11

Selling Ideas

Global Markets for Patented Inventions

> There is no patron to be compared with the public. . . . The natural reward of inventions . . . is the profit to be derived from them in the way of trade.
>
> —Jeremy Bentham (1825)[1]

Early economists explored the links between the expansion of competitive markets to economic growth and the relationship between new ideas and advances in productivity. If administrators offered rewards for inventions, they noted, inevitable errors in judgment would result in the misallocation of resources. In free markets, by contrast, ideas that added value to consumers and producers would garner rewards, whereas useless proposals would simply be ignored and their creators would bear the cost themselves. As Adam Smith pointed out, "if the invention be good and such as is profitable to mankind, he will probably make a fortune by it; but if it be of no value he will also reap no benefit."[2] American patent rules were based on the same precept that market demand, rather than courts or administrators, was the most effective arbiter of value. Supreme Court Justice Joseph Story and other members of the judiciary echoed the Smithian perspective when they ruled that the utility of the invention "is a circumstance very material to the interest of the patentee, but of no importance to the public. If it is not extensively useful, it will silently sink into contempt and disregard."[3]

Patents provided property rights in inventions and enforcement that facilitated markets in ideas. Many of the great inventors exploited personal connections that allowed them to readily tap into capital markets.[4] However, the majority of innovative patentees lacked either the desire or ready access to the means to directly commercialize their inventions, and technology markets allowed them to

[1] Bentham (1825: 68, 321).
[2] *Lectures on Jurisprudence* (1982 ed.), p. 103.
[3] *Lowell v. Lewis*, 15 F. Cas. 1018 (1817). "The popular demand for an article is, in the long run, the best test of utility," *Turrel v. Spalth*, 14 O.G. 377 (1878).
[4] Khan and Sokoloff (2006).

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specialize in inventive activity and obtain returns from the sale or licensing of their rights. Well-enforced property rights in invention facilitated the securitization of ideas, which allowed inventors to benefit by selling their ideas to third parties. In short, defining and enforcing a tradable asset in new technological knowledge was central to the evolution of open markets in technology, in part because such incentives for investment in inventive activity were especially important to relatively disadvantaged groups who would otherwise have found it difficult to benefit from their technological creativity.[5]

For instance, Francis Strong and Thomas Ross were two young New England mechanics "of limited means and compelled to rely upon their daily labor for their support" who would go on to devise six valuable patented inventions for platform scales. Strong was a journeyman at an iron foundry, and Ross was an immigrant apprentice in a small town in Vermont. The two collaborated on ingenious improvements that resulted in extremely sensitive platform scales, several tons in size, that could allegedly detect the weight of a penny. The patented scales were durable and impervious to the harsh cold and heat, operated equally well on a steep incline, and could be constructed by unskilled workers. However, "large capital was necessary to enable the inventors to compete successfully with the wealthy manufacturing establishment which . . . had a practical monopoly of the business. This they did not possess."[6]

The inventors were able to tap into the market for patents to finance their inventive activity. John Howe Jr., a very wealthy manufacturer of iron wheels, was impressed with their demonstration. He advanced a payment of $2,000 out of future royalties on the patent to allow the partners to meet their debts. His firm also retained Strong and Ross on a five-year employment contract, which included royalties on all scales sold. After six years, Howe bought the initial 1856 patent outright for $15,000 and paid $75,000 for the rest of the patents.[7] John Howe Jr. joined with his brother Frank in 1864 to open the Howe Scale Company, which became of one of Vermont's most important businesses. The manufacturers and their agents displayed the scales at numerous exhibitions and widely advertised all the premiums that the innovation had accumulated ("seven within sixty days"), highlighting the awards from the Franklin Institute exhibition. The

[5] Khan and Sokoloff (2004).

[6] Statement in *Decisions of the Commissioner of Patents*, granting the extension of the patent, January 6, 1871, notice of which was reported overseas. According to the *Encyclopedia of Vermont Biography* (1912), p. 328, "This scale, which had its inception in the little iron foundry of Vergennes, is accepted by all civilized nations as a standard of weights." The scales were demanded as far afield as Russia and Asia, and throughout South America. Litigation in 1879 provides details on the numerous assignments and subassignments that still characterized the market for the Strong and Ross patents. *Brandon Mfg Company v. David W. Prime*, 16 Blatchf. 453 (1879).

[7] In 1870, at the age of forty, Francis Strong held a portfolio of $70,000 in personal and real estate assets.

business was later acquired by the Brandon Manufacturing Company, largely because of the valuable patent rights, which firmly established the town of Brandon as a major producer of scales for the global market.

Globalization of Markets in Ideas

Observed changes over time in international comparative advantage in technological innovation and industry support the claim that intellectual property rights mattered. Crucial advances in global technology increasingly originated in the United States, and its position as a leading industrial nation had become evident by the so-called second Industrial Revolution that started around the 1870s. American patentees who were benefiting from the well-articulated domestic market for ideas extended the scope of their patenting and licensing activities to other countries. Foreign observers were convinced that American success at economic growth and innovation was related to its institutions to protect intellectual property, and this encouraged the harmonization of intellectual property laws across nations in the direction of the U.S. patent system.[8] American participation in global technology markets gathered momentum and consolidated early in the twentieth century.[9] In the process, innovative U.S. enterprises began to flourish and dominate both national and foreign markets.

The Singer Manufacturing Company offers an early example of the many American patentees who secured a prominent position in the global market for innovations and patented products.[10] Singer's claims as the inventor of key sewing machine improvements are debatable, but he was undoubtedly an exceptional innovator and entrepreneur (Figure 11.1). His enterprise was one of the largest in the United States and utilized modern techniques of product placement and marketing. Singer was an important player in the market for patent rights, building up a large portfolio of overlapping intellectual property rights. The company further secured their own patents in France and England and subsequently expanded their factory operations throughout Europe. Other corporations, such as Wheeler & Wilson, followed similar measures to retain their relative advantage in the industry. The sewing machine oligopoly became notorious for its pooling of patents and cross-licensing, and in the process large-scale U.S. enterprises began to flourish in both national and foreign markets.

[8] Penrose (1951).
[9] Wilkins (1974, 1988).
[10] Adam Mossoff (2011) provides an insightful analysis of the "sewing machine wars" at the middle of the nineteenth century. See also Davies (1969).

Figure 11.1 Singer Manufacturing Company in Global Markets
Isaac Singer was able to leverage his patents for improvements in sewing machines into dominance of "universal markets" (as the company claimed) through commercialization and the adept use of marketing techniques. In the battle for medals and other awards, Singer claimed to have amassed over two hundred prizes by the 1880s.

Source: Library of Congress.

Theoretical models in international economics suggest that exchange across countries creates the potential for greater access to a portfolio of higher-quality innovations. International trade in technology also tends to lower prices and increase output and variety in the marketplace, resulting in net gains from trade, and growth in national income for both sides of the market. Analyses of the relationship between relative market size and productivity at inventive activity indicate that strongly enforced intellectual property rights and patents were more effective in relatively larger markets, whereas less innovative countries initially benefited from furthering the interests of consumers rather than producers. Patenting and technology transfers in U.S. multinational enterprises typically increase when intellectual property rights are strengthened.[11] However, links between technological exchanges across countries and economic progress are complex and would benefit from further empirical investigation.

This chapter presents a comparative analysis of markets for inventions and patents across a diverse sample of countries over time. Patent assignments, or the sale of patent rights, provide an index of trade within national markets in technology over time. Further, foreign patenting, or the propensity of inventors to obtain property rights in other countries, is a proxy for transfers of important technologies across global markets. Foreign patentees seek to obtain rights in other countries for a number of reasons, ranging from the intent to appropriate returns from valuable inventions with a global market demand to the wish to protect a manufacturing enterprise producing the patented product in the foreign locale. Such patentees may have also filed for protection overseas to forestall on potential competition by employing their patent monopolies to block imitators or inhibit cumulative invention. Thus, assignments and foreign patenting offer different but complementary perspectives on markets in invention across countries.

Inventive activity and innovation markets were affected by institutional differences in the United States, Britain, Canada, New South Wales, Spain, Germany, and Japan during the nineteenth and early twentieth centuries. The discussion in this chapter first identifies salient features of patent rights and legal institutions in these different jurisdictions. The second part assesses the nature of technology markets and reports the results from quantitative analyses of factors that affected changes in patent assignments and foreign patenting. The final part highlights a case study of the market for technology in the chemical industry and further sheds light on foreign patenting and innovation markets in the United States. The overall findings confirm that the design of U.S. patent institutions enhanced the scope and efficiency of markets in ideas.

[11] Branstetter et al. (2006).

International Patent Institutions

Over the course of the first Industrial Revolution, evidence accumulated that technological progress was capable of altering the fate of nations, and appreciation of the potential importance of national technology policies grew over this era. As the chapters on France and Britain showed, an extensive variety of schemes were considered and implemented at one time or another, including grants, subsidies, procurement and investments by the government, cash prizes and honorary awards, and permanent monopoly privileges. However, by the end of the nineteenth century, non-market-oriented administered systems had lost favor, and patent systems emerged as the dominant method by which national governments attempted to promote the progress of new ideas, inventiveness, and economic growth. Despite the international consensus about the importance of patent laws and their enforcement, important differences existed across countries in how intellectual property institutions were structured (Table 11.1). Such differences persisted even after a series of international conventions over the 1870s and 1880s pursued uniformity in patent rules and standards.

Britain's early lead in industrialization and in new technological information was waning by the middle of the nineteenth century, and many attributed the loss of their competitive advantage to defects in the structure and management of British patent institutions. Jeremy Bentham was disparaging of the British system, in which an inventor

> goes with a joyful heart, to the public office to ask for his patent. But what does he encounter? Clerks, lawyers, and officers of state, who reap beforehand the fruits of his industry. This privilege is not given, but is, in fact, sold for from 100*l*. to 200*l*.: sums greater perhaps than he ever possessed in his life. He finds himself caught in a snare, which the law, or rather extortion, which has obtained the force of law, has spread for the industrious inventor. It is a tax levied upon ingenuity, and no man can set bounds to the value of the services it may have lost to the nation.[12]

British patent laws, administration, and enforcement disadvantaged the granting of property rights to inventors of smaller inventions and individuals with fewer financial resources, and they did little to encourage effective trade in technological information. Patent rights involved high monetary and transaction costs, and patent fees were deliberately set as a filter that selected inventors and inventions by the wealth of the applicant and rejected poor inventors and

[12] Bentham (1825: 73).

Table 11.1 International Patent Systems

	Examination System	Restrictions on Patent	Equal Treatment for Foreign Inventors	Cost
Canada				
1850	N	Y	N	Expensive
1870	Y	Y	Y	Cheap
1900	Y	Y	Y	Cheap
1920	Y	Y	Y	Cheap
Germany				
1900	Y	Y	Y	Expensive
1920	Y	Y	Y	Expensive
Japan				
1900	Y	Y	N	Moderate
1920	Y	Y	N	Moderate
New South Wales				
1870	N	N	Y	Expensive
1900	N	N	Y	Cheap
1920	Y	Y	Y	Cheap
Spain				
1850	N	Y	Y	Costly
1870	N	Y	Y	Costly
1900	N	Y	Y	Moderate
1920	N	Y	Y	Moderate
United Kingdom				
1850	N	N	Y	Expensive
1870	N	Y	Y	Expensive
1900	N	Y	Y	Expensive
1920	Y	Y	Y	Expensive
United States				
1850	Y	N	N	Cheap
1870	Y	N	Y	Cheap

Continued

Table 11.1 *Continued*

	Examination System	Restrictions on Patent	Equal Treatment for Foreign Inventors	Cost
United States				
1900	Y	N	Y	Cheap
1920	Y	N	Y	Cheap

Notes:

Cost: The code for cost indicates the estimated cost in current U.S. dollars for a patent taken to its full term; Cheap: Below $100; Moderate: $100–$250; Costly: $250–$400; Expensive: above $400.

Examination: The U.S. examination was the most stringent, consisting of a worldwide search for novelty. Britain's searches extended just to British patents filed in the previous fifty years and did not include foreign specifications. Spanish rules did not require novelty; patents were granted as long as they had not been previously practiced in Spain.

Restrictions: Primarily working requirements and/or compulsory licenses.

Treatment of foreign inventors: Before 1869, inventors who were not subjects of the queen could not obtain patents in British Canada. In Japan, foreigners could obtain patents only if their country had entered into a treaty with Japan; nonresidents had to be represented by a registered Japanese patent attorney or the patent right would be revoked. The earliest U.S. statutes restricted rights in patent property to citizens or to residents who declared their intention to become citizens. The first patent statute of April 1790 made no distinction regarding citizenship, but in 1793 patents were limited to citizens of the United States. In 1800 patent rights were extended to foreigners living in the United States for two years who swore that the invention was new to the world. The 1832 Patent Act allowed patents to resident aliens who intended to become citizens, provided that they introduced the invention into public use within one year, a period that was changed to eighteen months with the 1836 reforms. In 1836, the stipulations on citizenship or residency were removed but were replaced with discriminatory patent fees that retaliated for the significantly higher fees charged in other countries: nonresident foreigners could obtain a patent in the United States for a fee of $300, or $500 if they were British. The patent laws that stipulated discriminatory treatment of foreign nonresidents were repealed in 1861, and utility patent rights were available to all applicants on the same basis without regard to nationality. After 1904, New South Wales patents were granted as part of the federal system of the Commonwealth of Australia.

Sources: John Kingsley and Joseph Piesson, *Laws and Practice of All Nations and Governments Relating to Patents of Inventions* (New York, 1848); Fitch and Co., *United States and International Patent Office Manual* (New York, 1871); British and European Patent Agency, *Epitome of the World's Patent Laws and Statistics* (New York, 1891); Arthur Greeley, *Foreign Patent and Trademark Laws* (Washington, DC, 1899); W. P. Thompson, *Handbook of Patent Law of All Countries* (London, 1920).

"small inventions." Legal enforcement initially was questionable, with arbitrary judicial decisions that overturned even patents that had proven to be valuable in the marketplace. The law did not offer any relief to the purchaser of an invalid or worthless patent, so potential buyers in the market for ideas had to engage in costly searches before entering into contracts.

At the same time, ineffective provisions for public disclosure of the full specification (technical description) of patented inventions resulted in asymmetrical information between buyers and sellers that further hindered the market in technology. Policymakers were suspicious of "stock jobbing" and vigilant to

protect an unsuspecting public from fraudulent financial schemes on the scale of the South Sea Bubble, so ownership of patent rights was limited to five investors (later extended to twelve). The uncertainty that was inherent in the registration system added to the demand for specialized professionals who interceded on behalf of the applicant for a fee. Potential conflicts of interest arose when clerks employed at the Patent Office acted as agents, and a number of patent agents followed their self-interest and lobbied against reforms that would reduce the inefficiencies in the law. In short, despite its "firstcomer" status, the network of innovation and legal institutions in Britain hampered the potential for sustained growth in inventive activity and markets in patents.

Large numbers of interested parties, such as the renowned metallurgist and patentee Sir Robert Abbott Hadfield (1858–1940), voiced dissatisfaction with the pace and nature of institutional change in Britain. Hadfield was echoing complaints like Bentham's in the nineteenth century when he observed that "invention is discouraged by excessive fees, by inadequate preliminary search of the patent records, and by the complexity of the rules." In the early twentieth century, he advocated "a radical revision of the whole system after the American model, and he gives point to his suggestion by comparing the number of patents taken out in Great Britain and the United States. This suggestion, coming from a man who has taken out several hundred patents in England and abroad, is worthy of attention, but there are no indications that it is likely to be adopted."[13] Despite the inflexibility in its domestic institutions, patent systems in the British overseas jurisdictions were allowed some degree of autonomy, as the examples of New South Wales and its sister colonies in Australia indicate.

Institutions that allow for widespread democratic access were disproportionately associated with advances in economic and social welfare, as Stanley Engerman and Kenneth Sokoloff have demonstrated.[14] So it is not coincidental that patent institutions in the United States were based on the notion that, regardless of their identities, all inventors should have the opportunity to obtain and exploit rights to their creativity. Observers in other countries acknowledged that the American system was the most favorable in the world to all patentees, and its markets in patent rights were the most developed. A nineteenth-century English treatise on the law and practice of patents was merely echoing a common perspective when it stated that "in no country in the world are the rights of inventors more cherished than in the United States, and the number of patents issued there annually far exceeds that granted in any other country."[15] Large numbers of differentiated versions of a product could be protected, leading to a rapid expansion of available choices in the market for final goods. "The protection afforded by the

[13] U.S. Bureau of Foreign and Domestic Commerce, *Special Agents Series* (1920), p. 50.
[14] Engerman and Sokoloff (2012).
[15] Johnson and Johnson (1890: 422).

patent and the hope of reward have proved the incentives to invention, and the public, enabled to choose from many devices, obtains the best thing."[16]

From the beginning, policymakers in the United States had the objective of promoting extensive markets in patent rights.[17] Both the patent system and legal institutions were market oriented and likewise encouraged extensive trade in patented technologies. The first statute of 1790 included a special provision for keeping a national registry of all assignments (sales of patent rights), which made it easy to trace ownership and transactions in patented inventions. The patent agency of Munn & Company smugly noted:

> From January 1, 1865 to the 1st of December, the whole number of applications for patents to the British Patent Office will not have exceeded three thousand. Within the same period the applications made by Munn & Co. to the United States Patent Office number at least three thousand five hundred; thus showing that our professional business considerably exceeds the entire business of the British Patent Office.[18]

Patent agents in the United States acknowledged that the application process was so straightforward that inventors could prosecute a claim by themselves, and the primary role of intermediaries was in commercialization and market placement.[19]

American patent policy was exceptional in its insistence on affordable fees. The legislature debated the question of appropriate fees, and the first patent law in 1790 set the rate at the minimal sum of $3.70 plus copy costs. The 1869 *Report of the Commissioner of Patents* compared the $35 fee for a U.S. patent to the significantly higher charges in European countries such as Britain ($875), France ($300), Russia ($450), Belgium ($420), and Austria ($350). The commissioner pointed out that in the United States the fees were not intended to exact a price for the patent privilege or to raise revenues for the state—the disclosure of information was the price of the patent property right; rather, they were imposed merely to cover the administrative expenses of the Patent Office.[20]

Samuel Fisher, Commissioner of Patents, presented an insightful synopsis of the functions of the American patent system. It was impossible for society to offer inventors ample compensation for their contributions through some form

[16] *Annual Report of the Commissioner of Patents* (1869), p. 8.
[17] Khan (2005).
[18] *Scientific American* 13 (1865): 415.
[19] *Scientific American*, which was associated with the patent agency of Munn & Co., noted, "we advise every inventor who is able, to make application for himself, and thereby save some expense. There are forms and rules that will require study, but you can soon master them."
[20] *Report* (1869), pp. 4–9.

of administered process. Instead, he noted, the recompense is made in terms of time, by carving out a period during which inventors themselves can obtain financial rewards by taking advantage of market demand. The primary feature of the American patent system since 1836 was that all applications were subject to an examination for conformity with the laws and for novelty. The financial cost of an examination by the Patent Office was just $15, and Fisher was certain that both the private and social cost of patenting were lower in a system of impartial specialized examiners than under a system where similar services were performed on a fee-per-service basis by private solicitors on behalf of clients. The Patent Office was one of the few agencies that was consistently self-supporting financially throughout the century, but this was due to economies of scale in administration rather than to overly high fees.

The examination process, the central feature of the "American system," enabled early reviews of the technical validity of the patent grant. This certification helped to reduce uncertainty about inventive property, facilitated enforcement of rights, and furthered trade in patented technologies. As Chapter 9 discussed, American legislators from the very beginning realized that the diffusion of information would benefit both private and social welfare. They took particular care to ensure that details about the stock of patented knowledge was accessible, usable, and rapidly transmitted at low cost to interested members of the public.

Another fundamental principle of the American system, as Table 11.1 shows, is that the property right was unconditional. Once a patent was issued to the inventor, the validity was assured, and fraud constituted the only reason that courts accepted for overturning a patent grant. Property rights in new ideas wholly belonged to their creators, perhaps more securely than for the holders of titles in land, since there was no doctrine of eminent domain to expropriate owners of inventions. The United States universally rejected efforts to curtail the rights of patentees and did not distinguish between "practicing inventors" and nonpracticing entities. Working requirements or compulsory licenses were regarded as unwarranted infringements of the rights of meritorious inventors. In short, American patent laws provided strong protection for citizens of the United States and, after 1861, such rights were available to all applicants on the same basis without regard to nationality or residence.[21]

[21] See Khan (2005). The earliest statutes restricted patent property to citizens or to residents who declared their intention to become citizens. However, these provisions were not strictly enforced, and numerous foreign inventors were able to obtain patent rights by petitioning the legislature. In 1836, the stipulations on citizenship or residency were removed, but in retaliation for the high patent fees that Americans were charged overseas, foreigners could obtain a patent in the United States for a fee of $300, or $500 if they were British. The sole exception to this equal treatment was in times of war, when different policies were implemented against enemy combatants, but even they were later able to claim compensation.

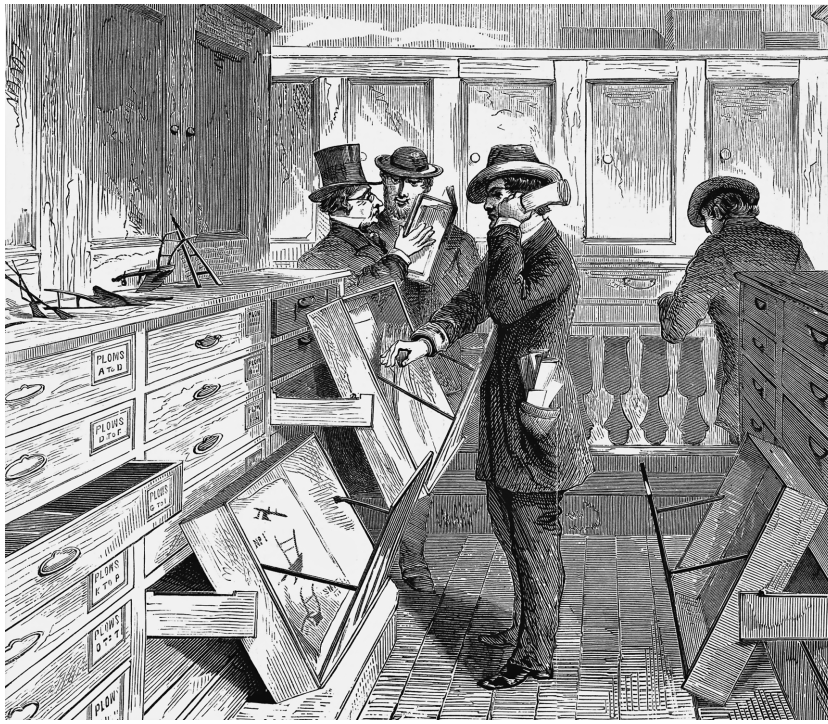

Figure 11.2 Patent Examiners at the U.S. Patent Office
Patent examiners in the nineteenth century, as today, were highly specialized in specific technological areas and identified the technical novelty of applications in accordance with the law. The patent examination process never attempted to gauge usefulness or commercial value, and it was up to the patentee to obtain returns in the marketplace. The examination system helped to secure property rights and facilitated markets in ideas.
Source: Library of Congress.

In the international sphere, lobbying by U.S. interest groups succeeded in overcoming controversies about patents, and intellectual property systems proliferated among the newly developing countries that followed the American lead. Their patent policies, however, were not entirely aligned with the orientation or objectives that motivated American intellectual property rights. When follower countries decided to establish or revise their patent rules, they modified existing institutions to fit their own particular needs. As might be expected, countries like Spain adopted patent systems that were very much focused on securing flows of technology from abroad, especially technological knowledge that was embodied in actual production. Patents of introduction were granted to any entrepreneur who wished to produce foreign technologies that were new to Spain, even if they were not the inventor. Patentees were required to work the patent or else the

Table 11.2 Patent Grants in Select Countries, 1800–1930

	1800–1870	1871–1900	1901–1930	1800–1930
Canada	87	2,241	7,662	2,815
Population	1.2	4.7	8.2	3.6
Germany	—	4,975	14,534	8,802
Population	—	47.3	67.0	56.4
Japan	—	262	2,390	1,650
Population	31.5	38.6	53.8	33.8
New South Wales	34	220	357	220
Population	0.07	1.0	1.9	0.41
Spain	62	938	3,020	1,176
Population	13.5	17.4	20.6	15.9
United Kingdom	706	7910	15,327	5,704
Population	25.4	36.3	46.5	30.1
United States	1,692	18,453	37,380	13,703
Population	15.3	58.2	102.5	30.0
US patents as % of total	65.6	61.5	56.5	—

Notes and Sources: The table shows annual average patents granted in each subperiod and population (in millions) at the midpoint of each period. Patent statistics are from P. J. Federico, "Historical Patent Statistics 1791–1961," *Journal of the Patent Office Society* 46 (February 1964): 89–171, and from annual reports of patent offices in each country. The data for New South Wales ranges from 1854 to 1920; for Germany from 1871 to 1930, excluding 1914–1919; and for Japan from 1885. Population data are from B. R. Mitchell, *International Historical Statistics, 1750–2005* (London, 2007).

invention would revert to the public domain.[22] Since patents of introduction had a brief term, they encouraged the production of items with immediate profits and a quick payback period.

Shortly after the end of the Civil War, American patentees expanded to international markets, and many began to attain dominant positions throughout the world economy (Table 11.2). In response, other countries implemented policies to protect and to moderate the potential negative impact on influential domestic interest groups. Britain introduced compulsory licenses in 1883 for fear that foreign inventors might injure British industry by refusing to grant other

[22] The most authoritative work on this topic is Sáiz González (1999).

local manufacturers the right to use their patent rights. Concerns also arose that patents by foreigners might be used to block production in Britain, so patentees who manufactured abroad were required to make the patented product in Britain or risk losing their property rights. Among today's leading economies, Japan and Germany stand out in terms of the extent to which they were influenced by the American example. Nevertheless, both still moderated the U.S. model to satisfy their own needs and priorities.[23] As might be expected, many developing countries imposed stronger restrictions than in Europe, with even higher fees and more attention to working requirements and compulsory licenses.

Harmonization of patent laws was motivated by the need to reduce the transaction costs of international trade in ideas. The United States was the acknowledged global leader in innovation and industry, and its self-interest dictated freer trade and open markets. American representatives coordinated with other developed countries and pursued the overarching goal of uniform international patent laws, although, even among these countries, there was little agreement about the specific rules and standards.[24] Ironically, owing to its already liberal patent rules, the United States found itself in a weaker bargaining position than nations that could make concessions by changing their restrictive provisions. Negotiations were further complicated because it soon became clear that the goals of nations with net demand often diverged from those of the regions that were net providers of innovations. Two issues that persisted concerned the rights of foreign patentees and protectionist trade policies. Countries resisted offering equal protection to foreigners because they feared that American patentees would overwhelm their domestic markets, and even the United States continued to use tariffs as a counterpoint to their liberal intellectual property laws. As a result, differences in international markets in invention persisted despite the publicly lauded international treaties for the harmonization of intellectual property laws.

Global Markets in Patents and Inventions

For researchers, the persistent variation in global innovation markets and institutions offers a valuable opportunity to explore significant facets of international markets in invention. This section investigates differences in patent rules and standards, in relation to two important features of global markets in ideas.

[23] Nishimura (2011).

[24] Meetings included the International Union for the Protection of Industrial Property in 1884. Other conferences were held in 1878, 1880, and 1883; Rome (1886); Madrid (1890–1891); Brussels (1897–1900); Washington (1911); The Hague (1925); and London (1934). See Khan (2005) and Penrose (1951).

First, patenting activity in foreign countries offers an index of inventive ideas that were likely to be of higher value. Second, the exchange of patent assignments and licenses provides another useful perspective on commercially valuable transfers of technology.

The propensity to file patents overseas varied significantly across nations, as Table 11.3 shows. Among all of these countries, the American experience in the realm of technological innovation was exceptional. U.S. laws were the most liberal to foreign inventors in the world, allowing them equal rights to patent protection by the 1830s, and the domestic market for inventions and innovations was rapidly expanding, creating the potential for abnormal profits. Nevertheless, during the early industrial period, the fraction of foreign patentees obtaining protection in the U.S. market was extremely low, averaging less than 7% between 1840 and 1920. George Richards Elkington, an inventor from Birmingham, England, was one of the foreign residents who obtained patents for his electroplate inventions in the United States. In 1838, he was granted a U.S. patent for an improvement in gilding metals, and in 1843, he also acquired the rights to Ernst Werner Siemen's German patent for electroplating. However, as a foreign patentee who was able to prevail in the highly competitive U.S. market, Elkington was anomalous.

American inventors and their inventions were renowned and admired throughout the world. But when they tried to obtain patents in other countries, they encountered a bewildering kaleidoscope of laws on the books and idiosyncratic practices that inhibited market efficiency for both buyers and sellers of ideas. This was true even of the colonies under British jurisdiction. One of the Fellows of the Chartered Institute of Patent Agents in England pointed out that "the American can place his invention more easily on the market than a British inventor can." However, he wryly continued, the patentee who wished to match the size of the U.S. market by selling the rights to his invention throughout the British empire "has to apply for thirty-nine different Patents; that is to say, he has thirty-nine different holes in his purse through which his money leaks if he wishes to take the fullest commercial advantage of his Majesty's Empire."[25]

Aspiring participants in global markets for ideas could refer to the proliferation of manuals containing advice and information that were increasingly published for their benefit. The handbook by Philip E. Edelman, an electrical engineer and patentee from New York, warned American inventors that foreign patent procedures were "full of pitfalls for the unwary."[26] Still, the profit incentives of going global were significant, and the American inventors who

[25] *Transactions*, Chartered Institute of Patent Agents (1902), pp. 211 and 212.
[26] Philip E. Edelman, *Inventions and Patents* (1915), p. 176.

Table 11.3 Markets in Technology, 1840–1920

	1840–1870	1871–1900	1901–1920	Total
Canada				
Foreign patents (%)	70.1	74.2	84.9	77.7
Assignments (%)	70.5	87.4	46.4	54.7
Germany				
Foreign patents (%)	—	34.6	33.6	34.0
Assignments (%)	—	5.5	10.1	8.1
Japan				
Foreign patents (%)	—	20.4	28.8	27.7
Assignments (%)	—	—	—	—
New South Wales				
Foreign patents (%)	—	30.1	37.8	—
Assignments (%)	16.1	26.6	31.4	27.0
Spain				
Foreign patents (%)	49.5	62.8	57.7	59.2
Assignments and licenses (%)	6.8	4.5	4.9	4.8
United Kingdom				
Foreign patents (%)	14.4	19.4	36.8	22.1
Assignments and licenses (%)	—	22.2	15.0	19.4
United States				
Foreign patents (%)	2.6	7.6	10.8	6.5
Assignments at issue (%)	12.0	23.1	28.1	25.2
Average for all countries				
Foreign patents (%)	27.8	57.0	45.6	45.4
Assignments (%)	13.5	26.4	22.4	22.3

Notes and Sources: Annual patent statistics are from P. J. Federico, "Historical Patent Statistics 1791–1961," *Journal of the Patent Office Society* 46 (February 1964): 89–171; and the World Intellectual Property Rights Organization. Patent assignments and foreign patents are from reports of the relevant patent offices, with the exception of the United States, Spain, Germany, and the United Kingdom. The U.S. foreign and assignments data were estimated from a sample of patent grants. Foreign patenting in the United Kingdom was calculated from a sample of some 15,000 patent grants, in which Ireland, Scotland, and Wales were included as domestic counts. I am grateful to Patricio Sáiz who provided the data for Spain, and to Carsten Burhop for the German assignments data. Percentages are expressed as a fraction of total patents granted. U.K. and Spanish data include both assignments and licenses, whereas the numbers for all other countries refer to assignments alone. The German time series extends from 1877 through 1913 for assignments, and from 1883 to 1920 for foreign patents. New South Wales became part of the Australian federal patent system in 1904.

achieved marked success in penetrating foreign markets provided encouraging examples.[27] As one publication optimistically declared:

> American inventors having valuable inventions, who do not secure such foreign patents as would seem to be of value, simply throw away their chances of realizing large profits, and in many cases large fortunes. Ordinarily it may be said that when an invention is valuable in this country that it is equally so in foreign countries. Indeed, American ingenuity is now so well known and appreciated that the foreign patents can frequently be sold to better advantage and in shorter time than the United States patent.[28]

Growth theories propose a positive relationship between trade, increasing returns to innovation, and the size of the market, and these models are supported by the historical patterns. In the antebellum United States, when transportation networks improved and contributed to expansions in market demand, inventive activity surged in response, especially in formerly isolated areas that had just gained access to markets.[29] Relatively ordinary individuals, such as artisans or workers without skills, were especially likely to turn to inventions that provided solutions to perceived bottlenecks and problems. Empirical analysis indicates that a similar process can be detected in international markets, for both inventions and sales of patent rights.[30] Foreign patenting and assignments were higher in regions with more profitable markets, as gauged by per capita gross domestic product. The same relationships between sales and foreign patents were observed when changes in market access were measured in terms of the spread of railroad networks. Foreign markets for patents may not have been as hospitable or transparent as in the United States, but American patentees and supporting intermediaries were entrepreneurial in their strategies to overcome market frictions.

David Meade Randolph, a Virginia merchant and relative of Thomas Jefferson, exploited his personal connections and persuaded an English friend to process his application for a patent in England in 1809 to protect his improvement in shoe-making.[31] Others had recourse to more professional intermediaries, including patent agencies with international representatives, who reduced

[27] Foreign patenting in registration systems is underestimated, since patents were often taken out in the name of the foreign patent agent or representative. For instance, Daniel Treadwell obtained a patent for improvements in ordnance carriages in 1845, under the name of the U.S. consul in London, Thomas Aspinwall (English Patent No. 10728 of December 23, 1845).

[28] E. L. Richards & Co., *The Inventors' Handbook* (1882), p. 18.

[29] Sokoloff (1988); Sokoloff and Khan (1990).

[30] For the supporting multivariate regression analysis, see Khan (2013a).

[31] David Meade Randolph was also the author of the 1810 *Treatise on Wheel Carriages*.

transaction costs for inventors who wished to participate in global markets.[32] The roster of the Chartered Institute of Patent Agents in England, which was founded in 1882, included 212 members in 1898, 82 of whom were domiciled overseas; in 1902, membership included 151 domestic agents and 101 foreign affiliates.[33] By the second half of the nineteenth century many American agents were skilled in negotiating international transactions in patent rights and patented technologies, either in person or through alliances. The *International Directory of Patent Agents* for 1897 included information on some 2,500 agents throughout the world, while the third edition in 1901 listed more than 4,000 professional intermediaries in this global market. The vast majority of entries on these international lists were American patent agents or foreign associates concerned with U.S. trade.

Geographical proximity was another factor that explained the distribution of foreign patenting for some countries. Canadians obtained 371 patents in the United States in 1890, relative to 178 by French inventors. At the same time, French patentees dominated the early market for invention in neighboring Spain, accounting for fully 75% of foreign patents filed in Spain prior to 1879.[34] In Japan, foreign patentees originated primarily from the leading industrial nations of the United States, Britain, and Germany, but rates of foreign participation in domestic patenting were nevertheless strikingly low.[35] We might speculate that the low rates of foreign patenting in Japan and New South Wales in the early twentieth century owed in part to the "tyranny of distance" and to the extent of the market. Low foreign patenting was also affected by concerns about the security of property rights, if not for patents themselves, then for other forms of assets. For instance, in Japan, the state could expropriate patents that were deemed

[32] "We (E. L. Richards & Co.) have agents in all the principal foreign countries, and have every facility for giving thorough work and securing the patents in the shortest possible time. The most desirable foreign patents for American inventors to secure are those of Canada, England, France, Germany, Spain, and Belgium. These six patents secure the exclusive monopoly among about One Hundred and Fifty Millions of the most intelligent people in the world." See also Swanson (2009).

[33] See the *Transactions of the Chartered Institute of Patent Agents* (various years). William Phillips Thompson (founder in 1873 of W. P. Thompson & Co., an agency that is still in existence) had also become a certified U.S. patent attorney, and the firm maintained links and formal alliances with other patent representatives throughout the world.

[34] According to Patricio Sáiz González, French dominance fell rapidly during the second Industrial Revolution, and the foreign roster for corporate patenting during the 1820–1939 period consisted of Germany (29.7%), France (19.7%), the United States (14.5%), and the United Kingdom (13.7%).

[35] It might be expected that the newly established Japanese patent office would lack the materials to conduct thorough searches, especially where leading technologies were described in a foreign language. Thompson (1920: 108) claimed that the Japanese patent procedures were somewhat arbitrary, and "the office are very apt to reject inventions which they consider closely resemble in appearance others known, and they frequently reject an invention as 'publicly known' without citing any specific proof." In 1903, Americans accounted for 52.6% of foreign patent applications in Japan, followed by Britain (21.0%) and Germany (14.2%).

in the public interest, whereas perceived infringement was punishable by harsh criminal penalties, including fines and imprisonment.

The early cross-border firms like the notable and notorious East India Company obtained profits in the traditional areas of trade in raw materials and natural resource extraction. More modern American multinational enterprises were characterized by trade based on technological innovations, and they typically exploited large portfolios of patents from different countries that leveraged their expertise in the domestic market. Transaction costs in the external markets for technology across national boundaries often led American firms to avoid arm's-length deals by setting up their own overseas subsidiaries. One of the first examples was Samuel Colt, a leading firearms patentee and founder of the Colt Patent Fire-Arms Manufacturing Company in Hartford, Connecticut. The inventor had been careful to secure patents from France and Britain, but he was still concerned about the potential for British firms to pirate his technology, given the lack of information and shaky legal enforcement by the courts. Accordingly, Colt traveled to England, where he established an English subsidiary, which began production at the start of 1853. This direct foreign investment allowed him to maintain quality control and to foreclose on potential competition. Colt carefully cultivated influential personal connections in Europe and was directly involved in commercialization. For instance, he attended the exhibition at the Crystal Palace and was honored with a large silver Telford Medal from the London Institution of Civil Engineers (apparently the most cherished of the twenty-four medals he received).

American patentees Richard Hoe and George Pullman also leveraged their inventions through early multinational enterprises. Hoe's patented rotary press revolutionized the printing of newspapers, and he initially expanded his New York custom to England to build the presses on contract. Demand proved to be so extensive that in 1857 he founded a London branch, which was managed by William Conquest, one of his main machinists. This direct investment strategy was in part motivated by nationalistic concerns of the *London Times* and other leading British newspapers, which did not wish to be viewed as patronizing a foreign American firm. Like Richard Hoe and Company, George Pullman (patentee of more than fifty inventions between 1860 and 1900) first went to Europe to satisfy bespoke orders, using parts that initially were made in Michigan and shipped for assembly overseas. Demand for the output of Pullman's Palace Cars Company proved to be so voluminous that it was deemed necessary to build factories not just in England but also in Italy, Belgium, and other countries.[36]

[36] Southard (1931).

In countries that did not honor patent rights to the same extent as in the United States, some American companies strategized to retain full control over their foreign subsidiaries, even to the extent of bringing over their own American employees. These alternative means of exclusion were especially important in protectionist jurisdictions where courts were biased against alien companies that were attempting to enforce their patent rights against domestic infringers. Indeed, one of the reasons that firms like Singer chose to set up shop themselves was to avoid the difficulty of monitoring and securing returns from arm's-length agreements with foreign entities. Singer in particular had learned this lesson when a French partner reneged on a contract in which the patentee would transfer the property rights and know-how for manufacturing his sewing machines in return for a fixed payment and per unit royalties on the units produced. This sort of market failure, of course, was precisely the reason that enforceable intellectual property rights were all the more important as firms entered into international markets and that U.S. representatives were lobbying for uniformity in laws and policies.

Foreign subsidiaries were not entirely immune to the array of transaction costs that arose from unfamiliar inputs, environments, institutions, and language. These difficulties created incentives for some companies to enter into joint ventures with local firms, a development that masked the extent of foreign participation in patenting and innovation markets. For instance, General Electric (GE) was affiliated with Tokyo Electric Company and Shibaura Engineering Works (the two companies merged in 1939 and are now known as Toshiba). GE entered into contractual agreements that allowed these affiliates in Japan to apply under their own names for patents that wholly belonged to GE.[37] GE was responsible for about three thousand patents that were filed in Japan under the name of their local affiliates in the interwar period. By allowing their patents to be filed as domestic inventions, GE was able to avoid significant bureaucratic hurdles and other transaction costs, including the costs of negotiation with their affiliates, and they also avoided the need to acquire information about the local markets. In effect, GE minimized the costs of participation in international patent markets by specializing in the creation of technology and outsourcing the management of its patent portfolios to local Japanese firms.

What were the factors that influenced the transfer of technology across countries? Statistical techniques that control for other variables show that technological capability in the receiving economy played a significant role.[38] Lower rates of

[37] Nishimura (2011).

[38] The multivariate regressions that support the general conclusions in this chapter are reported in Khan (2013a).

foreign patenting were related to greater indigenous innovation, whereas higher rates signaled a lack of domestic technological capability or a greater dependency on foreign inventive output. Foreign patenting rates were lower in regions that were more innovative, even when the outlier of the United States was excluded from the analysis. In the case of Japan, indigenous Japanese technological capacity was more advanced than is generally assumed, and this condition at least partially accounted for the low rate of foreign penetration in their technology markets.

The specific design of patent institutions significantly influenced global markets in ideas. In particular, the statistical analysis reveals that effective examination systems promoted trade in patents. The "American system" of patent rules and standards was universally associated with prior examination for novelty, and this model was emulated by followers such as Canada and Germany. Objective examination by specialized employees of the Patent Office served to reduce uncertainty about the technical value of the patent. Unlike administered systems, patent examiners merely determined the novelty of the patent property, and it was up to the patentee to secure returns in the market. After surviving the filter of examination, the patentee could more easily use the certified grant to mobilize capital to commercially develop the patented technology or to sell or license the rights to those who were better positioned to directly exploit the patent. Private parties could always, as they did under the registration systems prevailing in much of the world, pay third parties to make the same determination as the patent examiners. However, a centralized examination system reduced barriers to entry for inventors who could not retain their own private examiner, generated economies of scale, and produced positive externalities. Trade in patented technologies was, as a result, much more extensive under examination regimes, holding other factors constant. Technologically creative people without the start-up capital to go into business and directly exploit their discoveries were major beneficiaries.

Some economists contend that international markets for technology will benefit society, even if the transfer occurs because of expropriation. Many developing countries supported compulsory licenses and working requirements to ensure that patent grants were consistent with their social and economic agendas. However, U.S. policy has always rejected proposals to impose constraints and conditions on patent rights, considering them a disincentive to inventive activity. In some cases, the constraints were redundant, because many foreigners obtained patents with the intention of profiting from working their inventions in the overseas market anyway. In others, such policies were not strongly enforced, or could be avoided by hiring well-connected local agents. According to Spanish legislation, patents had to be implemented within three years of granting or the patent right would be revoked, but just 23% of patents were indeed put

into practice.[39] Policies like these invariably were associated with rent-seeking rather than with positive economic outcomes. Even if stipulations like the need to practice the invention did not significantly discourage foreign patentees, restrictions of this nature added to the implicit and explicit cost of patenting. Moreover, these requirements were most discouraging for individuals without a great deal of personal wealth, so they tended to increase inequality in the distribution of inventors.

As discussed before, the rationale for international treaties to coordinate intellectual property rules and standards was based on the assumption that harmonization would reduce the transaction costs of exchanges and transfers across borders. However, neither foreign patenting rates nor assignments were enhanced by adherence to such treaties. Instead, international markets for patents were more active in countries that did not participate in patent conventions. These results may have occurred because the provisions of multilateral treaties were not well enforced. The political economy of international agreements was contentious, as with Trade-Related Intellectual Property Rights and negotiations with China today. Fundamentally divergent interests created a divide between consumers and suppliers of innovations, so the terms that were ratified in intellectual property treaties had to satisfy the lowest common denominator. The United States, in particular, frequently achieved its aims in the realm of global technology markets through bilateral treaties and trade sanctions and negotiations rather than in multilateral patent conventions.

Foreign Patenting and Markets for Inventions in the United States

Any discussion of global markets in invention requires a closer scrutiny of the American experience. The United States stood out in its strong enforcement of a patent system that favored inventive rights and in the proliferation of patents and patented output in deep and extensive markets for technology. American patents accounted for two-thirds of the total granted in all of the sample countries during the nineteenth century. This was true even though patent examiners rejected a significant number of U.S. patent applications, whereas patents were merely registered in countries like England, Spain, and New South Wales. Today, in marked contrast to the nineteenth century, foreign residents obtain the majority of patents filed in the United States (Figure 11.3). An analysis of the historical process that got underway during the second Industrial Revolution promises

[39] Sáiz González (1996, 1999).

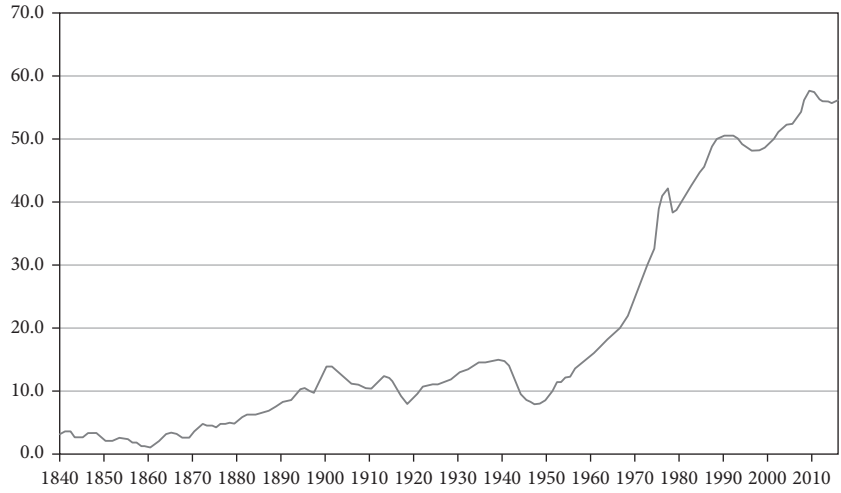

Figure 11.3 Foreign Patenting in the United States, 1840–2015 (Percentage)
Notes and Source: U.S. Patent Office. The graph shows the patents granted to foreigners as a percentage of total patents issued, three-year moving average.

to offer insights to better understand the factors that influenced changes over time in national comparative advantage in innovation.

Naomi Lamoreaux and Kenneth Sokoloff conducted an extensive survey of U.S. markets in invention during the second Industrial Revolution.[40] They examined patent assignments that occurred at the time the patent was granted, as well as a sample of assignments that were completed after the patent was issued. During the 1870s, inventors tended to be personally involved in the commercialization of their patented innovations, granting licenses to manufacturers in outlying regions. Over time a division of labor occurred, whereby invention and commercialization became separate pursuits, and specialized inventors sold off or licensed their rights to others. Intermediaries such as patent agents and patent attorneys played an important and productive role in facilitating transactions. Overall, their findings illustrate the depth of these markets in ideas and show its rapid expansion throughout the United States. Their project is exceedingly informative about markets in inventions by domestic American residents but does not take into account the experience of foreign patentees.

My own analysis sheds further light on long-term changes in the market for ideas by highlighting the patterns for foreign inventors who were granted patent protection in United States between 1870 and 1930. The random sample included

[40] Lamoreaux et al. (2011, 2013).

over nine thousand patents that were granted in 1870, 1900, and 1930, allocated to the sector of final use. These records included assignments at the time the patent was issued, the number of discoveries claimed in the patent specification, characteristics of domestic and foreign inventors and coinventors, whether an attorney signed the patent document, and the number of citations that other inventors made to the patent from the time of its issue through to the present. Of the sample, 36% of patents were assigned at the time the patent was issued, and 27% were assigned to corporations. However, patents can be transferred to other owners at any time during their term, so the information on assignments at issue underestimates the extent of markets in invention. Just over 10% of all patents were granted to foreign inventors. The majority of patents were for machine inventions (25%), whereas consumer products accounted for 13%, the technology-intensive electrical inventions accounted for 7%, and 4% of patents covered chemical discoveries.

These patterns show that a rapid change in the organization of invention occurred between 1900 and 1930. The probability that a patent would be assigned to a corporation markedly increased over this period, as did the role of coinvention and team production. Corporate assignments featured larger numbers of patent claims, perhaps indicating attempts to secure protection over a greater scope for their discoveries. Citations to these inventions by other patentees offer a proxy for the technical value of the patent, whereas the sale of the right was correlated with market value. Corporate assignments, however, were less related to commercial value and increasingly reflected procedural transfers from employees to their employers.[41] Foreign patentees who filed in the United States exhibited a lower propensity to employ attorneys, supporting the argument that the American institutions exhibited greater transparency, ease of processing, and straightforward administrative procedures. International patents tended to be of higher average value than domestic patents and therefore were positively related with assignments. At the same time, relative to resident inventors, foreign patentees were significantly less likely to assign their rights at the time the patent was issued, and they were also not as likely to assign them to corporations. Foreign patentees were often principals in their own companies or entrepreneurial independent inventors who were attempting to tap into the extensive American product markets.

Assignments and foreign patenting in the sample were higher in the electrical and chemical industries, in both of which Germans were at the forefront of advances in technology. The chemical industry in particular is interesting, for it provided an early sign of the shift in global comparative advantage in leading-edge technological innovations that would evolve over the twentieth century.

[41] For the legal aspects of employee-inventors, see Fisk (1998).

These patterns mirrored the experience of American innovators in the nineteenth century. The introduction of German national patent laws in 1877 bolstered innovations in their chemical industry, and German firms began to expand internationally, acquiring large portfolios of foreign patents.[42] Corporations like Bayer (Farbenfabriken), Badische Anilin und Soda–Fabrik (BASF), and Hoechst used patent rights to foreclose on potential rivals in the German market and overseas as well.[43]

The prominent role of intellectual property in Bayer's American business strategy can be discerned from its appointment of a patent attorney, Anthony Gref, as the president of its U.S. subsidiary. These enterprises combined intellectual property rights with such alternative methods of appropriation as trade secrecy, trademarks, and cartelization as key elements of their strategy to secure a competitive edge. Gref was active in using the courts to put an end to cheaper parallel imports of products into the United States.[44] In Germany, patents were offered for the protection of chemical processes alone but did not protect the final products, whereas in the United States, German patentees were able to exclude rivals from both the processes and the product itself. Thus, in part because of the differences in patent institutions, in Germany the market structure of this particular industry was more competitive than in the United States.

The overall patterns for Germans obtaining U.S. patents were quite distinct from the experience in German markets for technology, and the differences provide more specific insights into the influence of favorable patent rules and standards on markets for innovation. In the first decade of the twentieth century, over four thousand patents were granted to protect chemical and allied inventions, two-thirds of which were issued to foreign inventors. As Table 11.4 illustrates, in this industry German patentees dominated the ranks of patents as well as assignments in the United States. For instance, 16% of French chemical patents issued in the United States were assigned, as were 21% of British patents and 34% of American patents, whereas the assignment rates for German and Swiss patents were 75% and 87%, respectively. These remarkably high propensities to assign property rights for patented inventions can be compared to an average rate in Germany itself of 8%. Thus, 68% of assignments went to four German companies, which operated as a loose cartel or a "community of interest."[45] Germany supported a liberal work-for-hire patent policy, whereby

[42] Murmann (2003) provides an extensive study of the German chemical industry that compares the German innovation system to the experience of other countries.

[43] Marsch (1994).

[44] *Merck Report*, vol. 6 (1897).

[45] These included Aktiengesellschaft fur Farben, Badische Anilin Fabrik, Bayer/Farbenfabrik Elberfeld, and Meister Lucius & Bruening (Hoechst). See *United States Congressional Report on Schedule A: Chemicals, Oils, and Paints* (1912), p. 361.

Table 11.4 Domestic and Foreign Patenting and Assignments in the U.S. Chemical Industry, 1900–1910

All Chemical Patents	**Total Patents**	**Total Assignments**	**% Assigned**
Electrochemistry	256	117	45.7
Bleaching and dyeing	1,187	939	79.1
Chemicals	1,517	728	48.0
Explosives	156	61	39.1
Pharmaceuticals	649	155	23.9
Plastics	116	45	38.8
Glue	23	6	26.1
Liquid coating compositions	121	25	20.7
Ammonia and turpentine	43	11	25.6
All Foreign	**Foreign patents**	**Foreign Assignments**	**Assignments as % Patents**
Electrochemistry	89	25	21.4
Bleaching and dyeing	1,049	901	96.0
Chemicals	980	536	73.6
Explosives	59	6	9.8
Pharmaceuticals	212	67	43.2
Plastics	67	23	51.1
Glue	11	1	16.7
Liquid coating compositions	41	4	16.0
Ammonia and turpentine	8	0	0.0
Domestic U.S.	**U.S. Patents as % Total**	**U.S. Assignments as % U.S. Patents**	**U.S. Assignments as % Total Assignments**
Electrochemistry	65.2	55.1	78.6
Bleaching and dyeing	11.6	27.5	4.0
Chemicals	35.4	35.8	26.4
Explosives	62.2	56.7	90.2
Pharmaceuticals	67.3	20.1	56.8
Plastics	42.2	44.9	48.9
Glue	52.2	41.7	83.3
Liquid coating compositions	66.1	26.3	84.0
Ammonia and turpentine	81.4	31.4	100.0

Table 11.4 *Continued*

German	German Patents as % Total Patents	German Assignments as % German Patents	German Assignments as % Total Assignments
Electrochemistry	7.8	45.0	7.7
Bleaching and dyeing	69.9	92.5	81.8
Chemicals	45.2	68.5	64.6
Explosives	17.9	17.9	8.2
Pharmaceuticals	18.0	47.9	36.1
Plastics	32.8	31.6	26.7
Glue	34.8	12.5	16.7
Liquid coating compositions	16.5	15.0	12.0
Ammonia and turpentine	16.3	0.0	0.0

Notes and Sources: United States Congressional Report: H.R. No. 326, *Report on Schedule A: Chemicals, Oils and Paints* (1912).

corporations could file for patents that their employees had created, implying that German assignments primarily reflected economic transfers. However, assignment rates for German patents in the United States varied significantly across different industrial categories, suggesting that higher assignment rates also reflected the greater commercial viability of German discoveries.[46]

German enterprises virtually monopolized the market for dyes and chemicals, in particular, taking full advantage of their patent portfolios. Americans obtained just 12% and 35%, respectively, of patents granted in the United States in these fields. U.S. concerns about the German monopoly over this area of innovation peaked during the outbreak of hostilities in World War I.[47] An amendment of the Trading with the Enemy Act of 1917 authorized the confiscation of German intellectual property. The Chemical Foundation was formed two years later to manage several thousand expropriated patents, trademarks, and copyrights on behalf of the American chemical industry. Access to this windfall stock of intellectual property likely served as a subsidy that temporarily boosted U.S. capabilities and innovations. However, after the end of the war, despite the loss of their patents, the German firms were once again able to leverage their expertise and know-how to retain their competitive edge in dyes and chemicals

[46] Burhop (2010) estimated that 85% of assignments in Germany were economic transactions rather than procedural transfers.

[47] Steen (2001).

relative to American competitors. This event revealed that effective transfer of technology also requires tacit and explicit knowledge and experience, which can only be acquired through consensual negotiations and direct involvement in research and production.

The case of phenacetin, an analgesic that Bayer patented in the United States, exemplifies the conflicts that foreign patenting created for intellectual property policy. The German corporation priced phenacetin significantly lower in other countries where product patents were not granted for pharmaceuticals. For instance, the price in the United States was $1, whereas Canadians paid 15 cents, creating an arbitrage opportunity that would benefit American consumers. Bayer issued explicit instructions on its foreign packages that purchasers of their goods overseas were prohibited from resale in the United States. Edward Dickerson, a U.S. assignee of the Bayer patent, obtained a legal injunction against the sale of phenacetin in the United States, which the defendant had purchased outside the country. In keeping with the absolute rights conferred by the U.S. patent system during the term of the grant, the court ruled that the parallel importation of phenacetin, even if legally purchased from Bayer overseas, constituted an infringement. American patents guaranteed the right to make, use, or vend and to exclude, and thus "the letters patent allowed the foreign corporation to place restrictions barring resale in the United States by purchasers of phenacetine."[48]

Some policymakers attributed the underdeveloped state of the U.S. chemical industry to the irony of the strong protection for foreigners under its uniquely favorable patent laws:

> The American market is the most valuable in the world, and the foreign inventor or his foreign assignees naturally take all the advantage that the law gives them to exploit this market as profitably as they can. This very largely accounts for the tardiness with which the chemical industry develops in the United States.[49]

At the same time, the German patent office may have administered their own patent rules in a discriminatory fashion that was biased against foreign inventors, including those from the United States.[50] Thus, German enterprises were able to successfully exploit the differences across countries in patent institutions to dominate both the domestic and foreign markets.

In Britain, lobbyists for their domestic chemical industry succeeded in getting protectionist patent legislation passed that provided for working requirements.

[48] *Dickerson v. Tinling*, 84 F. 192, 195 (1897).
[49] *Report on Schedule A* (1912), p. 362.
[50] See Richter and Streb (2011).

Some American firms were sufficiently alarmed by developments in the chemicals market to petition Congress to revise the patent laws so that

> no patent shall be granted to a citizen of any foreign country which does not grant a corresponding patent to a citizen of the United States: And provided further, That no patent shall be granted upon any drug, medicine, or medicinal chemical except in so far as the same relates to a definite process for the preparation.[51]

These legislative measures for protectionist intellectual property rules in the chemical industry were defeated in Congress. The anomaly of wartime policies was just that—a temporary aberration. Numerous other similar proposals over the past century were also rejected, because they were not in keeping with the fundamentally market-oriented principles of the American patent system.

Conclusions

Enterprise and innovation have long spanned national and international borders and have led to persistent debates about markets in patented ideas that still have not been resolved. The historical experience indicates that technological capabilities and trade in patented ideas and innovations were not exogenous. Innovation markets responded to the incentives that specific institutional and organizational rules and standards provided. Salient features of technology markets today emerged during the course of the nineteenth century and crystallized during the second Industrial Revolution.

Corporations and individual patentees used a wide array of business strategies that were adapted to the circumstances they encountered in different environments. Thus, patterns of patenting and assignments differed significantly to accommodate and take advantage of country-specific rules and institutions. Innovative enterprises employed transfers of patent rights to acquire inventions from employees as well as to reward them, to collude with rivals in the same industry, to monopolize output markets and block potential competitors, to specialize in invention or commercialization, and to increase technical capabilities and productivity. Patentees' ability to follow select strategies depended on the nature of legal and market institutions, highlighting the need to understand how the design of specific mechanisms affected the extent to which desired social objectives could be attained.

[51] Hearings before the Committee on Patents, H.R. 13679 (1904), p. 3.

The study of markets in the later era and of the experience of "follower economies" raises other dimensions of the relevant tradeoffs. The U.S. patent system was open to all first and true inventors who created discoveries that were new to the world. This policy soon placed foreign inventors on an equal footing with domestic inventors, a position that was not a cause for concern as long as Americans retained their position as the world's leaders in technological innovations. However, the very openness of the system and its emphasis on the diffusion of information offered advantages that foreign competitors in the chemical industry and in machine-tool innovations were able to use to compete against domestic U.S. enterprise in this sector. These were just the grounds that other nations, and in particular the developing countries, were citing to support their less generous patent institutions and their employment of such liability rules as compulsory licensing and working requirements. For many developing economies, strong patents would primarily protect the rights of foreigners and would hinder their ability to imitate the technologies of the advanced countries.

The American experience in the chemical industry, however, suggests that dynamic comparative advantage was an outgrowth of endogenous factors and could not be achieved merely by expropriating property rights. Successful technological innovation also required inherent domestic capabilities and tacit knowledge acquired through learning by doing. Interest groups in the nascent U.S. chemical industry lobbied to change the market orientation of American patent rules to provide narrow benefits to their own constituents through compulsory licensing and working requirements. The costs to these domestic groups at the time were evident, but their efforts to retreat from competitive markets in ideas were repudiated. Property rights in inventions in the United States were not designed to enable protectionism and the political interests of special groups. Instead, policymakers acknowledged that open markets in ideas and innovation generated positive net benefits to society in general.

Intellectual property rights, like all other institutions, involve costs and benefits for all stakeholders. In the American context, these tradeoffs have been most evident in the realm of copyrights, which featured continual and continuing controversies about oligopsony buyers, international piracy, and cartelization among sellers, which had the potential to limit access to knowledge and learning.[52] The democratic American system of patents, by contrast, promoted dynamic competition in vibrant markets for patented ideas and innovations that dramatically expanded the choice set for consumers at ever-falling prices over time. This real world of literally millions of new ideas that were promptly alchemized into a society of material plenty was far removed from the abstract theories of "patent monopoly" and contrived scarcity that are still enshrined in the economics literature.

[52] Khan (2005).