue, and most analyses of the economic implications of patents during the period were produced by lawyers, engineers, and historians. It is worth mentioning, however, that the works of Joseph A. Schumpeter (1934, 1942)—in setting the stage for the modern economics of technological change—would influence the research agenda on intellectual property in years to come.

Welfare Economics and the Optimal Length of Patent Protection

Arrow's (1962) treatment of the incomplete appropriability of information was the seminal work for the modern economic theory on intellectual property. Arrow argued that:

[I]nformation obtained should, from a welfare point of view, be available free of charge (apart from the cost of transmitting information). This ensures optimal utilization of the information but of course provides no incentive for investment in research.... In a free enterprise economy, inventive activity is supported by using the invention to create property rights: precisely to the extent that it is successful, there is an underutilization of the investment. The property rights may be in the information itself, through patents and similar legal devices, or in the intangible assets of the firm if the information is retained by the firm and used only to increase its profits.

Arrow's work provided a unifying approach for the economics of intellectual property focusing on the creation and diffusion of knowledge, and laid the groundwork for further theoretical research into the implications of intellectual property as a resource allocator. Recognition of the interplay between the efficient allocation of knowledge in the present and its future production encouraged economists to look for second-best optimal solutions. The optimal term of intellectual property instruments became a major research topic.

Nordhaus (1969) provided the classic framework for the issue of optimal patent life.¹⁹ Focusing on "small" (or "run-of-the-mill") process innovations in a world of

¹⁹ For a recent review of this literature see Nogués (1990a). The Nordhaus-related literature usually refers to "inventions." In the Schumpeterian view of the process of technological change (see, for instance, Stoneman, 1987: chap. 2) invention is interpreted as the production of new ideas, which may or may not require R&D expenditures, whereas innovation is understood as the development of these new ideas into marketable products or processes. As Taylor and Silberston (1973: 28) point out, whereas "patents have traditionally been thought of as a device for protecting inventions, they are nowadays better regarded as a means of protecting novel technological ventures."

competitive product and factor markets, Nordhaus calculated the optimal life of a patent, assuming that property rights ensured complete appropriability and that there was no competitive patenting (that is, that firms did not engage in competitive research for the sole purpose of obtaining rents from patented innovation).²⁰ In Nordhaus's model, determining the optimal lifespan of a patent is a maximization problem in which the objective function is the net welfare gain for society (the additional producer surplus during the patent-monopoly period plus the gain in consumer surplus later on) brought about by the innovation, constrained by the requirement that the return to the innovator be sufficient to induce him to make the innovation available. Innovation, in Nordhaus's model, results from R&D investments: innovators determine their R&D efforts on the basis of profit maximization. Scherer (1972) provides a geometric interpretation of Nordhaus's model.

The main conclusions derived from the model may be summarized as follows: In most cases, there is a finite patent lifespan from a social point of view; its length is an inverse function of the price "elasticity of demand in the neighborhood of the preinvention and postinvention competitive equilibria" (Scherer, 1972: 424). For "run of the mill" innovations, as elasticity increases so does the welfare gain in the form of the additional consumer surplus potentially brought about by the innovation. Accordingly, the social cost of postponing the capture of this benefit (by extending the life of the patent) also increases. The easier the innovation, that is, the greater the cost reduction for a given level of R&D investment, the shorter should be the patent. The optimal duration is highly sensitive to changes in the parameters of the model such as the social rate of discount and the shape of the function that transforms R&D into innovation. The model also suggests that "life and breadth [i.e., the scope of coverage of patent laws] go hand in hand. Thus if coverage is narrowed the optimal life must increase to compensate" (Nordhaus, 1972: 430).

These theoretical findings have policy implications. First, they suggest that fixed patent terms are not optimal since "different industries, different technologies, and different market demands necessitate different optimal patent lives" (Stoneman, 1987: 106). Second, the model suggests that for run-of-the-mill innovations the losses from monopoly are smaller than the gains from innovation. From the second finding, one might conclude that "too long a patent life is better than too short a patent life," as long as trivial innovations could be barred from receiving patents (Nordhaus, 1972: 430).

The model also offers insights on the efficiency of the patent system. The efficiency costs associated with fixed patent terms, for instance, can be estimated for different combinations of parameters. These estimates show that the "welfare index is insensitive to the life of the patent once a life between six and ten years has been reached" (Nordhaus, 1969: 84). Therefore, the costs imposed by standardized patent terms, beyond a minimum

²⁰ Under circumstances of "competitive patenting" two inventions may be developed that are technologically distinct economic substitutes. The presence of one limits the ability of the other to command monopoly rents. This is the case with the vast majority of patents (except in countries with the highest standards of patentability), so an assumption to the contrary severely restricts the applicability of Nordhaus's analysis.

term, would not be very significant, an important result given the administrative benefits of this practice. In the same vein, Nordhaus shows that the patent system performs relatively well (in terms of its welfare costs) in the case of "small" innovations and/or inelastic demand conditions.

The apparent robustness of some of Nordhaus's theoretical results has lately come under attack. As described below, once some of the basic assumptions of the model are relaxed its theoretical results can change.

The Economic Cost of Patent Races

Recent criticisms of the conventional economics of patents reflect a reevaluation of the adequacy of the hypotheses of the Nordhaus model. Once the possibility of competitive patenting is allowed into the model, for instance, the patent system may entail additional social costs to the extent that it generates overinvestment in R&D.

Barzel (1968) was the first to point out that competition in the prepatent stage of R&D may induce private firms to introduce an innovation sooner than would be socially optimal.²¹ Such behavior would be fostered by the desire to secure exclusive control of an innovation in a dynamic environment in which the profitability of the innovation changed over time.²² This concept was further explored by Loury (1979), and became one of the points of departure of a growing body of literature treating the interactions of industrial organization principles, R&D patterns, and intellectual property. Beck (1976, 1981), for example, has focused on the waste associated with the duplication of R&D efforts.

The industrial organization literature, with its emphasis on game theory, grew fast in the 1980s. Its power to explore peculiar market interactions may explain the vitality of this line of theoretical research. Seminal contributions in this area were made by Dasgupta and Stiglitz (1980a, 1980b), who analyzed alternative combinations of competition at the product market level and in terms of R&D among firms. Assuming that firms engage in a Cournot game (i.e., that each firm takes its competitors' choices of R&D expenditure and output level as given), Dasgupta and Stiglitz showed that where demand is highly inelastic and there is free entry into the industry there "may be excessive duplication of research effort in a market economy in the sense that industry-wide R&D expenditures exceed the socially optimal level ..." (1980a: 289).

²¹ Usher (1964) had already raised this problem in a broader context, when he analyzed the "economics of invention."

²² Related problems, such as the potentially negative impact of patents on the duration of research projects and on the scale of innovations, are discussed in Kitti (1985).

Related to the growth of the industrial organization school was the evolution of a literature on preemptive patenting. Gilbert and Newbery (1982) spelled out the conditions under which a monopolist would manipulate patents, using them or letting them "sleep" in such a way as to deter entry into the industry. Dasgupta (1986) explored the same issue, but qualified the relevance of his results by pointing out that technological competition usually resembles a continuous game in contrast with the discontinuous ("winner take all") games implicit in the patent-race approach.

Patents and Knowledge Diffusion

The theoretical literature reviewed so far dealt above all with the impact of intellectual property rights on the production of invention and innovation.²³ However, if one accepts the proposition that the evolution of basic scientific knowledge influences the direction of invention and innovation in a society (Rosenberg, 1974), then the impact of intellectual property rights on the progress of such knowledge becomes an important question.

Dasgupta (1987) suggested that the scientific community perceives knowledge as a public consumption good, whereas the technology community tends to approach it as a private capital good. These different "social organizations" follow different rules, with the scientific community emphasizing complete disclosure and the technology community favoring secrecy. In science, the reward structure is built upon the "priority rule": awards and prestige are usually associated with winning the "scientific race." Thus the capacity to capture rents from new knowledge (through secrecy or patents) would not play a major role in fostering scientific research.²⁴

The question of knowledge diffusion—that is, the dissemination and application of innovation rather than its production per se—under systems of intellectual property rights has also received attention. Burstein (1984) asserts that in the case of knowledge-based products, which must "be sold bundled with education and other complementary services, ... intensity of diffusion will be sensitive to the nature of governing property-rights regimes." He argues "that there is more reason to be concerned about too paltry grants of property rights in knowledge-based products than with the magnitude of quasi-rents to innovation" (pp. 612, 632). To create demand for his product, the innovator must invest in the diffusion of the associated knowledge—particularly in developing countries. He may be reluctant to do so if

²³ A good review of the literature on alternative policies for fostering R&D is provided by Reinganum (1989).

²⁴ The scientific ethos is becoming more and more utilitarian. Universities in the developed world are obtaining patents in growing numbers (Sherwood, 1990b) and scientists are becoming much more concerned with secrecy. See, for instance, the debate on the technology of compressing pictures with "fractals" (irregular geometric patterns that repeat themselves on many scales) and the "proprietary" use of mathematical theorems described by Corcoran (1990).

property rights are "confined to primary invention." Thus if "the innovator is to receive a grant valuable enough to make diffusion worth his while, he may have to obtain protection of a number of his products, [including some] which may not require further instruction to be usefully 'consumed'" (Burstein, 1984: 609).

Diffusion through imitation is analyzed by Dasgupta (1988: 74) as "an instance of the idea of information spillover." Using race and waiting games to model R&D strategies, Dasgupta points out that spillovers "hold firms back from investing in R&D. But they do not hold them back completely, even when spillovers are so large as to make it positively beneficial to be an imitator. For if all hold back forever there will be no-one to imitate!" (p. 78).

The literature on licensing provides yet another perspective on the impact of patents on knowledge diffusion. Scherer (1977) has suggested that compulsory licensing would not significantly affect the incentives for firms to perform R&D if "reasonable" royalty rates were established. Tandon (1982) shows that compulsory licensing may improve welfare in a patent system where patent life and royalty rate are determined in an optimal fashion. In a different vein, Gallini and Winter (1985) and Katz and Shapiro (1985) use duopoly games to analyze the incentives to engage in licensing of technologies protected by patents.²⁵ In these cases, patents accelerate diffusion to the extent they contribute to the negotiation of technology packages. However, Shapiro (1985) calls attention to a situation in which the patent holder, by auctioning licensing contracts among oligopolists, may spread the use of the new technology, while accentuating the anticompetitive behavior of the industry.

Most recent literature propounds the view that strengthening intellectual property rights will promote *ex post* dissemination of R&D results through licensing. However, the growing concern about overinvestment in R&D stemming from the quest for international competitiveness has stimulated interest in *ex ante* R&D cooperation policies, i.e., agreements to share the fruits of an R&D project. Katz and Ordover (1990) provide a good review of the related theory.

Are Copyrights Different?

Economists tend to stress that "although the different schemes [of intellectual property protection] have different institutional structures, the principles on which they are founded are very similar" (Stoneman, 1987: 102). Yet most analysts have also acknowledged some important distinctions between copyrights and patents. As Benko (1987: 23) points out, while the economic interests of innovators are directly linked "to the ideas or information embodied in their works," the economic interest of authors and artists is related to a particular

²⁵ Gallini and Winter (1985) explore both *ex ante* and *ex post* licensing, while Katz and Shapiro (1985) limit their analysis to the *ex post* case, i.e., the case in which contracts are signed only after R&D has been implemented.

expression of a creative idea. Copyright law protects this particular expression against unauthorized copy. This is feasible because the literary or artistic work "and the information or ideas it contains are separable" (Benko, 1987: 23). Furthermore, controlling ideas per se would not only be impossible, but also undesirable to the extent that "it would stifle creativity and intellectual debate with little social benefit in return" (Maskus, 1989: 23). In many countries copyright laws allow exceptions to protection under the "fair use" doctrine, which permits limited reproduction of copyrighted works without the author's permission for purposes of criticism, scholarship, teaching, and news reporting. In short, copyrights provide a lower degree of monopoly power than do patents.

Formal modeling of the economics of copying, however, has been patterned after Nordhaus's approach.²⁶ For example, Hirschleifer and Riley (1979) have evaluated the impact of an increase in copyright protection in terms of its benefits (reduced welfare loss from underproduction) and its costs (increased welfare loss from underutilization). Despite their similarities to patent-related modelling, however, such analyses have produced more ambiguous results.

Novos and Waldman (1984) find that more stringent copyright protection will tend to decrease the social loss from underproduction—that is, the market provision of a product below the socially optimal quality level because of potential free-riding. This conclusion holds as long as the increase in the quality of the protected product does not cause consumers to shift from the primary market (in which the consumer purchases the copyrighted product directly from the monopolist) to the secondary market (in which the consumer borrows a unit of the copyrighted product and copies it). Their more interesting result, however, is that an increase in protection may lead to a decrease in social welfare losses from underutilization "once the costs involved in obtaining a...good through a secondary market" are taken into account (Novos and Waldman, 1984: 244). This unusual result reflects the assumption that "consumers at the margin are expending more resources in acquiring the good through the secondary market than would be incurred if the good were purchased from the monopolist" (ibid.). Johnson (1985) expands on this analysis, building into the model two distinct copying technologies and differentiation in consumer's tastes over the short and long term. According to Johnson, enhancing copyright protection could be welfare enhancing "even in the short run if copying induces a large reduction in demand for originals relative to its effect on total consumption" (p. 158). The long-term case in favor of protection is even stronger, if one assumes a high elasticity of supply of creative works or if consumers place a high premium on product variety.

Liebowitz (1985) criticizes these analyses, pointing out that Novos and Waldman's results do not take into account the major impact of new technologies on the costs of copying. Their model assumes "that the marginal cost of production for the monopolist is less than any consumer's private cost for reproducing the monopolist's output" (Novos and

²⁶ For examples of earlier economic opinion on copyrights, see Plant (1934) and Hurt and Schuchman (1966).

Waldman, 1984: 239), an assumption that is no longer valid in many cases. The costs of photocopying on a small scale may well be lower than the monopolist's marginal cost. Liebowitz argues further that low-cost copying may increase the productivity of originals and eventually foster their effective demand, thereby subverting Johnson's estimation of the trade-off between original and copy. More generally, McCain (1988) points out that most copyright utility models do not take into account the transaction costs associated with any property rights system.

Summing up, current economic theory offers only equivocal results on the implications of copyright protection. At the same time, practical problems of copyright law have been magnified by the growing demands of the so-called information age. As the value of information increases vis-à-vis the value of the medium by which it is conveyed, the case for copyright protection seems to get stronger (McCain, 1988: 270). Similarly, as new technologies undermine the "usefulness of the distinction between copyrights and inventions" (Benko, 1987: 24), the reach of copyright law has expanded, e.g., to protect computer software. Yet these same technological advances pose new challenges to the very concept of intellectual property rights by magnifying the transaction costs linked to their enforcement and the possibilities of cheap diffusion.

Trademarks and Counterfeiting

Historically, trademarks have been analyzed chiefly as devices to ensure quality. According to this view, trademarks perform an important role by helping diminish informational asymmetry. This type of market-failure, formally identified by Akerlof (1970), may drive products of higher quality out of the market if consumers "cannot discern the actual quality of individual products" (MacLaughlin et al., 1988: 103).

The negative effects of weak protection are not, however, restricted to the consumer. Trademarks allow firms to protect their investments in reputation. These sunk costs, in turn, create incentives for quality-oriented performance by the firms, without which they would be less inclined to introduce new products and maintain high levels of quality as they would not be able to recuperate expenses made in order to "create/sustain" the new market (Klein and Leffler, 1981). To the extent that "firms that pursue improvements in quality are also the innovators" (Benko, 1987: 24), weak trademark protection would also, in an indirect way, hamper innovation by dissipating the rents of such firms.

These considerations are particularly relevant for cases of deceptive counterfeiting in markets with imperfectly informed consumers. In such cases, consumers may attribute the poor performance of the counterfeit to the trademark holder (Grossman and Shapiro, 1988a: 60). "Nondeceptive counterfeiting of status goods" constitutes a different case, in which the impact on consumers is less clear. Despite the negative consumption externality, or "status degradation," caused by such activities, "counterfeiting allows some consumers to enjoy the status of displaying a prestigious label without paying for a high quality product." In other

words, counterfeits play a positive role to the extent that they "serve to unbundle the quality and prestige attributes of branded products" (Grossman and Shapiro, 1988b: 98).

The analyses of Grossman and Shapiro (1988a; 1988b) are particularly interesting because they show that even in the case of deceptive counterfeiting the welfare implications of fighting the abuse may be ambiguous, depending on entry conditions in the domestic industry. Their model assumes that domestic firms own trademarks and that foreign suppliers are responsible for counterfeits of domestic brand-name goods. With free entry into the domestic industry, "the quality adjustment in response to counterfeiting necessarily lowers home and global welfare. With a fixed number of domestic firms, however, brand-name producers may raise their quality in an effort to battle counterfeiters, and the quality enhancement may cause both home and global welfare to rise (since quality was initially undersupplied due to imperfect information)" (Grossman and Shapiro, 1988a: 73).

It is important to acknowledge that deceptive counterfeiting may be particularly harmful in the case of pharmaceuticals. As a representative of the pharmaceutical industry points out, "poor quality drugs or drugs with low or inconsistent bio-availability can represent a real safety hazard to the patient. The industry strongly believes that brand-names provide a unique identification of the products that it manufactures, linking the manufacturer's name and reputation with his product, and assuring the user that the manufacturer stands behind and *accepts responsibility* [emphasis added] for the quality of his product" (Peretz, 1983: 262).²⁷ On the other hand, it has been suggested that the "quality identification function of trademarks has become largely irrelevant in countries where the government has adequate facilities for testing the quality of drugs" (Chudnovsky, 1983: 190).

Benko (1987: 25) has concluded that the "social costs and benefits of nonpatent industrial properties [such as trademarks and industrial designs] are less clear and far more uncertain than those of inventions and copyrights. It is far less certain whether the monopoly rights of nonpatent industrial properties and the social costs in the form of static inefficiencies that they create will, in fact, generate dynamic efficiencies down the line."

Trade Secrets

Secrecy is an alternative to patent protection for certain types of inventions and innovations. Wright (1985: 42) points out that this is the case for "discoveries (such as a new assembly tool) that could be exploited in productive use without divulging their nature." In addition, secrecy may be used to protect certain discoveries that cannot be patented—e.g., "a new method for analyzing petroleum exploration data" (p. 42).

²⁷ It is illustrative to note that even in cases of tampering, companies tend to be held responsible for the safety of their products. See, for instance, the analysis of the Tylenol poisonings in Mitchell (1989).

Trade secrets have aroused little interest in economic literature, although it would clearly be valuable to know more about the circumstances under which trade secrets can be substituted for patents and at what welfare costs.

Wright argues that under some (rather theoretical) circumstances secrecy could be preferable to a patent. If two or more discoverers could not keep a secret, but one could, economic reward under conditions of secrecy would accrue only to the one who had made a marginally productive effort from a social point-of-view. Should two or more have come to the same result and none contributed any marginal benefit over the others, diffusion would take care of the social cost of appropriability. Under such circumstances, secrecy would have the same social effect as a patent (which by definition is available to one innovator only), but because of the absence of administrative cost would be marginally preferable.

However, secrecy may amplify the waste associated with research duplication, as trade secrets do not add to the base of technical knowledge available to the public. Folster (1985) points out that the welfare costs of secrecy may be higher than those associated with patents as secrecy makes it more difficult to achieve a socially optimal sequence of R&D.²⁸ Yet, litigation of trade secret disputes could be even more complex than patent litigation.

The Dependency Concept

Strengthening intellectual property in developing countries is often criticized as a measure that increases their technological dependence on technology exporters. According to this view, technology transferred from industrialized countries either through direct investment or licensing "serves to perpetuate the inequitable distribution of income and to fulfill the consumption demands of the elites" (Lall, 1975:801). The usefulness of the dependency concept in explaining underdevelopment has been extensively criticized—see, for instance, Lall (1975) and Balassa (1986)—and in a world characterized by growing interdependence, it is futile to equate technological independence with strict self-reliance. Furthermore, when operational definitions of technological dependence are suggested—e.g., high-technology imports paired with low-technology exports—no precise relationship between these variables and development levels can be established (Fritsch and Franco, 1989).

Bagchi (1986, 1988) provides an alternative definition of technological self-reliance for developing countries. In the case of technological followers, self-reliance would be defined "... as their ability 'to import, adapt, and absorb the technologies that are needed at the time they are needed and to develop those technologies for which need is felt but which cannot be imported from abroad' for a variety of reasons ranging from their absence in other

²⁸ Under the patent system, disclosure would help to diminish this problem. Some analysts, however, are skeptical of the significance of disclosure on the organization of R&D. See, for instance, Kitch (1977).

countries' technology spectra, a prohibitive cost demanded for their transfer, or an absolute barrier against their transfer" (Bagchi, 1988: 73).

One could plausibly argue that intellectual property reform may lessen "dependency" to the extent that it fostered local R&D. In this context, it could lead to the production of "appropriate technology" and/or the achievement of "technological mastery"—i.e., the capacity to operate imported technology in an efficient way (Stewart, 1981). Yet the negative impacts described above are usually the ones highlighted in the literature on dependency and intellectual property rights protection.

International Welfare Implications

Although many analysts, like Penrose (1951), have addressed the economic implications of intellectual property rights from an international perspective, formal modelling of the international welfare implications of intellectual property rights is a relatively new undertaking.

The analysis is necessarily complex since, as Berkowitz and Kotowitz (1982: 2) observe, a national government "is bound to value the welfare of its own citizens or residents more heavily than that of foreigners." Using a Nordhaus approach, these authors analyze the economics of patenting in a small, open economy with a local inventive capacity but in which domestic supply does not affect world prices. They conclude that, under competitive conditions in the invention industry, "if world protection is excessive [i.e., if the term of patent protection is very long], it may pay even large countries not to maintain a patent system, provided they are free of retaliation" (Berkowitz and Kotowitz, 1982: 9). With monopoly in the invention industry, the results may change. Countries having "a significant concentration of imperfectly competitive enterprises have an incentive to maintain a high degree of patent protection as well as to press for longer patent protection elsewhere" as long as local inventions are locally owned (p. 12). However, if an invention occurs abroad and is foreign owned then, as in the competitive case, it does not pay for the small country to protect it.

The demand for analyses of patent protection in a "North-South" context has increased over the last few years as intellectual property has become a major multilateral and bilateral negotiating topic. Chin and Grossman (1988), for instance, have treated the issue within the framework of a duopolistic competition between a northern and a southern firm. In their analysis, only the northern firm has the ability to invest in R&D, while the southern firm may imitate without costs if the South does not provide patent protection. Their results suggest that the interests of the North and South are generally at odds. "Unless the South comprises a majority share of the market for the good whose technology is subject to improvement or the prospects for cost-savings are quite substantial, social welfare in the South will be higher when it eschews protection of foreign intellectual property than when it succumbs to pressure from the North. The North, on the other hand, always benefits from

having the patents of its firms respected outside its border" (Chin and Grossman, 1988: 22). Higher levels of protection for intellectual property rights at the world level may or may not enhance global welfare, depending on the productivity of the R&D stimulated by the protection.

Diwan and Rodrik (1989) expand upon Chin and Grossman's analysis by assuming (a) free entry into the R&D sector for all firms in the North, (b) the presence of a continuum of potential technologies (but with different distributions of preferences in the two regions), and (c) various levels of patent protection. The major contribution of their model is that it makes explicit that intellectual property protection may "affect not only the quantity of innovation, but also its quality" (Diwan and Rodrik, 1989: 29). Under the model, the appropriate level of protection in the South will depend on how closely Southern preferences for technology match those of the North. In a world of similar preferences, the usual results ensue, with the free-ride motive in the South dominating the process. If, however, there are significant differences in the region's technological preferences, then the trade-off between free-ride benefits and availability of appropriate technology to the South may dictate an even higher level of protection in the South than in the North.

Subramanian (1990; forthcoming) also addresses the issue of patent protection in the South. He suggests (forthcoming) that developing countries, contrary to their commitment under the Paris Convention, should consider discriminatory treatment so that "in some situations (industries) the patent right will not automatically be granted to the foreign national, even if he were the first to apply for a patent right, or the first to invent a product or process whose patentability is in question."

Subramanian (forthcoming) arrives at this conclusion on the basis of a model that assumes constant marginal costs and a perfect monopoly as a result of patent protection. The foreign supplier has a technology advantage over the domestic supplier. Four policy scenarios are considered involving different combinations of levels of protection (high or low) and of the manner of protection (discriminatory or nondiscriminatory). Welfare implications are expressed as consumer surplus and pure profits for each one of these scenarios. The model illustrates the welfare tradeoffs between technology-importing and -exporting countries. Gains from a high level of protection are considered negligible for a "small" country. This type of economy would prefer to provide low protection without discrimination. When the implications of protection in the technology-importing country are not negligible, however, it may be welfare enhancing for the importing country to provide high protection with discrimination against foreign nationals.

The issue of discrimination is further explored in Subramanian (1990), where the author, on the basis of the same model, argues that for economies with "some domestic capacity to innovate, ... the welfare-superiority of discrimination could emerge in a wide range of empirical situations." Maskus (1989: 91) has criticized this conclusion, pointing out that Subramanian's analysis does not take into account the potential "costs of resource misallocation in other sectors, factor-price impacts, the likelihood of foreign retaliation, rent-

seeking for patent rights, and so on." In fact, Subramanian does mention some of these potential negative implications (although he restricts the possibility of retaliation to the intellectual property area); he argues that these drawbacks should not prevent a reexamination of the economic implications of the national treatment concept by technology-importing countries.

Finally, The Pragmatists' View

The so-called stages approach to intellectual property rights, according to which a developing country's intellectual property system evolves as the country grows, is a constant theme in the literature. From Penrose (1951) to Mansfield (1989), one can find explanations of why the benefits a country derives from intellectual property protection should increase as the country develops. An elegant summary of the basic economic forces at work is provided by the proposition that the "trade-off between encouraging the diffusion of existing technology through unlicensed imitation and stimulating the creation of new technology becomes steeper over time" (Frischtak, 1989: 1).

Yet this analysis does not provide much help to policy makers concerned with the details of a reform. Many questions remain. For example, is there a "development threshold" (Primo Braga, 1989: 260) after which intellectual property protection becomes fundamental? Is it feasible to administer gradualism in intellectual property protection in some "optimal" fashion? These questions have not been treated in the literature.

Frame (1987) provides a simple model tying intellectual property data to a country's stage of economic and scientific development. He defines technological capacity in terms of domestic patent applications and shows that the number of applications can be accurately predicted based on (a) a country's scientific capacity, represented by the number of scientific articles published by the country's scientists "in the world's premiere 3,000 scientific journals," (b) its GNP ... (which reflects, among other things, national market size), and (c) its capacity to generate world-class innovations (reflected in its ability to patent inventions successfully in the United States, the world's most significant market)" (Frame, 1987: 222-223). His analysis also suggests that countries usually identified as "problem countries" with respect to their commitment to supporting intellectual property laws are exactly those developing countries that are "at the threshold of the ranks of industrialized countries," being also "on the average larger than other Third World countries in population, economy, and scientific and technological capacity" (p. 210).

Frame's methodology and data suffer from a number of shortcomings. For example, it is not clear exactly what is being measured by the patent statistics he uses. In developing countries, where most patents are granted to foreigners, it may be difficult to construe patent figures as an indicator of domestic technological capacity. However, they can be interpreted as a measure of "technological absorptive capacity," since technological licensing arrangements and patent applications tend to be correlated (Frame, 1987: 223).

Nevertheless, the "stages approach" provides some reference for a country when assessing the costs and benefits to be derived from a reform of its intellectual property regime (see chapter 7). Also, industrial countries draw a distinction between the more and the less technologically advanced countries and see a greater threat to their technology exports from developing countries that have built a capacity to imitate and adapt. It is not coincidental, as Evenson (1990: 325) points out, that "the U.S. Department of Commerce's list of pirating nations is almost exactly the list of countries that most economists would regard as having made significant progress in economic development over the past thirty or forty years."

Conclusions

The theoretical debate on intellectual property rights has progressed significantly since Machlup (1958) produced his comprehensive review of the related literature. However, a sense of ambiguity remains. In the years since the contributions of Schumpeter (1942) and Arrow (1962), the importance of appropriability in determining R&D intensity has received a good deal of attention. Alternative explanations for R&D efforts, such as the role of demand factors (Schmookler, 1966) or of technological opportunities (Rosenberg, 1974), have also been extensively analyzed.²⁹

The main thrust of the recent literature has been that market incentives tend to produce underinvestment in R&D. Accordingly, protection has been considered a useful instrument to encourage R&D. Lately, however, there has been growing concern with the possibility that too much protection may create overinvestment in the production of knowledge.

Overall, economic theory has raised more questions about welfare implications of intellectual property than it has answered. The theory of intellectual property protection is fragmented and provides no robust answer to the question of the appropriate or optimal level of protection under various sets of real-world circumstances. In particular, its relevance to developing country concerns must be considered marginal. Nevertheless, a number of theoretical propositions should be taken into account by policy makers in developing countries. The literature on optimal patent life, for instance, suggests that the costs imposed by standardized patent terms are not very significant, an important result to the extent that standardization holds out the prospect of considerable administrative simplification. The dangers of overinvestment in R&D, in turn, would seem to constitute more a theoretical than a practical risk in developing countries, where, according to the evidence presented in chapter 4, R&D is seriously underfunded.

²⁹ Attempts to integrate these different determinants of research intensity are provided in Pakes and Schankerman (1984) and Levin et al. (1985).

IV. SURVEY OF EMPIRICAL STUDIES

Robert E. Evenson

Introduction

Chapter 3 of this report showed that economic theory provides little guidance for developing country policy makers who must determine whether or not to strengthen intellectual property protection. This chapter reviews the empirical literature on the subject.

We first review the literature devoted to measuring the rate of return to R&D investments. The studies under review cover both developed and developing countries, and both agricultural and industrial sectors. We then review a second group of studies, including surveys of intellectual property owners and potential investors from industrial countries, seeking an answer to the question of whether intellectual property protection stimulates investment in research. Finally, we review a group of studies that consider the acquisition of technology by developing countries.

Studies on R&D Investment: How Much Is Enough?

Studies of returns to industrial R&D are almost entirely confined to developed countries. These studies demonstrate that firms realize a rate of return on R&D that is at least as high as the rate realized on alternative investments. They also show that the social returns to R&D investments are higher than the private returns because firms succeed in capturing only a part of the full value of their inventions in royalties and profits. However, their findings cannot be directly applied to developing countries, which face different options when acquiring technology and engage more in "adaptive" research than most firms in developed countries. While the absence of a body of studies on industrial research in developing countries presents a serious gap, agricultural research in developing countries has been extensively evaluated, thus offering some empirical insights for policy makers in developing countries.

An International Comparison of R&D Investments

As background to our review of studies on R&D returns, it is useful to put into perspective R&D expenditure in industrial and developing countries, and to provide a short summary of the scale of R&D investment and how it is applied.

OECD and UNESCO data on the scale of investment in R&D and basic science around the world show ratios of R&D to GDP in the 2 to 3 percent range in the industrialized countries (see table 1). Among the more recently industrialized countries only Israel and South Korea approach this level; semi-industrialized and newly industrialized economies generally fall within the 0.3 to 1 percent range. Among the developing economies India stands out with a relatively high ratio. Most middle- and low-income developing economies have R&D investment ratios of less than 0.3 percent. Expenditures on basic science are even more concentrated in the industrialized countries.³⁰

Available estimates usually put the public sector as accounting for more than 80 percent of formal R&D expenditures in developing economies. An important exception to this pattern is South Korea, where in 1975 approximately 80 percent of R&D investments were financed by the public sector. By the late 1980s a complete reversal had occurred, and the private sector is now responsible for funding 80 percent of the total (Dahlman, 1989: 14). Estimates for Brazil suggest that the public sector is responsible for 70 to 90 percent of R&D-related expenditures. In the cases of Argentina, Mexico and India, comparable figures for 1982 were around 95, 90, and 86 percent, respectively. It should be noted, however, that some publicly funded research in these countries may, in fact, be conducted by industry. For further details see CNI (1988), Psacharopoulos and Saliba (1989), Evenson (1990b), and Deolalikar and Evenson (1990).

These statistics cover only formal R&D, that is, R&D explicitly organized as such. Most firms, however, engage in informal invention activity, including "blue collar" R&D (meaning that workers and managers develop product and process improvements on the shop floor). Few estimates of the magnitude of such informal R&D exist.³¹

³⁰ Outside the OECD, definitions of scientists and engineers engaged in research and development are not standardized across countries. UNESCO attempts to compile consistent data for developing countries. Caution is necessary because in some countries only scientists having Ph.D. and M.S. degrees are counted; in others, those with B.S. degrees may also be counted; similarly, an "engineer" may have graduate training or only a technical degree.

³¹ Mikkelsen (1984) reports that manufacturers of agricultural implements in the Philippines undertake a significant level of informal R&D. Evenson (1984a) reports similar findings for Indian manufacturers of agricultural implements. See also Dahab's (1986) study of Brazil.

TABLE 1
R&D Indicators

Countries	Applied R&D/GDP (x 100)		Applied R&D/ Value Added (x 100)		Scientists & Engineers Engaged in R&D in 1986		Basic Science/ GDP (x 100)
	All Sectors		Agriculture		Total	Per 1,000 Workers	1986
	1970	1986	1970	1986			
Industrial Economies							
United States	1.65	1.85	1.96	2.16	785,000	6.56	0.42
United Kingdom	1.56	1.71	3.95	5.27	86,500	3.32	0.31
France	1.58	1.94	0.78	1.52	72,889	3.09	0.46
Federal Republic of Germany	2.03	2.60	2.94	2.83	128,162	4.62	0.50
Japan	1.84	2.75	3.28	2.54	531,612	8.80	0.37
Centrally Planned Economies	2.60	3.00	0.75	1.00	—	—	—
Recently Industrialized Economies							
Spain	0.2	0.5	0.21	0.81	15,299	1.19	0.07
Greece	0.2	0.2	0.32	0.63	3,000	0.77	0.06
Portugal	0.2	0.4	0.89	0.61	3,475	0.71	0.08
Israel	1.1	2.5	2.93	4.47	3,350	2.32	0.90
Newly Industrialized Economies							
Korea, Republic of	0.5	1.8	0.38	0.56	32,117	2.05	0.19
Singapore	0.1	0.5	—	—	2,401	1.95	0.15
Middle-Income Developing Economies							
Venezuela	0.2	0.4	1.95	1.18	4,568	0.97	0.08
Argentina	0.5	0.4	0.68	0.44	10,500	0.87	0.08
Mexico	0.2	0.6	0.11	0.63	16,679	0.76	0.10
Brazil	0.2	0.7	0.50	0.95	32,508	0.75	0.06
Chile	0.1	0.4	0.89	1.21	1,600	0.43	0.10
Colombia	0.0	0.2	0.61	0.64	1,083	0.12	0.02
Turkey	0.1	0.2	0.44	0.41	7,747	0.49	0.04
Thailand	0.3	0.3	0.91	0.60	n/a	n/a	0.06
Egypt	0.8	0.2	0.39	0.40	19,939	1.61	0.04
Philippines	0.2	0.2	0.41	0.18	4,816	0.23	0.03
Low-Income Developing Economies							
Indonesia	0.1	0.3	0.29	0.45	24,895	0.45	0.06
Pakistan	0.2	0.3	0.05	0.31	9,325	0.41	0.03
Kenya	0.1	0.1	1.34	0.81	n/a	n/a	0.02
India	0.4	0.8	0.16	0.35	28,223	0.12	0.12
Bangladesh	0.1	0.2	0.15	0.34	n/a	n/a	0.20

SOURCE: Evenson, 1990b.

Developing countries are investing a higher share of GDP in agricultural than in industrial research (table 1). This can largely be explained by the fact that agricultural R&D has traditionally been performed in public-sector institutions, as few farms have been large enough to undertake, and profit from, effective R&D programs. The lack of protection for improved plants and animals in developing countries has contributed to the paucity of private R&D. In addition, studies have concluded that agricultural technology is highly location-specific (Evenson and Kislev, 1975).³²

Social and Private Rates of Return on Research Investments

As with capital or any other factor of production, marginal factor productivity decreases as more of that factor is employed in production. Thus a high rate of return to investment in R&D—"high" meaning a higher rate than could be earned on alternative uses of funds—implies that the country is not allocating its resources efficiently and would do better to shift resources into R&D from activities that currently earn low rates of return. By increasing the level of expenditure on R&D, the marginal return to R&D would fall to "normal" levels. In other words, high returns on R&D signal underinvestment.

Social returns accrue to the society at large, that is, to both producers and consumers. Private return is that portion of the social return captured by the producing firm.

Industrial R&D in Developed Countries

Surveys on returns to private R&D in developed countries show that investments in R&D, when evaluated *ex post*, yield returns to firms that are at least as high as returns to other investments (Griliches, 1984). Mansfield et al. (1977) report on 17 case studies of innovation for which the median private rate of return was 25 percent. Griliches (1980) reports returns to R&D for large industrial firms in the United States ranging from 30 to 50 percent.³³

Mairesse and Sassenou (1989) reviewed statistical estimates of the impact of research on a firm's productivity. He reviewed five economy-wide and four sector studies using cross-sectional, firm-level data to estimate research productivity elasticities (which approximate rates of return). His review covered seven U.S., five French, and four Japanese

³² The extension of intellectual property protection to biological and biotechnological discoveries in the developed world has been followed by an increase in private investment in agricultural research. See chapter 6, section D. Private-sector R&D has been important in the fields of agricultural chemicals and implements. See Table 2 for estimates of returns to this investment.

³³ Alam (1985) and Nogués (1990a) question the relevance of these results for R&D in developing countries.

studies.³⁴ All showed positive R&D elasticities of high statistical significance ranging from 14 to 42 percent, with a median of 27 percent. Through another set of firm-level studies in which rates of return were directly estimated, Mairesse and Sassenou confirmed their conclusion that for the three countries in question (including Japan during its imitation phase) private rates of return to R&D were at least as high as for other investments.

Social rates of return may be considerably higher than private rates, because the individual firm is incapable of appropriating, or capturing, completely the benefits from conducting R&D. Even with strong intellectual property protection, the private firm's rent from licensing or product sales generally represents only a fraction of the real value of the invention to the economy, that is, of the invention's social return. According to a study conducted by Mansfield et al. (1977), the median social rate of return from major innovations was 56 percent; the median private rate of return was 25 percent.

Industrial R&D in Developing Countries

Few studies have estimated returns to industrial R&D in developing countries. Pack (1990) has computed potential returns from productivity-enhancing R&D based on data for Philippine textile firms. He has shown that more than 80 percent of the firms in the industry would realize higher returns from this R&D than on alternative investments. Deolalikar and Evenson (1990) reported effects of R&D on factor demand but stopped short of computing returns to investment. Two studies of agriculturally related industrial R&D (see below) reported high rates of return as measured by their impact on agricultural productivity.

Agricultural R&D

On the basis of a review of 159 estimates of returns to agricultural R&D (table 2), most undertaken for developing countries, Evenson (1989) concludes that returns to agricultural research are higher than those resulting from other public-sector investments and generally higher than returns from industrial R&D. These returns are inherently "social" and should be higher than private returns because they measure the full impact of agricultural research on productive efficiency, not just gains captured by farmers.

It is of interest to note that the distribution of rates of return reported in these studies is approximately the same for the 54 estimates reported for developed countries and the 73 estimates reported for developing countries. Returns to research conducted in the International Agricultural Research Centers within the Consultative Group for International Agricultural Research (CGIAR) are also high, reflecting the high degree of adaptation potential or location specificity of most agricultural inventions. Crop varieties, animal breeding gains, and agronomic practices are affected by soil and climate factors. Specific crops can only be economically produced over a specific range of sites, and many are strictly

³⁴ See also Goto and Suzuki (1989) on rates of return in Japanese industry and their view of earlier work on this subject.

tropical crops where there is little or no scope for invention in developed countries. Accordingly, experiment stations, even with limited resources and research skills, can produce improved technology tailored to local conditions (Evenson and Kislev, 1975).

Five of the studies, two of which focused on developing countries (Brazil and India), report social returns to private-sector R&D in agriculture. These studies estimated the benefits realized on inventions in the input-supplying industries (chemicals, machinery, veterinary medicine). Interestingly, these benefits remained largely "uncaptured" by the supplying firms.

Despite the widespread pattern of high returns to agricultural R&D, the connection between underinvestment in agricultural R&D and the presence or absence of intellectual property protection is difficult to establish (even in the OECD countries), precisely because the field in question is agriculture. The bulk of agricultural research is publicly funded; moreover, in developing countries patents have not been used to appropriate returns to research, except in the area of agricultural implements and agricultural chemicals.

Determinants of R&D: Does Protecting Intellectual Property Stimulate Inventive Activity?

Studies that attempt to determine the incentive effects of intellectual property on the decisions to innovate and imitate fall into two categories: (1) studies of behavior, either of firms holding patents or of firms that conduct systematic R&D and may choose patenting as one option for appropriating returns, and (2) studies that try to establish for different sectors the intrinsic value of a patent (in comparison to the value of other rewards and incentives driving private R&D efforts).

TABLE 2
Rates of Return Estimates in Agricultural Research and Extension Studies

Scope of Study	Range of Estimated Returns on Investment (in %)		
	0-20	30-50	50+
Returns to Public Research			
Developed Countries	3	28	23
Developing Countries	8	28	37
International Research ¹			12
Returns to Private Research²			
Developed Countries			3
Developing Countries		1	1

SOURCE: Evenson, 1989

NOTES:

1 Studies on CGIAR international research centers.

2 Research on agricultural machinery and agricultural chemicals.

How Firms Value Patents

Few studies have directly measured the incentive effects of intellectual property protection in industrial countries. Watanabe (1985: 217, 250) reports a 1979-1980 survey of 2,390 Japanese firms. Of these firms, 29.7 percent cited the patent system as the most important incentive to industrial innovation, followed by 13.5 percent citing tax incentives, and 12.6 percent citing other financial incentives. With respect to the motivation of individual researchers within those firms, the possibility of patent protection was the third most important stimulus to invention, with 11.6 percent of researchers surveyed pointing toward it. This percentage trailed competition with other firms (22.9 percent) and academic or technical interest (16.8 percent).

A 1981 survey of United States firms in the chemical, drug, electronics, and machinery industries (Mansfield, Schwartz, and Wagner, 1981) elicited related data and found that these firms would not have introduced about one-half of the patented innovations that composed the sample without the benefit of patent protection.

Economy-wide, the evidence suggests that the benefits of a patent system are difficult to measure and vary widely across industries. Considering the issue historically, no evidence was found that the Netherlands or Switzerland were hampered economically during their patentless years (1869-1912 and 1850-1888, respectively; Schiff, 1971: 122).³⁵ A survey in Canada, a major technology importer, concluded that patents were not greatly important to the decision to invest in a Canadian subsidiary (Firestone, 1971: chaps. 7 and 10). Other surveys also rank patents as a low component of R&D investment determinants (reviews in Scherer, 1986: 446; Nogués, 1990a: 5-6). Greif (1987), however, shows that for the Federal Republic of Germany, R&D investments and patent applications are closely correlated, suggesting a role for patents in stimulating investment.

At the level of individual industries, the results are more supportive of patents, especially for pharmaceuticals. Taylor and Silberston (1973: chap. 14) attempted to simulate the effects of a weakened patent law in the United Kingdom. Their results indicated that the most affected industries would be pharmaceuticals and specialty chemicals, the two industries that use patents most intensively.

Despite the importance of patent protection implied by these results, there is also strong evidence that patents do not effectively deter imitation by rivals for very long. In part, this is because patents carry, in Schumpeter's words, "the seeds of their own destruction," in the sense that they disclose to rivals the means to reproduce the invention. A random 1985 survey of 100 U.S. firms (Mansfield, 1985) in 13 major manufacturing groups yielded an estimate of the average time period between a firm's decision to commit to a new process or product and the point at which the detailed nature and operation of that new

³⁵ It should be noted that conditions for invention may well have differed substantially in these periods from the contemporary setting.

product or process is known to its rivals. According to the firms in the sample, such information with regard to products is in the hands of rivals within roughly one year; with regard to processes it generally becomes available in less than 15 months. These firms listed patents as one of the chief conduits through which this knowledge spreads.

Levin et al. (1987) interviewed over 600 R&D managers in major U.S. firms, asking about the relative efficacy of patent rights in appropriating the returns to R&D. The survey was conducted by "line of business." In most lines of business, patents were rated as being less effective than trade secrets and effective sales and service as a mechanism for securing the returns from R&D. The survey confirmed Mansfield's 1985 results in showing that imitation, even in the presence of a patent, occurs rapidly and that patents disclose a significant degree of information to competitors. Results varied by line of business, with pharmaceuticals and scientific instruments attaching particular importance to patent protection, whereas in most electrical and mechanical fields, patents were deemed less important.

Furthermore, it does not appear from Levin's research that patent protection prevented competitors from entering the market. Except in certain chemical-related areas, it is generally not difficult to devise a functional substitute for a successful new product that does not actually infringe the original inventor's patent. Firms participating in Mansfield's 1985 survey believed that for about half of the sampled innovations patent protection postponed imitation by a matter of months only. Within four years of the introduction of the innovations in the sample, some 60 percent of those patented and profitable had been imitated. For just 15 percent of the sample did patent protection delay imitation by more than four years. And although patents increased imitation costs across the board, these costs were not so substantial as to markedly affect the speed with which imitators entered the market.³⁶

The studies discussed to this point do not allow us to draw meaningful conclusions for the behavior of firms in developing countries. There are two important sides to R&D: the discovery of new products and processes and the capability to quickly assimilate and modify results of rivals' research (Cohen and Levinthal, 1989). It is this latter capability that is particularly important, yet lacking, in developing countries.

Studies on the incentive effects of intellectual property in developing countries are few, and their approach appears to be narrowly focused. One survey that traces the role that stronger intellectual property protection (in this case, the protection of trade secrets) might play, was jointly conducted in Brazil by the Brazilian Action Center for Small- and Medium-

³⁶ One may well ask why, under these circumstances, firms would still elect to obtain patents. Evidently, the marginal benefits of patent protection outweigh their costs, including the costs of information disclosure to competitors. There are significant advantages to being first in a market (name recognition, etc.), even if a firm occupies the sole position for a relatively short period of time. In a rapidly changing field, or one in which the costs of changing suppliers are high, even a year's delay in the entry of rivals can result in substantial marketing advantages. See Levin et al. (1987).

Sized Companies (CEBRAE), the Ministry of Industrial Development and Commerce, and the American Chamber of Commerce for Brazil (Sherwood, 1990b: 115-116). Approximately 80 percent of 377 firms surveyed declared that they would invest more in internal company research and would improve training for their employees if better legal protection were available.

More recently it has been argued that because developing countries have a comparative advantage in adaptive invention—that is, in assimilating and modifying the inventions of developed-country firms—they require intellectual property systems that facilitate access to foreign inventions and stimulate adaptive or imitative domestic invention. An important element in such a system, according to Evenson (1990), is the utility model (or "petty patent") because it is well suited to stimulating adaptive invention. Table 3 reports registrations of utility models in 1986 for 13 countries with this property right. These data show significant use of this instrument in several countries. It also shows that most utility models are granted to nationals.

TABLE 3
Registrations of utility models ("petty patents"), 1986

Country	Registrations to Residents	Registrations to Non-Residents	Total Registrations
Brazil	439	27	466
China	2,478	52	2,530
Costa Rica	2	0	2
Germany, Federal Republic of	10,480	1,139	11,619
Italy	n/a	n/a	9,154
Japan	42,264	436	42,700
Malaysia	0	0	0
Peru	21	0	21
Philippines	278	8	286
Poland	1745	15	1,760
Portugal	36	11	47
Spain	4,633	2,327	6,960
Uruguay	100	13	113

SOURCE: WIPO, 1988b.

Evenson's point is corroborated by two studies of the agricultural implements industry in Brazil (Dahab, 1986) and in the Philippines (Mikkelsen, 1984) which concludes that the utility model stimulated adaptive inventions in these countries and enabled domestic firms to increase their competitiveness with multinational firms whose inventions they imitated. Another study by Otsuka, Ranis, and Saxonhouse (1988) reports similar conclusions for textiles in Japan and India. All three studies reported that much of this R&D was of the "informal" or "blue-collar" type. Ranis (1990) discusses the relevance of informal, blue-collar R&D in improving industrial productivity.

In Search of an Intrinsic Patent Value

Attempts to gauge indirectly the intrinsic value of a patent in different sectors are in their infancy. One promising avenue of such research has recently been opened in the work of Pakes (1986) and Schankerman and Pakes (1986). These authors observe that in countries where annual renewal fees are required to maintain patent protection (France, Germany, and the United Kingdom), the frequency with which patents are allowed to lapse, combined with the amount of the annual fee, can be used to infer the distribution of private patent values. Schankerman and Pakes found, for example, that the median patent value for a patent applied for in 1970 was about \$1,861 in the UK, \$847 in France and \$5,710 in Germany. Only the top 1 percent of all patents in each country had values exceeding \$100,000.

This work has been extended by Pakes and Simpson (1989) and Lanjouw and Schankerman (1989), who disaggregated their data to the industry level for Scandinavian countries and for France, respectively. Their results confirm other studies showing that chemical industry patents have higher mean values than patenting in other industries.

Several implications emerge from these studies. One is that the estimated private value of the annual patent stocks produced in these countries amounted to less than 20 percent of the value of private R&D conducted. This implies, in turn, that patents cannot be the primary mechanism of appropriating the returns to R&D and that because patent rights fail to capture a large fraction of the value of research, significant information spillovers are taking place across firms, industries, and countries.³⁷ One implication of this research for purchasers of patented technology is that the terms of such purchases are likely to be favorable. Another implication is that, in the majority of cases, the social costs of a patent system, especially the limited monopoly associated with it, are low.

³⁷ This incomplete capture does not imply that intellectual property rights are of little value as inducements to innovate. It attests to the relevance of the process of imitation.

Technology Acquisition Through Licensing

As noted earlier, protecting intellectual property influences economic behavior in two ways. First, it stimulates R&D, including the adaptive or imitative variety. Second, it affects the terms by which the rights to inventions are purchased and sold. For years international debates on intellectual property have focused on the terms of exchange rather than on the impact of intellectual property on R&D investment patterns. In the North-South debates of the 1970s, for example, developing countries voiced little interest in the stimulative effect of intellectual property protection on local R&D and concentrated almost exclusively on the terms by which they could acquire inventions (along with technical assistance and equipment) from industrial countries. This strategy produced effects that are at least partially revealed by the following evidence.

The direction of global technology flows can, to some extent, be traced through the patent statistics published annually by WIPO, by comparing the number of patents issued to nationals with that of patents granted to foreigners (Evenson, 1990). An inventor will normally obtain patent rights in a foreign country to facilitate the licensing of invention rights to a purchaser in the country, or to protect goods exported to that country. The actual extent of patenting abroad will vary with the level of technology involved and with the degree to which inventions are "adaptive."

Table 4 reports 1986 data for patents granted in selected countries to nationals and to foreigners, as well as patents granted to national inventors by foreign countries. The data indicate that all countries grant significant numbers of patents to foreigners, reflecting purchases from foreigners. Industrial countries are the largest purchasers in absolute terms.³⁸ They are also the largest producers of inventions. Developing countries and the newly and recently industrialized countries grant more patents to foreigners than to nationals and most of these grants are to residents of industrial countries.

Foreign patents granted to nationals indicate sales of technology. Developing countries are not significant sellers of technology (see table 4). Even the newly industrialized countries do not sell significant amounts of technology abroad. The low ratio of foreign patents to domestic patents granted to nationals indicates that the inventions produced in developing countries tend to be "adaptive" derivations of inventions originating in developed countries.³⁹

³⁸ Evenson (1990) has used these data and data on payments of technical fees and licensing to estimate purchases of technology. He concludes that technology purchases represent from one-half to one percent of GDP for most countries.

³⁹ Evenson (1990) calculates that sales of technology abroad represent more than one percent of GDP for developed countries but less than 0.1 percent for developing countries.

Some studies have tried to trace how technology transfers through licensing relate to local R&D activities. Deolalikar and Evenson (1990) have found that industrial firms in India responded to increased foreign invention by increasing their technology purchases from foreigners and increasing domestic R&D. Siddharthan (1987) found a similar "complementarity" between foreign technology and indigenous R&D in India. These studies did not consider the effect of Indian patent protection on R&D investment.⁴⁰

The role of multinational corporations as conveyors of technology to developing countries and as forces influencing R&D investment in developing countries has been the subject of a number of studies (Stewart, 1990; Lall, 1985). Lipsey et al. (1990) report that U.S. firms investing in production operations in developing countries are more R&D-intensive than are similar U.S. firms investing in developed countries. However, they perform little of their R&D in developing countries. The role of intellectual property protection in the host country in stimulating or retarding these investments was not reviewed by Lipsey.⁴¹

This evidence is generally consistent with Mansfield's 1985 findings on imitation of innovations in the United States. Few patents preclude imitation and adaptation. In fact, most stimulate "inventing around." Thus a developing country that purchases patented technology may initially pay more but may gain over the longer term due to the incentive to build up its imitative R&D capacity.

Conclusions

Evidence on rates of return to industrial R&D and on the incentive effects of intellectual property rights is largely confined to studies from developed countries. This evidence supports the conclusion that firm-level R&D in the private sector generally yields a rate of return that is at least as high as the return on other capital investments.

Industrial R&D studies report evidence that returns to R&D are not completely captured or appropriated by the property owner. This indicates that "social" returns to R&D generally exceed private returns.

⁴⁰ The "complementarity" noted here between acquired foreign technology and domestic R&D that modifies this technology is akin to the international product-cycle models developed by Vernon (1966, 1977) and Wells (1983).

⁴¹ An OECD survey on international technology licensing showed that inadequate intellectual property protection was among the major disincentives to licensing. See Frischtak, 1989.

TABLE 4
Invention Patent Summary

Country	Patents Granted to Residents			Patents Granted to Non-Residents			Foreign Patents Granted to Nationals		
	1967	1976	1986	1967	1976	1986	1967	1976	1986
Industrial Countries									
United States	51,274	44,162	38,124	14,378	26,074	32,736	73,960	90,273	69,247
Japan	13,877	32,465	51,276	6,896	7,582	8,624	6,843	20,246	40,469
Recently Industrialized Countries									
Spain	2,758	2,000	1,551	6,827	7,500	7,178	627	766	802
Israel	178	200	230	935	1,200	1,595	219	145	517
Greece	975	1,343	1,161	2,302	1,285	2,093	61	81	38
Portugal	84	46	202	1,045	1,319	3,835	53	50	18
Newly Industrialized Countries									
Korea, Republic of	207	1,593	458	152	1,727	1,436	--	--	--
Singapore	5	50	50	26	550	548	--	--	--
Other Developing Countries									
Turkey	30	35	56	438	588	227	--	--	--
Philippines	16	108	82	498	767	755	--	--	--
Argentina	1,244	1,300	198	4,488	2,800	400	81	102	26
Mexico	1,981	300	47	7,922	5,000	1,175	149	181	98
Chile	80	60	49	1,237	514	372	--	--	--
Brazil	262	450	442	684	1,500	2,493	63	88	262
Egypt	48	16	10	873	511	353	--	--	--
India	428	433	494	3,343	2,062	1,500	72	73	63
Sri Lanka	7	9	16	148	156	81	--	--	--
Venezuela	41	50	64	954	514	1,182	--	--	--
Colombia	49	30	11	851	600	87	--	--	--
Uruguay	165	46	14	351	110	87	--	--	--
Kenya	1	5	0	104	98	107	--	--	--
Morocco	28	23	27	391	334	228	--	--	--

Source: Industrial Property Statistics, 1986
World Intellectual Property Organization, Geneva, 1988.

Studies of agricultural R&D have been undertaken in several developing countries as well as in developed countries. These studies consistently report social rates of return considerably in excess of returns on alternative investments. However, the relevance of agricultural R&D studies for policy regarding industrial R&D should be considered limited.

International indicators of technology exchange show that developing countries are significant importers of technology from developed countries, but that they do not export technology to any significant extent until they reach an advanced stage of development.

There is little evidence on the question of whether and to what extent protection of intellectual property in developing countries actually affects the volume, type, and cost of technology imports. There is some evidence, however, that the protection of utility models stimulates adaptive domestic R&D. Accordingly, the stimulative effect of intellectual property on domestic R&D and on the capacity to adapt and imitate merits closer attention.

V. SECTOR ISSUES I: Pharmaceuticals and Chemicals; Information; The Audio, Video, and Publishing Industries

Carlos Primo Braga

The Pharmaceutical and Chemical Industries

The pharmaceutical and chemical industries have always been among the staunchest advocates of effective intellectual property rights and have often been involved in conflicts over those rights. For example, German chemical firms pushed for reform of the Swiss patent system at the beginning of this century (Penrose, 1951). The contemporary use of trade actions to foster intellectual property reform abroad has been particularly attractive to the U.S. pharmaceutical industry, as recent Section 301 actions against Brazil and Argentina suggest (Nogués, 1990b).

Pharmaceuticals and chemical products are often excluded from patent protection by developing countries and, in the case of pharmaceuticals, by some industrial countries as well (see appendix 1). In general, however, the industrial countries have historically moved toward higher levels of protection, while developing countries have at times taken the opposite course, for example, during the 1960s and 1970s.⁴² This latter trend has recently been reversed, as developments in Korea, Mexico and Chile suggest, although this reversal may be a response to trade retaliation or the threat thereof rather than a premeditated policy shift.⁴³

⁴² The extension of patent protection to pharmaceutical products occurred in 1949 in England, 1960 in France, 1968 in Germany, 1976 in Japan, 1977 in Switzerland, and 1978 in Sweden and Italy. Protection was weakened or abolished in Turkey in 1961, Brazil in 1968 (effective 1969), the Andean Pact countries in 1974, and Mexico in 1976. For details, see Kirim (1985), Chudnovsky (1983), Yankey (1987), Lobo (1988), Science Council of Canada (1990), and Nogués (1990b).

⁴³ The Brazilian government announced in June 1990 its intention to extend patent protection to pharmaceutical products and processes (Government of Brazil, 1990).

Why Patents Are Important

Several investigations have shown that the protection of intellectual property is disproportionately more important to the chemical and pharmaceutical industries (Taylor and Silberston, 1973; Scherer, 1977; Mansfield, 1986; Levin et al., 1987; Tocker, 1988). Mansfield (1986), using a random sample of 100 firms from 12 industries in the United States, reports that 65 percent of the innovations generated by pharmaceutical firms from 1981 to 1983 would not have been marketed, and 60 percent would not have been developed, if patent protection had not been available. The corresponding figures for firms in the chemical industry were 30 percent and 38 percent. The petroleum industry ranked a distant third with 18 percent and 25 percent, respectively.

The R&D investment required to develop a successful new chemical product are substantial. For the pharmaceutical industry, Virts and Weston (1981) estimate these costs to average approximately US\$54 million at 1976 prices.⁴⁴ Patents appear to be more effective in increasing imitation costs in these industries (particularly in the case of pharmaceuticals) than in sectors such as electronics and machinery (Mansfield et al., 1981).

As a general rule the degree of appropriability in a given industry drops as competition intensifies (Mansfield et al., 1982). Because product competition is particularly fierce in the pharmaceutical industry (Comanor, 1986), legal mechanisms such as patents, trademarks, and trade secrets legislation, which are designed to increase appropriability, are considered particularly valuable, the more so because it is comparatively easy to imitate pharmaceutical products, as suggested by the very short imitation lags for new products in this industry (Mansfield, 1985).

However, unlike for most other sectors in industrial countries, intellectual property protection for pharmaceuticals and certain chemical products such as pesticides is affected by government regulations. As Mossinghoff (1987) points out, the typical waiting period for regulatory approval of a new pharmaceutical product in the United States averages eight to nine years. In the case of pesticides, the time delay may be ten years (Anderson, 1986). As a consequence, the effective period of patent protection is significantly reduced. Some analysts argue that as "the regulatory clearance time" has been increasing "... a logical inducement for additional innovation would be to extend the patent life for pharmaceutical products, or to begin the patent life after approval is granted by the regulatory authorities for marketing the drug" (Blee, 1980: 131).⁴⁵ Wu (1981) called attention to the fact that the net

⁴⁴ Nogués (1990b: 9), quoting the Pharmaceutical Manufacturers' Association, suggests that current costs in the United States would "range from US\$50 million to US\$125 million." The agrochemical sector is also characterized by very high R&D costs necessary to meet environmental and health standards.

⁴⁵ Significant delays between the issuing of a patent and the commercialization of the related product are not exclusive to the pharmaceutical and chemical industries. See, for instance, Kitch (1977) for an analysis of the average delay between patentability and marketing of major innovations.

effect of government regulation on the ability to imitate new drugs could be ambiguous, since the imitator too must perform comprehensive clinical tests to support its product. As Grabowski and Vernon (1986) point out, however, the U.S. 1984 Drug Act has basically eliminated the need for duplicative clinical testing. The Act also permitted extensions of up to five years in the patent term to compensate for delays in introduction caused by administrative regulation.

Developing Countries' Perceptions

From the point of view of developing countries, weak protection of intellectual property rights in pharmaceuticals, chemicals, and foodstuffs is often explained as an instrument to avoid restrictions in "the supply of essential products" (Twinomukunzi, 1982). Implicit in such explanations is the perception of "technological innovation as a public rather than a private capital good" (Center for Economic Development, 1990: 104).

In the case of pharmaceutical products, the resistance to protection of intellectual property rights is magnified by ethical considerations that are well captured by the following words of Indira Gandhi, spoken at the World Health Assembly in May 1982: "The idea of a better-ordered world is one in which medical discoveries will be free of patents and there will be no profiteering from life and death."⁴⁶ In the same vein, UNCTAD in 1975 recommended that pharmaceuticals be made available to developing countries at marginal cost. Such a recommendation would require public R&D for new drugs tailored to the needs of developing countries needs. As the contribution of the South to the development of essential new drugs has so far been negligible (Parker, 1980), implementation of the UNCTAD recommendation would probably require significant external aid.

Other concerns of developing countries include the exploitation of market power by foreign companies and the impact of protection on domestic prices (Chudnovsky, 1983; Kirim, 1985). To the extent that innovation in these industries is concentrated in a few developed countries, it is often argued that higher intellectual property protection would allow foreign companies to displace domestic producers. In the case of pharmaceuticals, the available evidence from developed countries does not seem to support this proposition (see Jori [1988] for a preliminary account of the Italian experience), but the relevance of these results for developing countries is unclear. It is still too early to draw reliable conclusions from recent reforms in the Third World.

The experiences of Argentina (Chudnovsky, 1979), Costa Rica (UNCTAD, 1981), and Turkey (Kirim, 1985) are sometimes presented as cases in which the abolition of patents

⁴⁶ Quoted by Gadbow and Kenny (1988: 86).

played a major role in fostering the locally owned firms of the industry.⁴⁷ The evolution of the Brazilian pharmaceutical industry (Frischtak, 1989; Grynszpan, 1990), however, illustrates that the absence of intellectual property protection is not sufficient in itself to boost the market share of domestic companies.⁴⁸

According to Yankey (1987), articles 5(A)(1) and 5 *quater* of the Paris Convention confer upon patentees a virtual import monopoly that constitutes an important dimension of market power. Vaitsos (1976) suggests that Article 5 *quater* was introduced into the convention (Lisbon Revision Conference of 1958) at the behest of the chemical and pharmaceutical industries. Its impact on developing countries was qualified by the fact that a significant number did not ratify the Lisbon Act.

Impact on Prices

Debate continues on the impact of intellectual property protection on domestic prices of chemicals and drugs. Lieberman (1987: 274) found that on average "patenting [of process innovations] by producer firms appears to have retarded the rate of price decline" in the case of a sample of 24 chemical products marketed in the United States. Patenting by nonproducer firms and foreign firms, in turn, was found to contribute to market price reductions. The implications of patent expiration have been treated in the context of developed economies. The conventional view is that once the patent expires, competition will force the original holder of the patent to reduce his price or accept a loss in market share. Shaw and Shaw (1977), for instance, analyze this phenomenon in the case of the polyester fibers market. For pharmaceutical products, Taylor and Silberston (1973) and Grabowski and Vernon (1986) report similar patterns of price decay after patent expiration for the United Kingdom and the United States, respectively. Schwartzman (1976), however, points out that the extent of price competition varies across different drug markets, being significant mainly in the antibiotics market. Statman (1981: 150), in turn, "suggests that drugs protected by a patent are able to hold on to their market positions beyond patent expiration, although, in general, generic and other name brands gradually capture an increasing share of each drug's market." He explains these results in terms of brand loyalty, a rationale that is consistent with the finding that competition in the United States is more vigorous in the smaller hospital market than in the drugstore market.⁴⁹

⁴⁷ Kirim (1986: 517), however, points out that "it is difficult to state that the dominance of local firms in the Turkish pharmaceutical industry has been beneficial, because all the negative aspects [e.g., monopolistic pricing] of pharmaceutical production and exchange which the critics have attributed solely to [transnational corporations] have been similarly reproduced by local firms in the pharmaceutical industry in Turkey."

⁴⁸ Government procurement policies are often mentioned as a more effective instrument to achieve this objective. See, for instance, BNDES (1988).

⁴⁹ The logic is that the hospital market would be characterized by a "greater knowledge of drugs or ... [a] greater incentive to economize" (Statman, 1981: 150). The possibility of better informed consumers, in turn, would tend to diminish the role of trademarks in keeping brand loyalty alive.

The link between intellectual property protection and high domestic prices has often been made. In some cases, as in Canada in 1969, this link provided one of the main justifications for weakening the level of protection for drugs by means of comprehensive compulsory licensing practices (Firestone, 1971). International price comparisons are quite complex, however, due to the many distortions that characterize the markets for these products. Despite these problems, Schut and Van Bergeijk (1986) suggest that excluding pharmaceutical products from patent protection seems to have a downward influence on the price of drugs, although their results are not statistically significant. There is, however, clear recognition that other government policies, such as price controls (Schut and Bergeijk, 1986) and the promotion of generics (Chudnovsky, 1983), may have a greater impact on drug prices.

Stricter protection of intellectual property is usually assumed to increase prices of pharmaceutical products in developing countries. However, comprehensive analyses estimating the loss of consumer surplus from intellectual property reform are almost nonexistent. A study for Chile estimated "the consumer surplus benefits of not having had patent protection to pharmaceuticals" as being in the range of US\$7 to 15 million per year (Cocoma, Gabrielli, and Williamson, 1987).

The Information Industries

Information-related technologies, usually defined "to include data processing and communications services as well as electronic hardware" (Mody, 1989a: 298), pose some of the greatest challenges to intellectual property. Although the R&D-intensive firms that operate in this sector are greatly concerned with appropriability, they are continually developing new technologies that make that goal more difficult to achieve.

In developed countries, these industries rely extensively not only on patents, trademarks, and trade secrets, but also on copyright protection for software and on the protection of semiconductor chip designs.⁵⁰ The importance of each type of protection has varied over time and across subsectors of the industry.

In the case of hardware, patents have historically been the main instrument of protection. As patents in these areas are quite numerous and the costs of litigation significant, large companies rely extensively on cross-licensing.⁵¹ On the other hand, as the

⁵⁰ Bale (1988) provides a description of the relevance of the different forms of intellectual property protection for a major producer of computers and scientific instruments (Hewlett-Packard). A similar analysis for a major firm in the telecommunications sector (AT&T) is presented in Kefauver (1988).

⁵¹ Large companies in developing countries are also entering this type of arrangement. Korea's Samsung, the largest semiconductor producer in the developing world, has recently signed a thirteen-year licensing agreement with IBM covering existing and future patents on semiconductors (Mody, 1989b).

evolution of technology accelerates, the importance of patent protection tends to diminish, given "that the technology can easily be obsolete by the time a patent is granted" (Science Council of Canada, 1990: 15). Accordingly, trade secrets (Levin et al., 1987) and the search for new forms of intellectual property protection (Benko, 1987) have been attracting growing attention in these industries. The best examples of this search are provided by the extension of copyright protection to computer programs and the creation of a new form of protection for semiconductor layout design.

Computer Software

The debate on the use of copyrights for computer software has given rise to an extensive literature.⁵² Sherwood (1990b: 44) points out that although the "underlying idea for a program can be protected by the use of patent or trade secrets ... protection for the expression of the program" has become the realm of copyright law. According to Mody (1989c), the growing reliance on copyrights for computer software has come about almost by default as patent prerequisites have been judged too restrictive and trade secret legislation insufficiently effective in most circumstances.

The hybrid character of computer software, which combines utilitarian and literary characteristics, does not fit perfectly into traditional copyright law (Branscomb, 1990). Some criticize the length of protection as excessive (Karjala, 1987). Others argue that machine-dependent programs do not qualify as creative expressions (John Hershey, based on Branscomb, 1990). The "copyrightability" of software has also occasioned an intense debate in universities on ownership of programs developed by faculty authors. As Benko (1987: 46) points out, universities have typically claimed patents arising from academic work while "leaving copyrights to the authors." This attitude is changing, however, and some universities are now stressing the similarities of software and "hard" inventions (Reichman, 1989a).

Despite these problems, a separate form of protection for software has not evolved. Sherwood (1990b) implies that the benefits of international convergence (fostered by the copyright solution) were a major deterrent to the *sui generis* approach. Firms like IBM and AT&T, for instance, supported U.S. ratification of the Berne Convention in 1988 (Keefauver, 1988). By joining the convention in 1988 (Hatch, 1989), the United States adopted the highest level of protection available under copyright law.

The current debate on the "look and feel" of software suggests that a constituency exists for even higher levels of protection. Recent U.S. court interpretations seem to expand the reach of copyright law by adopting a more comprehensive interpretation of what represents the "expression" of a software program (Mody, 1989c). Pushing this trend to the limit, user interfaces that look and feel alike could give rise to claims of copyright

⁵² See, for instance, Keplinger (1985), Benko (1987), Kindermann (1988), and Branscomb (1990).

infringement (Sherwood, 1990b: 44). Such a development could have a major impact on the definition of industry standards at the user interface level (Branscomb, 1990).

Semiconductors

Protection for semiconductor chip designs, as adopted by several developed countries, is another important development linked to technological innovation in the information industries. In this case, a *sui generis* form of protection was adopted in several countries to accommodate the needs of this new technology.

With passage of the Semiconductor Chip Protection Act of 1984, the United States became the first country to protect a mask work (or layout-design) fixed in a semiconductor chip product. The "Chip Act" established a requirement for creativity or novelty that, although not as rigorous as the requirements of novelty and nonobviousness in the patent law, is "more rigorous than, or at least distinguishable from, the de minimis creativity requirement of U.S. copyright law" (McManis, 1988: 340). The term of protection extends ten years from the date of the first commercial exploitation or from the date of registration, whichever is earlier. Registration is required, but there is no examination. The protection does not require disclosure of sensitive information and provides for compensation of innocent infringement.

Reciprocity figures prominently in the U.S. Chip Act. Applicants may be denied protection if their country does not offer substantially equivalent protection for U.S. mask works (Gadbaw, 1989). The rationale for this approach was to put pressure on other countries, particularly Japan, to adopt similar procedures. By the end of 1988, the act had stimulated bilateral grants of reciprocity between the United States and 19 other countries, including Japan and the countries of the European Community. It is ironic that the WIPO Treaty on the Protection of Intellectual Property in Respect of Integrated Circuits, adopted in May 1989 as a multilateral response to U.S. actions, was not signed by the United States, Japan, or the countries of the European Community. The United States has faulted the WIPO treaty for its broad compulsory licensing rules, its shorter term of protection (eight years), its failure to address imports of equipment containing infringing chips, the lack of compensation for innocent infringement, and the absence of adequate dispute resolution procedures (McManis, 1988).

However, numerous authors emphasize the importance of multilateral solutions involving the developing world (Gadbaw and Richards, 1988; Mody, 1989c). Developing countries are often cited for violations of intellectual property rights in information industries. "Pirate" sales in the Third World of computers, semiconductors, and software are estimated to surpass US\$1 billion per year (MacLaughlin et al., 1988). Although participation in the most advanced segments of the information industries—for example, advanced semiconductors, computers, and telecommunication equipment—is restricted to a small group of developing countries, the so-called newly industrialized countries (NICs), entry barriers are

lower for other segments, such as minicomputers and software. In these cases, the number of infringing developing countries is much higher.

Developing Country Strategies

Developing countries often view intellectual property protection for information industries within the context of their strategies for the development of high-technology industries. Accordingly, pressures to force convergence of their intellectual property standards with those of the OECD countries are sometimes identified as a sophisticated new form of colonialism, designed to preserve knowledge-intensive industries to the First World (Stern, 1987). The North-South debate on the protection of mask works has provided an interesting example of this process. Developing countries strongly opposed proposals "to keep confidential certain elements of the registration document deemed to contain relevant or strategic technological information" (Almeida, 1989: 6). Even Korea, the largest producer of integrated circuits in the developing world, has expressed its preference for the WIPO version of mask work protection and has not supported the more restrictive U.S. proposal (Schumann, 1990).⁵³

A significant number of developing countries have extended copyright protection to software. At first glance, North-South convergence in software protection appears to be proceeding at a faster pace than in other segments of the industry.⁵⁴ However, in most instances enforcement remains weak.

Mody (1989c), suggests that strengthening intellectual property rights has had the effect of raising the price of information technology. He points out that recent developments such as IBM's demands for retroactive royalty payments from producers of IBM-compatible PCs, the increasing role of proprietary technology, and the "look and feel" debate tend to increase the barriers to reverse engineering and thereby hamper technology diffusion. He concludes that "current trends suggest that low-income countries will have to live through a more stringent technology transfer environment than did the NICs" (Mody, 1989c: 46).

Evans (1986) has suggested that "moments in which technological change is accompanied by a disjunction in established corporate control over technology" offer special conditions for developing countries to enter "otherwise impenetrable industries" (p. 603). The evolution of the computer industry since the mid-1970s is often offered as an example. The appearance of the personal computer and easy access to microprocessors played an important role in shaping this episode. The development discussed above suggests, however, that the possibilities of "leapfrogging" in the information industries will diminish in the future.

⁵³ For details on the Korean semiconductors industry see Mody (1989b).

⁵⁴ Gadbow and Richards (1988) provide details on the characteristics of software protection in Argentina, Brazil, India, Mexico, Korea, Singapore, and Taiwan.

The Audio, Video, and Publishing Industries

Developing countries are frequently accused of infringing the copyrights and "neighboring rights" (see chapter 2, p. 5) of the audio, video, and publishing industries. As noted elsewhere in this volume, copyright "piracy" has been facilitated by advances in copying technologies. Benko (1987: 33), quoting a 1984 CBS survey of "executives in the U.S. motion picture and television, prerecorded entertainment, publishing, and advertising industries," points out that copyright infringement was the "most frequently mentioned barrier to trade." Pirate sales of prerecorded music have been estimated to be around US\$1.2 billion per year. Losses by U.S. book publishers have been gauged at US\$700 million per year.⁵⁵ By 1985, market shares of pirated videocassettes were estimated to be close to 100 percent in Brazil, Colombia, Mexico, and Taiwan (Wildman and Siwek, 1988).

The OECD (1989: 15) has argued that it "is difficult to use the development needs of these countries as an acceptable justification" for the "pirating" of printed and audio-visual works. The same document also notes that inadequate copyright protection hampers the progress of domestic cultural enterprises, thereby undermining the defense of cultural identity.

Protection in Developing Countries

Recognition of the negative effects of weak protection is growing in Third World countries, particularly where local cultural industries carry significant economic weight. For example, India ranks among the top nine film-exporting nations of the world (Wildman and Siwek, 1988). The Federation of Indian Film Producers is a strong supporter of copyright protection and has been conducting "an active anti-piracy campaign" (Gadbaw and Kenny, 1988: 194). A similar phenomenon is found in Brazil, where the major local TV network (Globo, the largest TV network in the developing world) has been playing a major role in fighting video piracy in Brazil since it began marketing videotapes (Richards, 1988: 159).

Despite these examples of more stringent copyright protection, enforcement continues to pose a major challenge. The political economy of the process is easily grasped once one observes that in many countries "pirate" goods command well in excess of 50 percent of the market.⁵⁶ Recent experiences with reform, for example, as in Hong Kong in 1978 (MacLaughlin et al., 1988; Neal, 1988) and in Singapore in 1987 (Hoay, 1988) are often presented as a demonstration that displacement costs are not significant and that the impact of the reform on legitimate domestic businesses is quite positive.

⁵⁵ For additional information on the economic dimensions of "piracy" for these industries see MacLaughlin et al. (1988), Neal (1988), and Hatch (1989).

⁵⁶ Data reported in Hatch (1989), for instance, suggest that pirated cassettes constituted 41-60 percent of the Egyptian market and 90-100 percent of the Saudi Arabian market by the mid-1980s.

The difficulties of implementing these reforms should not be overlooked, however. The transaction costs of enforcing strict adherence to copyrights may be particularly high in developing economies, thereby placing a premium on the search for creative means of minimizing these costs.⁵⁷

Piracy of Broadcast Signals

One final example of copyright infringement is the piracy of broadcast signals. Satellite programming has magnified the potential for this type of infringement around the world. Developing countries are becoming increasingly involved in this type of activity, which has fostered an ironic reversal in negotiating positions.⁵⁸ Until recently developing countries were particularly concerned with unregulated information flows (see, for instance, the demands for a "New World Information Order" described in the MacBride Commission Report, 1980), whereas the United States has been a major supporter of the "free flow" approach. According to some analysts, the increasing incidence of unauthorized capture of broadcast signals has led the United States to rethink the meaning of "free flow." For example, Ospina (1986: 171) observes that it "seems that [the expression] 'free flow' [as applied to information] does not mean without pecuniary compensation." On the other hand, several developing countries have deemphasized previous concerns with cultural integrity in favor of more immediate economic benefits, for example, to foster their tourist industry by offering pirated foreign TV programs. Encryption of broadcast signals may provide one private solution, which nonetheless may entail significant global welfare loss (McCain, 1988). At this time, a negotiated multilateral solution appears remote, hinging as it does on the resolution of difficult questions of national sovereignty that go well beyond the realm of intellectual property rights (Ospina, 1986).

Conclusions

During the 1980s many developing countries began to strengthen intellectual property protection in some of the sectors examined above, reversing the trend toward weaker protection that characterized the previous decades. The recent movements toward stronger protection have come partially as a result of pressure from the developed nations and their industries.

⁵⁷ France, for instance, has amended its copyright law in 1985 in order "to impose a royalty on private copying of audio and audiovisual works... The home taping law imposes a surcharge on the copying material, that is, the blank tape. The sums collected are distributed by authors', performers' and producers' associations to their members" (Ginsburg, 1989: 279). Needless to say, the adoption of such a solution in a developing country would require appropriate institutions to set, collect, and distribute the royalties.

⁵⁸ According to Wildman and Siwek (1988: 104), CBS has reported "that the Jamaica Broadcasting Company has intercepted such premium satellite programming as HBO and various WTBS offerings in order to retransmit these signals to its viewers without authorization."

Whether higher intellectual property protection permits foreign pharmaceutical companies to displace domestic producers or results in higher domestic drug prices has not been conclusively shown. Government policies such as price controls and the promotion of generic products often compensate for partial welfare losses traceable to increased intellectual property protection for pharmaceuticals.

In the information industries, the pace of technological change has reduced the utility of patents and caused producers—particularly of software—to turn increasingly to trade secrets and copyright protection. Despite the shortcomings of both forms of protection, a new form of protection has not been developed, leaving the problem of piracy unresolved. A significant number of developing countries have increased software protection in response to the wishes of the developed world, but enforcement generally remains weak.

Recognition of the negative effects of weak protection for intellectual property in the audio, video, and publishing industries is growing in developing countries having strong local entertainment industries (such as India's film industry). However, given the widespread piracy made possible by advances in copying technology, enforcement remains difficult.

VI. SECTOR ISSUES II: Seeds and Plants

William Lesser

The evolution of intellectual property protection for agricultural inventions has been quite different from that of industrial products and processes. Indeed, much of modern patent law dates from the industrial revolution when agricultural inventions were not considered eligible for protection. Many national patent laws explicitly or implicitly excluded agricultural inventions and continue to do so today. Although the U.S. Patent and Trademark Office granted patents on some specialized yeast strains to Louis Pasteur in the 1870s, it rejected claims on seeds until 1985.

Requests for patent protection of seeds and plants began to surface in the early part of this century. In the United States, this led to the passage, in 1930, of the Plant Patent Act (limited to asexually propagated plants) and, in 1970, of the Plant Variety Protection Act (for plants propagated through pollination). In 1960, the International Convention for the Protection of New Varieties of Plants (UPOV; see chapter 2) was adopted. In its wake, other OECD countries introduced or modernized legislation pertaining to plant breeders' rights. In 1980, the Supreme Court of the United States, in the famous *Chakrabarty* decision (*Diamond v. Chakrabarty*, 1980), for the first time extended patent protection to living organisms. Plants and seeds were accorded protection in 1985 (*Ex parte Hibberd*, 1985) and animals in 1987 (*Ex parte Allen*, 1987). Today, the United States provides the broadest scope of patent protection for living organisms. By contrast, most industrialized nations, while allowing patenting of microorganisms and granting plant breeders' rights, still exclude living organisms (other than microorganisms) from patent protection (see appendix 1).

By and large, developing countries have not followed this pattern. Typically in developing countries, most breeding work is performed under public-sector programs and within international breeding centers. The principal exceptions are some private hybrid maize and sorghum breeding programs. A few countries in recent years have seen some private-sector activity with nonhybrids.

Incentive Effects in Agriculture

Would stronger intellectual property protection promote agricultural research in developing countries? This section examines the incentive effects of intellectual property protection on seed and plant research and its potential costs. It closes with a discussion of some issues in agricultural biotechnology.

Plant Breeders' Rights or Patents?

As earlier noted, most industrial countries, with the exception of the United States and Japan, issue PBRs but not patents for the protection of seeds and plants. The European Community is currently reviewing the comparative merits of these instruments (see, for example, UPOV, 1989b; Commission of the European Communities, 1988). Those in support of patents for seeds and plants note that PBRs provide little protection for bioengineered genes inserted into seeds (see, for example, Duffey, 1987); the "broad research exemption" to PBRs (see chapter 2) would allow such genes to be removed from one variety and bred into another.

Adherents of the opposite view insist that because patent law lacks the research and farmers' exemptions contained in most national statutes governing PBRs, patents applied to plants could inhibit subsequent breeding and prohibit farmers from replanting "saved seed" (International Development Research Centre, 1990; Mooney, 1989). Lesser (1986b) estimates that the cost of removing the farmers' exemption in the United States would be a small part of total production costs, in part because firms could not enforce more restrictive PBRs against large numbers of farm users. As yet, however, no conclusive evidence supports Lesser's estimates.

Experiences with Plant Breeder's Rights and Patents

The impact of PBRs is not well understood in developing countries, in part for lack of research but also because few developing countries have laws governing their use. By contrast, the U.S. experience has been well documented. Several studies conducted since 1980 suggest that the availability of PBRs has increased the number of private sector breeders, as well as the number of private varieties released and planted. Brim (1987) noted that the number of private-sector soybean breeders in the United States increased from two in 1966 to 63 in 1984, while the share of acreage planted to private varieties tripled (to 86 percent of total acreage) between 1977 and 1986 (Brim, 1987: tables 3 and 5). Butler and Marion (1983: chap. 3) found that many companies initiated proprietary breeding programs, particularly in the years between 1967 and 1970, "possibly in anticipation of the passage [of the Plant Variety Protection Act]." The number of soybean and wheat varieties released by the sampled firms increased sharply during the 1970s.

There is also some evidence, albeit weak, that privately developed varieties are more productive than publicly bred ones (Butler and Marion, 1983; Perrin, Hunnings, and Ihnen,

1983; Brim, 1987). Private agricultural research investment has been spread very unevenly among crops, with soybeans receiving the greatest attention. Minor crops, including several vegetables, have received no investment at all.

Critics have indicted the U.S. law for its alleged deleterious effects, including seed company mergers, monopoly prices, "cosmetic breeding," and adaptation of varieties to particular herbicides (Claffey, 1981; Mooney, 1979; Sasson, 1988: 261-80; Lacy and Busch, 1989). Others have challenged this analysis (Butler and Marion, 1983; Lesser and Masson, 1985; Lesser 1986b).

Butler and Marion conclude (p. 79) that on balance the Plant Variety Protection Act has produced modest private and public benefits at modest private and public costs. However, they make their conclusion contingent upon the existence of a significant public breeding effort as a counterbalance to possible monopolization by the private sector. For countries with smaller markets a strong role of the public breeding sector as a counterbalance to monopolization would seem to be even more important (International Development Research Centre, 1990).

To date few seeds have been patented in the United States and no assessment of the implications of patents has been completed.⁵⁹

The United Kingdom introduced PBRs in 1964. According to Murphy (1979), this has resulted in substantial incremental private breeding and a sharp increase in the number and quality of varieties available to farmers. Also public agricultural research benefitted from the royalties earned from protected varieties. The Plant Breeding Institute, Cambridge, was so effective at earning royalties that the government—as part of its privatization drive—sold off the institute's near-market activities, retaining only basic research in the public sector.⁶⁰

What little information there is on the impact of PBRs in developing countries comes from a field report on Chile and Argentina, two developing countries that have adopted some form of PBR but are not signatories to UPOV. Pray (1989) concludes that PBRs have had a small positive effect on private breeding in Argentina, especially of wheat and soybeans. In Chile, PBRs induced universities and perhaps the government research institute to invest more in plant breeding research. PBRs in Chile also appear to have improved access to fruit varieties from the United States and New Zealand, and indirectly increased seed exports. In both countries, PBRs facilitated joint ventures between government research institutes and private cooperatives and firms under which the private concerns have financed government-

⁵⁹ Stallman (1986) did evaluate the incentive effect of the U.S. Plant Patent Act, finding among other things that competition was maintained due to the role of the public sector and the difficulty of detection and enforcement.

⁶⁰ Sir Ralph Riley, Cambridge, U.K., personal communication.

performed research in return for rights to multiply and sell varieties owned by the government. These joint ventures have allowed the Argentine government to perform more research and, through increased salaries, to retain its scientists.

This account, although fragmentary, does suggest that PBR laws have the potential to produce public benefit, especially in countries like Chile and Argentina, which have the ability to adopt many temperate-zone plants and seeds without prior local adaptation.

Overall, private investment in plant breeding in developing countries remains limited. One explanation is that in some countries private firms are, or until recently have been, discouraged from engaging in breeding activities (see McMullen, 1987, on the situation in India through 1988). Another reason could be the absence of plant variety protection.

Pray (1987: table 16.1) estimates that for 1985 seven Asian countries⁶¹ had a combined private investment in seeds of a minuscule US\$3.3 million. Two countries (Indonesia and Malaysia) had no private research investment at all. Total private-sector research (seeds, chemicals, machinery, livestock) ranged from 1 percent of public agricultural research outlays in Pakistan and Bangladesh to 63 percent in the Philippines. Least-developed countries account for the least private research (Pray, 1987: 419). In the seeds sector, private investment has been concentrated in hybrid maize and, to a smaller degree, in hybrid sorghum. Geographically, investment is focused on the more favorable geographical areas, where irrigation or predictable rainfall allow improved varieties to realize their greatest yield response.

The concentration of private activity in the production of seed for hybrid varieties is explained by a natural phenomenon: The crop from a hybrid variety cannot be reused as seed (at least not without significant reductions in yield); this offers built-in intellectual property protection as long as the breeder guards the identity of or access to the parental lines used. This suggests that in developing countries, too, private breeding activity responds to the availability of protection for breeding secrets.

Potential Costs of Intellectual Property Rights Protection in Agriculture

In the United States, the entrance of private firms into seed breeding has generated considerable concern within the public agricultural research system (see especially Kenney, 1986, but also Lacy and Busch, 1989). Such concerns include their growing influence over the scope of research, with the risk of shifting public research to background breeding, a phenomenon that may remove the public sector as a force in the commercial seed market; loss of public confidence in the impartiality of public sector researchers; inhibition of the free flow of information and germplasm between and among private- and public-sector

⁶¹ India, Philippines, Thailand, Indonesia, Malaysia, Pakistan, and Bangladesh.

researchers; lower allocations of federal research funds; and conflicts of interest for researchers working simultaneously at universities and private firms. Some such concerns pertinent to developing countries are discussed below.

Narrowing of the Genetic Base

The genetic composition of major food crops is widely seen as limited and declining, increasing vulnerability to single-gene-based pathogens. The Irish potato famine of the 19th century and the U.S. southern corn blight of the 1970s are two commonly cited examples of the dangers of genetic uniformity (Sasson, 1988).

Critics have associated PBRs with this risk in two ways. First, the "homogeneity" requirement for PBR protection is said to encourage uniformity in make-up. Second, as the protected varieties tend to have higher yields, producers allegedly switch from their more genetically varied landraces.⁶²

Defenders of PBRs have responded with the following arguments: (a) The risk of widespread use of a single variety predates PBRs, being primarily associated with the high-yielding varieties developed during the "Green Revolution" and in the international breeding centers; (b) The problems linked to PBRs can also be found in countries that do not provide PBRs; and (c) The greater competition possible under PBRs may enhance diversity as firms attempt to distinguish their products from competitors.' (The preceding arguments are presented in Brown, 1988; Juma and Ojwang, 1989). That is, there is little evidence to suggest that PBRs have more than a very peripheral role in declining genetic diversity (Dias, undated).

Exchange of Breeding Material and Information

Because breeders depend on the availability of novel germplasm, the economic value imparted by PBRs may chill the current free exchange of protected material and thereby threaten future research (Mooney, 1979, 1989). At present, the research exemption in the UPOV convention grants free access to protected varieties for research use and allows commercialization of derived new varieties (UPOV: article 5[3]).⁶³ Also, access to the basic collections of germplasm for major crops is generally free, as these collections are for

⁶² For summaries of this position see, for example, Butler and Marion (1983: chap. 1.2); Juma and Ojwang (1989: chap. 6); U.S. National Academy of Sciences (1972).

⁶³ See chapter 2. This free access applies to varieties that have already been marketed. For varieties that have been protected but not yet marketed, access is less clear, especially in the United States. The derived new variety must be distinct so as not to violate the right of the holder of PBR. If the new variety meets the legal requirements of PBR it may be protected in its own right. Proposed revisions to UPOV would remove the free research use and commercialization. See UPOV (1989b).

the most part publicly held. Access to germplasm for minor crops is potentially more problematic; to date such crops have not attracted much private-sector interest.

Several surveys completed over the past decade have indicated no clear patterns of effects on exchange. In the United States, PBRs may have slowed the flow of scientific knowledge and materials from private breeders to universities, but not from universities to breeders, leading to no decline in the absolute amount. But protection may have changed the nature of these exchanges. It is increasingly common for U.S. breeders to sign agreements for the use of germplasm, agreements that can involve the payment of royalties if a new variety is marketed. If there is a general inhibition of exchange, it appears primarily to affect breeders in non-UPOV member countries (Juma and Ojwang, 1989: 153).⁶⁴

Whether the patenting of genes could further inhibit the free exchange of germplasm (see, for example, Duesing, 1989) will depend on the protection requirements of national patent laws and the responses of germplasm-rich tropical countries. Examples have not yet been documented.

Germplasm Preservation and Compensation

Two important sources for unimproved germplasm required in breeding operations are gene banks and private expeditions. Both have raised issues in the North-South context.

A large number of gene banks that preserve germplasm resources are located in industrial countries. This has raised political concerns over ownership and control of the collections (Juma, 1989a: 69-76; Swaminathan, 1988). Since most of the wild and locally cultivated, or "landrace," varieties that make up the collections originated in developing countries (Kloppenburg and Kleinman, 1988) and are available to breeders free of charge, some developing countries have proposed payments to compensate their farmers for their prior selection and improvement efforts by instituting a "farmers' right" as a complement to plant breeders' rights. The Food and Agricultural Organization (FAO), recognizing germplasm as a common heritage of humanity, in 1987 established the International Fund for the Conservation and Utilization of Plant Genetic Resources, proposed to be funded from a tax on seed sales, and adopted a bill of "farmers' rights."⁶⁵

⁶⁴ A recent, unpublished survey by the Agricultural Research Service of the U.S. Department of Agriculture revealed that 41 of 48 respondents felt "plant patents" would "adversely affect free exchange of germplasm among public and private breeders in the U.S." However the term "plant patents," which can have several interpretations and may include or exclude PBRs, was not defined.

⁶⁵ For overviews of the issue, see Sasson (1988: 295-302); Plucknett et al. (1987: 188-90); Juma (1989b: 170-73); and U.N. Food and Agricultural Organization (1989).

Agricultural Biotechnology

Since the first gene splice was made, the world's imagination has been captured by the new and rapidly expanding area of genetic engineering. In agriculture, where the yields of major crops may be reaching a ceiling, biotechnology was seen as a means of surpassing that ceiling. Countries dependent on agriculture, such as Brazil, India, Indonesia, and the Philippines, have launched biotechnology programs (Persley, 1989).

This section provides a brief overview of the potential economic costs and benefits of biotechnology to developing countries, followed by an examination of the special intellectual-property issues raised by agricultural biotechnology. The final subsection contains a summary account of ethical and safety issues associated with biotechnology as it is protected under intellectual property law.

Promises and Potential Costs of Biotechnology

Biotechnology has the potential to improve pest, disease, and drought resistance, but experience has shown that benefits are difficult to achieve in practice.⁶⁶ For example, research work with rice, which has received significant financial support, has progressed rapidly but remains at a comparatively early stage of experimental research (Stevens, 1990).

Among the few products nearing market readiness which promise substantial impacts on costs are growth-inducers for animals (somatotropin). These can increase milk production and enhance lean meat growth in cattle, hogs, and sheep (Kalter, et al., 1985; Lemieux and Wohlgenant, 1989). Animal vaccines now on or nearing the market tend to complement existing products rather than providing major new opportunities (Walsh and Sundquist, 1988; Frick and Lesser, 1989). A possible exception is a cheap and effective hoof and mouth vaccine capable of eradicating the disease and thereby opening new markets to exports of fresh meat.

One potential cost of biotechnology to developing countries is the replacement of traditional exports produced through other means. Several pharmaceutical products currently extracted from organic sources can be produced using biotechnology (Buttel, et al., 1985; Sasson, 1988: 278-80; Juma, 1989a). An oft-cited example is the replacement of industrial use of sugar by high fructose corn syrup and synthetic sweeteners. In 1983, U.S. consumption of nonsugar sweeteners exceeded sugar consumption. By 1989, per capita consumption of corn- and low-calorie sweeteners was 50 percent higher than per capita sugar consumption, representing a loss of some US\$3.5 billion in sugar sales (U.S. Department of Agriculture, 1990: 82, 86). Also threatened in the longer term is cocoa butter, for which

⁶⁶ Sasson (1988), Roberts and Granados (1988), Persley (1989), Juma (1989a), Farrington (1989), Vasil (1990).

alternative production processes involving genetically altered microorganisms are being actively sought (Sasson, 1988: 276-78).

Intellectual Property Protection of Agricultural Biotechnology Products

The development of agricultural biotechnology by the private sector depends critically on sufficient intellectual property protection because so many innovations in the field are easily copied. However, patent protection for living organisms poses legal and practical problems not found in connection with other forms of technology:

(a) Because genetically improved seeds can be replicated naturally, secrecy offers no protection beyond the usual time lags required for copying. Hence, legal protection is often the only available form of protection.

(b) It can be difficult to identify a patented plant product and define exactly what has been patented because plants and seeds are subject to natural genetic drift and spontaneous mutation.

(c) Agricultural inventions can give rise to a chain of derivative inventions, with the result that multiple royalties may accrue on a single product. In legal parlance, this is known as "dependence."⁶⁷

(d) It is virtually impossible for holders of patents on engineered microorganisms to prove infringement. The infringer has access to the culture sample, but the inventor has no right to inspect the suspected infringer's production facility to determine whether the patented organism is indeed being improperly used.⁶⁸

When, as with seeds, the patented product is marketed directly, the enforcement situation is altered. As many patents are and will be based upon novel genes, it is possible to test for their presence. If no such genes are present, it is possible to insert an inactive gene for use as a "genetic fingerprint." In the more distant future, it may be possible to compare the entire genetic makeup of a variety to an allegedly infringing variety. Enforcement using such mechanisms may well prove costly and difficult in developing countries, especially for small firms.

⁶⁷ See Beier, Crespi, and Straus (1985: part 3); but see the proposed royalty collection procedure in Lesser (1989).

⁶⁸ This issue is especially acute in countries, such as those adhering to the European Patent Convention, where samples become available *before* the patent issues. Complex procedures involving "experts" have been established to protect the inventor in such cases, but the solution is not completely satisfactory to any of the parties (Lesser 1986a).

(e) The exclusion of protection for "plant and animal varieties and essentially biological processes for the production of plants and animals" under article 53(b) of the 1973 European Patent Convention (European Patent Office, 1985) has posed obstacles to the exploitation of plant-based biotechnology in Europe. The same exclusion has become law in developing countries that have adopted the WIPO (1979) model patent law, where it appears as section 112.3(ii). PBRs may provide an alternative mode of protection, although the broad research exemption to PBRs makes them inadequate for protecting, say, an altered gene. Because PBRs protect the entire plant, it would be possible to remove the gene and insert it into a different variety. The Commission of the European Communities (1988) is considering modifications to current law that would narrow the definition of "plant variety." UPOV (1989b) is considering a broader definition.

Other critical issues are the appropriate standards for scope of protection and nonobviousness (inventive step), matters that must always be faced upon the emergence of a new technology. However, the broad significance of agriculture magnifies the effect of potential policy errors, such as offering too much protection or requiring too great an inventive step, which could limit competition and lead to higher prices. Although economic theory and practice offer no clear guidance to the policy maker faced with certain national circumstances, an effort must nevertheless be made to strike an optimal balance of protection and disclosure.

Ethical and Safety Issues

The patenting of living organisms, and the rights of ownership over germplasm created thereby, have been attacked on ethical grounds (see, for example, Hoyt, 1988). These same concerns may make it difficult to extend protection of seeds and plants to some countries.

The unforeseen consequences of releasing biotechnological inventions into the environment preoccupy many researchers and policy makers. Some argue that such risks outweigh the potential rewards, whereas others conclude they can be treated, albeit with great care, through existing procedures. Good overviews of both positions have been produced by the U.S. National Academy of Sciences (1987) and the U.S. Office of Technology Assessment (U.S. Congress, 1988). In the United States, the less restrictive position seems to be in ascendance, based on the results of several carefully controlled environmental tests approved over the past few years.

Developing countries will have to assess the trade-offs on the basis of their own circumstances. Brumby et al. (1989) recommend that developing countries wishing to introduce the controlled use of biotechnology on their soil form national review bodies, adopt safety review procedures, and perform annual assessments of their experiences and policies.

Conclusions

Protection for intellectual property in seeds and plants in developed countries has resulted in increased private breeding activity. By contrast, in the developing world, where protection is generally not available, breeding remains largely a public-sector activity. There is evidence that private breeding activity in developing countries would respond to the availability of protection; in the view of many, it must, however, be balanced by the maintenance of a strong public breeding sector.

Some potential costs of protecting intellectual property in agriculture have been anticipated but not established. These include the problem of continued free access to germplasm. No consensus has yet been reached on the most appropriate and effective means of protecting intellectual property in the new field of biotechnology.

VII. THE DEVELOPING COUNTRY CASE FOR AND AGAINST INTELLECTUAL PROPERTY PROTECTION

Carlos Primo Braga

The literature on the economics of intellectual property, particularly patents, says little about the implications of intellectual property rights for developing countries, a gap pointed out by several authors (Mansfield, 1989; Evenson, 1990; Sherwood, 1990b; Maskus, 1989). Over the last few years, however, interest in the subject has increased significantly, pushed by the "marriage of convenience" (Gadbaw, 1989) between trade law and intellectual property rights in the developed countries. Under the threat of trade retaliations, many developing countries have begun to reevaluate their intellectual property systems. At the same time, "trade-related intellectual property" concerns (TRIPs) have become a major negotiating topic at the Uruguay Round.

The present chapter reviews the state of discussion on intellectual property directly relevant to developing countries. Following a brief historical account of arguments advanced and positions taken, it traces the discussion on the costs and benefits facing a country when it strengthens protection of intellectual property.

Changing Perceptions

Perceptions of the economic significance of intellectual property for a developing country have not remained static over the last few decades. For most of this period, however, economists have been rather negative about the benefits a developing country might

expect to extract from intellectual property rights.⁶⁹ The conventional wisdom presented in the pre-1970 literature is well captured in this statement by Penrose (1951: 220): "... non-industrialized countries and countries in the early stages of industrialization gain nothing from granting foreign patents since they themselves do little, if any patenting abroad. These countries receive nothing for the price they pay for the use of foreign inventions or for the monopoly they grant to foreign patentees." She concluded her analysis by suggesting that developing countries "should be exempt from any international patent arrangements" (Penrose, 1951: 233).

Implicit in this type of criticism was the assumption that innovative activities in developing countries were not particularly sensitive to domestic intellectual property protection. Even so, the World Intellectual Property Organization and its predecessor organization (the United International Bureaux for the Protection of Intellectual Property—BIRPI) developed model intellectual property legislation for developing nations during the 1960s (BIRPI, 1965, 1967; WIPO, 1970). Experts from developing countries contributed to these texts, which were widely circulated.

A major qualification to this approach was developed in the context of the broader issue of technology transfer to developing countries. A United Nations document on the relationship between patents and technology transfer, for instance, pointed out that when "... the technical services, management experience and capital resources as well as other connexions of the foreign patentee himself are essential for the introduction of the patented process in the under-developed country, basically the situation is that in one form or other the minimum terms and conditions of the foreign patentee must be met if the innovation is to be brought to the under-developed country" (United Nations, 1964: 50). Accordingly, even though this situation was perceived as "a one-sided relationship," the potentially positive role of intellectual property protection in the process of acquiring foreign technology had been recognized.

In the 1970s, the negative attitude toward intellectual property protection in developing countries grew stronger amid a general movement in favor of regulation of technology transfers and of foreign capital in the Third World (Helleiner, 1979; Wallender, 1980; Wionczek, 1976). The literature on the subject became particularly critical of the benefits for the Third World of the existing systems of protection (Grundmann, 1970; Anderfelt, 1971; Vaitzos, 1972, 1976; Penrose, 1973). Some authors, such as Greer (1973), bluntly suggested the complete abandonment of the patent system by developing countries.

The discussion was accompanied by much debate over technology licensing agreements under which technology is transferred from a multinational corporation to a local

⁶⁹ Of course, one can also identify numerous demonstrations of support for intellectual property rights in developing countries dating back to the pre-World War II era. However, most of this support was not based upon an analysis of the economic implications of such policies. For a discussion, see Grundmann (1970) and Schiff (1971).

firm or affiliate. The literature indicated that developing nations paid a rather high price for such transfers (UNCTAD, 1972; for analysis, see Stewart, 1979 and UNCTAD, 1987). Rents were extracted in the form of profits, transfer pricing favorable to the firm, and management or training contracts, as well as in the stated royalties.

Following these studies, and in imitation of Japan's Ministry of International Trade and Investment, a number of developing nations, including those of the Andean Pact, enacted technology-transfer legislation during the 1970s. Such legislation typically required that a government office review all technology-transfer contracts. In some cases, royalty rates could not exceed a specified ceiling and efforts were made to curtail hidden payments. Nearly all such laws restricted the use of specific restrictive clauses, particularly those that might hinder the technological competitiveness of the local affiliate or prevent the exportation of products to the developing world.

This trend also significantly influenced the North-South debate on the so-called New International Economic Order (NIEO), with developing countries seeking the establishment of an International Code of Conduct on the Transfer of Technology (United Nations, 1980; UNCTAD, 1985; McCulloch, 1981; Roffe, 1984). This code would have affirmed the right of nations to review technology-transfer contracts and, depending on the specific terms selected for incorporation into national law, made it more difficult to include various restrictive clauses then in common use.

In the international arena, the main result of these developments was growing pressure by developing countries for revision of the Paris Convention.⁷⁰ The gist of the proposed reform was "to weaken the international standards of industrial property protection" (Kunz-Hallstein, 1989: 269). The developing countries were not successful in their attempts at reform (Geneva, 1980; Nairobi, 1981; Geneva, 1982, 1984), mainly because of the firm opposition of the United States.⁷¹

By the second half of the 1980s, developed countries had regained the initiative in the international debate on intellectual property rights. The use of trade laws by the United States and the European Community in their war against "piracy," and the evolution of the discussions on TRIPs in multilateral trade negotiations, played an important role in this process. External pressures, in the context of this new climate, were particularly effective in fostering reforms in several developing countries (Winter, 1988; Bifani, 1989). Several developing nations modified their technology-transfer laws or enforced them less strictly. For example, the Andean Pact weakened certain of its investment restrictions on direct investment (Decision 220 of May 11, 1987), and Mexico issued new regulations in January 1990 that

⁷⁰ In reality, this pressure can be traced back to the so-called Brazilian resolution presented at the United Nations in 1961. This draft resolution made "several critical references to the working of the international patent system" (Anderfelt, 1971: 172) and led to the drafting of the above-mentioned UN report of 1964.

⁷¹ For a description of these negotiations see Yankey (1987: chap. 2).

radically weakened that country's 1972 and 1982 legislation on technology transfer, patents, and trademarks. At the same time, technological developments have enhanced the economic value of knowledge-appropriation as the world economy becomes more R&D intensive, economic globalization evolves, copying becomes easier, and the prevailing jurisprudence on intellectual property rights is challenged (Mody, 1989c; Primo Braga, 1990). In view of these parallel developments, the growing concern of developed countries with intellectual property is not surprising.

It is equally true that the attitudes of developing countries toward foreign investments and technology transfers have changed significantly over the 1980s (UNCTAD, 1988). The foreign debt crisis, decreasing private capital flows to developing countries, negative experiences with the regulatory approach, outward-oriented development strategies, and the ongoing "technological revolution" are some of the possible explanations for the more liberal posture adopted by many developing countries on intellectual property. Yet for a developing country the economic implications of the trade-off between static and dynamic aspects of the production and allocation of knowledge remain open to debate.

There is a renewed academic interest in assessing the potential advantages of strengthening intellectual property in the Third World. Mansfield (1988: 24-26; 1989: 29), although recognizing that it is not "always socially beneficial to strengthen intellectual property rights, regardless of other factors," points out that "a reasonable amount of respect for intellectual property rights" is fundamental for stimulating technological change. Accordingly, the "widespread resistance to a strengthening of intellectual property rights" in developing countries should be evaluated not only in terms of its implications for local innovative activity, but also in terms of its impact "on R&D and innovation in developed countries." According to Mansfield, there is good reason to believe that worldwide R&D investments are below their socially optimal level and that "weak protection of intellectual property rights in developing countries aggravates this important problem. What is unknown is whether this is a major or a minor aggravation from the point of view of the developing countries, the developed countries, and the world as a whole."

Sherwood (1989a, 1990a, 1990b), in turn, claims that important benefits of strengthening intellectual property systems occur at a micro level and are not easily captured by conventional economic analysis. He emphasizes the positive influence of strong intellectual property protection on the accumulation and diffusion of corporate business practices that contribute to welfare in the form of training offered by companies, the productivity of research parks, and interactions between universities and the business community, and by fostering "an inventive habit of mind in the population and, more specifically, in the workforce" (Sherwood, 1990b: 138). In the same vein, he suggests that "much of the [negative] effect of non-protection is invisible," and therefore difficult to

measure.⁷² His evaluation is built upon a series of case studies from Mexico and Brazil, and as such provides a more "hands-on" perspective on the economics of intellectual property rights than is typically found in the conventional literature.

Sherwood (1990b) also emphasizes the need to adopt a comprehensive approach when evaluating a country's intellectual property rights system. His analysis suggests that weak protection is the equivalent of no protection. Accordingly, Sherwood questions the soundness of attempting to strengthen the intellectual property system in step with economic development.⁷³

The pages that follow review the costs and benefits that can be identified as befalling a developing country strengthening its intellectual property rights system. Among the costs are the administrative and enforcement costs associated with the reform; the increase in payments for foreigners' proprietary knowledge; the costs of economic displacement of "pirates;" the opportunity cost of additional domestic R&D; and the loss in consumer surplus generated by the anticompetitive aspect of such measures. The main benefits are the cost savings derived from additional domestic R&D and the disclosure of new knowledge; positive contributions to global technological dynamism; benefits from additional technology transfers; and more capital formation in knowledge-intensive sectors. (See also Primo Braga, 1989.)

Costs

Administration and Enforcement

The administrative costs of implementing an effective intellectual property system are not trivial. The United States spends over \$300 million each year to operate the Patent and Trademark Office (Sherwood, 1990b: 181). Such costs are highly correlated with the size of the domestic market and the R&D intensity of the economy. Nonetheless, as reflected in WIPO's Industrial Property Statistical Report, many developing countries' systems already deal with a significant number of patents, which are the most expensive form of protection from an administrative point of view.

Brazil spends approximately US\$ 30 million per year to support its National Institute of Industrial Property (INPI). INPI is the government agency responsible not only for

⁷² Sherwood (1990b: 152-155) mentions the following negative effects: Venture capital may not be obtainable; technology may become unavailable from external sources; private research may not be performed; and training procedures and science and technology careers may be downgraded.

⁷³ The "stages approach" was discussed in chapter 3. A different perspective can be found in Rozek (1987: 63): "Even in the absence of a patent law, a country with a relatively strong trademark law may have an overall acceptable level of intellectual property protection. Therefore, trade-offs may exist among various tools for protecting intellectual property."

patents, trademarks, computer software registrations, but also for the regulation of technology transfers. It employs approximately 800 people, including 110 patent examiners (Cardozo, 1987: 8). INPI has historically operated with a sizable backlog of patent applications. By 1980, there was a record number of applications pending: 150,000 (INPI, 1989: 17). The situation has since improved, but the period of patent protection in Brazil is significantly reduced by the delay in processing applications.

Other developing countries with sizable patent offices include:⁷⁴ Mexico which has approximately 330 employees in its patent examination division (Gwynn, 1988: 253); India, which in addition to clerical staff and administrative personnel, works with 35 patent examiners (Gadbaw and Kenny, 1988: 201); and South Korea, which operates its Office of Patent Administration with a staff of 380 including 20 trial and appellate trial examiners, 15 trademark examiners, 72 patent and utility model examiners, and 11 design examiners (Gadbaw, 1988: 293).

The typical situation in many developing countries is well captured by Yamaguchi (1989: 327): "Some of these patent offices receive several hundred or several thousand patent applications, filed mostly from foreign countries such as Japan and the United States. There are about ten examiners in each of these patent offices to examine this large number of patent applications..."

The administrative costs of strengthening patent systems in developing countries may be significant for some of them. However, there are many ways to improve the effectiveness of these systems without imposing a major financial burden on these countries. User fees, international cooperation (for example, the Patent Cooperation Treaty, the International Patent Documentation Centre, and the African regional arrangements described in chapter 2), and networking with patent offices in developed countries are some of the available alternatives.⁷⁵ And by choosing a registration system (in which the application undergoes only a superficial review) instead of an examination system (in which detailed technical evaluation is performed) a country can significantly reduce the administrative costs of its patent office (Sherwood, 1990b: 182). Needless to say, the latter advantage may be superseded by higher enforcement costs, particularly, in terms of court litigation. Besides, as Machlup (1958: 8) points out, a pure registration system may allow "a mass of worthless, conflicting, and probably invalid patents, onerous to the public as well as to bona fide owners of valid patents."

The costs of administering other instruments of protection tend to be much smaller than is the case for patents. The protection of trade secrets, for instance, does not entail any

⁷⁴ Data concerning the size of national patent offices are dated 1987/88.

⁷⁵ Singapore, for instance, does not examine its patent applications for novelty. Its Registry of Trade Marks and Patents (with a staff of 45 employees) relies largely on evaluations made in the United Kingdom. See Richards and Kenny (1988: 324).

administrative cost. Furthermore, the registration and search of trademarks and, eventually, copyrights are being revolutionized by computer techniques. Some countries have indirectly increased the administrative costs of their copyright systems by adopting discretionary regulations for the registration of computer software. (For example, Brazil's "similarity" requirement allows imported software to be marketed only if there is no "similar" domestic substitute.)

In summary, although administrative costs must be taken into account by any country interested in strengthening its intellectual property system, they do not seem to impose a major constraint. The improving conditions of access to international information networks on intellectual property rights suggest that developing countries may well face decreasing costs in this area. On the other hand, the domestic availability of human resources may, in some cases, be a binding constraint. Griliches (1989: 5), for instance, has shown that in the case of the United States the number of patent examiners explains much of the variance in the number of patents examined and granted each year. WIPO educational programs and international cooperation are two possible responses to this problem.

The enforcement component of a "mature" intellectual property rights system, in turn, is not something easy to emulate in Third World countries. Surveys on systems of intellectual property rights, taking US standards as the basis for analysis, tend to list a large number of enforcement inadequacies in developing countries (U.S. International Trade Commission, 1988; Gadbaw and Gwynn, 1988). Problems often mentioned include: the slowness of the enforcement process; discrimination against foreigners; biased court decisions; inadequate civil and or criminal remedies; and corruption.

It is true the enforcement of intellectual property rights is often laden with uncertainty in the developed countries as well.⁷⁶ Nonetheless, such problems seem to be much more pervasive in developing countries. Unfortunately, there are no available estimates of the costs that developing countries would face in bringing enforcement up to the levels prevailing in industrialized countries. The establishment of specialized intellectual property courts, for instance, could play a role in improving these systems. It would be naive, however, to expect developing countries to implement highly effective enforcement systems in the short run. The recognition of this limitation, in turn, qualifies the benefits one should expect from intellectual property reforms.

Increased Royalty Payments

Because developing countries are net importers of both embodied and disembodied knowledge, strengthening their intellectual property rights systems would tend to increase the level of payments abroad for proprietary knowledge. Patent statistics, for instance, show that

⁷⁶ See, for instance, Engel (1985) on the uncertainties of patent litigation in the United States. It is also worth mentioning that these uncertainties tend to be exacerbated if the "Patent Office and courts apply different standards of patentability" (Machlup, 1958: 8).

"only one per cent of existing patents [are] held by nationals of developing countries" (OECD, 1989: 21). Furthermore, patenting activity in developing countries is dominated by nonresident patentees.

It is reasonable to expect that a reform in a developing country—for instance, an expansion of the degree of coverage of patents or of the term of protection—would result in higher payments for foreign technology. The long-term impact of the reform in terms of the balance of payments is not easy to forecast given its potential effect on foreign investment flows and on exports of technology. Abstracting from these other effects, it remains to be determined if such an increase would be significant.

This type of consideration has always been present in the analyses of intellectual property rights in developing countries. The United Nations, for instance, pointed out that "... as long as we are concerned merely with the role of the patent system as such in creating these balance of payments burdens, it seems irrefutable that its particular role in the circumstances can only be called a minor one" (United Nations, 1964: 44). Some recent analyses, tend on the other hand to significantly overestimate this burden, as the following quotation illustrates: "If the United States succeeds [in changing the GATT rules to accommodate intellectual property protection] countries will be expected to pay, annually, additional royalty charges that could be equivalent to 5% of global trade and which could double or even triple the foreign exchange outflow caused by Third World annual debt repayments (about US\$60 billion in 1988)."⁷⁷ These numbers reflect additional technology-related payments that would be made both by developing and developed countries. It seems, however, that they were estimated based on evaluations by U.S. industries of their worldwide revenue losses—see, for instance, U.S. International Trade Commission (1988). Accordingly, they cover not only royalty payments, but other "loss factors," such as export losses, reduced profit margins, foregone research opportunities, and so on.⁷⁸

In order to keep these numbers in perspective, it is worth mentioning that a country like Brazil—which is usually listed as a "problem country" (Rozek, 1990: 42)—spent an average of US\$214 million per year on disembodied technology imports during 1980–88 (INPI, 1989: 20). This represented approximately 1.3 percent of Brazilian expenditures on imported services over this period, suggesting that even a steep increase in technology imports following an intellectual property reform in Brazil would have a relatively slight impact on the country's balance of payments. Currently, restrictive technology acquisition regulations play a more important role than "defective" intellectual property laws in explaining Brazil's technology import performance.

⁷⁷ Rural Advancement Fund International (1989: 8).

⁷⁸ This estimate includes assumed losses by companies that failed to respond to the International Trade Commission questionnaire. The U.S. International Trade Commission's report points out that the "limitations and lack of statistical validity [of these figures] should be kept in mind" (1988: H-3).

Displacement of "Pirates"

Imitation is understood differently by economists and lawyers. The latter tend to equate imitation with infringement of intellectual property rights (Sherwood, 1990b: 73-74), whereas the former are often more concerned with any imitation, whether legal or not, as imitation constitutes an important part of competition at the national and international levels. As used in this survey, the term "pirate" denotes an economic agent riding free on the intellectual property of another economic agent, irrespective of legality.

From a social perspective the displacement of "pirates" may not entail a welfare loss. As MacLaughlin, Richards, and Kenny (1988: 107) point out the "transfer of sales or royalty payments to other nationals would represent merely a transfer of income from one member of society to another and therefore, from the nation's perspective, would represent *no* net loss at all." Assuming, however, that all excess demand generated by the war on "piracy" would be captured by foreign intellectual property owners, one can estimate the impact of a reform. MacLaughlin, Richards, and Kenny (1988: Appendix) have estimated the additional revenue that intellectual property owners would enjoy in the event of a reform (by different industries and developing countries, and assuming that "pirate" supply would disappear completely after the reform).

The estimates of revenues foregone due to lack of intellectual property protection vary significantly among industries and countries, reaching (for the year 1985) record levels in the case of the pharmaceutical industry in India (US\$953.7 million) and Argentina (US\$241.2 million), and of the software industry in Brazil (US\$220.9 million).⁷⁹

These results can be criticized on several grounds, including their underlying assumptions with respect to price elasticities of demand, ad hoc estimates of the role played by price controls in the process, and extensive recourse to extrapolations in estimating market size and pirate sales. However, even if one accepts these figures at face value, it is quite clear that they overestimate the social cost of displacing "pirate" firms. First of all, they reflect the extreme assumption that these companies would be wiped out entirely. As suggested by the experience of several countries that have undergone some intellectual property rights reform, this is usually not the case. In Singapore, for instance, with the new Copyright Act of 1987 "the large volume audio cassette and video tape pirates [quickly] switched to legitimate businesses, such as producing blank cassettes and cassette parts, primarily for exports" (Hoay, 1988: 113). Second, to use "pirate" sales as a proxy for the cost of displacement is tantamount to assuming that the factors of production displaced from the affected industry would not find employment in other sectors of the economy.

⁷⁹ Revenues foregone are estimated by subtracting the revenue currently being earned by intellectual property owners in a given market from the estimated revenue that would be earned if "pirate" sales were eliminated. See MacLaughlin, Richards, and Kenny (1988: Appendix). The estimates reflect market conditions and intellectual property systems prevailing in 1985.

Maskus (1989) describes an evaluation of the economic impact of "piracy" on U.S. producers developed by Feinberg and Rousslang (1988) based on data from the U.S. International Trade Commission. This analysis deals explicitly with the welfare of the infringers. "Their estimates suggest that in 1986 U.S. legitimate producers lost some \$2.3 billion in profits, while consumers (U.S. and foreign) gained \$3 billion and infringers profited by \$0.6 billion" (Maskus, 1989: 96). As in the case of the previous estimates, the robustness of these results is untested. However, according to Maskus, the Feinberg and Rousslang (1988) figures "suggest that global welfare [from a static perspective] is enhanced by the current state of piracy."

Opportunity Cost of Increased R&D

If national and foreign corporations in a developing country strengthening its intellectual property regime respond with some additional investment in R&D, the opportunity costs of these activities should be assessed.

An intellectual property rights reform would primarily stimulate R&D financing by the private sector. In economies characterized by a relatively low endowment of human capital, additional demand for this scarce resource could bid its price up and "even have a negative short term impact in terms of income distribution" (Primo Braga, 1989: 257).

Combined with existing distortions in the foreign trade regime, strengthened intellectual property protection could also lead to potentially inefficient R&D investments. As Nogués (1990a: 22-25) suggests, an intellectual property reform could lead to wasteful R&D ("reinventing the wheel") in economies characterized by high levels of trade protection.

Anticompetitive Effects

A major concern in developing countries over strengthening intellectual property is that it would not only bring significant increases in prices, but would also impair the process of technological diffusion.

It is difficult to assess the impact that an intellectual property reform would have on prices in economies characterized by high levels of foreign trade protection and price distortions, as is often the case in the Third World. The estimates of MacLaughlin, Richards, and Kenny (1988), which should be seen as educated guesses, suggest that price increases would be substantial—in excess of 100 percent in some countries—in the case of audio and video products as well as software.⁸⁰ Royalty payments *per se* constitute only part of the cost of strengthened intellectual property rights. Increased market power enables the seller to reduce output and raise prices, resulting in a greater producer surplus (which is typically

⁸⁰ Among other things, MacLaughlin, Richards and Kenny (1988: Appendix) assume that the impact of the reform on the prices of pharmaceutical products would not exceed 5 percent because governments would apply price controls to avoid any steeper increases.

repatriated), and driving a larger wedge between price and marginal cost, increasing static welfare losses. The economic significance of the price effect, however, can only be adequately evaluated once other factors such as quality considerations and informational benefits—for example, those conveyed to consumers by trademarks—are also taken into account.

Evidence from developed countries suggests that patents "in most cases do not prevent imitation—and thus may not slow down diffusion to any great extent" (Stoneman, 1983: 17). It is recognized, however, that intellectual property rights may affect learning economies and increase entry barriers. The role played by brand identification on the consumer side and by firm-specific knowledge on the supply side immediately comes to mind. It may be argued that brand loyalty will be a more effective barrier to entry under a strengthened intellectual property rights system. Analogously, trade secrets legislation may constrain the movement of knowledge embodied in the labor force.

The discussion on intellectual property and technology diffusion must be seen within the context of the pattern of technological activities in developing countries. Most of these activities can be classified as adaptive and associated with minor innovations (Dahlman, Ross-Larson, and Westphal, 1985; Evenson, 1984b; Braga and Matesco, 1989). Furthermore, they are typically implemented via "blue-collar" or informal R&D" (Deolalikar and Evenson, 1990: 233). In such an environment, trade secrets and petty patents may have a greater role to play in fostering domestic technology production than conventional invention patents (Frischtak, 1989; Evenson, 1990).

The impact on technological progress of strengthening trade secret legislation, for instance, will depend "on how minor innovations are generated" in a developing country (Frischtak, 1989: 16). If, as the works of Katz (1987) and Sherwood (1990b) suggest, minor innovations require specific efforts by producers, then the negative impact of protection on diffusion may be balanced by the spurt of innovative activities. But if minor innovations basically reflect learning by doing, then protection would impair diffusion alone and would not have any major impact on the introduction of such innovations. Even then, one could argue that weak protection would affect the quality of the learning process—as training activities might evolve at a slower pace (Sherwood, 1990b)—and with it the economic significance of diffusion.

Other common concerns include "patent non-use or their use as import monopolies" (UNCTAD, 1988: 22). Some form of compulsory licensing is the traditional response to this type of problem. Developed countries tend to suggest that "these regulations should be invoked only in exceptional circumstances to correct patent abuses which cannot be dealt with through anti-trust and competition laws" (OECD, 1989: 8). It is quite true that in many cases patents are not used because patentees conclude that economic exploitation would not be feasible (Machlup, 1958). Yet, as the trend toward a more "stringent" environment for international technology transfer evolves (Mody, 1989c; Primo Braga, 1990), concerns over

nonuse tend to become more influential and are often voiced in the context of the debate over "dependency" (see chapter 3).

Benefits

Domestic Research and Development

As noted in chapter 4, there is very little empirical evidence of the impact of stronger intellectual property protection on domestic R&D in developing countries. In part, this reflects the fact that major reforms introduced during the 1980s have not been in effect long enough to be firmly evaluated. The evidence presented by those who support intellectual property reform tends to be based on questionnaires treating the hypothetical reaction of companies to stronger protection (see, for example, Sherwood, 1990b).

Analyses of the elasticity of R&D investments to changes in the protection of intellectual property in developing countries generated considerable skepticism for many years. For example, in 1970 Grundmann (p. 198) asserted "that by far the most efficient way for developing countries (and also industrialized countries) of encouraging the production of new technology is an increase in education in the technical and science field and not a law on the protection of inventions." The same author continued his analysis by pointing out that "inventors" in developing countries faced so many other obstacles (for example, lack of capital and higher levels of uncertainty than those prevailing in developed countries), that inventor's certificates and exploitation of the invention by the state would be more efficient than conventional intellectual property rights. The several cases in which nations have eliminated protection do not suggest that weak intellectual property rights lead, *ipso facto*, to more competition or to the substitution of exogenous technology for domestic R&D investment.⁸¹

Even analysts who believe that the drive toward internationalization of intellectual property could "deter or block imitation and leap-frogging in technology" recognize the importance of intellectual property protection for "developing countries wishing to develop their scientific and technological capacity and benefit from the accelerated rate of technological progress" (Bifani, 1988: 179-80). In his analysis of the Brazilian intellectual property rights system, Frischtak (1989) points out that strengthening intellectual property rights "could contribute to firms making R&D a more systematic activity with an overall stronger commitment to innovation," although he cautions against overstating its role "in explaining the technological performance of Brazilian industrial firms."

In summary, the protection of intellectual property rights is considered by most authorities to be neither necessary nor sufficient for strong technological activity. South

⁸¹ See chapter 5 based on Kirim (1985) and the experience of the Turkish pharmaceutical industry.

Korea and Taiwan are often mentioned as examples of countries that significantly increased their technological efforts (as measured by the relative R&D-intensity of their economies) before reforming their intellectual property rights systems (Frischtak, 1989). From a historical perspective, one can also find episodes of "vigorous inventive activity" under weak intellectual property rights protection—for example, Switzerland during the patentless era between 1850 and 1888 (Schiff, 1971: 123). However, there is growing appreciation for the role that intellectual property rights can play in the development process, particularly under dynamic technological circumstances (Bifani, 1988; Primo Braga, 1990). The qualitative implications of intellectual property rights—i.e., the degree to which they foster genuine innovation as opposed to mere imitation (Sherwood, 1990b)—are also receiving more attention, even though most evidence remains at the anecdotal level. A balanced evaluation of intellectual property reform in developing countries would also have to take into account its influence on informal R&D.

Disclosure of New Knowledge

One of the oldest arguments in favor of patents is the exchange-for-secrets thesis mentioned in chapter 3. Grundmann (1970: 196) criticizes the relevance of this argument for developed and developing countries alike. In the case of developing countries, his criticism runs as follows: To the extent that most patents granted in developing countries "cover inventions already patented abroad, ... a good library of published letter patents" would perform the same function [of disclosure] at a lower cost. That "the published information is usually insufficient, taken by itself, to be of much use ..." would further lower the value of disclosure per se in developing countries.

However, despite the fact that the drive toward stricter protection of intellectual property rights around the world has a clear bias in favor of secrecy, disclosure continues to receive attention, particularly as an instrument to enhance the efficiency of technology transfers. As Ullrich (1989: 110) points out, "since patent claims are clearly defined, they allow the technical and territorial scope of any technology transfer transaction to be precisely defined, as well as the technology to be transferred to be clearly distinguished from any other technical knowledge of which a partner may learn during the transfer contracts." It is also interesting to mention that "governments in some developing countries have taken action to make the information disclosed in patent applications readily available to their nationals" (Sherwood, 1990b: 56). Deolalikar and Evenson (1990) point to the correlation between U.S. patent grants and Indian inventive activity, suggesting broadly that disclosure stimulates inventive activity.

Global Technological Dynamism

The thesis that reform of intellectual property rights in developing countries could have an impact on global technology trends may be developed along two different lines of argument. The first rests on the proposition that domestic R&D fostered by the reform would lead to technological innovations otherwise not available or that would take longer to

be introduced in the international market if the reform had not been implemented. It is difficult to envisage such a scenario, but to the extent that leapfrogging into new technologies—particularly, biotechnology—is considered a possibility, one cannot completely discard this proposition.

The second argument is the one examined by Mansfield (1989). Industries for which intellectual property rights protection is fundamental may curtail their R&D projects because of weak protection in developing countries. Vernon (1957: 12) long ago called attention to this possibility in observing "that inventors in the industrialized areas of the world may need some special incentive to concentrate their talents on products of special utility to underdeveloped areas." The performance of First World research into tropical diseases, for example, is a natural topic for investigation.

Technology Transfer

This is the most traditional argument for intellectual property rights protection in developing countries. Since the 1964 UN report discussed above, several studies have analyzed the link between intellectual property protection and technology transfers to developing countries (Anderfelt, 1971; UNCTAD, 1974; Vincent, 1984). The argument rests on the proposition that technology owners do not have an incentive to transfer their proprietary knowledge to countries with weak intellectual property rights systems, in view of the potential for "piracy" (Sherwood, 1989b).

There is evidence that many technology exporters consider inadequate protection of intellectual property to be a strong disincentive to technology transfer to developing countries. A survey conducted by the OECD listed intellectual property problems among the most significant barriers to licensing in developing countries.⁸² However, as the case of South Korea suggests, weak intellectual property systems can coexist with intense licensing activity (Schumann, 1990).

The need for a developing country to be more aware of the potential role of intellectual property protection in attracting foreign technology through licensing has recently been pointed out by Sherwood (1989b, 1990b) and Frischtak (1989). As Frischtak suggests, in a less benign yet more competitive global trading environment, it is indispensable for a developing country to revise its regulatory environment, including its intellectual property regime, so as to attract foreign expertise of the kind most beneficial to it.

⁸² Exchange controls (88 percent) and prior government approval (80 percent) were the only significant disincentives to score higher than inadequate intellectual property protection, which was mentioned by 75 percent of survey respondents. The survey covered 109 executives in manufacturing firms. For further details, see Frischtak (1989: 19).

Capital Formation

A common argument linking intellectual property rights and investments focuses on foreign direct investment. According to this view, "it is common knowledge that [if] intellectual property rights are not adequately protected in particular markets, foreign firms will tend to *avoid selling licenses in these countries and investing there*" (OECD, 1989: 11, emphasis in the original). The magnitude of the problem is debatable. Surveys conducted with multinational executives suggest that the impact of weak intellectual property systems, although often referred to as a problem, is overshadowed by other considerations—particularly the overall economic environment of the country (Frischtak, 1989). Furthermore, as UNCTC (1988) data suggest, insecure intellectual property rights were not enough to deter foreign direct investment in manufacturing in many developing countries. In such cases, transnational corporations account for the same proportion of output and employment in developing countries as they do in developed economies. Still, it can plausibly be argued that the influence of intellectual property rights protection as a determinant of foreign direct investment is bound to increase as the world economy becomes more knowledge-intensive. If this is true, weak systems of intellectual property rights will have a negative effect on the composition of foreign direct investment in a developing country. Present evidence is inadequate to permit a definitive analysis, however.

Other Benefits

The literature contains references to other benefits in addition to those discussed above. These include encouragement of international trade (OECD, 1989); incentives to additional human-capital formation—through better training practices and an environment more conducive to R&D (Sherwood, 1990b); procompetitive effects such as "patenting around" existing technology (thereby increasing marginal innovation, at least in theory, and preventing any single invention from taking on a dominant role by providing close substitutes); and an increase in the introduction of inventions (Firestone, 1971); the protection of cultural identity—for example, by fostering truth in "appellation of origin" labels such as Champagne and Bordeaux (OECD, 1989); and consumer benefits through greater variety and quality of products and services (Firestone, 1971). Some of these benefits can be understood as by-products of the impacts discussed above—mainly, the potential stimulus to innovation in developing countries that undertake intellectual property reform. Their importance for individual countries may vary greatly.

Trade Considerations

For developing countries, the possibility of trade retaliation against their intellectual property rights systems must be included in the economic analysis of the costs and benefits of reform. Primo Braga (1989: 262) suggests that expected "export revenue losses ... should be included among the variables considered in the benefit function," a variable that could easily

affect the economic assessment of intellectual property reform for countries with significant trade links to the industrialized world.⁸³

Bilateral disputes and negotiations under the threat of unilateral trade sanctions have become the norm over the last few years. U.S. trade laws have been expanded to include evaluation of the intellectual property protection offered by a foreign nation in establishing that nation's status under the U.S. Generalized System of Preferences (GSP) or to justify investigation under Section 301 of U.S. law on unfair trade practices (Gadbaw, 1989). The Omnibus Trade and Competitiveness Act of 1988 went a step further by creating the possibility of accelerated "301 investigations" against countries identified as "the most egregious intellectual property rights transgressors ... that do not undertake or make progress in negotiations" with the United States (Abbott, 1989: 708). The European Community has also developed new commercial policy instruments to deal with intellectual property rights issues (Brueckmann, 1990). Accordingly, developing countries with "weak" intellectual property rights systems have been exposed to growing pressures to reform their systems under the threat of trade sanctions. The United States, for instance, has "secured major changes in the intellectual property rights regimes of Korea, Taiwan, and Singapore" (Gadbaw, 1989: 229). Trade sanctions have been imposed in some instances: In December 1987, the European Community suspended its GSP benefits for Korean products as a response to Korean practices favoring intellectual property rights of "U.S. nationals under the terms of a Section 301 agreement" (Brueckmann, 1990: 305); in October 1988, the United States "imposed 100 percent [punitive] tariffs against \$39 million of Brazilian goods" (U.S. Trade Representative, 1989: 20) as a result of a Section 301 investigation of Brazil's refusal to grant patent protection to pharmaceutical products (this investigation was sparked by a complaint from the U.S. Pharmaceutical Manufacturers' Association).⁸⁴

The use of trade leverage to force intellectual property reform is not a novelty in itself, as the history of the German-Swiss tariff negotiations of 1904 suggests (Penrose, 1951: 16-17). The present episodes, however, have achieved a much greater economic and political significance, reflecting the growing relevance of knowledge-appropriation on an international scale.

Intellectual property considerations have been present in the General Agreement on Tariffs and Trade (GATT) since its original draft.⁸⁵ Yet, GATT has not imposed any standard with respect to the intellectual property rights systems of its contracting parties. Article IX(6) simply requires cooperation among parties in order to avoid misrepresenting

⁸³ For more details on the issue of trade retaliation, see Nogués (1990a).

⁸⁴ These punitive tariffs have recently been withdrawn in response to changes in Brazil's stance on intellectual property rights.

⁸⁵ For detailed descriptions of the treatment of intellectual property rights under the GATT regime see Hartridge and Subramanian (1989) and Reichman (1989b).

marks of origin in international trade. The most significant reference to intellectual property rights in GATT appears in Article XX(d), among the so-called general exceptions to GATT. This article "allows Contracting Parties to take measures for the enforcement of intellectual property rights that normally would be inconsistent with the General Agreement" (Hartridge and Subramanian, 1989: 900).

This disregard for intellectual property laws under GATT has been interpreted either as a lack of concern for intellectual property in trade in the 1940s (Primo Braga, 1990), or as a compromise solution adopted in the belief that "there could be no GATT unless it were recognized that intellectual property law is outside GATT" (Stern, 1987: 203).

Since the 1970s, however, TRIPs have been receiving more attention at the multilateral level. The efforts of the United States in favor of an Anti-Counterfeiting Code during the Tokyo Round marked the beginning of this new era. In the 1980s, the debate became much more intense, leading to a series of GATT panels related to intellectual property rights and, finally, to the inclusion of TRIPs as a major theme for negotiation at the Uruguay Round.⁸⁶

At the core of this debate is the issue of trade distortions generated by intellectual property systems. One type of problem is related to the use of national intellectual property laws as a disguised restriction on international trade. Section 337 of the U.S. Tariff Act of 1930 has often been denounced in this context and has even been the subject of two GATT dispute-settlement panels.⁸⁷ But the main concern of developing countries is the proposition, championed by the United States, that the negotiations should pursue the establishment of substantive standards for intellectual property rights protection on a world-wide basis. Abbott (1989) provides a summary of the U.S. proposal.

Stern (1987: 205) points out that disharmony between national intellectual property systems has an effect similar to nontariff trade barriers. Accordingly, multilateral harmonization could encourage international trade in knowledge-intensive products (OECD, 1989).⁸⁸ However, the adoption of standards—"presumably ... modelled after [U.S.]

⁸⁶ There is an extensive literature on the evolution of the debate on TRIPs at the multilateral level. Bradley (1987), Gadbow and Gwynn (1988), Primo Braga (1989), Abbott (1989), and Yusuf (1989) provide complementary descriptions of this process. For a bibliographic essay on TRIPs at the Uruguay Round, from a lawyer's perspective, see Walker (1989).

⁸⁷ Section 337 "permits the ITC to prohibit the importation of foreign goods when material injury to a U.S. firm results as a consequence of unfair trade practices, including patent and copyright infringement" (Benko, 1987: 57). For further details on the GATT panels on Section 337, see Gadbow (1989), Hartridge and Subramanian (1989), and Yusuf (1989). Section 337 has come under fire within GATT because it is perceived to discriminate against foreign defendants in ITC actions.

⁸⁸ This proposition is qualified by the arguments in favor of discrimination in international intellectual property legislation surveyed in chapter 3. See Subramanian (1990).

legislation" (Greenwald, 1988: 9)—poses many problems for the negotiators, even if one leaves aside political considerations. First of all, most analysts point out that "weak" intellectual property systems by themselves do not violate GATT rules (Abbott, 1989; Hudec, 1989; Jackson, 1989).⁸⁹ In order to introduce higher standards in the General Agreement, developed countries would have to offer a quid pro quo to developing countries. Needless to say, the price of any "concession" by developing countries on intellectual property rights is one of the most contentious issues in the Uruguay Round. Second, there are many doubts about the appropriateness of GATT as a forum for negotiating substantive standards for intellectual property rights protection. Most developing countries tend to prefer WIPO as the proper institutional locus for these discussions. The lack of effective enforcement powers in the WIPO conventions, however, is sometimes presented as the reason behind the U.S. efforts in favor of a GATT-related solution (Kastenmeier and Beier, 1989). Third, developing countries also resist the comprehensiveness of the U.S. proposal. Countries such as Brazil and India, for instance, oppose the inclusion of trade secrets in the negotiations, because they believe that international property laws properly apply only to "disclosable" matters.

Conclusions

Greater intellectual property protection will entail both costs and benefits for developing countries. The economic impact of a reform will tend to vary significantly across countries, depending on the responsiveness of domestic innovators to higher protection, the responsiveness of foreign direct investment, demand elasticities for protected products, the volume of existing local infringing activity, and other factors. It will have to be assessed for each country individually in an intertemporal framework.

Generally, it should be expected that actual system cost, that is, the cost of introducing and maintaining intellectual property, may not be unreasonably high, particularly when a country opts for registration rather than a full-fledged examination system, and introduces its enforcement mechanism gradually. Incremental royalty payments may also weigh less heavily in the balance-of-payments than some of the estimates raised in public debate would suggest, particularly when compared to overall expenditures on imports of disembodied services. Estimates of economic losses resulting from reining in or eliminating pirating activity have not yet been subjected to empirical tests. New R&D activities spurred by stronger intellectual property protection may draw resources away from other economic activity, and this could present a cost. Finally, the risk of anticompetitive behavior of the intellectual property owner, generally believed to lead to higher prices, and higher entry barriers to newcomers, may be at least partly contained or reduced as in most cases protection does not prevent legal imitation.

⁸⁹ For attempts to demonstrate that weak intellectual property protection is "GATTtable," see Sherwood (1987) and Gadbow and Gwynn (1988). Primo Braga (1990b) provides a critical analysis of these attempts.

The benefits of protection are no easier to establish. Like the costs, most benefits believed to flow from stronger protection in developing countries have not been empirically established, such as the positive impact on domestic R&D activity (a conclusion already advanced in chapter 4), the knowledge diffusing effect of patent disclosure, the boost to higher world technological activity resulting from better protection in all countries, and generally, its favorable effects on technology transfer through licensing, and on capital formation, especially through more foreign direct investment.

The only clear-cut conclusion—one almost too obvious to state yet no more quantifiable than preceding ones—concerns the risk of trade retaliation, which for countries following an outward-oriented development strategy appears relevant enough to justify a review of the international acceptability of their intellectual property regimes.

VIII. CONCLUSIONS AND RECOMMENDATIONS

Wolfgang E. Siebeck

Should developing countries strengthen intellectual property protection? Have we moved beyond Machlup's (1958) often cited conclusion that we know too little about the effects of patent systems either to introduce them where they do not exist or to remove them where they do? Our survey has shown that we have, at least with regard to industrial countries. Analytical and empirical work in recent years has provided a number of clues and shed light on the workings of the system and its effects on an economy. By contrast, for developing countries our knowledge is wanting.

Main Conclusions

After its initial overview of intellectual property systems, this survey has reviewed the theoretical and empirical economic literature on intellectual property, as well as specific issues in four major sectors, and has attempted to weigh the costs and benefits that a developing country must consider when deciding to strengthen protection of intellectual property. The main conclusions emerging from the various chapters are summarized below.

An Overview of Intellectual Property Systems (Chapter 2)

Our knowledge of the scope, standards, and effectiveness of intellectual property protection in developing countries is seriously inadequate. We must develop a better understanding of what is in place and what is missing, not only in terms of legal norms, but in the way laws are observed and implemented. It will be necessary to apply some measurement of the strength and efficiency of intellectual property protection in developing countries that reflects factors such as the government's attitude toward private sector research, the competitive business climate, its ethical standards, and other ingredients making up a "business culture" conducive to investment and innovation.

Guidance from Economic Theory (Chapter 3)

Although the review in chapter 3 may have convinced the reader that the economic literature is of little direct relevance to the concerns of developing countries, there are a number of suggestions that should be looked at closely:

An optimal *length of protection*—a contentious patent issue that the Paris Convention leaves to the discretion of national legislation but that has been raised in some proposals tabled in the Uruguay Round—cannot be deduced from economic theory. Nordhaus (1969) concluded, welfare losses beyond an initial patent life of six to ten years will be of little significance; empirical studies (Mansfield, 1985) have shown that the proprietary knowledge protected by patents becomes available to rivals within a year to 15 months on average.

Economic analysis has concluded that in a perfectly competitive market without intellectual property protection firms will underinvest in R&D, whereas protection could lead to excessive duplication of R&D efforts, and thus to *overinvestment*. Neither concern may be relevant to developing countries, which on the whole tend to underinvest in R&D. Yet developing countries want to know how they can create a more optimal R&D environment while containing the anticompetitive effects of protection and minimizing the cost of acquiring foreign technology.

Contrary to widely held beliefs, patents spread knowledge, though not necessarily through legal *disclosure* requirements. They do so selectively, through licensing and other transfer arrangements. This sets them apart from trade secrets, which contribute little to the diffusion of knowledge.

Survey of Empirical Studies (Chapter 4)

By and large, developing countries underinvest in both public and private research. The bulk of research activity is in agriculture—which in many countries may be a correct choice—but it is confined to the public sector, which may be inappropriate. Industrial R&D is often nil.

Intellectual property protection cannot be shown to be the decisive factor in encouraging R&D but it appears to be an important ingredient in any policy package designed to support R&D activity. While studies on industrial countries show high private returns on R&D and even higher social returns, the relevance of these studies for developing countries remains to be demonstrated.

"Petty patents" may be a suitable tool for developing countries to use to protect their typically more adaptive and imitative research activity.

Sector Issues (Chapters 5 and 6)

Patent protection of pharmaceutical and chemical products and processes is critical to justify high R&D expenditure in these sectors. More research should be undertaken to determine the validity of developing country concerns about the growing market power of multinational corporations and their control over drug prices.

Intellectual property protection is less divisive an issue in information industries, as more developing countries apply copyright protection to software products.

Copyright protection in the audio, video, and publishing industries appears to be as much an issue among developing countries as it is in all countries where the interests of consumers and producers so strongly differ. A serious problem is the policing of protection in light of the technical facility of copying.

The introduction of plant breeders' rights has influenced private breeding activity in at least two industrial countries. There are tentative indications that private breeding activity in developing countries, which currently is very modest, would respond positively to the availability of protection.

The Developing Country Case for and against Intellectual Property Protection (Chapter 7)

The discussion of costs and benefits to developing countries strengthening their intellectual property systems has pointed to a number of conclusions:

Few of the cost figures cited in the current debate are based on empirical research. The costs of administering and enforcing intellectual property, while not insignificant, are likely to be small in relation to the economic activity to which the system is designed to apply. Some well-publicized estimates of royalties lost by industrial countries to piracy in developing countries are almost certainly overstated, and more research, by country and sector, will be required to arrive at more credible numbers. Constraints on imitative activity—pirating as well as legal imitation—are likely to involve less economic loss than is often feared. The opportunity cost of trained manpower attracted into increased R&D should be factored in as a cost. Finally, while intellectual property creates monopoly rents, its effects need to be isolated from those of other price distorting factors. Such effects will vary considerably between countries according to level and pattern of technological activity.

The benefits of protecting intellectual property are likely to be even more difficult to quantify than the costs. Whether protecting intellectual property spurs R&D, capital formation, and foreign direct investment has not been conclusively shown. The disclosure of knowledge, the traditional rationale for patents, may have less impact on innovation than is generally believed. However, uncertain or otherwise inadequate protection in developing countries may dampen the desire of industrial country corporations to invest in research of

specific interest to those developing countries (for example, research on tropical diseases), but only anecdotal evidence is available on this subject. The same holds true for the question of whether protection is needed to facilitate the purchase of proprietary knowledge through licensing.

The threat of trade retaliation for alleged violations of intellectual property rights, although not easy to quantify, will have to be seen by export-dependent developing countries as a cost in any assessment of potential costs and benefits, a cost that may persuade many to review their current intellectual property protection.

Recommendations

Substantial economic research has been focused on intellectual property in industrial countries, yet it has failed to explain fully the linkages between protection and research, and between productivity and growth. Remarkably little work has been done to date on the effects of stronger or weaker intellectual property protection on developing economies.

To ascertain the role of intellectual property in the development process, six broad areas for priority research are suggested:

- The scope and effectiveness of current intellectual property protection in developing countries
- The incentive effect of intellectual property protection on research and development activities in developing countries
- The incentive effect of intellectual property protection on investment, especially foreign direct investment
- The incentive effect of intellectual property protection on technology transfer, especially through technology purchases (licensing)
- The potential benefits of granting petty patents in developing countries
- The potential benefits of protecting plant breeders' rights in developing countries

Except for what appears in legal texts of patent and other intellectual property laws, very little is known about the way developing countries do or do not protect intellectual property. A thorough treatment of the first theme identified above would include (a) a historical account of why and how individual countries have introduced protection (whether inherited with independence or subsequently introduced or abolished); (b) a description of the

institutional elements of the system (existence of registries, number of patent examiners, number of patents granted, delay from filing date to the granting of a patent, scope and intensity of examination, availability of effective court protection, etc.); and (c) a sample survey of local and foreign investors (already established in the country) covering the achievements and shortcomings of the system.

The second, third, and fourth themes would investigate the alleged beneficial economic effects of intellectual property protection in developing countries. This research would—to some extent—replicate empirical work already done on industrial countries (discussed in chapter 4 of this survey). However, it would also have to take into account the markedly different conditions and interests of developing countries, which are net importers of technology and where the protection of intellectual property is often weak and technological skills are primarily adaptive. It should include countries that changed their intellectual property regime at one point or another—either by strengthening or weakening protection—so as to allow a comparison of conditions before and after the changes. A major, and expensive, task would be to establish reliable data on R&D activities, technology transfer through foreign investment, and outright technology purchases in individual countries. Another task would be to estimate social and private rates of return on research activities, technology transfers under direct investment, and licensing arrangements, in both the public and private sectors. The studies should identify differences in the policy and institutional environment of countries that are strong performers in terms of research and technology acquisition, and those that are not.

The last two themes merit immediate attention because there is some evidence that introducing petty patents and plant breeders' rights in developing countries would yield substantial benefits. To corroborate this should be possible with a modest research effort, largely based on available data on industrial countries.

The first theme would, by necessity, be investigated in selected countries. Research on the second, third, and fourth themes could also be undertaken in the form of country studies, producing a comprehensive assessment of existing intellectual property protection in a country and of the pros and cons of strengthening the policy environment. These studies should include countries which at one point or another have strengthened or weakened their system or level of protection.

Because they would largely assess existing industrial country data, the last two themes should be handled separately from the preceding four themes.

To be useful to developing country policy makers and to the international lending institutions that fund technology transfer projects, the proposed studies should lead to specific policy recommendations. For instance, if it is correct that the bulk of technological innovation will continue to be supplied by industrial countries for some time to come, the studies should show whether and for which countries the acquisition of technology through purchases rather than "free-riding" is the more viable option. Where this is the case, the

thrust of a country's policy should then shift from trying to contain dependence on foreign technology toward promoting its acquisition. This would involve (a) building an indigenous research capability to absorb and adapt foreign technology (including "reverse engineering" and legal imitation); (b) encouraging its nationals to buy foreign technology rather than trying to develop a costlier indigenous substitute; and (c) removing regulatory constraints (including foreign exchange constraints) that contribute to high transaction costs of technology purchases.

Resource requirements will be important, and these research tasks should be shared in a carefully coordinated way among agencies and research institutions in industrial and developing countries.

Appendix 1

Overview of Patent Protection Worldwide as of 1988

Country	Duration of Protection	Memberships			Available Patent Protection 1: Petty Patents 2: Pharmaceuticals 3: Food Products 4: Chemical Products 5: Plant/Animal Varieties 6: Surgical Procedures 7: Microorganisms and Products Thereof						
		Paris	Berne	UPOV	1	2	3	4	5	6	7
LOW INCOME											
Bangladesh	16c,d				■	■	■	■	■	■	■
Benin	10a,d	■	■		■	■	■				■
Burkina Faso	10a	■	■		■	■	■				■
Burundi	20a	■			■	■	■	■	■	■	■
Central African Republic	10a,d	■	■		■	■	■				■
Chad	20a	■	■				■	■	■	■	■
China	15a	■									■
Gambia, The	20a				■	■	■	■	■	■	■
Ghana	20a	■					■	■			■
Guinea	e	■	■		■	■	■	■	■	■	■
Guinea-Bissau	e	■			■	■	■	■	■	■	■
Haiti	5,10,20c	■			■	■	■	■	■	■	■
India	14b		■						■		■
Indonesia	e	■			■	■	■	■	■	■	■
Kenya	20a	■		‡	■	■	■				■
Lesotho	20a				■	■	■	■	■	■	■
Liberia	e				■	■	■	■	■	■	■
Madagascar	e	■	■		■	■	■	■	■	■	■
Malawi	16b,d	■			■	■	■	■	■	■	■
Mali	10a,d	■	■		■	■	■				■
Mauritania	10a,d	■	■		■	■	■				■
Niger	10a,d	■	■		■	■	■				■
Nigeria	20a	■			■	■	■			■	■
Pakistan	16c,d		■				■	■	■	■	■

Country	Duration of Protection	Memberships			Available Patent Protection						
		Paris	Berne	UPOV	1	2	3	4	5	6	7
Rwanda	20a	■	■			■	■	■	■	■	■
Sierra Leone	20a					■	■	■	■	■	■
Sri Lanka	15c	■	■			■	■	■			■
Sudan	20a	■				■	■	■	■	■	■
Togo	10a,d	■	■			■	■	■			■
Uganda	20a	■				■	■	■			■
Tanzania, U. Rep. of	20a	■				■	■	■			■
Viet Nam	15a	■							■	■	■
Zaire	20a	■	■			■	■	■	■	■	■
Zambia	16b	■				■	■	■	■	■	■
LOWER-MIDDLE INCOME											
Bolivia	15c								■	■	■
Botswana	20a					■	■	■	■	■	■
Brazil	15a	■	■		■	+	+		■	■	
Cameroon	10a	■	■			■	■	■			■
Chile	e		■	†		■	■	■	■	■	■
Colombia	5c,d		■			+	+	■			■
Congo	10a,d	■	■			■	■	■			■
Côte d'Ivoire	10a,d	■	■			■	■	■	■	■	■
Dominican Republic	5,10,15c	■				■	■	■	■	■	■
Ecuador	5c,d							■			■
Egypt	15a,d	■	■					■	■	■	■
Jordan	16a	■				■	■	■	■	■	■
Lebanon	15a	■	■					■	■	■	■
Malaysia	15c					■	■	■			■
Mauritius	14a,d	■				■	■	■	■	■	■
Mexico	14c	■	■			+	+				■
Morocco	20a	■	■					■	■	■	■
Peru	5c,d		■					■			■
Philippines	17c	■	■		■	■	■	■	■	■	■
Poland	15a	■	■		■						■
Senegal	10a,d	■	■			■	■	■			■
Swaziland	20a					■	■	■	■	■	■
Syria	15a	■						■	■	■	■
Thailand	15a		■					■		■	■

Country	Duration of Protection	Memberships			Available Patent Protection						
		Paris	Berne	UPOV	1	2	3	4	5	6	7
Tunisia	5,10,15,20a	■	■					■	■	■	■
Turkey	5,10,15a	■	■			*	■	■	■	■	■
Zimbabwe	20a	■	■			■	■	■	■	■	■
UPPER-MIDDLE INCOME											
Algeria	20a	■				■	■	■		■	■
Argentina	5,10,15c	■		■			■	■	■	■	■
Barbados	15a,d	■	■			■	■	■			■
Gabon	10a,d	■	■			■	■	■			■
Greece	15a	■	■				■	■	■	■	■
Hungary	20a	■	■	■				■	■		
Iran	5,10,15,20a	■					■	■	■	■	■
Iraq	15a	■					■	■	■	■	■
Korea, Republic of	12b	■			■	■			■	■	■
Libya	15a,d	■	■					■	■	■	■
Malta	14a,d	■	■			■	■	■	■	■	■
Portugal	15c	■	■		■					■	■
Romania	15a	■	■								
Seychelles	20a					■	■	■	■	■	■
South Africa	20a	■	■	■		■	■	■			■
Suriname	e	■	■			■	■	■	■	■	■
Taiwan (China)	15c				■	■		■			
Trinidad & Tobago	14c	■	■			■	■	■	■	■	■
Uruguay	15c	■	■		■		■		■	■	■
Venezuela	5,10c		■						■	■	■
Yugoslavia	7b,d	■	■								
HIGH INCOME											
Austria	18b	■	■			■	■	■			■
Australia	16b,d	■	■			■	■	■	■	■	■
Bahamas	16a	■	■			■	■	■		■	■
Belgium	20a	■	■	■		■	■	■			■
Canada	17c	■	■				■	■			■
Cyprus	20a	■	■			■	■	■			■

Country	Duration of Protection	Memberships			Available Patent Protection							
		Paris	Berne	UPOV	1	2	3	4	5	6	7	
Denmark	20a	■	■	■		■	*	■				■
Finland	20a	■	■					■				■
France	20a	■	■	■		■	■	■				■
Germany, Fed. Rep. of	20a	■	■	■	■	■	■	■				■
Iceland	15c	■	■					■	■	■		■
Ireland	16b,d	■	■	■		■	■	■	■	■		■
Israel	20a	■	■	■		■	■	■				■
Italy	20a	■	■	■	■	■	■		§			■
Japan	15b	■	■	■	■	■	■	■	■			■
Liechtenstein	20a	■	■			■	■	■				■
Luxembourg	20a	■	■			■	■	■			■	■
Netherlands	20a	■	■	■		■	■	■				■
New Zealand	16b	■	■	■		■	■	■	■	■		■
Norway	20a	■	■					■				■
Spain	20a	■	■	■	■		■					†
Sweden	20a	■	■	■		■	■	■				■
Switzerland	20a	■	■	■		■	■	■				■
United Kingdom	20a	■	■	■		■	■	■				■
United States	17c,d	■	■	■		■	■	■	■	■		■
UNCLASSIFIED (INCOME DATA NOT REPORTED)												
Bulgaria	15a	■	■									■
Cuba	10a,d	■										■
Czechoslovakia	15a	■	■						■			
German Dem. Rep.	18a	■	■									
Korea, Dem. Ppl's Rep.	15a	■				■	■	■	■	■		■
Mongolia	15a	■							■			■
U.S.S.R.	15a	■						■				■

SOURCES: WIPO (1988a), Gadbow and Richards (1988). Ranking according to World Bank national income data.

NOTES: *a* from filing date; *b* from publication date; *c* from grant date; *d* extension possible—typically 5 years; *e* no information available; ■ denotes membership; ¶ grants PBRs, but not member of UPOV; * processes patented under some circumstances; § Italy allows plant varieties but not animal varieties; † excluded until 1992; ‡ PBRs not yet implemented.

Appendix 2

Multinational Intellectual Property Agreements

Industrial Property Agreements administered by the World Intellectual Property Organization (WIPO)

PARIS CONVENTION (1883, 98 STATES) Mandates that foreigners receive the same protection as national inventors and trademark holders ("national treatment")

MADRID AGREEMENT (INDICATIONS OF SOURCE) (1891, 32 STATES) Permits confiscation or prohibition of importation of goods bearing false or misleading indications of source

MADRID AGREEMENT (MARKS) (1891, 27 STATES) Provides for international registration of trademarks, with subsequent filing in individual states

HAGUE AGREEMENT (1925, 21 STATES) International deposit of industrial designs

NICE AGREEMENT (1957, 32 STATES) Assists in the registration of trademarks by establishing worldwide uniformity, including a classification system

LISBON AGREEMENT (1958, 16 STATES) Protects appellations of origin

INTERNATIONAL CONVENTION FOR THE PROTECTION OF NEW VARIETY OF PLANTS (1961,⁹⁰ 17 STATES) Establishes standards for the protection of plant varieties

LOCARNO AGREEMENT (1968, 15 STATES) Facilitates worldwide uniformity in the registration of industrial designs

PATENT COOPERATION TREATY (1970, 40 STATES) Allows for a single search and, on request, preliminary examination effective in all member states

INTERNATIONAL PATENT CLASSIFICATION AGREEMENT (1971, 27 STATES) Establishes worldwide uniformity in the classification of technologies

BUDAPEST TREATY (1977, 12 STATES) Provides for a single deposit of a microorganism at an authorized international depository for the purpose of patent descriptions

⁹⁰ This convention is administered by UPOV, a sister organization to WIPO.

NAIROBI TREATY ON THE PROTECTION OF THE OLYMPIC SYMBOL (1981, 32 STATES)
Controls commercial use of the Olympic symbol

TREATY ON THE PROTECTION OF LAYOUT-DESIGNS (TOPOGRAPHIES) OF MICROCHIPS (1989) Establishes standards for protecting microchips

Copyright Agreements Administered by WIPO

BERNE CONVENTION (1886, 79 STATES) Establishes minimum standards and procedures for copyright protection

ROME CONVENTION (1961, 32 STATES) Protects broadcast rights to literary and artistic creations

GENEVA CONVENTION (1971, 42 STATES) Protects producers of phonograms from unauthorized reproductions

BRUSSELS CONVENTION (1974, 7 STATES) Protects satellite signal transmission

MADRID MULTILATERAL CONVENTION (1979, NOT IN FORCE) Intended to prevent double taxation of copyright royalties

Other International Industrial Property Agreements

EUROPEAN PATENT CONVENTION (1973, 11 STATES) Provides for joint granting of "bundled" national patents applicable in member states

COUNCIL FOR MUTUAL ECONOMIC ASSISTANCE AGREEMENT (1976, 10 STATES) Provides for "title of protection" in socialist countries

Other International Copyright Agreements

MEXICO CITY CONVENTION ON LITERARY AND ARTISTIC COPYRIGHT (1902, 16 STATES) AND BUENOS AIRES CONVENTION ON LITERARY AND ARTISTIC COPYRIGHT (1910, 20 STATES) National treatment for duly registered works

INTER-AMERICAN CONVENTION ON THE RIGHTS OF THE AUTHOR IN LITERARY, SCIENTIFIC, AND ARTISTIC WORKS (1946, 21 STATES) Allows authors to retain some control over the modification of a work following sale of the copyright

UNIVERSAL COPYRIGHT CONVENTION (1952, 75 STATES) Constitutes a less stringent convention than the Berne Convention and includes exceptions for developing countries and limited individual country exceptions

CONVENTION FOR THE PROTECTION OF PRODUCERS OF PHONOGRAMS AGAINST UNAUTHORIZED DUPLICATION OF THEIR PROGRAMS (1971, 32 STATES) Prohibits unauthorized duplication and importation; abandons national treatment

SOURCES: WIPO 1988; Benko, 1987: Appendix

REFERENCES

- Abbott, F.M. 1989. "Protecting First World Assets in the Third World: Intellectual Property Negotiations in the GATT Multilateral Framework." *Vanderbilt Journal of Transnational Law* 22, 4: 689-745.
- Akerlof, G.A. 1970. "The Market for Lemons: Qualitative Uncertainty and the Market Mechanism." *Quarterly Journal of Economics*, no. 84: 488-500.
- Alam, G. 1985. "India's Technology Policy and Its Influence on Technology Imports and Technology Development." *Economic and Political Weekly* 20: 2073-2080.
- Almeida, P.R. 1989. "The 'New' Intellectual Property Regime and Its Economic Impact on Developing Countries: A Preliminary Overview." Paper read at the Conference on the Uruguay Round of GATT and the Improvement of the Legal Framework of Trade in Services, September 21-23, 1989, Bergamo, Italy.
- Anderfelt, U. 1971. *International Patent Legislation and Developing Countries*. The Hague: Martinus Nijhoff.
- Anderson, E.V. 1986. "Intellectual Property: Foreign Pirates Worry U.S. Firms." *Chemical and Engineering News*, September.
- Arrow, K.J. 1962. "Economic Welfare and the Allocation of Resources for Inventions." In R.R. Nelson, ed., *The Rate and Direction of Inventive Activity*. Princeton: Princeton University Press.
- Bagchi, A.K. 1986. "The Pursuit of Self-Reliance in a World of Flux." In *Facets of India's Development*. Bombay: Industrial Credit and Investment Corporation of India.

- Bagchi, A.K. 1988. "Technological Self-Reliance, Dependence and Underdevelopment." In A. Wad, ed., *Science, Technology, and Development*. Boulder, Colo.: Westview Press.
- Balassa, B. 1986. "Dependency and Trade Orientation." *World Economy* 9: 259-273.
- Bale, H.E. 1988. "A Computer and Electronics Industry Perspective." In *Intellectual Property Rights and Capital Formation in the Next Decade*. See Walker and Bloomfield.
- Barton, J.H., R.B. Dellenbach, and D. Kunuk. 1989. "Toward a Theory of Technology Licensing." *Stanford Journal of International Law* 25: 195-229.
- Barzel, Y. 1968. "Optimal Timing of Innovations." *Review of Economics and Statistics*, August, pp. 348-355.
- Beck, R.L. 1976. "Patents, Property Rights, and Social Welfare: Search for a Restricted Optimum." *Southern Economic Journal* 43, 2.
- Beck, R.L. 1981. "Competition for Patent Monopolies." *Research in Law and Economics* 3: 91-110.
- Beier, F.K., R.S. Crespi, and J. Straus, 1985. *Biotechnology and Patent Protection: An International Review*. Paris: OECD.
- Benko, R.P. 1987. *Protecting Intellectual Property Rights: Issues and Controversies*. Washington, D.C.: American Enterprise Institute.
- Bent, S. 1989. "Issues and Prospects in the USA." In W. Lesser, ed. *Animal Patents: The Legal, Economic and Social Issues*. Proceedings of the Animal Patents Symposium, Ithaca, N.Y., December 5-6, 1988. London: Macmillan.
- Berkowitz, M.K., and Y. Kotowitz. 1982. "Patents Policy in an Open Economy." *Canadian Journal of Economics* 15, 1: 1-17.
- Bifani, P. 1989. "Intellectual Property Rights and International Trade." In *The Uruguay Round: Papers on Selected Issues*, UNCTAD/ITP/10. New York: United Nations.
- BIRPI. 1965. *Model Law for Developing Countries on Inventions*. Geneva: BIRPI.
- BIRPI. 1967. *Model Law for Developing Countries on Marks, Trade Names, and Acts of Unfair Competition*. Geneva: BIRPI.

- Blee, F.J. 1980. Commentary on K.W. Clarkson et al., "The Economics of Pharmaceutical Information: International Impact of U.S. Regulatory Reform." In *The International Supply of Medicines: Implications of U.S. Regulatory Reform*. See Helms, 1980.
- BNDES. 1988. "O Capital Estrangeiro na Industria Brasileira: Atualidade e Perspectivas," BNDES Study no. 10. Rio de Janeiro: Banco Nacional do Desenvolvimento Economico e Social.
- Bradley, A.J. 1987. "Intellectual Property Rights, Investment, and Trade in Services in the Uruguay Round: Laying the Foundations." *Stanford Journal of International Law* 23: 57-98.
- Braga, H., and V. Matesco. 1989. "Desempenho Tecnológico da Industria Brasileira: Uma Análise Exploratória." INPES/IPEA Internal Discussion Paper no. 162. Rio de Janeiro: INPES/IPEA.
- Branscomb, A.W. 1990. "Computer Software: Protecting the Crown Jewels of the Information Economy." In *Intellectual Property Rights in Science, Technology, and Economic Performance: International Comparisons*. See Rushing and Brown, 1990.
- Brim, C. 1987. "Plant Breeding and Biotechnology in the United States of America: Changing Needs for Protection of Plant Varieties." In *Proceedings of the Symposium on the Protection of Biotechnological Inventions*, Ithaca, New York, June 4-5, 1987. Geneva: WIPO.
- Brown, W.L. 1988. "Plant Genetic Resources: A View From the Seed Industry." In *Seeds and Sovereignty*. See Kloppenburg, 1988.
- Brueckmann, W. 1990. "Intellectual Property Protection in the European Community." In *Intellectual Property Rights in Science, Technology, and Economic Performance: International Comparisons*. See Rushing and Brown, 1990.
- Brumby, P., V. Giddings, G. Persley, and A. Pritchard. 1989. "Agricultural Biotechnology and the World Bank: A New Challenge." Unpublished discussion paper for Biotechnology Study Group, Canberra, May 25-27, 1989.
- Burstein, M.L. 1984. "Innovations and Property Rights: Introduction." *Economic Inquiry* 22, 4: 608-633.
- Butler, L.J., and B.W. Marion. 1983. *Impacts of Patent Protection in the US Seed Industry and Public Plant Breeding*. University of Wisconsin, NC-117 Monograph 16, September.

- Buttel, F.H., M. Kenney, and J. Kloppenburg. 1985. "From Green Revolution to Biorevolution: Some Observations on the Changing Technological Bases of Economic (Re)formation in the Third World." *Economic Development and Cultural Change* 34: 31-55.
- Cardozo, A.C. 1987. "Notas Sobre o Instituto Nacional de Propriedade Industrial e a Regulacao da Transferencia de Tecnologia no Brasil." Rio de Janeiro: INPI.
- Center for Economic Development. 1990. "Breaking New Ground in U.S. Trade Policy." Washington, D.C.: Center for Economic Development.
- Chin, J.C., and G.M. Grossman. 1988. "Intellectual Property Rights and North-South Trade." National Bureau of Economic Research (U.S.) Working Paper Series no. 2769, November.
- Chudnovsky, D. 1979. "The Challenge by Domestic Enterprises to the Transnational Corporations' Domination: A Case Study of the Argentine Pharmaceutical Industry." *World Development* 7: 45-58.
- Chudnovsky, D. 1983. "Patents and Trademarks in Pharmaceuticals." *World Development* 11, 3: 187-193.
- Claffey, B.A. 1981. "Patenting Life Forms: Issues Surrounding the Plant Variety Protection Act." *Southern Journal of Agricultural Economics* 13: 29-37.
- CNI. 1988. *Competitividade Industrial: Uma Estrategia para o Brasil*. Rio de Janeiro: Confederacao Nacional da Industria.
- Cocoma, F., A. Gabrielli, and C. Williamson. 1987. "Efecto de las Patentes de Medicamentos sobre el Mercado Farmaceutico y su Impacto sobre la Salud y el Gasto Fiscal." Unpublished manuscript, Catholic University of Chile, June.
- Cohen, W.M., and D.A. Levinthal. 1989. "Innovation and Learning: The Two Faces of R&D." *Economic Journal* 99, 397 (September): 569-596.
- Comanor, W. 1986. "The Political Economy of the Pharmaceutical Industry," *Journal of Economic Literature*, September.
- Commission of the European Communities. 1988. "Proposal for a Council Directive on the Legal Protection of Biotechnological Inventions." COM(88) 496 final-SYN 159. Brussels, October 17.
- Coquelin, C. 1873. "Brevets d'invention." In *Dictionnaire de l'Economie Politique*. Paris.

- Corcoran, E. 1990. "Not Just a Pretty Face: Compressing Pictures with Fractals." *Scientific American* 262, 3: 77-78.
- Crespi, R.S. 1988. *Patents: A Basic Guide to Patenting in Biotechnology*. Cambridge: Cambridge University Press.
- Dahab, S. 1986. "Technological Change in the Brazilian Agricultural Implements Industry." Doctoral dissertation, Yale University.
- Dahlman, C. 1989. "Impact of Technological Change on Industrial Prospects for the LDCs." World Bank Industry Series Paper no. 12. Washington, D.C.: The World Bank.
- Dahlman, C., B. Ross-Larson, and L.E. Westphal. 1985. "Managing Technological Development: Lessons from the Newly Industrializing Countries." World Bank Staff Working Paper no. 717. Washington, D.C.: The World Bank.
- Dasgupta, P. 1986. "The Theory of Technological Competition." In J.E. Stiglitz and G.F. Mathewson, eds., *New Developments in the Analysis of Market Structure*. Cambridge, Mass.: M.I.T. Press.
- Dasgupta, P. 1987. "The Economic Theory of Technology Policy: An Introduction." In P. Dasgupta and P. Stoneman, eds., *Economic Policy and Technological Performance*. Cambridge: Cambridge University Press.
- Dasgupta, P. 1988. "Patents, Priority and Imitation or The Economics of Races and Waiting Games." *Economic Journal* 98: 66-80.
- Dasgupta, P., and J. Stiglitz. 1980a. "Industrial Structure and the Nature of Innovative Activity." *Economic Journal* 90, 358: 226-293.
- Dasgupta, P., and J. Stiglitz. 1980b. "Uncertainty, Industrial Structure and the Speed of R&D." *The Bell Journal of Economics* 11, 1: 1-28.
- Deolalikar, A.B., and R.E. Evenson. 1990. "Private Inventive Activity in Indian Manufacturing: Its Extent and Determinants." In *Science and Technology: Lessons for Development Policy*. See Evenson and Ranis, 1990.
- Diamond v. Chakrabarty*. 1980. 447 U.S. 303.
- Dias, C.J. Undated. "Saying No to Plant Patenting: The Need for Third World Solidarity." Unpublished manuscript.

- Diwan, I., and D. Rodrik. 1989. "Patents, Appropriate Technology, and North-South Trade." PRE Working Paper Series no. 251. Washington, D.C.: The World Bank.
- Duesing, J.H. 1989. "Patent Protection for Inventions from Agricultural Biotechnology." In *Patenting Life Forms in Europe*. Proceedings of the ICDA Seeds Campaign, Barcelona, March 1989.
- Duffey, W. 1987. "The Marvelous Gifts of Biotechnology: Will They Be Nourished or Stifled by Our International Patent Laws?" In *Proceedings of the Symposium on the Protection of Biotechnological Inventions*, Ithaca, New York, June 4-5, 1987. Geneva: WIPO.
- Engel, R.L. 1985. "Patent Enforcement: The Uncertainties of Patent Litigation." In *The Economics of R&D Policy*. See Tolley et al., 1985.
- European Patent Office. 1985. *Convention on the Grant of European Patents*. 3d edition. Munich: European Patent Office.
- Evans, P.B. 1986. "State, Capital, and the Transformation of Dependence: The Brazilian Computer Case." *World Development* 14, 7: 791-808.
- Evenson, R.E. 1984a. "Analysis of Determinants of Inventive Activity in Firms Manufacturing Tractor-Drawn Implements." Unpublished manuscript, Economic Growth Center, Yale University.
- Evenson, R.E. 1984b. "International Inventions: Implications for Technology Market Analysis." In *R&D, Patents and Productivity*. See Griliches, 1984.
- Evenson, R.E. 1989. "Human Capital and Agricultural Productivity Change." In A. Maunder and A. Valdes, eds., *Agriculture and Governments in an Interdependent World*. Proceedings of the Twentieth International Conference of Agricultural Economists. International Association of Agricultural Economists, Queen Elisabeth House, University of Oxford: Dartmouth.
- Evenson, R.E. 1990. "Intellectual Property Rights, R&D, Inventions, Technology Purchase, and Piracy in Economic Development: An International Comparative Study." In *Science and Technology: Lessons for Development Policy*. See Evenson and Ranis, 1990.
- Evenson, R.E., D.D. Evenson, and J.D. Putnam. 1987. "Private Sector Agricultural Invention in Developing Countries." In *Policy for Agricultural Research*. See Ruttan and Pray, 1987.

- Evenson, R.E., and G. Ranis, eds. 1990. *Science and Technology: Lessons for Development Policy*. Boulder, Colo.: Westview.
- Evenson, R.E., and Y. Kislev. 1975. *Agricultural Research and Productivity*. New Haven: Yale University Press.
- Ex parte Hibberd*. 1985. 225 *U.S. Patent Quarterly* 443.
- Ex parte Allen*. 1987. 2 *U.S. Patent Quarterly* 2d 1425.
- Farrington, J., ed. 1989. *Agricultural Biotechnology: Prospects for the Third World*. Nottingham, U.K.: Russell Press.
- Feinberg R.M. and D.J. Rousslang. 1988. "The Economic Effects of Intellectual Property Right Infringements." Unpublished manuscript.
- Firestone, O.J. 1971. *Economic Implications of Patents*. Ottawa: University of Ottawa Press.
- Folster, S. 1985. "Government Co-ordination of Competitive R&D Projects." D. Phil. thesis, University of Oxford.
- Frame, J.D. 1987. "National Commitment to Intellectual Property Protection: An Empirical Investigation." *The Journal of Law & Technology* 2, 2: 209-227.
- Frick, H., and W. Lesser. 1989. "Economic Losses to New York's Dairy Sector Due to Mastitis." Agricultural Economics Research Paper no. 89-13, Department of Agricultural Economics, Cornell University, Ithaca, N.Y., August.
- Frischtak, C.R. 1989. "The Protection of Intellectual Property Rights and Industrial Technology Development in Brazil." World Bank Industry Series Paper no. 13. Washington, D.C.: The World Bank.
- Fritsch, W., and G.H.B. Franco. 1989. "O Investimento Direto Estrangeiro em uma Nova Estrategia Industrial." *Revista de Economia Politica* 9, 2: 5-25.
- Gadbaw, R.M. 1988. "Republic of Korea." In *Intellectual Property Rights: Global Consensus, Global Conflict?* See Gadbar and Richards, 1988.
- Gadbaw, R.M. 1989. "Intellectual Property and International Trade: Merger or Marriage of Convenience?" *Vanderbilt Journal of Transnational Law* 22, 2: 223-242.

- Gadbaw, R.M., and R.E. Gwynn. 1988. "Intellectual Property Rights in the New GATT Round." In *Intellectual Property Rights: Global Consensus, Global Conflict?* See Gadbaw and Richards, 1988.
- Gadbaw, R.M., and L.A. Kenny. 1988. "India." In *Intellectual Property Rights: Global Consensus, Global Conflict?* See Gadbaw and Richards, 1988.
- Gadbaw, R.M., and T.J. Richards, eds. 1988. *Intellectual Property Rights: Global Consensus, Global Conflict?* Boulder, Colo.: Westview Press.
- Gallini, N., and R. Winter. 1985. "Licensing in the Theory of Innovation." *Rand Journal of Economics* 16, 2: 237-252.
- Gilbert, R.J., and D. Newbery. 1982. "Pre-emptive Patenting and the Persistence of Monopoly." *American Economic Review* 72, 3: 514-526.
- Ginsburg, J.C. 1989. "French Copyright Law: A Comparative Overview." *Journal of the Copyright Society of the USA* 36, 4: 269-285.
- Ginsburg, J.C. 1990. "A Tale of Two Copyrights: Literary Property in Revolutionary France and America." *Tulane Law Review* 64, May.
- Goto, A., and K. Suzuki. 1989. "R&D Capital, Rate of Return on R&D Investment, and Spillover of R&D in Japanese Manufacturing Industries." *Review of Economics and Statistics* 71, 4.
- Government of Brazil. 1990. "Diretrizes Gerais para a Política Industrial e de Comercio Exterior." *Diario Oficial*, June 27, pp. 12367-12371.
- Grabowski, H., and J. Vernon. 1986. "Longer Patents for Lower Imitation Barriers: The 1984 Drug Act." *American Economic Review* (Papers and Proceedings) 76, 2 (May): 195-198.
- Greenwald, J.A. 1988. "The Protection of Intellectual Property Rights in the GATT and the Uruguay Round: The US Viewpoint." In K.R. Simmonds and B.H.W. Hill, eds., *Law and Practice Under the GATT*. New York: Oceana.
- Greer, D.F. 1973. "The Case Against the Patent System In Less-Developed Countries," *Journal of International Law and Economics* 8, 2.
- Greif, S. 1987. "Patents and Economic Growth." *International Review of Industrial Property and Copyright Law* 18: 191-213.

- Griliches, Z. 1980. "Returns to Research and Development Expenditure in the Private Sector." In Kendrick, J.W., and B.N. Vaccara (eds.), *New Developments in Productivity Measurement and Analysis*, Conference on Research in Income and Wealth, Vol. 44, Studies in Income and Wealth. Chicago: University of Chicago Press.
- Griliches, Z., ed. 1984. *R&D, Patents and Productivity*. Chicago: University of Chicago Press.
- Griliches, Z. 1989. "Patents: Recent Trends and Puzzles." In *Brookings Papers on Economic Activity: Microeconomics*: 291-319.
- Grossman, G.M., and C. Shapiro. 1988b. "Foreign Counterfeiting of Status Goods." *Quarterly Journal of Economics* 103: 79-100.
- Grossman, G.M., and C. Shapiro. 1988a. "Counterfeit-Product Trade." *American Economic Review* 78: 59-75.
- Grundmann, H.E. 1970. "The Economic Arguments for Patents and Their Validity for Developing Countries." *Indian Economic Journal* 19, 2: 193-207.
- Grynszpan, F. 1990. "Case Studies in Brazilian Intellectual Property Rights." In *Intellectual Property Rights in Science, Technology, and Economic Performance: International Comparisons*. See Rushing and Brown, 1990.
- Gwynn, R.E. 1988. "Mexico." In *Intellectual Property Rights: Global Consensus, Global Conflict?* See Gadbow and Richards, 1988.
- Hartridge, D., and A. Subramanian. 1989. "Intellectual Property Rights: The Issues in GATT." *Vanderbilt Journal of Transnational Law* 22, 4: 893-910.
- Hatch, O.G. 1989. "Better Later Than Never: Implementation of the 1886 Berne Convention." *Cornell International Law Journal* 22, 2: 171-195.
- Helleiner, G.K. 1979. "International Technology Issues: Southern Needs and Northern Responses." In J. Ramesh and C. Weiss, Jr., eds., *Mobilizing Technology for World Development*. New York: Praeger.
- Helms, R.B., ed. 1980. *The International Supply of Medicines: Implications of U.S. Regulatory Reform*. Washington, D.C.: American Enterprise Institute.
- Hirschleifer, J., and J.G. Riley. 1979. "The Analytics of Uncertainty and Information: An Expository Survey." *Journal of Economic Literature* 17: 1375-1421.

- Hoay, T.B. 1988. "The 1987 Singapore Copyright Act and Its Economic Consequences." *APLA [Asia-Pacific Lawyers Association] Journal*, no. 4 (December): 111-115.
- Hoyt, J.A. 1988. "Patents and the Constitution: Transgenic Animals." Hearings before the Subcommittee on Courts, Civil Liberties and the Administration of Justice of the Committee of the Judiciary, U.S. House of Representatives, June 11, July 22, August 21 and November 5, 1987, Serial 23.
- Hudec, R. 1989. "Remarks." *Vanderbilt Journal of Transnational Law* 22, 2: 321-323.
- Hughes, J. 1988. "The Philosophy of Intellectual Property." *Georgetown Law Journal* 77, 2: 287-366.
- Hurt, R.M., and R.M. Schuchman. 1966. "The Economic Rationale of Copyright." *American Economic Review* 56: 421-432.
- INPI. 1989. *Relatorio 1988*. Rio de Janeiro: Instituto Nacional de Propriedade Industrial.
- International Development Research Centre. 1990. "Plant Breeders' Rights." Unpublished position paper. Ottawa: IDRC.
- Jackson, J.H. 1989. "Remarks." *Vanderbilt Journal of Transnational Law* 22, 2: 343-355.
- Johnson, W. 1985. "The Economics of Copying." *Journal of Political Economy* 93, 1: 158-174.
- Jori, G. 1988. "The Impact of Pharmaceutical Patents: The Italian Experience." *Patents and Trademarks News*, no. 19 (October).
- Juma, C. 1989a. *Biological Diversity and Innovation*. Nairobi: African Centre for Technology Studies.
- Juma, C. 1989b. *The Gene Hunters: Biotechnology and the Scramble for Seeds*. Princeton: Princeton University Press.
- Juma, C. and J.B. Ojwang. 1989. *Innovation and Sovereignty: The Patent Debate in African Development*. Nairobi: African Center for Technology Studies.
- Kalter, R.J., R. Milligan, W. Lesser, W. Magrath, L. Tauer, and D. Bauman. 1985. "Biotechnology and the Dairy Industry: Production Costs, Commercial Potential, and the Economic Impact of the Bovine Growth Hormone." Cornell University, Department of Agricultural Economics, Agricultural Economics Research Paper no. 85-20, December.

- Karjala, D.S. 1987. "Copyright, Computer Software, and the New Protectionism." *Jurimetrics* 28 (Fall): 82-83.
- Kastenmeier, R.W., and D. Beier. 1989. "International Trade and Intellectual Property: Promise, Risks, and Reality." *Vanderbilt Journal of Transnational Law* 22, 2: 285-307.
- Katz, J., ed. 1987. *Technology Generation in Latin American Manufacturing Industries*. New York: St. Martin's Press.
- Katz, M.L., and J.A. Ordover. 1990. "R&D Cooperation and Competition." In *Brookings Papers on Economic Activity: Microeconomics*. Washington, D.C.: The Brookings Institution.
- Katz, M., and C. Shapiro. 1985. "On the Licensing of Innovations." *Rand Journal of Economics* 16, 4: 504-520.
- Kefauver, W.L. 1988. "Communications: An Industry Perspective." In *Intellectual Property Rights and Capital Formation in the Next Decade*. See Walker and Bloomfield, 1988.
- Kenney, M. 1986. *Biotechnology: The University-Industrial Complex*. New Haven: Yale University Press.
- Keplinger, M.S. 1985. "Authorship in the Information Age: Protection for Computer Programs Under the Berne and Universal Copyright Conventions." *Copyright* 21, 3: 119-128.
- Kindermann, M. 1988. "The International Copyright of Computer Software: History, Status and Developments." *Copyright* 24, 4: 201-226.
- Kirim, A.S. 1985. "Reconsidering Patents and Economic Development: A Case Study of the Turkish Pharmaceutical Industry." *World Development* 13, 2: 219-236.
- Kirim, A.S. 1986. "Transnational Corporations and Local Capital: Comparative Conduct and Performance in the Turkish Pharmaceutical Industry." *World Development* 14, 4: 503-521.
- Kitch, E.W. 1977. "The Nature and Function of the Patent System." *Journal of Law and Economics* 20, 2: 265-290.
- Kitti, C. 1985. "Patent Life and the Optimal Timing of Innovations." In *The Economics of R&D Policy*. See Tolley et al., 1985.

- Klein, B., and K. Leffler. 1981. "The Role of Market Forces in Assuring Contractual Performance." *Journal of Political Economy*, August, pp. 615-641.
- Kloppenborg, J.R., ed. 1988. *Seeds and Sovereignty*. Durham, N.C.: Duke University Press.
- Kloppenborg, J.R., and R.L. Kleinman. 1988. "Seeds of Controversy: National Property Versus Common Heritage." In *Seeds and Sovereignty*. See Kloppenborg, 1988.
- Kunz-Hallstein, H.P. 1989. "The United States Proposal for a GATT Agreement on Intellectual Property and the Paris Convention for the Protection of Industrial Property." *Vanderbilt Journal of Transnational Law* 22, 2: 265-284.
- Lacy, W.B., and L. Busch. 1989. "The Changing Division of Labor Between the University and Industry: The Case of Agricultural Biotechnology." In J.J. Molnar and H. Kinnucan, eds., *Biotechnology and the New Agricultural Revolution*. Boulder, Colo.: Westview Press.
- Lall, S. 1975. "Is 'Dependence' a Useful Concept in Analysing Underdevelopment?" *World Development* 3, 11/12 (November-December): 779-810.
- Lall, S. 1985. "Trade in Technology by a Slowly Industrializing Country: India." In N. Rosenberg and C. Frischtak, eds., *International Technology Transfer: Concepts, Measures and Comparisons*. New York: Praeger.
- Lanjouw, J.O., and M. Schankerman. 1989. "Patent Renewal Data for Germany and the U.K., 1880-1980: A First Glimpse." Paper presented at the National Bureau of Economic Research (U.S.) Conference on Patent Count and Patent Renewal Data, August.
- Lemieux, C.M., and M.K. Wohlgenant. 1989. "Ex Ante Evaluation of the Economic Impact of Agricultural Biotechnology: The Case of Porcine Somatotropin." *American Journal of Agricultural Economics* 71: 903-914.
- Lesser, W. 1986a. "Patent Culture Samples: The 'Expert Solution' for Europe." *Biotechnology* 4 (November): 959.
- Lesser, W. 1986b. "Patenting Seeds in the United States of America: What to Expect." *Industrial Property* 25: 360-367.
- Lesser, W. 1987a. "Anticipating UK Plant Variety Patents." *European Intellectual Property Review* 6: 172-177.

- Lesser, W. 1987b. "Intellectual Property Agreements for Protecting Biotechnology Products and Processes Worldwide." *Agribusiness* 3: 351-376.
- Lesser, W. 1989. "Implications for Breeders." *Animal Patents: The Legal, Economic and Social Issues*. Proceedings of the Animal Patents Symposium, Ithaca, N.Y., December 5-6, 1988. London: Macmillan.
- Lesser, W.H., and R.T. Masson. 1985. *An Economic Analysis of the Plant Variety Protection Act*. Washington, D.C.: American Seed Trade Association.
- Levin, R.C., W.M. Cohen, and D.C. Mowery. 1985. "R&D Appropriability, Opportunity, and Market Structure: New Evidence on Some Schumpeterian Hypotheses." *American Economic Review* 75, 2: 20-24.
- Levin, R.C. A.K. Klevorick, R.R. Nelson, and S.G. Winter. 1987. "Appropriating the Returns from Industrial R&D." *Brookings Papers on Economic Activity* 3 (Special Issue on Microeconomics): 783-820.
- Lieberman, M.B. 1987. "Patents, Learning by Doing, and Market Structure in the Chemical Processing Industries." *International Journal of Industrial Organization* 5: 257-276.
- Liebowitz, S.J. 1985. "Copying and Indirect Appropriability," *Journal of Political Economy* 93: 945-951.
- Lipsey, R.E., M. Blomström, and I.B. Kravis. 1990. "R&D by Multinational Firms and Host Country Exports." In *Science and Technology: Lessons for Development Policy*. See Evenson and Ranis, 1990.
- List, F. [1841] 1966. *The National System of Political Economy*. New York: Augustus M. Kelley.
- Lobo, F. 1988. "La Evolucion de las Patentes sobre Medicamentos en los Paises Desarrollados." Caracas: Sistema Economico Latinoamericano.
- Loury, G.C. 1979. "Market Structure and Innovation." *Quarterly Journal of Economics* 93, 3: 395-410.
- MacBride Commission Report. 1980. *Many Voices, One World: Report by the International Commission for the Study of Communication Problems*. Paris: UNESCO.

- Machlup, F. 1958. "An Economic Review of the Patent System." Subcommittee on Patents, Trademarks and Copyrights, Committee on the Judiciary, U.S. Senate, Study no. 15. Washington, D.C.: U.S. Government Printing Office.
- Machlup, F., and E. Penrose. 1950. "The Patent Controversy in the Nineteenth Century." *The Journal of Economic History* 10, 1: 1-29.
- MacLaughlin, J.H., T.J. Richards, and L.A. Kenny. 1988. "The Economic Significance of Piracy." In *Intellectual Property Rights: Global Consensus, Global Conflict?* See Gadbar and Richards, 1988.
- Mairesse, J., and M. Sassenou. 1989. "R&D and Productivity Growth: An Overview of the Literature." Paper presented at the OECD International Seminar on Science, Technology, and Economic Growth, June 5-8.
- Mansfield, E. 1985. "How Rapidly Does Industrial Technology Leak Out." *Journal of Industrial Economics* (December): 217-223.
- Mansfield, E. 1986. "Patents and Innovation: An Empirical Study." *Management Science* (February): 173-181.
- Mansfield, E. 1988. "Intellectual Property Rights, Technological Change, and Economic Growth." In *Intellectual Property Rights and Capital Formation in the Next Decade*. See Walker and Bloomfield, 1988.
- Mansfield, E. 1989. "Protection of Intellectual Property Rights in Developing Countries." Washington, D.C.: The World Bank.
- Mansfield, E., J. Rappoport, A. Romeo, S. Wagner and G. Beardsley. 1977. "Social and Private Rates of Return from Industrial Innovations." *Quarterly Journal of Economics* 91, 2 (May): 221-240.
- Mansfield, E., A. Romeo, M. Schwartz, D. Teece, S. Wagner, and P. Brach. 1982. *Technology Transfer, Productivity, and Economic Policy*. New York: W.W. Norton.
- Mansfield, E., M. Schwartz, and S. Wagner. 1981. "Imitation Costs and Patents: An Empirical Study." *The Economic Journal* (December): 907-918.
- Maskus, K.E. 1989. "The Economics of International Protection of Intellectual Property Rights: Background and Analysis." International Labor Affairs Bureau, U.S. Department of Labor, Washington, D.C.
- McCain, R.A. 1988. "Information as Property and as a Public Good: Perspectives from the Economic Theory of Property Rights." *The Library Quarterly* 58, 3: 265-282.

- McCulloch, R. 1981. "Technology Transfer to Developing Countries: Implications of International Regulation." In A.W. Heston and H. Pack, eds., "Technology Transfer: New Issues, New Analysis." *Annals of the American Academy of Political and Social Science* 458: 110-122.
- McLeland, L., and H.J. O'Toole. 1987. "Patent Systems in Less Developed Countries: The Cases of India and the Andean Pact Countries." *Journal of Law and Technology* 2: 229-248.
- McManis, C.R. 1988. "International Protection for Semiconductor Chip Designs and the Standard of Judicial Review of Presidential Proclamations Issued Pursuant to the Semiconductor Chip Protection Act of 1984." *The George Washington Journal of International Law and Economics* 22, 2: 331-378.
- McMullen, N. 1987. *Seeds and World Agricultural Progress*. Washington, D.C.: National Planning Association.
- Mikkelsen, K.W. 1984. "Inventive Activity in Phillipine Industry." Unpublished doctoral dissertation, Yale University.
- Mill, J.S. [1848] 1965. *Principles of Political Economy*. Toronto: University of Toronto Press.
- Mitchell, M.L. 1989. "The Impact of External Parties on Brand-Name Capital: The 1982 Tylenol Poisonings and Subsequent Cases." *Economic Inquiry* 27, 4: 601-618.
- Mody, A. 1989a. "Information Industries in the Newly Industrializing Countries," in R.W. Crandall and K. Flamm, eds., *Changing the Rules: Technological Change, International Competition, and Regulation in Communications*. Washington, D.C.: The Brookings Institution.
- Mody, A. 1989b. "Institutions and Dynamic Comparative Advantage: Electronics Industry in South Korea and Taiwan." World Bank Industry Series Paper no. 9. Washington, D.C.: The World Bank.
- Mody, A. 1989c. "New Environment for Intellectual Property." World Bank Industry Series Paper no. 10. Washington, D.C.: The World Bank.
- Mooney, P.R. 1979. *Seeds of the Earth*. Ottawa: Inter Pares.
- Mooney, P.R. 1989. "From Cabbages to Kings: Intellectual Property vs. Intellectual Integrity." In *Patenting Life Forms in Europe*. Proceedings of the ICDA Seeds Campaign, Barcelona, March.

- Mossinghoff, G.J. 1987. "Research-Based Pharmaceutical Companies: The Need for Improved Patent Protection Worldwide," *The Journal of Law and Technology* 2, 2 (Fall): 307-324.
- Murphy, D.W. 1979. "Plant Breeders' Rights in the United Kingdom." *European Intellectual Property Review* 1 (September): 236-240.
- Neal, A.deH. 1988. "A Perspective from the Recording Industry." In *Intellectual Property Rights and Capital Formation in the Next Decade*. See Walker and Bloomfield, 1988.
- Nelson, P. 1978. "Advertising as Information Once More." In D.G. Tuerck, ed., *Issues in Advertising*. Washington, D.C.: American Enterprise Institute.
- Nogués, Julio. 1990a. "Patents, Distortions, and Development." PRE Working Paper Series no. 315. Washington, D.C.: The World Bank.
- Nogués, J. 1990b. "Patents and Pharmaceutical Drugs—Understanding the Pressures on Developing Countries." PRE Working Paper Series no. 502. Washington, D.C.: The World Bank.
- Nordhaus, W.D. 1969. *Invention, Growth and Welfare*. Cambridge, Mass.: M.I.T. Press.
- Nordhaus, W.D. 1972. "The Optimum Life of a Patent: Reply." *American Economic Review* 62: 428-431.
- Novos, I.E., and M. Waldman. 1984. "The Effects of Increased Copyright Protection: An Analytical Approach." *Journal of Political Economy* 92, 2: 236-246.
- OECD. 1989. "Economic Arguments for Protecting Intellectual Property Rights Effectively," TC/WP(88) 70. Paris: OECD.
- Ospina, S. 1986. "Piracy of Satellite-Transmitted Copyright Material in the Americas: Bane or Boon?." In D.A. Demac, ed., *Tracing New Orbits: Cooperation and Competition in Global Satellite Development*. New York: Columbia University Press.
- Otsuka, K., G. Ranis and G. Saxonhouse. 1988. *Comparative Technology Choice: The India and Japanese Cotton Textile Industries*. London: Macmillan Press.
- Pack, H. 1990. "Industrial Efficiency and Technology Choice." In *Science and Technology: Lessons for Development Policy*. See Evenson and Ranis, 1990.
- Pakes, A. 1986. "Patents and Options: Some Estimates of the Value of Holding European Patent Stocks." *Econometrica* 54, 755-784.

- Pakes, A., and M. Schankerman. 1984. "An Exploration into the Determinants of Research Intensity." In *R&D, Patents, and Productivity*. See Griliches, 1984.
- Pakes, A., and M. Simpson. 1989. "Patent Renewal Data." In *Brookings Papers on Economic Activity: Microeconomics*, 331-410.
- Parker, J. 1980. "Pharmaceuticals and Third World Concerns: The Lall Report and the Otago Study." In *The International Supply of Medicines: Implications of U.S. Regulatory Reform*. See Helms, 1980.
- Penrose, E. 1951. *The Economics of the International Patent System*. Baltimore: Johns Hopkins University Press.
- Penrose, E. 1973. "International Patenting and the Less-Developed Countries." *Economic Journal* 83 (September): 768-786.
- Peretz, S.M. 1983. "Pharmaceuticals in the Third World: The Problem from the Suppliers' Point of View." *World Development* 11, 3: 259-264.
- Perrin, R.K., K.A. Hunnings, and L.A. Ihnen. 1983. "Some Effects of the US Plant Variety Protection Act of 1970." North Carolina State University, Economic Research Report no. 46.
- Persley, G., ed. 1989. *Biotechnology Study Project Papers*. 3 vols. Agriculture and Rural Development Department. Washington, D.C.: The World Bank.
- Plant, A. 1934. "The Economic Aspects of Copyright in Books." *Economica* 1: 167-195.
- Plucknett, D.L., N.J.H. Smith, J.T. Williams, and N.M. Amishetty. 1987. *Gene Banks and the World's Food*. Princeton: Princeton University Press.
- Pray, C.E. 1987. "Private Sector Agricultural Research in Asia." In *Policy for Agricultural Research*. See Ruttan and Pray, 1987.
- Pray, C.E. 1989. "The Seed Industry and Plant Breeders' Rights: Report of October 4-13, 1989 Trip to Argentina and Chile." Unpublished report submitted to U.S. Agency for International Development.
- Primo Braga, C.A. 1989. "The Economics of Intellectual Property Rights and the GATT: A View from the South." *Vanderbilt Journal of Transnational Law* 22, 2: 243-264.
- Primo Braga, C.A. 1990. "Propriedade Intelectual, Comércio Internacional e os Países em Desenvolvimento." Paper read at the conference "A Inserção Internacional do Brasil nos Anos 90." Sao Paulo: Conselho Regional de Economia.

- Psacharopoulos, G., and A. Saliba. 1989. "Brazil's Effort on Research and Development." Human Resources Division, LAC Technical Division. Washington, D.C.: The World Bank.
- Ranis, G. 1990. "Science and Technology Policy: Lessons from Japan and the East Asian NICs." In *Science and Technology: Lessons for Development Policy*. See Evenson and Ranis, 1990.
- Reichman, J.H. 1989a. "Computer Programs As Applied Scientific Know-How: Implications of Copyright Protection for Commercialized University Research." *Vanderbilt Law Review* 42, 3: 639-723.
- Reichman, J.H. 1989b. "Intellectual Property in International Trade: Opportunities and Risks of a GATT Connection." *Vanderbilt Journal of Transnational Law* 22, 4: 747-891.
- Reinganum, J.F. 1989. "The Timing of Innovation: Research, Development, and Diffusion." In R. Schmalensee and R.D. Willig, eds., *The Handbook of Industrial Organization*, vol. 1. Amsterdam: North Holland.
- Richards, T.J. 1988. "Brazil." In *Intellectual Property Rights: Global Consensus, Global Conflict?* See Gadbow and Richards, 1988.
- Richards, T.J., and L.A. Kenny. 1988. "Singapore." In *Intellectual Property Rights: Global Consensus, Global Conflict?* See Gadbow and Richards, 1988.
- Roberts, D.W., and R.R. Granados, eds. 1988. *Biotechnology, Biological Pesticides and Novel Plant-Pest Resistance for Insect Pest Management*. Ithaca, N.Y.: Boyce Thompson Institute.
- Roffe, P. 1984. "UNCTAD: Transfer of Technology Code." *Journal of World Trade Law* 18: 176.
- Rosenberg, N. 1974. "Science, Invention and Economic Growth," *Economic Journal* 84: 90-108.
- Rozek, R.P. 1987. "Protection of Intellectual Property Rights: Research and Development Decisions and Economic Growth." *Contemporary Policy Issues* 5 (July): 54-65.
- Rural Advancement Fund International. 1989. *RAFI Communiqué* (May/June): 8.
- Rushing, F.W., and C.G. Brown. 1990. *Intellectual Property Rights in Science, Technology, and Economic Performance: International Comparisons*. Boulder, Colo.: Westview Press.

- Ruttan, V.W, and C.E. Pray, eds. 1987. *Policy for Agricultural Research*. Boulder, Colo.: Westview Press.
- Sasson, A. 1988. *Biotechnologies and Development*. Paris: UNESCO.
- Schankermann, M., and A. Pakes. 1986. "Estimates of the Value of Patent Rights in European Countries During the Post-1950 Period." *The Economic Journal* (December): 1-25.
- Scherer, F.M. 1972. "Nordhaus's Theory of Optimal Patent Life: A Geometric Reinterpretation." *American Economic Review* 62 (June): 422-427.
- Scherer, F.M. 1977. *The Economic Effect of Compulsory Patent Licensing*, Monograph Series in Finance and Economics, New York University.
- Scherer, F.M. 1986. *Innovation and Growth: Schumpeterian Perspectives*. Cambridge, Mass.: M.I.T. Press.
- Schiff, Eric. 1971. *Industrialization without National Patents*. Princeton: Princeton University Press.
- Schmookler, J. 1966. *Invention and Economic Growth*. Cambridge, Mass.: Harvard University Press.
- Schumann, Gunda. 1990. "Economic Development and Intellectual Property Protection in Southeast Asia: Korea, Taiwan, Singapore and Thailand." In *Intellectual Property Rights in Science, Technology and Economic Performance*. See Rushing and Brown, 1990.
- Schumpeter, J.A. 1934. *The Theory of Economic Development*. Cambridge, Mass.: Harvard University Press.
- Schumpeter, J.A. 1942. *Capitalism, Socialism, and Democracy*. New York: Harper.
- Schut, F., and P. Van Bergeijk. 1986. "International Price Discrimination: The Pharmaceutical Industry." *World Development* 14, 9: 1141-1150.
- Schwartzman, D. 1976. *Innovation in the Pharmaceutical Industry*. Baltimore: Johns Hopkins University Press.
- Science Council of Canada. 1990. "Innovation and Intellectual Property Rights in Canada." Ottawa: Science Council of Canada.

- Shapiro, Carl. 1985. "Patent Licensing and R&D Rivalry." *American Economic Review* 75, 2: 25-30.
- Shaw, R.W., and S.A. Shaw. 1977. "Patent Expiry and Competition in Polyester Fibers." *Scottish Journal of Political Economy* 24 (June): 117-132.
- Sherwood, R.M. 1987. "Thoughts on IP in the GATT." Unpublished manuscript made available by author, Alexandria, Va. (U.S.).
- Sherwood, R.M. 1989a. "Non-Protection of Intellectual Property: The Impact within a Developing Country Economy." Paper read at the 64th Annual Western Economic Association International, Lake Tahoe, Nevada, June 18-22.
- Sherwood, R.M. 1989b. "New Theory of Conductivity in Licensing." *Les Nouvelles* 24, 4 (December): 186-189.
- Sherwood, R.M. 1990a. "A Microeconomic View of Intellectual Property Protection in Brazilian Development." In *Intellectual Property Rights in Science, Technology and Economic Performance*. See Rushing and Brown, 1990.
- Sherwood, R.M. 1990b. *Intellectual Property and Economic Development*. Boulder, Colo.: Westview Press.
- Siddharthan, N.S. 1987. "In-house R&D, Imported Technology, and Firm Size: Lessons from Indian Experience." Unpublished manuscript. Institute of Economic Growth, Delhi University, Delhi.
- Stallman, J.I. 1986. "Impacts of the 1930 Plant Patent Act on Private Fruit Breeding Investment." Unpublished doctoral dissertation, Department of Agricultural Economics, Michigan State University.
- Statman, M. 1981. "The Effect of Patent Expiration on the Market Position of Drugs." In *The International Supply of Medicines: Implications of U.S. Regulatory Reform*. See Helms, 1981.
- Stern, Richard. 1987. "Intellectual Property." In J. M. Finger and A. Olechowski, eds., *The Uruguay Round: A Handbook on the Multilateral Trade Negotiations*. Washington, D.C.: The World Bank.
- Stevens, W.K. 1990. "Bioengineering Points to Better Rice Plant." *New York Times*, February 6, pp. C1, C14.
- Stewart, F. 1979. "International Technology Transfer: Issues and Policy Options." World Bank Staff Working Paper no. 344. Washington, D.C.: The World Bank.

- Stewart, F. 1981. "Arguments for the Generation of Technology by Less-Developed Countries." In A.W. Heston and H. Pack, eds., "Technology Transfer: New Issues, New Analysis." *Annals of the American Academy of Political and Social Science* 458 (November): 97-109.
- Stewart, F. 1990. "Technology Transfer for Development." In *Science and Technology: Lessons for Development Policy*. See Evenson and Ranis, 1990.
- Stoneman, Paul. 1983. *The Economic Analysis of Technological Change*. New York: Oxford University Press.
- Stoneman, Paul. 1987. *The Economic Analysis of Technology Policy*. New York: Oxford University Press.
- Straus, J. 1987. "The Principle of 'Dependence' under Patents and Plant Breeders' Rights." *Industrial Property* (December): 433-443.
- Straus, J. 1989. "Patent Protection in Developing Countries: An Overview." In W. Lesser et al., "Equitable Patent Protection for the Developing World." Cornell University, Department of Agricultural Economics Staff Paper no. 89-36, November.
- Subramanian, A. 1990. "Discrimination in the International Economics of Intellectual Property Right Protection." *Economic and Political Weekly [India]* 25, 11: 549-554.
- Subramanian, A. Forthcoming (1991). "The International Economics of Intellectual Property Right Protection: A Welfare-Theoretic Trade Policy Analysis." *World Development* 19.
- Swaminathan, M.S., 1988. "Seeds and Property Rights: A View from the CGIAR System." In *Seeds and Sovereignty*. See Kloppenburg, 1988.
- Tandon, P. 1982. "Optimal Patents with Compulsory Licensing." *Journal of Political Economy* 90, 3: 470-486.
- Taylor, C.T., and Z.A. Silberston. 1973. *The Economic Impact of the Patent System*. Cambridge: Cambridge University Press.
- Tocker, E. 1988. "A Chemical Industry Perspective." In *Intellectual Property Rights and Capital Formation in the Next Decade*. See Walker and Bloomfield, 1988.
- Tolley, G.S., J.H. Hodge, and J.F. Oehmke, eds. 1985. *The Economics of R&D Policy*. New York: Praeger.

- Twinomukunzi, C. 1982. "The International Patent System: A Third World Perspective," *Indian Journal of International Law* 22: 31-68.
- Ullrich, H. 1989. "The Importance of Industrial Property Law and Other Legal Measures in the Promotion of Technological Innovation." *Industrial Property* (March): 102.
- UN Centre on Transnational Corporations. 1988. *Transnational Corporations in World Development: Trends and Prospects*. New York: UNCTC.
- UN Food and Agricultural Organization. 1989. "Outcome of the Third Session of the Commission on Plant Genetic Resources." CL 95/14, June.
- UNCTAD. 1972. *Transfer of Technology. Policies Relating to Technology of the Countries of the Andean Pact: Their Foundations*. Junta del Acuerdo de Cartagena. Geneva: UNCTAD.
- UNCTAD. 1974. "The Role of the Patent System in the Transfer of Technology to Developing Countries." TD/B/AC 11/19. Geneva: UNCTAD.
- UNCTAD. 1975. "The Role of the Patent System in the Transfer of Technology to Developing Countries." TD/B/AC 11/19/Rev. 1. Geneva: UNCTAD.
- UNCTAD. 1975. "Major Issues in Transfer of Technology to Developing Countries: A Case Study of the Pharmaceutical Industry." TD/B/C.6/4. Geneva: UNCTAD.
- UNCTAD. 1981. "Examination of the Economic, Commercial, and Developmental Aspects of Industrial Property in the Transfer of Technology to Developing Countries: Review of Recent Trends in Patents in Developing Countries." TD/B/C.6/AC.5/4. Geneva: UNCTAD.
- UNCTAD. 1985. *Draft International Code of Conduct on the Transfer of Technology*. TD/CODE TOT/47, June 20. Geneva: UNCTAD.
- UNCTAD. 1987. *Trade and Development Report*. Geneva: UNCTAD.
- UNCTAD. 1988. "Technology-Related Policies and Legislation in a Changing Economic and Technological Environment." TD/B/C.6/146. Geneva: UNCTAD.
- United Nations. 1964. *The Role of Patents in the Transfer of Technology to Developing Countries*. Report of the Secretary General. New York: United Nations.
- United Nations. 1980. *Draft International Code of Conduct on the Transfer of Technology as of 6 May 1980*. New York: United Nations.

- UPOV. 1985. *International Convention for the Protection of New Varieties of Plants*. Geneva: UPOV.
- UPOV. 1989a. "General Information", UPOV publication no. 408(E). Geneva: UPOV.
- UPOV. 1989b. "The Interface Between Patent Protection and Plant Breeders' Rights." CAJ/XXIV/4, Geneva, April 3, 1989.
- U.S. Congress, Office of Technology Assessment. 1988. *New Developments in Biotechnology, 3. Field-Testing Engineered Organisms: Genetic and Ecological Issues. Special Report. OTA-BA-350*, May.
- U.S. Department of Agriculture. 1990. *Outlook '90 Charts: 66th Annual Agricultural Outlook Conference*, ERS, AGES 9001, February.
- U.S. International Trade Commission. 1988. "Foreign Protection of Intellectual Property and the Effect on U.S. Industry and Trade." Publication 2065. Washington, D.C.: International Trade Commission.
- U.S. National Academy of Sciences. 1972. *Genetic Vulnerability of Major Crops*. Washington, D.C.: National Academy Press.
- U.S. National Academy of Sciences. 1987. *Introduction of Recombinant DNA-Engineered Organisms into the Environment*. Washington, D.C.: National Academy Press.
- Usher, D. 1964. "The Welfare Economics of Invention." *Economica* (August): 279-287.
- U.S. Trade Representative. 1989. *The National Trade Estimate Report on Foreign Trade Barriers*. Washington, D.C.: Office of the U.S. Trade Representative.
- Vaitsos, C. 1972. "Patents Revisited: Their Function in Developing Countries." *Journal of Development Studies* (October): 71-97.
- Vaitsos, C. 1976. "The Revision of the International Patent System: Legal Considerations for a Third World Position." *World Development* 4, 2: 85-102.
- Vasil, I.K. 1990. "The Realities and Challenges of Plant Biotechnology." *Bio/Technology* 8: 296-301.
- Vernon, R. 1957. *The International Patent System and Foreign Policy*. Study of the Subcommittee on Patents, Trademarks and Copyrights of the Committee on the Judiciary, U.S. Senate. Washington, D.C.: Government Printing Office.

- Vernon, R. 1966. "International Investment and International Trade in the Product Cycle." *Quarterly Journal of Economics* 80: 190-207.
- Vernon, R. 1977. *Storm over the Multinationals*. Cambridge, Mass.: Harvard University Press.
- Vincent, D. 1984. "The Role and Function of Patents as Tools of Technology Transfer." *Industrial Property* 23, 7-8: 256-260.
- Virts, J.R., and J.F. Weston. 1981. "Expectations and the Allocation of Research and Development Resources." In *The International Supply of Medicines: Implications of U.S. Regulatory Reform*. See Helms, 1981.
- Walker, C.E., and M.A. Bloomfield, eds. 1988. *Intellectual Property Rights and Capital Formation in the Next Decade*. Lanham, Md.: University Press of America.
- Walker, W.M. 1989. "Uruguay Round TRIPs: A Bibliographic Essay." *Vanderbilt Journal of Transnational Law* 22, 4: 911-919.
- Wallender, H. 1980. "Developing Countries Orientations Towards Foreign Technology in the Eighties: Implications for New Negotiations Approaches." *Columbia Journal of World Business* (Summer): 21-22.
- Walsh, M.E., and W.B. Sundquist. 1988. "A Case Study of Genecol-99: Possible Implications for Other Single-Use Agricultural Biotechnology Products." *North Central Journal of Agricultural Economics* 10: 25-34.
- Watanabe, S. 1985. "The Patent System and Indigenous Technology Development in the Third World." In J. James and S. Watanabe, eds., *Technology, Institutions and Government Policies*. London: Macmillan.
- Wells, L.T. 1983. *Third World Multinationals*. Cambridge, Mass.: M.I.T. Press.
- Wildman, S.S., and S.E. Siwek. 1988. *International Trade in Films and Television Programs*. Washington, D.C.: American Enterprise Institute.
- Winter, H.J. 1988. "A View from the U.S. State Department." In *Intellectual Property Rights and Capital Formation in the Next Decade*. See Walker and Bloomfield, 1988.
- Wionczek, M. 1976. "Notes on Technology Transfer through Multinational Enterprises in Latin America." *Development and Change* 7: 135-155.
- WIPO. 1970. *Model Law for Developing Countries on Industrial Designs*. Geneva: WIPO.

- WIPO. 1979. *WIPO Model Law for Developing Countries on Inventions. Vol. I. Patents.* Geneva: WIPO.
- WIPO. 1988a. "Existence, Scope and Form of Generally Internationally Accepted and Applied Standards/Norms for the Protection of Intellectual Property." WO/INF 129, September. Geneva: WIPO.
- WIPO. 1988b. *Industrial Property Statistics, 1986.* Geneva: WIPO.
- WIPO. 1989. "General Information." Geneva: WIPO.
- Wright, B.D. 1985. "The Resource Allocation Problem in R&D." In *The Economics of R&D Policy.* See Tolley et al., 1985.
- Wu, S.Y. 1981. "Pharmaceutical Innovation, Product Imitation, and Public Policy." In *The International Supply of Medicines: Implications of U.S. Regulatory Reform.* See Helms, 1981.
- Yamaguchi, Y. 1989. "Remarks." *Vanderbilt Journal of Transnational Law* 22, 2: 325-327.
- Yankey, G.S. 1987. *International Patents and Technology Transfer to Less Developed Countries: The Case of Ghana and Nigeria.* Aldershot, U.K.: Avebury.
- Yusuf, A.A. 1989. "Developing Countries and Trade-Related Aspects of Intellectual Property Rights." In *Uruguay Round: Papers on Selected Issues*, UNCTAD/ITP/10. New York: United Nations.

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