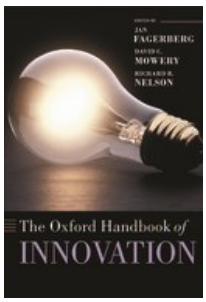

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CHAPTER

10 Innovation and Intellectual Property Rights

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Abstract

The use of property-like rights to induce innovations of various kinds is perhaps the oldest institutional arrangement that is particular to innovation as a social phenomenon. It is now customary to refer to these rights as intellectual property rights (IPRs), comprising old types of rights such as patents for inventions, trade secrets, copyrights, trademarks, and design rights, together with newer ones such as breeding rights and database rights. The various IPRs usually have long legal and economic histories, often with concomitant controversies. Nonetheless, despite their long history, until recently IPRs did not occupy a central place in debates over economic policy, national competitiveness, or social welfare. In the last quarter of the twentieth century, however, a new era—dubbed the pro-patent or pro-IP era—emerged, first in the US and then globally. These changes provided policy makers in both developed and developing countries with new challenges.

Keywords: innovation, intellectual property rights, inventions, trade secrets, copyrights, trademarks, design rights

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10.1 Introduction[1]

THE use of property-like rights to induce innovations of various kinds is perhaps the oldest institutional arrangement that is particular to innovation as a social phenomenon. It is nowcustomary to refer to these rights as intellectual property rights (IPRs), comprising old types of rights such as patents for inventions (judged as sufficiently novel, non-obvious and useful), trade secrets, copyrights, trademarks, and design rights, together with newer ones such as breeding rights and database rights.[2] The various IPRs usually have long legal and economic histories, often with concomitant controversies. Nonetheless, despite their long history, until recently IPRs did not occupy a central place in debates over economic policy, national competitiveness, or social welfare. In the last quarter of the twentieth century, however, a new era—dubbed the pro-patent or pro-IP era—emerged, first in the US and then diffused globally. This change was embedded in a deeper, more broad-based and much slower flow of events towards a more information-(knowledge-) intensive and innovationbased economy. (This type of economy has in recent years been dubbed the "new economy" somewhat misleadingly, as if the entire economy has suddenly changed ↳ into something new, replacing the old.) These changes provided policy makers in both developed and developing countries with new challenges.

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10.2 History of the IPR System

The brief historical account below will focus primarily on patents, being in general the most important and representative IPR, and will be divided into eras, summarized in Table 10.1.

10.2.1 The Non-Patent and Pre-Patent Era

Ancient cultures, as in Babylonia, Egypt, Greece, and the Roman Empire are not known to have had any patent-like institutions for technical inventions, but there are clear indications of other forms of IP in these cultures. It was not until late medieval times that patent-like institutions started to appear, mostly in the form of privileges granted by rulers to special individuals or professions.

10.2.2 The National Patent Era

Concepts of IP became more elaborate and closely linked to political institutions as trade and technology developed in the Middle Ages. In 1474 Venice promulgated the first formal patent code. Inventions shown (at least by a model) to be workable and useful received ten years of protection from imitation, subject to certain compulsory licensing provisions. The 1474 patent code constituted a policy for Venice to attract engineers from the outside and stimulate orderly technical progress. These laws signified the emergence of a new era, which we refer to as the "national patent era," since patent systems typical of this period were national (or local) phenomena pertaining only to single city-states or nations.

The granting of patent-like privileges by governments or rulers was not confined to Venice and the practice spread within Europe. As nation states with more absolutist governments emerged, controversies also emerged between governments and rulers regarding the conditions for granting patents and monopoly privileges.[3]

The practice of granting patents also spread in England and France during the sixteenth century as part of national mercantilist policies. Thus patents became ↳

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linked to trade policies, a link that has been important as well as controversial ever since.

Table 10.1 Eras in the history of patents and IP[1]

Era		Characteristics
1.	Non-patent era (Ancient cultures: Egypt, Greece, etc.)	Emergence of science separated from technology Emergence of cultural and industrial arts Secrecy and symbols emerging as recognized IP No patent-like rights or institutions for technical inventions
2.	Pre-patent era (Middle Ages to Renaissance)	Emergence of universities Secrecy, copyright and symbols (artisan/trade marks/names) as dominant IP, also collectively organized Emerging schemes to grant privileges and remunerate disclosure Extensions of mining laws to inventions
3.	National patent era (Late 15th–late 18th cent.)	Breakthrough of natural sciences Local codifications of laws for patents (Venice 1474, England 1623, etc.), copyrights (Venice 1544, England 1709, etc.), etc. Regulation of privileges Conscious stimulation of technical progress at national level, linked to economic policies (e.g. mercantilistic)
4.	Multinational patent era (Late 18th–late 19th cent.)	Emergence of modern nation states Industrialization Continued international diffusion of the patent system Local anti-patent movements Emerging international patent relations (e.g. disputes)
5.	International patent era (Late 19th–late 20th cent.)	Emerging industrial and military R&D International coordination of the patent system (Paris Convention 1883, WIPO, PCT, EPO, etc.) Separate IP regimes in socialist countries and LDCs
6.	The pro-patent/pro-IP era (Late 20th cent.–?)	Intellectual capital surpasses physical capital for many entities Intensified international competition Global activism for IP from industrialized countries, especially from the US (leading to TRIPS and the WTO) Almost worldwide adoption of the patent system Increased international patenting

Note:

1 Discerning eras, epochs or stages in a historical stream of events may be a useful sorting device but it always involves some arbitrariness, even if good criteria are used. (Here the degrees of codification and geographical diffusion of the patent system are used as primary criteria for distinguishing different eras.) Also, beneath the events that surface in an era is often an undercurrent of events that lead up to a later era.

An important event in the early diffusion of the patent system was the passage in 1623 of the Statute of Monopolies by the English Parliament, which gave a clear recognition of the underlying ideas and specific form of a patent system.[4] This later came to serve as a model, for example, for British colonies in North America, which started to adopt similar patent laws in the seventeenth century. An interesting feature of the statute was that although the patent granted monopoly privileges to the true and first inventor, the invention had to be new in England. This provision was intended to stimulate domestic technical progress (e.g. by attracting foreign engineers and entrepreneurs to England) and reflected concern by England's political leadership that the nation had fallen back in some technical areas and needed to catch up. The statute established a 14-year lifetime for a patent (twice the time needed for a master to train a generation of apprentices). A third interesting feature of the statute was its explicit shift of the granting authority from a royal ruler or sovereign to a government or its bureaucracy. The government was considered the source of patent rights, in contrast to the views that patent rights derived from sovereigns or were natural rights of the individual. The latter view underlined the French patent law at the time of the French Revolution in 1791 and lived on in nineteenth-century France.

Another important event was the US enactment of a federal patent law in 1790. The importance attached to patents and individual IPRs in the newly created USA is clear from the fact that the American Constitution stated that Congress had the power "to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries".

Thomas Jefferson played a key role in the early days of the US patent system. As Secretary of State he was responsible for administering the patent laws, and as a head of a newly created "Patent Board", he personally examined patent applications. He was noted for his opposition to monopolies but believed in the value of limited monopolies for authors and inventors. The new US patent system had a slow start, just as it had had in Venice three centuries earlier and would have in Japan a century later. The Act of 1793 made substantial changes, omitting the requirement that a patentable invention had to be "sufficiently useful and important". The examination of applications for novelty and usefulness was replaced by mere registration, making the issuing of patents more or less a clerical matter, and the Patent Board was abolished. The Patent Act of 1836 in essence reestablished the examination system that had been in place until 1793 and created an executive Patent Office as a separate bureau within the Department of State. The US Patent Office created by the 1836 Act was administered by a Commissioner of Patents, appointed by the President upon approval by the Senate. The present US system for reviewing and administering the patents is largely based on the principles set forth in the Act of 1836.

Box 10.1 International IP conventions

The Paris International Convention for the Protection of Industrial Property of 1883 (the "Paris Convention") covering patents, trademarks, and designs and the accompanying Berne Convention for the Protection of Literary and Artistic Works of 1886 covering copyright and some related rights were the results of complex interplay between different interests during preceding decades. Switzerland without a patent system at the time but with an increasingly pro-patent watch industry was one of the countries active in pulling through the Paris Convention (plus housing the Berne Convention) and was entrusted with secretariats to administer and supervise these conventions. The secretariats shortly thereafter merged into a bureau ("BIRPI"). In 1967 it was reorganized as the World Intellectual Property Organization (WIPO). Largely through the diplomatic efforts of the former US representative to the Paris Union and the Berne Union (respectively consisting of the signatories to the Paris Convention and the Berne Convention), WIPO later became a United Nations agency in 1974.

The Paris Convention is based on two major principles: (*a*) Foreigners and foreign patent applications should receive the same treatment in a member state as domestic applicants and applications (non-discrimination); (*b*) a priority claim established in one member state should be recognized by all others, i.e. once an application for a patent is filed in a member state, the applicant can within twelve months file a patent application for the same invention in any other member state, which must regard the latter applications as being filed on the date of the original first application.

10.2.3 The Multinational Patent Era

The period from the late eighteenth to the late nineteenth century was characterized by the diffusion of the patent system throughout the industrial and industrializing economies, though at an uneven rate and not without setbacks. An anti-patent movement emerged in Germany and somewhat later in Holland, where patent laws were repealed in 1869, and Switzerland rejected several patent law proposals. Even England considered a proposal to weaken significantly her patent laws, and France had already weakened patent protection at the time of the French Revolution.

The anti-patent movement was a consequence of free trade and anti-monopoly movements which considered patents to be associated with mercantilist policies and monopoly privileges. However, interest groups in emerging industries and in some strong-patent nations created pro-patent lobbying groups that gradually gained influence. Finally, the worldwide depression in the 1870s revived protectionism and the anti-patent era by and large ended in the 1870s.

The case of Switzerland provides an interesting illustration of the forces affecting the international diffusion of the patent system. After popular referendums in 1866 and 1882 had rejected proposals to
p. 271 introduce patent laws, Switzerland finally ↳ approved such laws in a referendum in 1887, mainly because its important watch industry was under pressure from foreign imitations. However, the 1887 law limited patent protection within Swiss borders to mechanical inventions, since firms in the emerging Swiss chemical industry wanted to imitate and catch up with the more advanced German chemical industry. After Germany threatened Swiss chemical firms with retaliatory tariffs, Switzerland extended its patent coverage to include chemical process (but not product) inventions in 1907 (see Penrose 1951 and Kaufer 1989).

10.2.4 The International Patent Era

Eventually the patent system was widely adopted, concomitant with the growth of international trade and competition in industrial goods. Nation states adopted various policies for promoting their industries, policies that often discriminated against foreign individuals or firms, in turn creating a need for international cooperation in patent matters. The Paris Convention of 1883 was the first milestone in this respect, followed by several other treaties and agreements, such as the Berne Convention for copyrights in 1886, covering a wide range of IPRs (see Box 10.1).

The emergence of industrial R&D in the twentieth century transformed the modes and settings for innovative work. The individual inventor, who was the original target for patent laws, gradually became less important. Inventions increasingly required large resources, and industrial firms became the prime movers of technology in both the East and the West. Economic and industrial differences between various categories of nations increased and became alarmingly large, creating tension among institutions, including national IP regimes in developed and developing nations. Science and technology progressed and accumulated tremendously at an increasing pace. Nonetheless, the IP system and its essential ideas survived and continued to spread internationally, not least after the downfall of the Soviet Union and other planned economies.

International harmonization of the world's patent systems received a new impetus after the end of World War II, as part of a broader set of efforts to establish or strengthen international organizations. A convention establishing the World Intellectual Property Organization—WIPO—was promulgated in 1967 by fifty-one governments, mostly from developed nations. WIPO joined the UN system in 1974 and thereby came under much stronger influence from developing countries. Although WIPO was established to administer and supervise various international IP treaties such as the Paris Convention, the organization also became involved in teaching, arbitration, and consultancy, and the processing of patent applications within the framework of the Patent Cooperation Treaty (PCT), signed in 1970 but not effective until 1978.
p. 272 This treaty was an important step in the process of ↳ international harmonization, since it established an international clearing house enabling a patent application to take effect in some or all of the PCT member states (103 in 1999) at the applicant's choosing.

In Europe the European Patent Convention (EPC), which was signed in 1973 and became effective in 1978, began a process for the adjustment of national patent laws of signatory nations (thirteen in 1986) to a European standard. The European Patent Office (EPO) was established in 1977 in Munich to process patent applications for the protection of an invention in some or all signatory nations. However, a patent issued by EPO is only a bundle of national patent rights that are enforceable according to the local law and court system in each national jurisdiction. A European Community Patent Convention was signed in 1975 to establish a unified European patent that would be valid in all member states, but this goal has not been achieved as of 2003. A key issue in the full harmonization of the European IPR system is the design of a court system and court procedures for enforcement, potentially including the creation of a single European Court of Appeal for IPR disputes similar to the US Court of Appeals for the Federal Circuit (CAFC), discussed below.

The case of Japan provides an interesting illustration of the creation of a patent system for the purpose of catching up with advanced nations. The visit by US Commodore Perry to Japan in 1852 demonstrated to Japanese leaders the power of modern military innovations and forced Japan to reopen the country to foreigners. The Meiji Restoration and its broad program of industrial modernization and "catch-up" led to Japan's first patent law in 1871. In the following decades, new laws were enacted for various IPRs (patents, trademarks, utility models, and designs), each of them modeled on various European and US laws. A Japanese Patent Office was established in 1885, with K. Takahashi, who subsequently served as Japan's Prime Minister, as its first Director General. The Japanese patent system evolved over the years into an important vehicle for catching up and promoting national interests. In the beginning, foreigners were

barred altogether from obtaining patent rights but became eligible when Japan in 1899 became a member of the Paris Convention.

The postwar IP system in Japan was but one component of a broader complex of policies for trade, industry, and technology that focused on reconstruction and "catch-up" with the West, especially the United States. Laws were passed in 1950 for regulating foreign investment, exchange, and trade, inaugurating a period of substantial technology imports from the US and Europe. Japanese government agencies and firms collected and analyzed technical information, including information disclosed in domestic and foreign patent documents, to evaluate technological developments abroad and within Japan. The Japanese requirement for publication of patent applications within eighteen months of the filing of an application (a policy similar to that of many European patent systems that was adopted by the United States only in 1999) supported domestic as well as international diffusion of technical information.

p. 273 The Japanese patent system limited both the number and scope of patent claims. Many Japanese firms acquired large portfolios of relatively narrow domestic patents and participated in dense patent networks (also in their foreign patenting, see Granstrand 1999). IP disputes were avoided and cross-licensing and diffusion of technical information were promoted by special features of Japanese patent laws and practices (see Ordover 1991). Use of patents (both foreign and domestic) by Japanese firms for technological "catch-up" purposes was facilitated by the often lax enforcement by Western firms of their IPRs, as well as the limited attention paid to dynamic competition and IP matters by Western nations until the 1980s.

Nonetheless, Japan supported international harmonization efforts. In 1978 Japan acceded to the PCT. The Japanese Patent Office (JPO), together with a small number (around ten) of other patent offices (in other PCT member states), was entrusted with authority to perform international searches for prior art to assess whether the novelty criterion for patentability was met. Japan subsequently became active in trilateral patent office cooperation among the EPO, JPO, and USPTO(United States Patent and Trademark Office), another vehicle for international coordination and harmonization among the industrial nations.

By 1999, 155 nations had adopted the Paris Convention, which in 1883 had been signed by ten. In 1994, another large step towards international harmonization was taken with the signing of the US-inspired TRIPS agreement (see Box 10.2), considered by most experts to be the most important international IPR agreement since the Paris Convention. The TRIPS agreement has been criticized for favoring developed nations and impeding economic development in developing ones. The least developed nations in particular, many of which lack the capabilities to enter a virtuous catch-up development circle by themselves, may be hindered by the TRIPS agreement, although most such nations have a considerable period of time to adhere to all of the provisions of TRIPS (see e.g. the collection of articles in Mansfield and Mansfield 2000).

Despite long-standing efforts to coordinate and harmonize the national patent laws, many important differences remain, and a global patent system, with international or global patents, seems far away.

10.2.5 The Pro-Patent Era

Towards the end of the twentieth century a new era—the pro-patent era—emerged, characterized by stronger enforcement of a broader array of IPR-holder rights and by additional efforts at international coordination and harmonization. The downfall of the Soviet empire and US diplomatic pressure contributed to a higher rate of convergence of IP regimes in the world, exemplified by the TRIPS agreement and the creation of the WTO (see below).

p. 274 Four developments in the United States led to the "pro-patent era" (see Table 10.2 for an overview). The first concerned the creation in 1982 of the Court of Appeals for the Federal Circuit (CAFC) to hear patent appeals in lieu of the other circuit courts of appeal.[5] This type of specialized court had been discussed for a

long time in patent circles.[6] As the complexity of patent disputes grew, the pressures within pro-patent circles in law and industry for a specialized court of appeals mounted and finally resulted in the creation of the CAFC. As many of its proponents had hoped, the CAFC began to act in a pro-patent manner, in contrast to what US courts had done previously. The validity of patents was upheld far more often (as if they were "born valid"), and patent damages were increased. The effect of the CAFC's creation and its decisions was to increase the economic value of patentholder rights.

A second factor behind the emergence of the pro-patent era was linked to a change of attitude within the Antitrust Division of the US Department of Justice in the early 1980s under Assistant Attorney General William Baxter. Since the late 1930s, the Antitrust Division had been hostile to IP legislation and IP licensing, interpreting patents as monopolies harming competition. Baxter was instrumental in shifting the Justice Department's enforcement policy to emphasize the role of patents in promoting innovation, emphasizing the dynamic benefits rather than the static costs. This change in attitude could be traced back to ideas and perspectives emerging in the 1960s among economists, especially within the emerging field of law and economics.[7] The shift in antitrust policy in the early 1980s in the USA is a good (albeit rare) example of how changes in scholarly thinking have had a direct impact on policies.

The third stream of events contributing to the rise of the pro-patent era came from large US corporations that pressed for stronger IP protection and enforcement against infringers and counterfeiters domestically and abroad. US industry also pressed for a "trade-based approach" to improve IP protection by including IP matters in US trade negotiations and in the GATT framework of international trade negotiations, resulting in a number of "trade related aspects of IPRs" (TRIPS) subjected to negotiations (see Box 10.2). These initiatives, which were spearheaded by US pharmaceuticals, entertainment, and electronics firms, were part of a larger upsurge in political concern over the competitiveness of US industry and a growing belief that technology was a key asset that had to be protected. Individual US corporations such as Texas Instruments and Motorola became aggressive litigators against both domestic and foreign, especially Japanese, infringers in the mid-1980s. Most of the largest awards of damages in patent infringement cases, however, occurred in litigation among US firms. A landmark case in this connection was *Polaroid Corp. v. Eastman Kodak*, which in 1991 resulted in a damages award to Polaroid of almost $US900 million.[8] Cases like these and the financial success of the litigation strategy of Texas Instruments were widely publicized and drew the attention of top corporate management to IP matters and the economic value of strong patent portfolios and well-conceived IP strategies.[9]

Box 10.2 Trade-Related aspects of Intellectual Property Rights—TRIPS

The idea of linking IP policies to trade policies can be traced far back in history (for instance, in the national patent era IPRs were often used in a mercantilistic way). The acronym TRIPS refers to a US initiative of the 1980s that sought to link more stringent, internationally harmonized IP policies to international trade policy. The US strategy was to move IPR issues from the auspices of WIPO (seen by US as too weak and narrowly focused) into the GATT Uruguay Round of multilateral trade negotiations in which the US had more influence. The outcome was a success for the US and its allies, but developing nations were frustrated. When the World Trade Organization (WTO) came into being in 1995 as a successor to GATT, the TRIPS agreement was one of its founding components. The agreement consisted of seven parts and seventy-three articles covering all aspects of IPRs, their enforcement and institutional arrangements. It provided general obligations regarding national nondiscrimination and transparency, it stipulated substantive minimum standards in almost all IPR areas (patents, copyrights, trademarks etc.) plus standards for effective enforcement of IPRs (also involving dispute settlement mechanisms at the WTO). It further set up a TRIPS Council for monitoring the operations of the agreement. Finally, transition periods were stipulated, giving one year for developed nations from entry into the WTO to comply with all TRIPS requirements and eleven years for least-developed nations (i.e. until 1 January 2006) with an option to request extensions. The TRIPS agreement implied particularly significant changes in the coverage of patents (forcing many nations to extend patent protection to chemical, pharmaceutical, and biotechnological inventions), requirements for protection of plant varieties, protection of computer software and effective measures to protect trademarks and trade secrets (see e.g. Maskus 2000 for details).

The TRIPS agreement of 1994 has been characterized as the most significant international harmonization effort of IPRs in history, certainly on par with the Paris Patent Convention of 1883. It also appears to become the most controversial one, perhaps creating an anti-IP movement of much larger international proportions than the anti-patent movement in Europe in the 1850s to 1870s. Particularly controversial issues concern developing nations' access to new technologies, especially drugs, and the effects of stronger IPRs on the efforts of these nations to catch-up economically (see e.g. Scherer 2004, Scherer and Watal 2002, and the chapters by Anawalt, Barton, and Verspagen in Granstrand 2003).

A fourth force behind the emergence of the pro-patent era was the US Government, especially the Reagan administration. This "political stream" was also related to the growing domestic concern of the 1980s for US industrial competitiveness, which included the widespread perception that a number of Asian economies were "free-riding" on US technology as they made significant inroads into US markets. In addition, US industrially funded R&D spending was growing slowly during the early 1980s with little or no increase in
p. 276 patenting. Meanwhile foreign corporations, ↳ especially Japanese firms, increased their patenting in the USA.[10] One component of a broader policy response to the perceived decline in US competitiveness was legislative action to strengthen IPRs and other incentives to invest in R&D (such as R&D tax credits and favorable conditions for the creation of R&D consortia), and to encourage patenting of the results of federally funded R&D to facilitate interinstitutional R&D collaboration and technology transfer. The Bayh–Dole Act of 1980 simplified the procedures under which US universities could patent and license the results of federally funded R&D (see Ch. 8 by Mowery and Sampat in this volume).

p. 277 **Table 10.2** Chronological overview of major events in US post-war IPR development (through 2000)

Year	Event
1949	Patents so frequently declared invalid when litigated that Supreme Court Justice Jackson remarks, “the only patent that is valid is one which this Court has not been able to get its hands on”. (Jungerson v. Ostby & Barton Co.)
1952	The present (as of 2003) US Patent Law is passed. Revisions have occurred continually.
1976	US Copyright Act enacted.
1979	US Senate and President Carter desire to strengthen domestic patent enforcement.
1980	US Supreme Court declares man-made microorganisms to be patentable and states in a dictum that “anything under the sun that is made by man” can be patented. Bayh–Dole Act enacted, facilitating for universities to patent inventions from federally funded research.
1981	The US Justice Department revises its antitrust enforcement activity to make it easier for patents not to violate antitrust statutes. US Supreme Court decision in the Diehr case leads through its USPTO interpretation to patentability of certain computer software.
1982	CAFC is established. In quick order, the court changes the validity of litigated patents from 30% to 89%, thus initiating an era in which patents are of much greater interest to industry.
1983	Patent Commissioners' trilateral conference started.
1985	WIPO Harmonization conference. USITC litigations increased. The Young Report delivered to President Reagan by the Commission on Industrial Competitiveness (headed by Hewlett-Packard's John Young).
1986	TI semiconductor patent litigation initiated at USITC. GATT TRIPS negotiations started.
1988	US Trade Act (Special 301). US Tariff Act 337 amended.
1989	The Structural Impediments Initiative (SII) talks initiated between the USA and Japan remove structural impediments to trade between the two nations, and include intellectual property protection. Japan on Watch List of Special 301.
1992	US Patent Law reform report. Honeywell won patent litigation against Minolta.
1993	GATT TRIPS negotiations completed.
1994	World's industrialized nations agree to harmonize aspects of their intellectual property protection under the auspices of GATT, known as the TRIPS agreement. US–Japan Patent Commissioners' Understanding signed. After years of favorable court decisions, all software is now clearly patentable.
1995	GATT-related TRIPS agreement causes USA (and other nations) to amend its patent laws to expand the patent term to 20 years from filing date (from previous 17 years from issuing date, thus giving mixed effects depending upon the application processing time at the USPTO), allow inventive activity abroad to be considered by the patent office, and permit the filing of provisional patent applications.

1998	The CAFC declares inventions of so-called business methods to be patentable (which include e.g. financial inventions, teaching methods, and e-commercial methods) in State Street Bank and Trust v. Signature Financial Group by stating that "since the 1952 Patent Act, business methods have been, and should have been, subject to the same legal requirements for patentability as applied to any other process or method". The Digital Millennium Copyright Act enacted.

The CAFC and the change in antitrust policies paved the way for effective domestic enforcement of existing US IP laws. The trade-based approach to IP legislation, however, focused primarily on international standards and enforcement of intellectual property protection. This effort was largely successful (from the US point of view), in part because the US Congress created leverage for US trade negotiators through a number of changes in US trade laws.[11] However, the propatent era, set in motion by the actions of US corporations and policy makers, gained ground internationally for other reasons as well. Technology-based MNCs, not only in the USA but also in Europe and especially in Japan, shared an interest in stronger international protection for intellectual property.

There is an ongoing debate, fueled by the bursting of the "IT bubble," as to whether in fact a new type of economy has emerged and what characterizes such a "New Economy". Although much of the "New Economy" rhetoric is now discredited, many scholars believe a new type of economyhas emerged, albeit gradually, in which intellectual capital has surpassed physical capital in importance. "Intellectual capitalism", then, refers to a capitalist economic system with a dominance of intellectual capital (see Granstrand 1999). What role did the IP system and the propatent era play in the emergence of "Intellectual capitalism"? A definitive answer to this question is difficult at this stage, but a few observations may still be in order.

ICTs are generally recognized as a key technological contributor to the emergence of "intellectual capitalism" as well as the "New Economy." It is natural to ask, therefore, how important the IP system was for the emergence of ICTs; let us consider some well-known cases. The transistor was patented at Bell Labs
p. 278 but ↳ licensed liberally (in part because of antitrust litigation and pressure from the US Justice Department). The subsequent emergence of the semiconductor industry was significantly spurred by public procurement and a lax IP regime (Mowery 1996). The same could be said about the emergence of Internet under the Defense Advanced Research Projects Agency (DARPA). The software industry also emerged under a lax IP regime (Samuelson 1993). The telecom industry was largely operated by national monopolies until the 1980s and 1990s, and IPRs played little role in the rapid advance of technology in this industry. Mobile telephony also emerged until the late 1980s under a lax IP regime (Granstrand 1999). The conclusion seems to be that the IP system has not been of major importance for the emergence of ICTs (at least not in the early stages). In fact it may even be argued that lax IP regimes were instrumental for the emergence of several ICT industries.

The strengthening of the IP regime may have reinforced some features of intellectual capitalism, but it appears that the pro-patent era was as much a consequence of intellectual capitalism as a cause of it, and that it was not a necessary condition for the emergence of the industries and technologies that fostered it.

10.3 Role of IPRs in Innovation Systems

10.3.1 Perspectives on IPRs

The IP system has over the years spawned a series of legal and economic controversies. Among the legal controversies is the nature of IPRs: are they rights in the first place? Couldn't a liability approach do better? Do they have to be exclusive and/or temporary rights? And if a right, what kind of right? Is it an individual natural (or moral) right or a right conferred to the individual by society, justified on the grounds that its consequences are beneficial to the society? These types of questions are primarily addressed by legal scholars in jurisprudence and, although important, will not be discussed further here.

As for economic issues, there has been a continuing discussion (with varying intensity) over the centuries about the pros and cons of the patent system. One key question is whether the system can correct for (or lead to) over-or underinvestment in R&D and innovation (from a societal point of view). Another issue is whether the system distorts, redirects, or blocks technological progress. Still another (but related) topic concerns how the patent system affects static and dynamic efficiency through its impact on competition and trade. For a classic review of these issues, see Machlup (1958); for a more recent contribution, see Mazzoleni and Nelson (1998).

p. 279 Surprisingly, for much of the twentieth century, economists devoted little attention to the patent system, and even less to other IPRs. From the 1960s onwards, however, the literature on the economics of IPRs, and patents in particular, has grown significantly. A seminal work in this category is Arrow (1962) who argued that, from society's point of view, private firms will underinvest in R&D because of their inability to appropriate sufficient returns of their R&D investments.[12] Following this view, patent protection can be justified as one of several alternative means, such as contracts, prizes, subsidies, and research consortia, to deal with this market failure. Alternative means to address market failures in the innovation process are also discussed by, among others, Wright (1983) and David (1993) emphasizing conditions and factors (such as uncertainty and elasticity of research supply) determining their relative advantages.

The opposite view, that capitalist economies may overinvest in R&D and innovation, also has its adherents. A number of recent theoretical contributions in industrial economics, growth theory, and behavioral finance examine this possibility, highlighting the ways in which competitive races affect incentives for innovation and can result in overinvestment in R&D. The intuition behind such models is that patent races may result in substantial duplication of R&D investments by the competing firms and lead to industry-wide levels of R&D investment for which the social returns may be less than the cost of the overall investment.[13] Such overinvestment is most likely in races in which rewards are skewed heavily to the early finishers. In this case agents face strong incentives to accelerate both the start and the completion of R&D projects (at least until rents are dissipated).

Thus appropriability problems may lead to underinvestment in innovation, e.g. in “waiting games”, on the one hand, or prospects of a quick success may lead to “patent races” that result in overinvestment. Which type of game is actually observed will depend on many circumstances. Most of this literature is theoretical, and few empirical studies have addressed these theories and models.

Another important issue that attracts considerable interest concerns the length of the time for which an inventor should be awarded a patent. For instance, Nordhaus (1969) argued that increasing the length of patent protection increases the incentives for investment in process innovation (and hence “dynamic efficiency”) but at the expense of “static efficiency” (since increased protection means less competition, higher prices, and slower diffusion). An “optimal patent length”, Nordhaus pointed out, involves a trade-

off between these two effects, and will depend on the nature of competition, the price elasticity of demand and the R&D elasticity of process cost reduction.

More recent research focuses on the optimal breadth or scope of a patent (see Jaffe 2000 for an overview) as well as optimal combinations of length and breadth (Klemperer 1990). The scope of a patent defines the range of its industrial applications by delineating the set of technological designs that the claims in the
p. 280 issued patent give protection to (i.e., exclusion of imitators). In most industrial-economy ↳ patent systems, patent scope is initially determined by negotiations between the applicant and a patent examiner; ultimately, however, the scope for "important" patents (those deemed by patentholder or competitors as especially valuable) is likely to be determined in the courts as a result of private lawsuits initiated by the patentholder or others.

The scope of a patent is far more difficult to parametrize than its duration. Thus, the "optimal" scope for patents is a very complex issue, as shown by Merges and Nelson (1990). The scope of a patent affects the private as well as the social rates of return from patented industrial innovations (just as the time duration of a patent does), and these returns will vary among industries and technologies. Accordingly, it is difficult for legislators to design an overall "optimal" patent system that fits equally well everywhere. For example, patent offices often issue broad patents to applicants pioneering in a new technological field characterized by little patent-based "prior art" and a great deal of uncertainty. (Such patents are often regarded as being too broad by ex post observers.)

In order to obtain a patent for an invention, the inventor has to disclose information. The resulting disclosure of patent information accelerates the diffusion of patented technical information, and may reduce duplicate R&D, induce substitute technologies (through "inventing around" an important patent), stimulate new ideas, direct R&D efforts to opportunity-rich areas or bottleneck problems, provide a basis for bench-marking and competitive intelligence, and stimulate technology exchange and cooperation.[14] Thus, the disclosure requirement is one of the key features of the patent system and a rationale behind it (see Ordover 1991). It should be kept in mind, however, that there are several other channels for dissemination than just disclosure of patent information, and that, in general, information about new technologies leaks out fairly quickly (see Mansfield 1985).

In summary, IPRs, particularly patents, play several important roles in innovation systems—to encourage innovation and investment in innovation, and to encourage dissemination (diffusion) of information about the principles and sources of innovation throughout the economy. However, as we shall see, the importance of these roles varies across sectors (industries) and countries, and over time.

10.3.2 Evidence on IPRs

Mansfield (1986), in an empirical study of US firms, shed light on the impact of a possible abolition of the patent system on the rate of invention and innovation, and concluded that the effects of abolition would be small in most industries. The exceptions were pharmaceuticals and chemicals, for which the patent system was shown to be essential. In spite of this evidence on the relatively modest effects of patents on innovation, however, the firms in Mansfield's study patented extensively.

p. 281 The propensity to utilize the patent system (instead of alternative means) is the subject of a large literature: see e.g. Scherer (1983) and Arundel and Kabla (1998). The Yale study by Levin, Nelson and others (Levin et al. 1987) investigated, through a survey of hundreds of R&D managers in the US in more than a hundred industries, sector-specific variations in appropriability conditions and the role of patents. Their study also concluded that innovations would continue to appear in the absence of patent protection, and that in general patents were not sufficient to appropriate or capture all benefits from innovation (once again, a significant exception to this general finding was pharmaceuticals, where patent protection was deemed to

be especially valuable). The Yale study was followed up by an expanded international study (the Carnegie–Mellon study), which revealed substantial nation-and sector-specific differences in the use of patents, secrecy, lead times and other means for appropriation of the returns from innovation (see e.g. Cohen et al. 2003). For instance, the latter study indicated that lead time and patents were the most important appropriation mechanisms for Japanese firms, while lead time and secrecy were most important for US firms.

A comparative study of Japanese and Swedish corporations, accounting for more than 50 per cent of industrial R&D in Japan and over 90 per cent in Sweden (Granstrand 1999), also shed light on this issue. Table 10.3 compares the results from this study with the results in Levin et al. (1987). As in the Carnegie–
p. 282 Mellon study, Japanese firms stand out by assigning greater importance to patent protection than ↳ firms from other countries. A 1988 study of Swiss firms, however, concluded that lead time was the most important mechanism for appropriating the returns from innovation, while patents ranked lowest (Harabi 1995). One has to interpret these results with care, though. First, the different mechanisms are to some extent complementary (both patents and secrecy may be seen asmeans to create lead time by increasing speed to market relative to competitors). Second, the attitudes of firms towards IPRs have changed recently, following the emergence of the pro-patent era. Particularly European industry in general was slow to adapt to this new environment.

Table 10.3 Means for commercializing new product technologies
(Scale: No importance = 0,1,2,3,4 = Major importance)

Means	Japan[1]	Sweden[1]	US[2]
Taking out patents to deter imitators (or to collect royalties)	3.3	1.9	2.0
Exercising secrecy	2.4	2.0	1.7
Creating market lead times	2.7	2.4	2.9
Creating production cost reductions	2.9	2.7	2.7
Creating superior marketing	2.7	3.0	3.1
Creating switching costs at user end	1.9	1.7	n.a.

Notes:

1 Sample of 24 large corporations. Perceptions for 1992.

2 As reported in Levin et al. (1987). Perceptions for mid-1980s, rescaled to the scale used in Granstrand (1999).

Source: Granstrand (1999).

10.3.3 Differences in IPRs across Sectors

As shown in most if not all studies of the role of IPRs, especially patents, differences across industries or sectors are strikingly large (see e.g. the studies by Mansfield, Scherer, Levin et al., and Cohen et al. cited above and also Malerba, Ch. 14 in this volume).[15] Table 10.4 provides an illustration of this for the sample of large Japanese companies mentioned above. Similar findings have also been reported for US and UK firms (Mansfield 1986, Taylor and Silberston 1973). Several explanations have been set forth for these inter-industry differences, including industry and market structure (competitive conditions, size and diversification of firms, barriers to entry, market growth, R&D intensity etc.), the nature of the technology (technological opportunities, codifiability, capital intensity etc.) and the nature of IPRs (patents for technology, copyright for software and creative industries, trademarks in mass consumer markets, etc.). But these largely static cross-industry comparisons rarely have incorporated considerations of the stage of industries' evolution.[16]

Table 10.4 Sensitivity of the R&D investments of large Japanese corporations to length of term (1992)

What would the effect be on your company's total R&D budget (as a rough percentage), if the maximum length of patent protection was:	Chemical (n=9)	Electrical (n=10)	Mechanical (n=5)	Total (n=24)
(a) Increased by 3 years	+8.5	+2.8	+0.3	+4.8
(b) Decreased to 10 years	−21.2	−3.7	−0.3	−10.7
(c) Decreased to 0 years (i.e. patent protection ceases)	−59.2	−40.0	−5.5	−38.2

Source: Granstrand (1999).

p. 283 As mentioned above, the role of a strong IP regime in emerging industries is ambiguous. There is some evidence that several leading-edge US industries based on ICTs developed after World War II under a fairly lax IP regime (see above). On the other hand, there also exist cases in which a strong IP regime has fostered the emergence of new leading-edge industries—pharmaceuticals and chemicals are among the best-known examples of such industries.

In general, patents are most likely to support the growth of knowledge-intensive industries in fields characterized by low ratios of imitation to innovation costs. Such low ratios are likely in areas with large-scale R&D projects, especially if the R&D results in highly codified knowledge, as in chemicals (see Table 10.4), and reverse engineering is cheap.[17] In such industries other institutional means to induce innovation than patents are also commonly employed, e.g. procurement contracts, consortia, or natural monopolies. However, many emerging industries are characterized by relatively low innovation costs and strong "first-mover advantages", making firms in such sectors less sensitive to free-rider problems and "waiting games" and, hence, reducing the importance of patents.

In the later stages of industry evolution, the R&D scale is often high, and barriers to entry tend to be built up by incumbents, especially against small firms (see e.g. Granstrand and Sjölander 1990, and Arora et al. 2001). The use of various patent portfolio strategies such as blanketing or "evergreening" together with litigation threats by large firms (both incumbents and diversifying entrants) may serve this purpose (see Granstrand 1999, 2004).[18] This may result in a division of R&D labor, in which small firms specialize in early-stage R&D, and license their new technologies to established firms specializing in later stages of the

innovation process, and/or seek to be acquired by established firms (rather than investing in production and marketing).

These intersectoral differences in the importance of IPRs have led several scholars to criticize the "one-size-fits-all" design of the patent system. Reform proposals have suggested a more differentiated industry tailored system, e.g. regarding patent duration or special new (*sui generis*) types of IPRs for certain industries such as software (see e.g. Thurow 1997 and Reichman 1994). Counterarguments to industry-specific schemes for IPRs emphasize the resulting high transaction costs, including IP administration costs, and the fact that a certain amount of industry tailoring already exists in the laws and practices of patent offices and courts. Perhaps because of these complexities, the debate over "industry-specific" patent systems has raged for many years with little or no action by industrial-economy governments.

10.3.4 Differences in IPRs across Nations

There is widespread consensus today that technical progress, the promotion of which is one of the purposes
p. 284 of the patent system, is the major determinant behind ↳ economic progress.[19] It is therefore logical to turn to economic history for evidence on the role of IPRs. However, a strong patent system has not been necessary for countries' industrialization and economic growth. Although many countries, including Japan, successfully industrialized in the presence of a patent system (see e.g. Dutton 1984), other countries such as Germany, Holland, and Switzerland did not (see e.g. Kaufer 1989). Schiff (1971), studying Holland and Switzerland, found no evidence that industrialization in these countries was hampered by the absence of a patent system. Moser (2003), studying two nineteenth-century world fairs (in London 1851 and Philadelphia 1876), found no evidence that strong patent laws increased national levels of innovative activities but concluded that they influenced the intersectoral distribution of innovative activities. Lerner (2000), examining 177 policy changes across sixty countries over the past 150 years, found that changes increasing patent protection had much stronger effect on inward patenting by foreigners than on patenting by domestic entities.

Thus the IPR system in general, and the patent system in particular, have been neither necessary nor sufficient for historically significant technical and/or economic progress at national and company level. Although hardly surprising, this is an important conclusion. There seems to be some consensus in the scholarly literature that the patent system has made positive contributions to technical progress, but these contributions are secondary and complementary to other factors, particularly other institutional developments such as a general property rights system (see North 1981 and Nelson 1993).

Moreover, current research provides little guidance on the potential contributions of an internationally strong patent system to the prospects for "catch-up" by the less developed countries in the contemporary world. Indeed, a certain amount of "free-riding" under a weak IP regime, elements of which are apparent in the nineteenthcentury United States or the Japanese economy of the 1950–80 period, may aid in successful catch-up. In this context TRIPS may be seen as an attempt by leading countries and companies to increase the economic payoffs of their R&D, making it more costly for developing countries to catch up.

10.4 Summary and Conclusions

Instruments, strategies, and policies for protection of IP, ranging from trade secrets and trademarks to copyrights and patents, have a long history. From this perspective, TRIPS is only the latest expression of the links between trade and intellectual property protection. Despite this long history, surprisingly little
p. 285 scholarly attention ↳ has been devoted to the study of intellectual property rights and innovation. One impetus for research on IPRs has been a series of controversies in various national jurisdictions over their effects. These controversies reveal many basic similarities across nations and centuries, although they often concern different types of IPRs (patent, copyrights, trademarks, design rights, etc.).

It seems fair to say that until recently the role of IPRs in national, sectoral and corporate innovation systems has been relatively modest (although not without exceptions). However, a US-originated pro-patent or pro-IP era has emerged since the 1980s, perhaps as a consequence rather than a cause of a much broader and gradual transition into a new type of capitalist economy that is based more heavily on knowledge (and information), innovation and intellectual capital. The consequences of the pro-IP era have been far-reaching and seem likely to broaden, since there are no signs of a reversal of these global trends. IPRs have been applied to more forms of intellectual property through extensions of old and creation of new types of rights; they have become more economically valuable and have assumed a more strategic role in national, sectoral and corporate innovation systems.

More research on the complex relations between IP and innovation is clearly needed, especially since the emergence of the pro-patent era has led to significant change and created new challenges (e.g. the so-called "anticommons" problem that stems from a proliferation of interdependent IPRs: see Heller and Eisenberg 1998 for a pioneering work). Future research in this area needs to focus on the interplay between economic, technical, and legal dynamics and, in a better way than before, link theoretical work with empirical longitudinal studies.

Notes

1. Helpful comments from the editors and participants in the TEARI-project and the assistance of Thomas Ewing are gratefully acknowledged.

2. Breeding rights refer to exclusive time limited rights to commercialize certain cultivated plant or animal varieties. Database rights refer to exclusive time limited rights to commercialize certain collections of data or content material, including literary, artistic, and musical works or collections of material such as texts, sound, images, numbers, and facts. However, the term "database" should in this context not be taken to extend to computer programs used in the making or operation of a database. Database rights exist in Europe since the mid-1990s (although with some older precedents) but not in the US, and has so far created a great deal of controversies.

3. The history of the term "patent" is interesting in this context. In English the term was short for "letters patent," in turn deriving from "litterae patentes," which in medieval Europe referred to sealed but open royal letters, granting the holders certain rights, privileges, titles, or offices. The term derives from Latin *patere*, meaning "to be open."

4. In fact, the patent monopoly rights became an exemption in the Statute of Monopolies, which generally limited monopoly
p. 286 privileges. The handing out of such privileges by the ↳ royalty had degenerated, and the English Parliament wanted to put an end to it, apparently recognizing the exceptional importance of technical progress.

5. See further the Federal Courts Improvement Act of 1982 and Dreyfuss (1989).

6. A proposal can e.g. be found in recommendations of the US Senate Committee TNEC from the 1940s, see Folk (1942: 281–95).

7. Prof. William Baxter, personal communications.

8. The total cost to Kodak was much more, however, since Kodak paid damages to customers and legal fees, had to shut down a plant and fire about 700 people, and lost investments and good will (see Granstrand 1999 and Rivette and Klein 1999). The original Polaroid damages claim was over $US 5 billion, which if awarded could bankrupt even a large corporation such as Eastman Kodak.

9. A number of law suits against (alleged) Japanese infringers were brought by US firms, and a number of out-of-court settlements also were reached among these parties. Royalty rates for licenses were also raised. In general, these events signified the outbreak of the so-called patent war between USA and Japan. (See Warchofsky (1994) and Granstrand (1999).) The increased management attention paid to patenting also contributed to the surge of patenting in the US (see Kortum and Lerner 1999), as well as in several other developed nations.

10. In fact, the share of foreigners' patenting in the USA rose from 22 per cent in 1967 to 40 per cent in 1980 (Evenson in Griliches 1984, p. 92).

11. Important new trade legislation included the Trade and Tariff Act of 1984, which included Section 301 (authorizing US government to take retaliatory action against countries judged to give an inadequate IP protection) and Section 501 (authorizing the President to judge the adequacy of IP protection in granting tariff preferences to a country), combining to a stick and carrot approach. The Omnibus Trade and Competitiveness Act of 1988 moved further along these lines with a "Special 301" that required the US Trade Representative to watch, identify and investigate foreign states denying adequate IP protection to US firms.

12. Empirical studies have followed this up by collecting data on imitation costs and times in relation to innovation costs and times for a number of sectors. Patents do increase imitation costs, especially in pharmaceuticals, but apart from that industry, patents have not been essential for the rate of innovations, at least not before the pro-patent era. (See in particular Mansfield et al. 1981. See also below.)

13. Central references in this literature include Scherer (1966, 1967), Barzel (1968), Dasgupta and Stiglitz (1980), Fudenberg et al. (1983), and Aghion and Howitt (1992). For overviews, see Baldwin and Scott (1987), Tirole (1988), Romer (1996) and Aghion and Howitt (1998).

14. There is in fact a whole service industry emerging around the processing of patent information for various purposes. Japan is a nation that has significantly fostered and benefitted from patent information analysis through methods subsumed under "patent mapping". Disclosure of patent information imposes a disadvantage upon patentees but its perceived advantages to patentees were found to be significantly higher in Japanese firms (see Granstrand 1999).

15. Cross-national differences might be larger than industry differences, however, as was the case between Japan and Sweden in Granstrand (1999). One has also to keep in mind that firms are diversified and more so regarding their patent portfolio than their product portfolio (see Pavitt 1999).

p. 287 16. An exception to this statement is the longitudinal study of patenting behaviour in an industry by Hall and Ziedonis (2001).

17. Note that both secrecy building and secrecy breaking in itself is technology dependent and thus results in cost changes as new technologies appear (e.g. in cryptography and chemical analysis).

18. "Evergreening" refers to a patent strategy aimed at prolonging the effective duration of patent protection in a business area through continually patenting related inventions, often incremental ones covering product and process improvements and new applications, as well as through patenting new, emerging technologies for technology transitions into new product generations in the area.

19. Note that a patent is granted to a technical invention based on whether it is novel to the world and non-obvious (i.e. its technical advance has a certain size, i.e. it fulfills a minimum inventive step requirement) but not based on its economic merits (apart from a general requirement of industrial applicability or usefulness of the invention), although the underlying assumption is that by so doing, economic progress will be stimulated.

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