CAN THE PATENT SYSTEM CONTINUE TO ADAPT TO THE MODERN GLOBAL KNOWLEDGE ECONOMY?

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Paper to be presented to the Nelson and Winter Conference,
Aalborg, Denmark, June 12-15, 2001, organized by DRUID

Theme (F)

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ABSTRACT

In recent years, more and more patents have been issued, patent protection has been extended into new areas like software and biotechnology, and patent rights have been strengthened around the world. At the same time, calls for the reform of the patent system have intensified. Yet while the specifics differ, the types of criticisms made today have been heard – and addressed – in the past. The basic difficulty in reforming the patent system is that the problems are integral to the fabric of the system itself and the inevitable tradeoffs incurred, given its characteristic mix of benefits and costs. Over the years, patent controversies have focused on two main issues. The first concerns what should be eligible for patent protection. Should the patent system be extended into new areas? Should patent examiners apply new criteria – like ethical criteria – in granting patents? How can we achieve the right balance between public and private knowledge? The second issue has to do with how strong patent protection should be. How can we achieve the right mixture of incentive effects and costs? Should the patent system be applied equally to all countries? This paper discusses how these issues play out in the modern global knowledge economy. We conclude that patent-related problems can be addressed in several ways: by changing the patent system, and by introducing and/or strengthening related laws and administrative measures. What is important is to focus on the problem itself, applying a mixture of methods, and not the structure of the patent system more generally. This enables the implementation of solutions appropriate to particular issues, technologies, countries or regions, reducing the costs of the patent system in targeted areas of concern while preserving its overall consistency and broader benefits.

1. Introduction

With the transition to the knowledge-based economy and the rising role of intangible assets in achieving competitive advantage, patents have taken on increased importance (e.g. Teece, 2000, Grandstrand, 2000, Grindley & Teece, 1997). More and more patents are being issued, and many firms have come to regard patents as integral to their innovative and competitive success (e.g. Rivette & Kline, 2000a,b). Patent protection has been extended into new areas like software and biotechnology, and patent rights have generally been strengthened around the world (e.g. Merges & Nelson, 1994, Cohen *et al.*, 2000).

The patent system has existed for over five hundred years. Other institutions this old have disappeared or been drastically altered, but the patent system has survived – modified, but with its basic principles intact. This paper asks: can the patent system continue to adjust successfully to the conditions and demands of the modern global knowledge economy?

Recently, commentators from both academics and business have advocated the need for changes. Merges & Nelson (1994), for example, argue that allowing and enforcing broad patent rights can actually hinder technological progress, and that it is vital to reform the patent

system to promote greater pluralism and rivalry. Thurow (1997) contends that the optimal patent system will differ according to industry, type of knowledge, and inventor, and that the world's current one-size-fits-all system must be overhauled to create a more differentiated one. Seth Shulman (2000:75), in a impassioned critique of the recent extension of patent protection to Internet business methods in the United States, objects that the patent system was never intended "to grant a monopoly for every trifling device, every shadow of a shade of an idea." Amazon.com's Jeff Bezos has suggested that patent term for Internet business methods should be shortened to three to five years, providing a limited incentive effect while enabling other firms to build more effectively on the knowledge published in the patent (Mullaney & Ante, 2000). Doubts concerning the patentability of living entities (Moise, 1999) and the implications for the Third World of the recent WTO agreement on intellectual property (TRIPS) (e.g. Prima Braga, 1995) have sparked controversy around the world.

Yet traditionally, there have been many calls for reform of the patent system. While the specifics differ, the types of criticisms made today have been heard – and addressed – in the past. The fundamental difficulty in reforming the patent system is that the problems are integral to the fabric of the system itself and the inevitable tradeoffs incurred, given its characteristic mix of benefits and costs. The patent system has also frequently become embroiled in social and moral controversies whose implications go further than patents *per se*; today, these reflect the ongoing disruptions of globalization, research into new areas, accelerating technological change and ethical concerns.

Over the years, patent controversies have focused on two main issues. The first has to do with what types of inventions should be eligible for patent protection. Recently, there been considerable debate as regards extending patent protection into new areas like biotechnology, software, and Internet business methods. To what degree is patent protection suitable for these technologies? To what degree should patent examiners apply new criteria – such as ethical criteria – in making decisions about granting patents? How can we achieve the right balance between public and private knowledge? The second issue has to do with how strong patent protection should be. How can we achieve the right mixture of benefits and costs? Should the logic of the patent system be applied equally to industrialized and developing countries? By considering the problems confronting the patent system in this context, it is hoped to develop a broader perspective by which to assess the current proposals for reform.

We conclude that patent-related problems can be addressed in a number of ways: by changing the patent system (adjusting the criteria of patentability, altering the length of patent protection for certain types of products, introducing exceptions for particular countries, and the like), and by introducing and/or strengthening related laws and administrative measures. What is important is to focus on the problem itself, and not the structure of the patent system more generally, applying a mixture of methods to develop a workable solution..

The paper starts by discussing the growth and development of the patent system. Section 3 investigates the role and importance of the patent system in its larger context. Following this, we investigate how the two main issues briefly outlined above play out in the modern global knowledge economy (Sections 4 and 5). Section 6 considers different approaches to addressing the problems confronting the modern patent system. The conclusions of the analysis form the subject of Section 7.

2. Recurring themes

The emergence of what we today call the patent system can be traced to two developments in 15th century Europe: the invention of the printing press around 1450, and the growth of the systematic use of monopoly privileges for inventors in Venice. The first inventor who can be said to have received a patent was the Venetian Giovanni de Spira, who on 18 September 1469 was granted an exclusive 5-year privilege to practice book-printing, and on this basis introduced the printing press to that city. In 1474, the Venetian Republic extended this principle by generally promising privileges of ten years to inventors of new arts and machines. The patent could be revoked if the invention was not worked, and royalty rates had to be reasonable. This edict has been called “the first patent law.” (Penrose, 1951).

The use of patents soon spread to other areas, including Germany, the Netherlands, and England. Applications could also be refused. In one case, August of Saxony wrote to the partners of a would-be inventor of a new type of stove:

> ...we are not, thanks to God, so grossly unwise and even ungracious not to consider it as just that inventors of novel, useful and wholesome things should receive and obtain due and grateful reward and respect. But we do entertain fair misgivings about giving a ten year consent for their selfish ends to those who did not invent the (process) but

> merely purchased it from the inventor for their own profit in order to put a levy and burden upon almost the entire country." (quoted in Penrose, 1951, p. 3)

Sometimes, there was no pretense that patents served to promote the public welfare. In 1582 in England, William Harebrowne received a patent for a method to make salt, at least in part "for 'the relief of the decayed' state of the fortunes of the Harebrownes attributable to losses at sea." Popular resentment against widespread abuse of the patent system finally led to adoption of the Statute of Monopolies in 1624, the first law by a modern state to lay down the principle that a patent would be given only to the "first and true" inventor. It established a period of protection of fourteen years, and stipulated that the patented invention "be not contrary to the law nor mischievous to the State, by raising prices of commodities at home, or hurt of trade, or generally inconvenient" (Penrose, pp. 6-7).

What is crucial about these early attempts to establish a fair and effective patent system is that lawmakers recognized that a delicate balancing act was involved. On the one hand, there was a desire to encourage and reward inventors by allowing them to exclude others from making or selling their inventions, given that imitators did not have to bear the original costs of invention and development. On the other, there was an awareness of the social costs.

Over the years, the patent system has successfully adapted to the shifting demands of the mercantilist era of the 16th and 17th centuries, the industrial revolution of the 18th and 19th centuries, and the advances in electronics, telecommunications, and new materials in the 20th. It has served the commercial needs of the medieval guilds and the princes of international trade. The patent system has been decried, praised, extended, restricted and re-interpreted in a myriad of different ways. It has even survived attempts to abolish it.[1]

At the center of patent controversies over the years, as mentioned above, have been two main issues: what should be eligible for patent protection, and how broad should patent rights be? A focus of particular controversy has concerned patents for pharmaceuticals. Some countries, such as Italy in the period 1939-1983, rejected any form of patent protection for drugs. Others, such as Denmark up to the late 1980s, banned patents on drug products, while allowing them on drug processes. This, it was argued, created a better balance between the costs and benefits of drug patents: it both rewarded the inventor of the drug process, and

encouraged other firms to find more efficient processes to make the same drug, thereby encouraging competition (and price reductions) in drug production.

The official reason for treating patents on drugs differently from patents on most other goods was that it was wrong to give monopoly protection to substances so important to peoples' health and well-being. Yet as Gruber and Kroher (1984) pointed out in their analysis of pharmaceutical patenting in Germany, changes in the patent laws over time have reflected both changes in the technology and the interests of the companies. In the mid-nineteenth century, German drug manufacturers opposed patent protection for drug products, since this would deter later inventors who found cheaper, more effective ways of making the drug from applying for their own patents (and instead keep the process secret). This concern was reflected in the first German patent law. Later, firms found it preferable to protect a new drug product via a patent on the process. The German patent law was subsequently changed to this effect. After World War II, the costs and risks of pharmaceutical research increased, leading to a further change in the German law to permit the patenting of drug products, which afforded a much stronger protection than process patents.

At times, the patent system has directly blocked technological progress. When the commercial potential for radio became apparent in the early twentieth century, several large corporations, including Marconi, General Electric and Westinghouse, invested large sums to develop radio technology, taking out multiple patents. By 1918, it became clear that several interdependent technologies were needed to manufacture radio systems – central elements of which had been patented by different firms. "The result," write Grindley and Teece, "was deadlock. A number of firms had important patent positions and could block each other's access to key components. They refused to cross-license each other. It was a 'Mexican standoff' with each firm holding up the development of the industry" (1997: 11).

The solution came with the formation of the Radio Corporation of America (RCA) by the major U.S. patent holders. RCA took control of the relevant patents and ensured their orderly, joint use, acquiring the U.S. rights to the Marconi patents and cross-licensing the rights for other major patent portfolios, thereby acquiring the rights to all the constituent radio patents (over 2,000 patents in all). Even though RCA became the technical leader in radio, the other cross-licensees could continue their own development efforts in related fields, or as suppliers to RCA. On this basis, the radio industry grew rapidly.

But the companies are not always able to find a workable solution. During the mid-20th century, AT&T and IBM controlled patents of fundamental importance to their fields. A 1956 antitrust decree forced them to license out their patents to all applicants for a modest royalty fee, provided that the licensees also granted licenses to them in return. The result was to make a vast amount of basic semiconductor and telecommunications technology widely available for virtually nothing, greatly stimulating technological progress.

Modern companies specializing in semiconductors and electronics have developed a third solution: strategic (voluntary) cross-licensing. Firms have accumulated huge patent portfolios, containing patents key not only to their own R&D programs, but also to those of their competitors. The more valuable a company's patent portfolio, the more others will be interested in negotiating with them for cross-licenses. The royalties earned can be a highly valuable source of income (Grindley & Teece, 1997). Nine of the ten firms that received the most patents in the United States in 1998, in fact, were in electronics (Cohen *et al.*, 2000: 27).

As indicated by these historical examples, the problems of the patent system are integral to the logic of the system itself. By adjusting particular aspects of the system, a different mixture of costs and benefits can be achieved. Factors such as the costs of concentrating too much power in the hands of the patent-holder, and the tensions between patent rights and concerns for public health, are as old as the system itself. It is against this background that we consider how these issues play out in the modern global knowledge economy.

3. Finding the right "balance" between benefits and costs

The economic rationale of the patent system is based on the problem of appropriability (Arrow, 1962, Nelson, 1959), which concerns the degree to which the profits from a new technology accrue to the innovator or to other market participants (competitors, imitators, "second generation" innovators, buyers, suppliers, consumers). New knowledge is valuable because at least initially, it is private to the innovator. When the knowledge is revealed (as when the product is marketed), its value decreases, since other firms can exploit all or part of the knowledge to their own ends, without having to pay for its creation. Thus the ability of the

innovator to appropriate the rents from its investments in R&D will inevitably decline over time, unless the innovator takes measures to prevent this.

A patent confers on the inventor the legal right to exclude others from making, selling, or using the new product or process for a specified period of time, in return for publishing the details in the patent document. The patent system generates both benefits (incentives to invest in R&D, information disclosure) and costs (the deadweight welfare losses associated with monopoly, various forms of rent-seeking, e.g. Harris and Vickers, 1985, Dam, 1994, and the costs to both firms and society of the patent application process and patent enforcement).[2] It has long been recognized that patents are only imperfect instruments of appropriability. For one thing, it is not possible to describe the invention sufficiently in the patent so as to appropriate all the rents. One result is that innovators often take out additional patents on different aspects of their inventions.

Achieving the right "balance" between the benefits and costs of patenting is complex. For example, the basic innovations leading to the Internet were not patented. How, then can we explain why the Internet initially grew so rapidly? What was the incentive to invest in R&D in Internet-related inventions? How might the extensive patenting of Internet business methods today change this equation? To the degree that patents on basic Internet business methods are found valid and enforceable, critics warn, they could threaten the Internet's traditionally open access system. Patent proponents reply that in the knowledge economy, it is appropriate, important – indeed, necessary – to extend patent protection from physical products and processes to concepts and ideas.

There will always be uncertainties connected with patenting. The invention described in the patent application may not fulfill the criteria of patentability and be rejected, the patent may later be overturned in a lawsuit, other firms may take out their own patents on marginal improvements of the original invention, the patent may be infringed. No reform of the patent system can effectively resolve these problems, nor should it try. Moreover, all reforms are costly. In the past, reforms of the patent system, typically made at considerable cost often themselves later led to calls for further changes, sometimes restoring previous conditions. But not implementing reforms can be costly as well.

In seeking to assess the economic effects of extending patent protection into new areas, and how strong patent rights should be, a number of factors should be considered. One has to do with the motivations for taking out patents. Many companies have begun to use patents more strategically, developing sophisticated policies by which to realize the value of their intellectual property (Cohen *et al.,* 2000, Rivette and Kline, 2000a,b, Davis, 1998). Patents can be used to block other firms from entering a particular area, to "enclose" firms with existing patents in an area, as a negotiation tool in complex cross-licensing agreements, or as part of a technology sharing agreement. They can be used to signal intent to other market participants, or as an indication of stock market value. Yet when patents are used for purposes other than protecting new knowledge, the strengthening of patent rights may well impose new costs without concomitantly resulting in greater (incentive) benefits.

Firms may also have reasons to invest in R&D which have nothing to do with appropriability, but with the critical importance to competitive advantage of staying abreast of, understanding and contributing to the latest technological developments (e.g. Rosenberg, 1990). Even in industries where patents are not seen as effective against imitation, firms still take out patents (e.g. Mansfield, 1986). To a greater or lesser degree, then, firms would conduct R&D anyway, whether or not the patent system existed. In such cases, granting a patent monopoly might again be said to impose unnecessary social costs.

A further factor concerns the extent to which the prospects for patent protection become too central in governing firm choices of R&D priorities. The biotech firm Genetics Institute, for example, chooses among competing candidates for new drug development partly as a result of their relative performance in clinical trials, but also in relation to which version of the new drug can obtain the strongest patent position. For this firm, patents are a “leading factor” in deciding which research to pursue (Rivette and Kline, 2000a). More generally, to what degree does the nature of patent protection influence firm choices in investing in particular technologies?

Finally, patents are but one strategy by which firms can appropriate the profits from their investments in R&D; others include secrecy, lead time, and superior sales efforts. Empirical studies show that patents are generally evaluated as among the least effective strategies of appropriability, except in specific industries like pharmaceuticals (e.g. Levin *et al.*, 1987,

Cohen *et al.*, 2000). By altering the patent system in a general manner, these choices will clearly be affected.

4. What should be eligible for patent protection?

4.1. Should patent protection be extended into new areas?

Patents are the strongest form of intellectual property right. Typically, it is quite difficult to obtain a patent. (By contrast, an author of an original book or work of music automatically receive a copyright.) To be patented, an invention must not only be new, it must also differ substantially from existing work. But the precise definition of the criteria of patentability is open to interpretation. When does a new invention not infringe an existing patent? It is not unusual for the Patent Office to grant protection, only to have the decision overturned in the courts.[3] Country differences exist as well. In the United States, a patentable invention must be novel, non-obvious, and industrially applicable. In Europe, it must be novel, involve an inventive step, and have a technical effect. While these differences are not great, they are real. For example, a U.S. court allowed Merrill Lynch to patent a business method which included the use of a computer; an English court rejected Merrill Lynch's application for the same invention (Davies, 1999, p. 16, note 23).

In deciding whether or not to grant a patent, examiners must determine the degree to which the invention described differs substantially from existing knowledge, which means they must search exhaustively through technical sources in many different languages, in all parts of the world. (This is termed "prior art " and can be seen, on the patent application, as references to patents or other written work on which the application builds.) It is this requirement that makes the patent the strongest of the various forms of intellectual property rights – but which additionally puts great pressure on patent authorities to be as certain as possible that granted patents fulfill it.

A patent must disclose enough information that others skilled in the art can reproduce the invention. This criterion has similarly been open to different national interpretations. The United States has permitted the patenting of certain types of plants since 1930. Most other countries rejected such patents, contending that the plant could not, necessarily, be

reproduced every time by applying the same breeding methods. Notably, with the development of biotechnology, breeding techniques have become far more reliable. The same engineering process leads to the same plant, every time. Thus by normal standards, such inventions should be patentable (Moise, 1999).

A notable source of controversy concerns the patentability of software and software-related technologies. Originally, innovations in computer programs fell under copyright law (Choi *et al.*, 1997). A copyright, however is a much weaker form of intellectual property right than the patent, protecting only the concrete version of the program (the written source code for a computer game, a word processing program, and the like), not the technical principle underlying it. Another firm, by marginally changing the source code, could create a nearly identical program and obtain its own copyright. To limit this form of free riding, patent protection (first in the U.S., later in Europe and Japan) was gradually extended to cover the technical principle underlying the program, with copyright protection retained for the program itself.

As indicated earlier, in the United States, it is now possible to patent Internet business methods. For example, Dell Computer has been issued over forty patents covering its build-to-order direct sales model, with the goal of thoroughly protecting is its basic method of doing business. Amazon.com has a U.S. patent on its one-click online shopping cart technology, which enables shoppers to purchase products online with a single mouseclick (bypassing the process of entering shipping and payment information).

According to critics, many of these methods represent little more than digital versions of commonly used business practices. Priceline.com, for example, patented a “name-your-own price system” that is, in essence, similar to the way car buyers and dealers haggle. Should it receive an exclusive right to this simply because the system has been developed to operate over the Internet? Patent experts note that a large percentage of such patents may well later be declared invalid if subject to a lawsuit and thereby submitted to the scrutiny of a court (Rivette and Kline, 2000).

Outside the United States, Internet business methods have generally not been deemed patentable, on the grounds that they lack the requisite degree of novelty, inventiveness or technical effect. European patent authorities argue that it is important that patent monopolies

are granted only where it is possible to determine the subject and scope of the monopoly with a high degree of certainty (Davies, 1999). What, for example, is "prior art" for a new technical field like the Internet?

4.2. Should patent examiners use other criteria to differentiate among patent applications?

When patent examiners evaluate whether or not to grant a patent, they base their decision solely on whether or not the invention fulfills the criteria of patentability. No judgment is made as to the degree to which the invention is commercially valuable, or whether the applicant is the best suited to develop the idea commercially. The recent proliferation of patent applications, particularly in the United States, has led to substantial concern as to the degree to which too many "worthless" patents are being granted. Controversy has centered especially on Internet business methods. But while it may be true that many worthless patents are granted today, the phenomenon is not new.[4]

Patents for certain types of technologies, in particular in the life sciences, also raise thorny ethical questions. To what extent should private companies receive exclusive legal rights to living entities? If patents are allowed on inventions at the molecular biological level, why should they not be allowed for higher animals and plants? What is the basis for the ethical distinction made? Where do we draw the line?

It has long been a principle of the patent system that a patent may not be given to a "discovery" (that is, something which already existed when people became aware of it, such as a new plant species growing in a remote mountain valley). This restriction serves to limit the number of patentable inventions, and underpin the incentive effects of the patent system to encourage original research and development. But with biotechnology, such distinctions become blurred. Many patented inventions represent synthesized versions of existing biological entities. What is new, here, is not the invention itself, but its reproduction in a laboratory. Identifying the human growth hormone, for example, was not an invention in itself, since the hormone already existed and could be extracted from the human body. The synthesized version of this hormone, nevertheless, was patented – and commercially developed to prevent dwarfism in children.

Critics of the extension of patent protection to products of this type argue that, even though they are synthesized in a laboratory, they still basically represent discoveries, not inventions, and therefore should be made freely available to all. Proponents respond that had the pioneers of biotechnology been denied the opportunity to patent their inventions, the industry might not have been developed in the first place, or might have developed much more slowly, with the resultant social costs. For example, had the synthetic human growth hormone not been patentable, it might not have been made available to treat children affected by dwarfism.

4.3. What is the right balance between public and private knowledge?

A third central issue as regards what should be eligible for patent protection has to do with the wider implications of extending patent protection into areas earlier considered the domain of public science. Thurow (1997), for instance, writes that there has been a substantial decline in public knowledge from the 1980s on, reflecting both the more proprietary approach taken by companies like AT&T (and Bell Labs) to their innovations and broad decreases in public financing of research. What are the societal costs and benefits of enabling firms (and individual scientists and their universities) to protect fundamental advances in science-based technologies as proprietary knowledge?

For example, given that many inventions in biotechnology have been wholly or partly publicly funded, how much of the recent progress in mapping the human genome should remain in the public domain, and how much should be eligible for patent protection or otherwise appropriated by innovating firms (e.g. Mowery *et al.*, 2001)? Again, this issue is not new. Inventions in chemicals and pharmaceuticals have traditionally been heavily based on university research. Corporate scientists have benefited from the publication of this research, using it as a basis for their own experiments and patents; university scientists have also often left academia to found their own companies to develop commercially their research results.

Obviously, the specifics of the debate have changed. More patents are being taken out today than in the past, more are being issued to companies rather than individuals, and more are being issued to university researchers than before. As a result, relatively more knowledge

today is being protected as proprietary. Yet if a new product is patented, the details of the invention are published in the patent document – it cannot be kept secret. In this sense, the information disclosure requirement of the patent law can be said to encourage the publication of new knowledge that otherwise might be kept secret.

The relative importance of patents and secrecy as methods of appropriation have been investigated in two recent empirical studies. One (Arundel, 2001) is based on data from the 1993 European Community Innovation Survey for up to 2849 R&D performing firms; the second (Cohen *et al*. 2000), using a similar methodology as the earlier classic study by Levin *et al.* (1987), assesses the patenting activity by U.S. manufacturing firms. Both studies conclude that firms today not only consider secrecy a substantially more valuable strategy of appropriation than patents, but its importance is increasing. Arundel's investigation, for example, found that a higher percentage of firms in all size classes rated secrecy as more valuable than patents. This was particularly true for small firms that patented product innovations. When Cohen *et al.* asked firms why they did not apply for patents, the two main reasons were: the ease of inventing around the patent, and information disclosure (the latter reason appears to have received a higher rating since the Levin survey was carried out).

Whether new knowledge is published in the patent or kept secret is a central – if often ignored – aspect of the social and economic effects of the patent system. The more patents that are taken out, the more knowledge that is disclosed that might otherwise have been kept secret. And the more knowledge that is disclosed, the greater the opportunity for other inventors to read it, build upon it, and take out their own patents – revealing further knowledge. The important question, for our purposes, and one not considered by the empirical studies cited earlier (Cohen *et al.*, 2000, Arundel, 2001) is: What would have happened, more generally, if patent protection had not been extended into new technological areas? To what degree might incidence and value of secrecy have been even more rampant, with the resultant social costs? One of the societal benefits of patent disclosure is to reduce duplicate (and therefore wasteful) R&D, since other firms are aware of what their rivals are doing.

Even if the opportunity to patent new products and processes facilitates greater information disclosure, the question still remains as to whether or not certain types of knowledge, by their very nature, should remain in the public domain. Many argue, for example, that patents on drugs fundamental to human health in the Third World should be treated differently from

other types of products (we will return to this in the next section). Another key issue concerns the patentability of the laboratory versions of other types of products used for centuries by traditional societies, such as seeds or medicinal potions. To what extent should firms be granted patent rights on such products, simply because they have developed methods to synthesize them artifically? What will be the effects of these patents, not only on the traditional peoples concerned, but also on firm incentives to invest in R&D? Should the chemical synthesis of a long-known traditional medicine be "rewarded" in the same way as investments in risky basic research?

5. How strong should patent protection be?

5.1. How can we achieve the right mixture of incentive effects and costs?

In most countries, in recent years, there has been a general strengthening of patent rights, and a broadening of the scope of the claims covered in the patent. The patent term has also been extended and standardized at twenty years. What are the implications of these changes?

It is important to see the trade-offs implied by the patent system both in terms of the relationship between innovator and imitator (e.g. Mansfield, 1986), and between first- and second-generation innovators (e.g. Scotchmer, 1991). An example of the first is the practice by generic pharmaceutical firms of producing exact copies of patented drugs as soon as the drug comes off patent, typically substantially reducing its cost. The patent gives the inventor the incentive to invest in R&D, but because the patent monopoly is limited in time, other companies can subsequently benefit from the opportunity to manufacture the drug, and consumers can benefit from the lower price. But the process does not directly contribute to further innovation. The broader the patent, the less the innovator has to be concerned about rivals encroaching on its protected technology, but the more the potential social costs.

The second trade-off raises the question of the division of benefits between innovators over time: the firm that invents the basic idea, and the firm that seeks to develop the idea further as part of its own substantial innovative effort. This "second generation" innovator builds on the knowledge published by the original patent-holder, but with the purpose of creating a new product or process eligible for its own patent protection. The effect on consumer prices is less

(if it exists at all), but consumers will clearly benefit more generally from the fruits of continued innovation. The broader the patent taken out by the first generation innovator, the greater the adverse effects on second generation innovators (and vice versa). To mitigate these inter-generational effects, the involved companies can enter into joint ventures and licensing agreements.

Ordover (1991) argues that strong patents are not necessarily inimical to the diffusion of knowledge, to the extent that they reduce the incentive to keep the knowledge secret, and strengthen the legal basis for licensing. Nor do weak patents necessarily decrease the incentives to invest in R&D, as for example when companies engage in extensive cross-licensing to share the benefits of these investments. Thus it is extremely complex to determine how strong patent protection "should" (optimally) be.

Even so, when patents are too broad, they may well impede innovation and technological progress. According to Merges and Nelson (1994: 20), in cumulative systems technologies (like semiconductors, electronics and telecommunications, as described in Section 2), where developments in one area of technology are closely related to developments in another, and firms are mutually dependent on having access to each other's technology to proceed, broad pioneer patents have "caused nothing but trouble." Lawsuits filed by patent-holders restricted other firms from commercially developing their own, often superior ideas, generally slowing technological progress until the parties negotiated the necessary cross-licensing agreements. The same is true for biotechnology (though for different reasons), they contend: patent protection has been too broad, threatening to harass competitors out of the field.

To a certain extent, changes in the life of the patent can mitigate the costs of the patent system while preserving the benefits. Throughout history, the length of patent protection has been frequently changed. In mid-15th century Venice, as mentioned earlier, the patent term was five years. In 17th century England, it was fourteen years. In the United States in the 19th and 20th centuries, the patent term was seventeen years. In recent years, in most countries in Europe, the patent term has been twenty years. The WTO agreement on intellectual property rights (TRIPS) standardized the patent term for its signatory countries to twenty years. But for pharmaceuticals, the patent term has been further extended, to reflect the long R&D lead times that go into developing a new drug, and the need to test new drug candidates thoroughly, shortening the period of actual commercial exploitation. By what criteria should

the length of the patent life be established? Why is twenty years now felt to be better than five – or fourteen?

There exists a long-standing economic literature on how adjustments in the patent term can be used to create the best balance between benefits and costs (e.g. Nordhaus, 1969, Scherer, 1980). Generally speaking, the longer the life of the patent, the greater the benefits that can be accrued by inventors, and therefore the greater the incentive to invest in R&D. At the same time, the longer the period of monopoly control, the greater the amount of deadweight loss generated. In principle, the optimal patent life is different for each invention – though for practical reasons, countries have sought to establish a general rule that will work best, on average.

5.2. Should the patent system be applied equally to industrialized and developing countries?

In 1995, the TRIPS agreement (Trade-Related Intellectual Property Rights), under the WTO, was ratified, standardizing the content and enforcement of patents and other intellectual property rights around the world (including, as of 2005, most of the world's poorest countries). Prima Braga (1995), in assessing the economic effects of the TRIPS agreement, argues that it will most likely tend to strengthen international trade (reducing the incidence of internal technology transfers in multinational enterprises), international investment, and general technology transfer from north to south. On the other hand, it will probably also lead to higher prices in the Third World, and thus the transfer of rents from south to north, in that developing countries can no longer produce cheap copies of drugs that are patented elsewhere, but have heretofore been excluded from patentability there.

Ultimately, according to Prima Braga, the treaty might lead to the replacement of imitators by licensees in the developing countries, and greater R&D investments in the south, and ultimately stronger economic development in the south, as domestic companies become innovators in their own right. Yet clearly, at least in the short run, the economic effects of the TRIPS agreement will be (and have proved to be) highly disruptive for the developing countries, particularly with regard to drugs.

Here, as with the ethical controversies described earlier, the patent system has become entangled in a set of issues that have less to do with patenting *per se* than with the disruptions of globalization and the increasing economic gap between rich and poor. Logically, strengthening the incentive effects of the patent system should benefit all innovators. But since innovative capacity is concentrated in the industrialized world, it is here where the main incentive effects will be felt. The social costs of the patent system, too, logically apply to all countries; but here they will be felt far more acutely by the developing countries, since they can no longer appropriate as high a portion of the benefits from innovations as before. These costs will be felt particularly in terms of prices increases for drugs in the face of massive public health problems.

The patent system evolved in the industrialized countries (more or less) in harmony with the ongoing technological changes in those countries. For many centuries, inventors were accustomed to patenting new products and processes, and building on existing knowledge to creating new technologies. In the Third World, technologies and medicines have largely been developed without patent protection. Thus tensions cannot help but arise when the patent system, fine-tuned to the technological ideals and advances of the industrialized countries, is imposed "from above" on societies with different traditions.[5]

6. Perspectives on reforming the patent system

How might we adjust the patent system to achieve the best mix of benefits and costs in the modern global knowledge economy? Grandstrand (2000:1075), for example, suggests that much might be gained by raising the standard of what is meant by non-obviousness. The greater the clarity of definition of what is patentable, the lower the chance that the patent will later become the subject of a lawsuit. This change might well limit the number of "trivial" patents being applied for today on Internet business methods. Thurow (1997) proposes that efforts should be increased to strengthen the laws governing the enforcement of intellectual property rights, and the institutions responsible for dispute resolution.

Raising the criteria of patentability and strengthening the enforcement of patent rights would *ceteris paribus* increase innovators' incentives to invest in risky basic research – but might on the other hand limit the distribution of benefits to second generation innovators, and thereby

the latter's incentives to improve on existing innovations. Such a reform would raise the costs to innovators as regards determining what is patentable – and impose extra societal costs by giving greater monopoly power to patent-holders. At the same time, not implementing reforms of this type imposes other benefits and costs. For example, the lower the standard of non-obviousness for the individual patent (again *ceteris paribus*), the greater the incentive to apply for a larger number of patents (and the higher the associated costs).

Should the same type of protection be given to all inventions? In a case described by Thurow (1997: 95-6), a physician received a patent for a diagnostic test based on his observation that there was a relationship between an elevated level of a particular human hormone and a congenital birth defect. The test itself was not useful, as it led to too many false positives. But scientists later found that if his test were used together with two other tests, it would accurately predict whether a fetus had Down's Syndrome. The physician then insisted that every laboratory that used his part of the test should pay him a fee of $9, more than doubling the cost of the test. For Thurow, this case illustrates the need for a more differentiated patent system; an inventor who observes how an existing gene works should not be eligible to receive the same kind of patent protection as, say, the inventor of a new gene that can replace the defective one. Yet should patent examiners make these kinds of decisions?

There are several reasons why patent examiners do not try to assess the scientific or commercial value of the inventions described in the applications they read, or whether the applicant is the best to develop the invention. One is that it is virtually impossible to know, at the time of the patent application, whether a particular idea will prove worthwhile or not. A second reason is that patent examiners are hired for their technical skills, not their commercial experience. Third, criteria such as novelty, non-obviousness and industrial applicability represent an attempt to introduce a measure of objectivity into the patent application process, ideally leaving it less vulnerable to lobbying by individual inventors, companies, or politicians. Fourth, opening up for new criteria would risk adding new inconsistencies to the system. And finally, such a reform would be extremely costly, adding on to the burdens already faced by overextended national patent offices.

Some countries have established different patent term and fee structures to encourage the more effective use of patents. In the German system, a full-term patent is granted for major inventions, and a three-year patent is granted for minor developments. Patent renewal fees

also rise during the life of the patent, increasing inventors' incentives to develop and commercialize their inventions as early as possible, and perhaps eventually license out the rights to another firm as they turn their R&D efforts to new innovations. The United States has also adopted an increasing annual fee to maintain the patent (Dam, 1994). Wider use of this German "two tier" would arguably preferable to the creation of a more ambitious, more highly differentiated patent system, since it would both help to solve the problems associated with "trivial" patents while being considerably less costly to implement and enforce.

Other laws and administrative measures can serve as valuable supplements to address patent-related problems. One (e.g. Kremer, 1997) involves the creation of a government agency to buy out the rights to specific patents critical to the public welfare, making this knowledge freely available. The concept of patent buy-outs is again not new. To take one example, the French government bought the patent on the Daguerreotype process in 1839 and put it in the public domain. The main problem with implementing patent buy-outs, writes Kremer, is to establish the private value of the patent. A government could determine this value through an auction, then offer to buy out the patent at this value times a fixed markup (corresponding to the estimated typical ratio of the social and private values of inventions). To induce bidders to reveal their valuations, a few patents would ultimately not be placed in the public domain but instead be sold to the highest bidder.

The advantages of patent buy-outs include eliminating monopoly price distortions and wasteful reverse engineering, enabling the social value of the invention to be realized while preserving both the innovating firm's incentive to invest in R&D, and its ability to determine the direction of its own research. The main disadvantage is that patent buy-outs are potentially vulnerable to influence activities like bribery and collusion. Patent buy-outs might be particularly apt for pharmaceuticals. Patents are frequently used in this industry and regarded as effective. Substantial information about drugs is provided as part of the government approval process, which should reduce bidding costs and problems of asymmetric information. It would have benign distributional effects as well.

Patent buy-outs might additionally provide a workable compromise solution to the tensions between the pharmaceutical companies and the Third World. The companies could realize the social value of their inventions, while the drugs could be made widely available at reasonable prices. Such a system might even give drug companies an incentive to invest in R&D in

diseases that typically strike the Third World in particular with devastating results, such as malaria; today, there is little incentive to invest in such drugs. Clearly, to implement this solution, sufficient public funding must be provided.

Other forms of government intervention, such as anti-trust regulation, can curb the effects of the concentration of too much market power in the hands of the patent-holder. Further, patents are but one of many types of government incentives to invention and innovation; alternative incentive systems include subsidies, prizes and procurement contracts (e.g. Davis, 1988). Subsidies to university science, for example, can generate valuable external economies in the form of basic research that companies can build on in their own R&D programs (e.g. Nelson, 1959, Mowery *et al.*, 2001).

With regard to the ethical controversies surrounding patenting living organisms, some countries explicitly prohibit patents on inventions that raise ethical concerns or pose risks to people, animals, plants, or the environment. Examples include diagnostic, therapeutic or surgical methods for treating animals, or inventions of higher plants or animals and the biological processes producing them. According to a recent OECD report, ethical aspects of this type are used to justify exclusions in every country in OECD Europe, Japan, Korea and New Zealand.

Yet even where countries permit the patenting of life forms, this does not necessarily mean that patents are granted. Australia, Canada and the U.S. do not recognize such general grounds for restricting patents on life forms. But due to specific laws in these latter countries banning specific practices in this regard, the end result has been the same. Thus patents on the use or cloning of human beings, and animal experiments involving suffering not justified by the benefits are not permitted in any OECD country (OECD, 1999). Clearly, the countries involved are not as far apart on this issue as might appear by looking only at their patent laws.

Finally, it is important to ensure that national and international patent offices receive the resources they require to administer the patent system as effectively as possible. The plethora of information contained on the World Wide Web, for example, combined with the increase in other sources of scientific and technical information more generally, makes it even more difficult for patent examiners to ascertain whether inventions described in patent applications are new. Making decisions about prior art is problematic even for the U.S. Patent and

Trademark Office and the European Patent Office, with their modern data processing systems. But it is even more difficult for patent examiners in other countries. India, for example, a country of a billion people, has just 44 patent officials (as opposed to 3,000 in the United States, with one-fourth the population of India), rendering effective administration of the Indian patent system impossible. The accelerating availability of information available over the Internet only makes such problems worse.[6]

One difficulty faced by all government patent offices is that the salaries offered are not competitive with those in business. Not surprisingly, many talented patent examiners leave government service after a few years and move to private firms. This not only deprives patent offices of expertise, but also imposes new costs in the form of training replacements, and enables the firms that hired the former examiners to draw on their expertise without having to pay for it. This problem is particularly acute with regard to recruitment for examiners in new technical areas such as biotechnology and software-related patents.[7]

7. Conclusion

This paper has sought to investigate the current problems faced by the patent system in the context of the forces driving the development and change of the patent system over time. What is new, we have argued, is not the nature of the problems confronting the patent system, but their modern manifestation. Today, as through the centuries, controversies have arisen as to what should be patented, and how strong that protection should be. Earlier disputes focused on whether patents were appropriate for pharmaceuticals and related products critical to public health and welfare – or whether or not we should have a patent system at all, given the potential for abuse. Today, talk of abolishing the patent system has subsided, but the extension of patent protection into biotechnology and Internet business methods, and the standardization of international patent practices to include the world's poorest countries, has aroused heavy debate. The problems associated with granting worthless patents, the debates over optimal patent breadth and life, we have demonstrated, are in essence equally old.

The problems faced by the patent system can be tackled numerous ways: by reforming different aspects of the patent system, and by introducing and/or strengthening related laws

and administrative measures. What is important is to focus, as much as possible, on the problem itself, without seeking radical changes in the patent system more generally.

Based on the findings of this paper, different “cocktails” of patent-related reforms can be envisioned. The ingredients might include (but not be limited to) raising the criteria of patentability for major inventions and introducing a second type of patent for minor ones, facilitating the more consistent enforcement of patent rights, sharpening the definition of what constitutes abuse of the patent monopoly, specifying ethical limitations, and implementing patent buy-outs for inventions crucial to public welfare. The elements of the individual “cocktails” could be differentiated according to the type of technology involved, the market power of the patent-holders, ethical considerations, and so forth. This would enable the implementation of solutions appropriate to particular issues, technologies, countries or regions, reducing the costs of the patent system in targeted areas of concern while preserving its overall consistency and broader benefits.

BIBLIOGRAPHY

Arrow, Kenneth (1962). "Economic welfare and the allocation of resources for invention," *The Rate and Direction of Inventive Activity: Economic and Social Factors.* Conference No. 13, Universities-National Bureau of Economic Research (Princeton, Princeton University Press).

Arundel, Anthony (2001). "The relative effectiveness of patents and secrecy for appropriation," *Research Policy* 30, 611-624.

Choi, S-Y, D.O. Stahl & A.B. Whinston (1997). *The Economics of Electronic Commerce – The Essential Economics of doing business in the Electronic Marketplace* (Macmillan Technical Publishing, Indianapolis, Indiana).

Cohen, Wesley, Richard R. Nelson and John P. Walsh (2000). Protecting their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or not). NBER working Paper 7552. (Cambridge, National Bureau of Economic Research), February.

Dam, K.W. (1994). "The economic underpinnings of patent law," *Journal of Legal Studies*, 23, 247-72.

Davies, L. (1999). *A Model for Internet Regulation?* London, Information Technology Law Unit. Available on the Internet at www.scl.org/content/ecommerce, 1999.

Davis, Lee N. (2001). "R&D Investments, Information and Strategy," forthcoming in *Technology Analysis and Strategic Management*, Vol. 13:3.

Davis, Lee N. (1998). "Patents and innovation: a strategic perspective," in Thomas Riis & Ruth Nielsen, eds., *Law and Economics. Methodology and Application* (Copenhagen: DJØF Publishing), pp. 11-31.

Davis, Lee N. (1988). *The Patent System and Related Incentives to Invention and Innovation* (Lyngby, Denmarks Technical University).

Grandstrand, Ove (2000). "The shift towards intellectual capitalism – the role of infocom technologies," *Research Policy* 29, pp. 1061-1080.

Grindley, Peter C. and David J. Teece (1997). "Managing intellectual capital: licensing and cross-licensing in semiconductors and electronics," *California Management Review*, Vol. 39, No. 2, Winter, pp. 8-41.

Harris, Christopher and John Vickers (1985). "Patent races and the persistence of monopoly," *Journal of Industrial Economics*, vol. 33, No. 4, June, pp. 461-82.

Kremer, Michael (1997). *Patent Buy-Outs: a Mechanism for Encouraging Innovation*. NBER Working Paper 6304. Cambridge, Mass.

Levin, R.C., A.K. Klevorick, R.R. Nelson, and S.G. Winter (1987). "Appropriating the returns from industrial research and development," *Brookings papers on Economic Activity* 3, pp. 783-820.

Mansfield, Edwin (1986). "Patents and innovation: an empirical study," *Management Science*, Vol. 32, No. 2 (February 1986), pp. 173-81.

Merges, Robert P. & Richard R. Nelson (1994), "On limiting or encouraging rivalry in technical progress: The effect of patent scope decisions," *Journal of Economic Behavior and Organization*, 25, pp. 1-24.

Moise, Evdokia (1999). "Intellectual property: rights and wrongs," *OECD Observer*, No. 216, March, pp. 35-38.

Mowery, David C, Richard R. Nelson, Bhaven N. Sampat, and Arvids A. Ziedonis (2001). "The growth of patenting and licensing by U.S. universities: an assessment of the effects of the Bayh-Dole act of 1980," Research Policy 30

Mullaney, Timothy J. and Spencer E. Ante (2000). "Info wars," *Business Week*, June 5, 2000.

Nelson, Richard R. (1959). “The simple economics of basic scientific research,” *Journal of Political Economy*, Vol. 67, June, pp. 297-306.

Nordhaus, William (1969). *Invention, Growth and Welfare* (Cambridge, Mass: MIT Press).

OECD (1999). *Intellectual Property Practices in the Field of Biotechnology*. Paris, OECD.

Ordover, Janusz A., "A patent system for both diffusion and exclusion," Symposium on Intellectual Property, *Journal of Economic Perspectives*, Vol. 5, No. 1 (Winter, 1991), pp. 43-60.

Penrose, Edith T. (1951). *The Economics of the International Patent System* (Westport, Con: Greenwood Press Publishers, 1973). Reprint from the Johns Hopkins Press.

Primo Braga, Carlos A. (1995). “Trade-related intellectual property issues: the Uruguay Round Agreement and its economic implications,” in Martin, Will and L. Alan Winters, ed., *The Uraguay Round and the Developing Economies*, World Bank Discussion Papers. Washington, D.C. the World Bank), pp. 381-411.

Rivette, Kevin G. and D. Kline (2000a). “Discovering new value in intellectual property,” *Harvard Business Review*, January-February 2000, pp. 54-66.

Rivette, Kevin G. and David Kline (2000b). *Rembrandts in the Attic. Unlocking the Hidden Value of Patents* (Boston: Harvard Business School Press).

Rosenberg, Nathan (1990). "Why do firms do basic research with their own money?" *Research Policy* 19, pp. 165-174.

Scherer, F.M. (1980). *Industrial Market Structure and Economic Performance* (Chicago: Rand McNally).

Scotchmer, Suzanne, "Standing on the shoulders of giants: cumulative research and the patent law," Symposium on Intellectual Property, *Journal of Economic Perspectives*, Vol. 5, No. 1 (Winter, 1991): pp. 29-41.

Shulman, Seth (2000). “Software patents tangle the web,” *Technology Review*, March/April, pp. 68-76.

Teece, David J. (2000). *Managing Intellectual Capital*. (Oxford, Oxford University Press).

Thurow, Lester C. (1997). “Needed: a new system of intellectual property rights,” *Harvard Business Review*, September-October, pp. 95-103.

NOTES

[1] During the 1850s, a major movement in the UK and Germany emerged to this end, and both Holland and Japan actually abolished their patent systems. Switzerland, the only industrialized country in Europe which had never adopted a patent system, consistently rejected proposals to do so, citing economic experts who had declared that the principle of patent protection was "pernicious and indefensible." Yet the reform movement was short-lived. During the 1870s, most countries reinstated their patent systems, and in 1910, Holland followed suit (Machlup, 1968).

[2] A further dimension of the incentive effects of the patent system was noted by Kitch (1977) in his analysis of the patent as a "prospect." Not only was the patent a reward to innovative work, he contended, it also enabled the firm to explore, and perhaps commercially exploit, the possibilities of a promising technological area free from the interference of others. By awarding the exclusive ownership of each of its technological prospects to one inventor shortly after discovery, society both optimized the use of technological resources and minimized waste, since other inventors did not allocate resources in the area of the prospect.

[3] In the United States, the courts have generally found that a new patent does not infringe an existing patent on three grounds (see Merges & Nelson, 1994): (1) *The original patent is declared invalid*. For example, Sawyer and Mann lost a suit brought by Edison as regards their patent on a light bulb filament; the courts ruled that the original patent was unclear, and its claims too broad. (2) *The new patent is characterized as "non equivalent"* (that is, the new patent differs substantially from the existing one). For example, International Nickel was granted a patent on an alloy called nodular iron, which described the addition of a "small but effective" quantity of magnesium (minimum 0.04%) to the molten iron; a patent taken out by Ford Motor Company involving the addition of 0.02% magnesium was later found invalid as it was judged to cover an equivalent substance. (3) *The new patent involves a substantial improvement* (i.e. one that was not foreseen in the original patent). An example concerns Texas Instrument's patent on the hand held calculator. During the years after the original patent was granted, the calculator was subject to many improvements and changes, and eventually, these improvements became substantial enough to warrant the issuance of a new patent.

[4] During the 1960s and 1970s, a British patent examiner reportedly got so tired of spending time on patent applications describing trivial inventions that he began deliberately to apply for his own worthless patents. One concerned the development of an elaborate system of pipelines stretching from the Arctic to North Africa, through which giant snowballs could roll propelled by the force of gravity, thereby providing water to the desert. Another concerned the construction of a special rocket by which to blast the British Patent Office into space. Since the patent examiner well understood which kinds of inventions were eligible for patent protection and which were not, he had no trouble receiving patent protection for each of his many applications!

[5] It should also be recognized that the problems confronting the developing countries go far beyond patent policy. In the recent controversy between the South African government and the pharmaceutical companies, the government admitted that even if the price of anti-AIDS drugs fell so much as only to cover actual production costs, the medicine would still be too expensive to solve the country's AIDS crisis.

[6] Described by Bruce Lehman, President and CEO, International Intellectual Property Institute, Washington, in his presentation, "The future of the global patent system," at the conference by the Danish Patent and Trademark Office, Copenhagen, January 19, 2001. Countries may have different traditions as regards searching for prior art. In the past, for example, the Japanese Patent Office only looked at Japanese patents to establish prior art (supplemented by the patent databases of the USPTO and the EPO). Yet most prior art for new technologies is not available here, but in other types of technical publications.

[7] Not only do U.S. patent examiners reportedly start at salaries of $28,000, their workloads have also swelled in recent years, and they are asked to make decisions in new technological areas that even seasoned patent officials find difficult. While the number of patent applications rose 11% between 1998 and 1999, funding for the U.S. patent office fell, and it was required to spend 16% less on operations. (Ross, 2000).