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INDUSTRIAL PROPERTY INSTITUTIONS, PATENTING, AND TECHNOLOGY INVESTMENT IN SPAIN AND MEXICO, C. 1820-1914

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INDUSTRIAL PROPERTY INSTITUTIONS, PATENTING, AND TECHNOLOGY INVESTMENT IN SPAIN AND MEXICO, c. 1820-1914*

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I. INTRODUCTION

IDEAS are what economists call a "public good." Unlike more tangible objects, they are free to circulate and spread. As Thomas Jefferson wrote, "that ideas should freely spread from one to another over the globe…seems to have been peculiarly and benevolently designed by nature, when she made them, like fire, expansible over all space, without lessening their density in any point, and like the air in which we breathe, move, and have our physical being, incapable of confinement or exclusive appropriation."[1]

Yet most nations have adopted laws which work to restrain this free diffusion. Patent laws aim to create a property right to the industrial application of new ideas and confer to one person or firm an exclusive monopoly to their use. These temporal monopolies yield benefits for the patent holder and costs to society. Although anti-patent movements over the centuries have argued that the social costs of private monopolies are dominant, patent laws have been justified as balancing social costs with substantial social benefits. Primary among these, patent proponents have long argued, is that patent laws increase incentives to invest in a privately risky but socially desirable enterprise: inventive and innovative activity. The result is that in most countries over the past two hundred odd years patent laws have been adopted, sustained, and strengthened.

Although nineteenth century advocates also argued that inventors had a "natural right" to their inventions, the economic rationale has typically been the central argument of policy makers at those historical moments when national patent laws have been

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[1] From his 1813 letter to Isaac McPherson, quoted in David, 1992, p. 1.

adopted or reformed.[2] It has also been taken up recently by economic historians who argue that property rights institutions play a crucial role in shaping incentives (or disincentives) to invest in productive activities.[3]

Yet the primary focus of this argument has been on the relationship between patent law and incentives to *invent* new technologies—the concern foremost on the minds of policy makers and inventors in the early industrializers, especially England and the U.S. from the late eighteenth through the late nineteenth centuries, as well as for academic analysts interested in those cases.

What if, in a nation seeking to stimulate technological progress, domestic invention is not the primary source of new technology? The late-industrializing nations of the nineteenth century, especially those with relatively low levels of human capital and a relatively backward state of existing productive technology, saw technology transfer as the primary path to economic progress.[4] For nations in such circumstances, was awarding monopoly rights to new technologies necessary to attract technology imports? Would patent rights, in other words, increase incentives to invest in technology transfer sufficiently to overcome the social cost of the temporal monopolies in the same way that patents' proponents argued they increased incentives to invest in inventive activity?

Despite the fact that governments in many nations around the world adopted some form of codified patent law in the nineteenth century, all were not alike. All sought in some fashion to encourage investment in new technologies. However, as this paper argues, there existed a fundamental division between those systems which favored *inventive activity* and those which favored *innovative activity*. Those in the latter category tended to be late industrializers, and their patent laws recognized that the most likely source of novel technologies was from abroad.[5]

This paper thus explores the nature and implications of nineteenth century patent law in two late-industrializing countries: Spain and Mexico. Both inherited earlier *ancien regime* monopoly practices, both adopted aspects of modern, codified patent systems in the early nineteenth century, and both sought primarily to encourage

[2] See, for example, the discussion of early patent law in Machlup, 1958, among others.
[3] On patents and incentives, see North, 1973, pp. 2-3, 5, 148, 154-55; North, 1981, pp. 164-65; Coatsworth, 1978, pp. 92-93; Khan and Sokoloff, 1998, p. 292; and Khan, 1995, pp. 58-59, 93 among others.
[4] For one recent statement concerning the views of Mexican elites on foreign technology in the late nineteenth century, see Weiner, 2000, p. 646. For the view of Spanish elites and the importance of technology transfer in the long run, see Sáiz, 2005a.
[5] To our knowledge, no work has asserted or explored this issue for the nineteenth century.

innovation and especially the introduction of foreign techniques. Mexico, however, abandoned this orientation in 1890 in favor of an emphasis on supporting inventive activity while Spain retained this orientation until recently. After presenting an overview of the conceptual and historical issues regarding comparative patent systems in section one; section two compares the nature of the Spanish and Mexican systems in the nineteenth century; while sections three and four examine the implications of patent law: its impact on trends in patenting behavior and—more tentatively—its probable consequences for investment in technological change.

II. Comparative Legal Systems

IF THE FAMILIAR justification for patent law has been as an incentive to invest in inventive activity, this was not always the case. The roots of the modern patent system lie in the European *ancien regime* practice of conferring monopoly rights to those who promised to introduce or undertake a novel economic activity. From at least the fifteenth century, monarchs and local rulers in Italy, France, England, Spain, and elsewhere granted such privileges in order to favor and protect new industry and to raise revenue.[6] Some, like the early Venetian system, based conferral on novelty and utility, while others rested more closely on royal favor and patronage. Either way, *ancien regime* practice typically conferred privileges rather than rights, sought primarily to encourage the introduction and commercialization of new techniques and activities from abroad, and thus favored innovation over invention. The practice of conferring and administrating such privileges was rarely codified, and consequently privileges were discretionary in their allocation, broad in their scope, and vague in their specification. They formed one part of a broader set of mercantilist practices which included monetary awards, bounties, licenses, and charters.

Out of this traditional practice, the modern patent system emerged by the end of the eighteenth century. In England it evolved in common law following the 1624 Statute of Monopolies and was legislated in France (1791) and the United States (1793).[7] In contrast to *ancien regime* practice, modern systems reduced or eliminated

[6] On *ancien regime* practice see David, 1992; Long, 1991; MacLeod, 1991; and Penrose, 1951, pp. 2-4.
[7] See MacLeod, 1991and 1988; Dutton, 1984; Boehm, 1967; Hilaire-Pérez, 1991; Penrose, 1951, ch. 1. On the American system, see also David, 1992; Bugbee, 1967. England's Statute of Monopolies was based on the 1602 court case Darcy v. Allin which challenged a patent for exclusive importing, selling, and making of playing cards. The court's decision denied exclusive grants to exercise a trade for private

room for discretion by establishing formal rules concerning the allocation, administration, and adjudication of patent rights and generally narrowed the criteria of what was patentable to new products and processes. They also fixed the term and the fees for patenting and made some provision for the publication of patent applications. In short, they promised temporal monopoly rights to anyone who met the criteria specified by law upon application and payment of set fees.

Such "modern" systems moved towards conferring property rights rather than privileges. These systems codified inventors' right to the exclusive use of their inventions while ensuring that society would also benefit: first, through the public disclosure of new knowledge and second, by the encouragement of further invention. Potential inventors would be less likely to invest in inventive activity, the logic goes, without the additional security of monopoly rewards.[8] Policy-makers believed it was desirable to encourage inventive activity and argued that monopoly privileges were the best way to do it. Through the first half of the nineteenth century, the vast majority of countries around the world had adopted some form of these modern patent systems.[9]

Yet not all nineteenth century patent systems were cast in the same mold. Some, like those of England, France, and the United States, replaced the *ancien* bias on innovation with an emphasis on genuine invention.[10] In these countries, specific clauses of the new laws specified and strengthened the rights of inventors. These could include,

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gain but affirmed the legality of grants to further the "weal public" (the essence of the notion that patents trade the social cost of private monopolies for the social gain of increased invention and innovation). See Penrose, 1951, p. 6; Machlup, 1958, pp. 56-58.

[8] Penrose, 1951, p. 17. This logic was stated succinctly in 1624 by Sir Edward Coke, who played a central role in drafting the English Statute of Monopolies: It is "because the inventor bringeth to and for the Commonwealth a new manufacture by his invention, cost and charges, and therefore is reason, that he should have a privilege for his reward (and the encouragement of others the like) for a convenient time." Quoted in Boehm, p. 17. It was repeated in the 1790s by Jeremy Benthem, among others; see Stark, 1965, pp. 62-66.

[9] See Penrose, 1951, pp. 12-13, 39; Kingsley and Persson, 1848; United Nations, 1975, annex I; Sáiz, 1999b, p. 74.

[10] The US law of 1793 did this decisively. England's nineteenth century patent system presents something of a hybrid, in part because it evolved haphazardly over several centuries of common law cases. It allowed protection to those who might introduce a new technology, but it is unclear whether this was significant. Notably, of the three recent major studies of English patent law (MacLeod on the 18th century, Dutton on the 19th century, and Boehm on the 19th and 20th centuries) only one mentions introduction patents. Boehm suggests that they might be an anomalous holdover from previous (16th century) practice. MacLeod argues that the British system favored inventors' rights even more than the U.S. and French systems, a view also echoed by the other two authors. David (1992, p. 39) states that in the eighteenth century English courts "increasingly construed the purpose of patents to be the encouragement of indigenous invention," rather than technology transfer. More recently, Khan and Sokoloff tentatively suggest that British patents of introduction may have yielded negative net effects relative to the asserted goal of the institution: to encourage invention. They give no indication, however, of the extent of patents of introduction. See Khan and Sokoloff, 1998, p. 312 n. 25. French law also exhibited hybridity; it spoke of the natural rights of inventors but also allowed for patents of introduction and compulsory working. See Plasseraud and Savignon, 1989 and Savignon, 1989.

for instance, conferring patent rights to only the actual inventor, narrowing the criteria for patentability to new technological advances, allowing patentees priority over improvements, and instituting examinations for novelty. Such systems sought to strengthen the rights of inventors and left innovation largely up to market forces. Promoting the introduction of foreign technology was at best a secondary goal to encouraging domestic invention.

Meanwhile, other countries retained an emphasis on domestic innovation even while adopting other aspects of 'modern' nineteenth century patent institutions. This was the tendency in countries intent on catching up to the early industrializers. They adopted codified and impersonally administered systems, they created *de jure* and protected inventors' rights, but they sought above all to encourage the importation and innovation of novel foreign techniques. Specifically, these countries often offered "patents of introduction," a codified version of *ancien* privileges.[11] Usually (although not always) limited in duration and definition, these patents allowed any third party to solicit and receive monopoly rights to exploit a new technology or activity not yet known in the country, whether or not they were the actual inventor.[12] Late-industrializing countries were also more likely to include compulsory working or licensing clauses in their patent laws, as well as other restrictions on inventors' and patentees' rights, designed to promote innovation. Compulsory use regulations also ensured that patents for technologies manufactured abroad could not be used as exclusive import monopolies.

These two types of nineteenth century patent systems do not accurately mirror any one national system. There was in fact a broad spectrum of variation among national laws, as nineteenth century advocates of international uniformity quickly realized.[13] But these two types do reflect an essential divergence in intent and mirror the different perspectives of policy-makers' on the requisites of economic progress in their respective countries. They also reflect the relative position of countries vis-à-vis the leading edge of industrial technology. In other words, the difference between systems favoring *invention* and those favoring *innovation* typically marked the division

[11] There is scant reference in the literature to the significance of this practice; see Todd, 1995, p. 22; Boehm, 1967, p. 14; Khan and Sokoloff, 1988, p. 300.
[12] Even when *ancien regime* practice utilized the word "invention" its definition often included "to found," "to establish," and "to find." See David, 1992; Penrose, 1951, p. 4 n. 9.
[13] There were a great many differences between nineteenth century patent systems. In fact, the great diversity of national systems became quickly evident during the early debates preceding the creation of the International Paris Convention in 1883. See, for instance, Boehm, 1967, p. 3 and Penrose, 1951, ch. III.

between technology exporters and technology importers. Technology exporters, like the United States and England, tended to adopt patent systems that protected the rights of inventors. In contrast, technology importers, like Spain and Mexico, adopted the form of modern patent law first established in the early-industrializing, technology-exporting countries, but tended to balance the protection of inventors' rights with an emphasis on the commercial innovation of technologies, especially those from abroad.[14]

Although there is a relatively large literature on the nature of patent systems in the early-industrializers, there is scant analytical work on the comparative nature and implications of patent systems in nineteenth century follower countries.[15] Spain and Mexico provide instructive case studies for several reasons. First, both are late industrializers relative to England and the U.S. Although parts of Spain (especially Catalonia) experienced some industrialization in the early nineteenth century, the more sustained phase of early (if still halting and problematic) industrialization came for both in the second half of the century.[16] Second, both industrialization experiences were based heavily on imported technology, raising the question of the relationship between policy and investment.[17] Third, both began the nineteenth century with the same legal regime, focused primarily on innovation. However, Mexican law underwent substantial reform after 1890, making possible an interesting comparison between legal types and an analysis of the importance of legal reform. Fourth, data on patent law and patenting is available for both countries.[18] Finally, we should note that the following discussion outlines the *formal* provisions of legal policy. However the patent institution (like any), involves the rules and norms by which formal law is interpreted through the daily practice of administrative, allocative, and adjudicatory procedures, in both the government bureaucracy and the courts. These issues are touched on briefly below.

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[14] As Paul David has noted, patent law, like nearly every political policy, law, or institution, is not a direct function of current policy objectives (even if there is a policy consensus among elite players) but rather reflect the historical antecedents as well as current aims and beliefs of policy makers. David, 1992.

[15] See references above. On Mexico, for instance, there are several works which offer a descriptive account of nineteenth century law and legal reform, but none which place it in a comparative framework and trace its implications for patenting and investment in technologies. See, for instance, Soberanis, 1989; Sánchez Flores, 1980. On Spain, see especially Sáiz González, 1999. There is a much larger literature (and international political debate) on patent systems in developing countries in the late twentieth century; for one survey and good bibliography, see Siebeck, 1990.

[16] On Mexico, see Marichal and Cerutti, 1997; Haber, 1989; and Beatty, 2000 among others. For a general view of Spanish industrialization, see Tortella, 1973 and Nadal, 1975.

[17] See, for instance, Beatty, 2001.

[18] For Spain, both have been collected and compiled by Patricio Sáiz González at the Universidad Autonoma de Madrid and the Spanish Patent Office; see the citations above. For Mexico, both law and data have been collected by the author; see the appendix for a full description of the latter.

1. *Spain*

Since at least 1478 the Spanish Crown granted royal privileges to those who might invent or introduce a new idea or new activity.[19] Together with other forms of rewards and protection, these royal grants constituted discretionary and uncodified compensation for investment in invention or the introduction of novel activities. In 1811, however, Napoleon exported the French patent code of 1791 to Spain as the basis for that nation's first modern patent system. Not until the 1820s, however, did political stability allow for the codification of a domestic patent system that would endure in its essential characteristics through the rest of the nineteenth century. The decrees of 1820 and 1826 together with the laws of 1878 and 1902 established the foundation for the Spanish system. Throughout the century it retained its basic characteristics, outlined briefly in TABLE 1. Two of these features warrant further discussion.

First, throughout the century Spanish law offered protection to both new inventions as well as to the introduction of novel activities. "All who invent, perfect, or introduce a branch of industry," the law of 1820 began, "have the right to their property for a term and under the conditions indicated in this law."[20] Each successive law took pains to specify the criteria for an invention, with increasing specification but little significant difference from one to the next. The 1820 law defined an inventor as "*aquel que hace por primera vez una cosa que hasta entonces no se habia hecho…el que idee una máquina, aparato, ó procedimiento desconocido*." The language of the 1878 law offered this definition of invention: "*Las máquinas, aparatos, instrumentos, procedimientos ú operaciones mecánicas ó químicas que en todo ó en parte sean de propia invención y nuevos*." Inventions, then, had to be discrete technological advances of products or processes, and protection was limited to the actual inventor.

Each law also offered patent protection to introductions. Patents of introduction offered monopoly rights to any person who would commercialize a machine, apparatus, instrument, process, or mechanical operation that, in the words of the 1826 law, "*no esten establecidos del mismo modo y forma en estos Reinos*" (or, in the language of 1878, that "*no se hallen establecidos ó practicados…en los dominios españoles*"). Patents of introduction, in other words, allowed third parties to apply for and receive patent protection for another's invention as long as it was novel in the country. The

[19] See García Tapia, 1990 and 2001.

[20] All quotations from Spanish law come from the legal texts in Sáiz, 1996, as follows: Law of 7/16/1811 pp. 50-51; Law of 10/2/1820 pp. 53-54; Law of 3/27/1826 pp. 58-60; Law of 7/30/1878 pp. 98-98; and Law of 5/16/1902 pp. 175-195.

intent, like *ancien regime* monopolies, was to provide additional incentives to establish novel techniques from abroad.

The rhetoric of Spanish law consistently supported the intent of patents of introduction. Its language emphasized that its primary purpose was to promote new industries in the country. Implicitly this emphasis on innovation asserted priority over the rights of inventors. From the broad language of 1820 ("*Todo el que invente, perfeccione ó introduzca un ramo de industria*") to the introductory sentences of the 1878 and 1902 laws ("*Todo…que pretenda establecer ó haya establecido en los dominios españoles una industria nueva…tendrá derecho a la explotación exclusiva*"), the laws' general rhetoric and specific provisions favored the commercial exploitation of new industry over the protection of inventors' rights.[21] This bias was reinforced by further regulation of patent rights.

Second, the Spanish system clearly limited and regulated the scope of all patents in order to encourage commercial innovation. This was especially true for patents of introduction. Most importantly, each law contained a compulsory working clause: it threatened revocation of any patent unless the patented object was worked within a fixed term (which fluctuated between one and three years over the century). To work a patent meant, according to the 1878 law, "*que se ha puesto en práctica en los dominios españoles, estableciendo una nueva industria en el país*." Inventors, in other words, only had an exclusive right if they commercially exploited their invention. This also meant, moreover, that foreign inventors and holders of patents of introduction could not use their patent to create an exclusive monopoly to import the patented object, but had to develop the manufacture or productive use of their patented object in the country. The laws were explicit on this. They offered protection to "*ejecutar y poner en practica en estos reinos algún objeto, pero no para traerlo hecho de fuera*" (in the 1826 law), and the 1902 law specified that patents of introduction protect "*la fabricación, la ejecución o la producción, pero no da facultades para impedir la introducción y venta de objetos similares del extranjero*." Finally, patents of introduction were limited to just five years duration.

The only significant change to the basic characteristics of Spain's nineteenth century patent system came in the new law of 1878, when the duration and cost of

[21] This emphasis is found even within the definition of what constitutes a new invention. For instance, in the 1878 and 1902 laws: "*Los productos ó resultados industriales nuevos, obtenidos por medios nuevos ó conocidos, siempre que su explotación venga a establecer un ramo de industria en el país*."

patent protection was substantially altered.[22] The new legislation extended the term of patent protection to twenty years (although patents of introduction remained at five years). More importantly, the law slashed the burden posed by the initial patent fees to 4% of its previous level, from a previous minimum payment of 1,100 reales (250 pesetas) for a five year term to an initial payment of 10 pesetas, with successive annual payments of 20, 30, 40 pesetas and so on to extend protection.[23] The 1878 law also explicitly mentioned foreign patentees for the first time, granting them priority if they applied for a Spanish patent within two years of their foreign patent. Spain joined the Paris Convention in 1884, ensuring that foreign inventors would be granted "national treatment" under Spanish law. National treatment gave foreign patentees equal protection with domestic patentees, and the Convention assured foreign patentees right-of-priority for a year after the conferral of the original patent.[24]

In sum, although Spanish law more carefully specified the protection of invention and the rights of inventors, the rhetoric of law continued to emphasize the broader national goal of establishing new industries. Spain's principle means to achieve this goal was the combination of patents of introduction and a compulsory working clause. The first allowed any entrepreneur to claim protection for introducing a new technique or industry while the second required domestic innovation of any patented invention or introduction and prevented foreign patents from protecting import monopolies.

2. *Mexico*

Unlike Spain, legal reform in Mexico yielded two significantly different patent regimes in the nineteenth century, one running 1832-1890, the next 1890-1910.[25] TABLE 2 presents a brief summary of the main elements of each phase of Mexican law.

From independence until 1890 Mexico's formal patent system differed little from Spain's. Indeed, upon independence in 1821, Mexico inherited the Spanish patent

[22] The laws of 1878 and 1902 went much further than previous legislation to detail administrative and adjudicatory processes. These seems true of many national laws in the late nineteenth century; see the British reforms of 1852 and 1883 and Mexico's reforms of 1890 and 1903, for instance. Such increased attention to the specification of patent law was driven by the rapidly increasing international trade in technology in the second half of the century.
[23] Sáiz, 1999b, p. 135.
[24] WIPO/IBIP 1983 p. 216 for the text of the 1883 Paris Convention and its amendments.
[25] The analysis of this paper stops with the end of Porfirian Mexico in the Revolution of 1910, but the post-1890 patent system remained in force until the late 1920s. All quotes are taken from Dublán and Lozano, *Legislación Mexicana*; see Table 2 for specific page references. For a more detailed account of Mexican law and its reform, see Beatty, 1996, though the conclusions here differ.

law of 1820, although this was replaced with a new, wholly Mexican but very similar law in 1832. Both the Spanish and Mexican regimes were registration systems, offering no examination for novelty or utility, both offered protection to inventions and introductions, both had compulsory working clauses (in Mexico after 1843), and both made little mention of foreign patentees (until the 1878 law in Spain and the 1890 law in Mexico). Yet subtle and important differences existed between the two.

First, Mexican law before 1890 defined patents of introduction far more broadly than did Spanish law. "*El introductor de algún ramo de industria,*" stated article 21 of the 1832 legislation, "*que á juicio del congreso general, sea de grande importancia, podrá obtener privilegio exclusivo.*" The language of the law permitted the conferral of monopoly rights, with no limits specified, to any kind of "important" industry, at the discretion of a political body. Such privileges, though codified, appear little different from traditional royal grants of *ancien regime* systems. Furthermore, nothing in the language of the 1832 law limited patents of invention to discrete technological advances, establishing only that exclusive rights could be held by "*el que invente ó perfeccione alguna industria en la república.*" Broad monopolies could apparently be conferred *de jure* on a wide variety of activities, and on a discretionary basis.

Second, Mexican law before 1890 placed less clear and stringent limitations on patents generally and patents of introduction particularly. As we have just seen, patents of introduction could in theory be awarded for virtually any kind of economic activity, with no restriction on their temporal limit. Like Spanish law, the language of Mexican law emphasized commercial innovation. While a compulsory working clause was not introduced until 1843, the 1832 law required that half of all workers employed by patentees be Mexicans, an effort to diffuse the know-how of new techniques. The compulsory working clause of 1843 gave patentees five years to "*plantee y comience a usar el objeto privilegiado.*" Neither piece of legislation spoke directly of the "rights of inventors."

Thus the first Mexican patent regime of the nineteenth century was "modern" in the sense that it established a codified, relatively impersonally administered system to award temporal monopolies to those who fit certain criteria. Yet, even more than the Spanish system, Mexico's regime retained elements of *ancien* privileges, most clearly in the specification of patents of introduction in the 1832 legislation which offered the discretionary allocation of broadly defined monopolies. Like Spain, the pre-1890 regime gave clear priority to commercial innovation over the rights of inventors.

In 1890, after a decade of reform efforts, Mexico replaced the 1832 legislation with an entirely new and radically different patent system.[26] First, the new law more clearly defined the criteria for patentability: "*todo descubrimiento, invención ó perfeccionamiento que tenga por objeto un nuevo producto industrial, un nuevo medio de producción ó la aplicación nueva de medios conocidos para obtener un resultado ó un producto industrial*." Patents were limited to discrete technological advances. Second, the law ended the conferral of patents of introduction. The object of the patent had to be new both in Mexico and abroad. Patents could only be sought for objects publicized or practiced abroad if they were the subject of a foreign patent and if the applicant in Mexico was the original inventor or their legal agent. Only actual inventors, domestic or foreign, could defend patent rights. Third, although the 1890 law retained the compulsory working clause, this was dropped by 1896 (and there is not indication it had been enforced earlier). In practice, even before 1896 foreign patentees received a five-year monopoly permit to import the patented good; thereafter they could do so for the duration of the patent. There were no other limitations or regulations on patent rights in the 1890 law, although a number had been proposed during the reform movement of the 1880s. The new law of 1903 added more detailed specification of administrative and adjudicatory procedures but did not alter the essential aspects of the post-1890 system.

Late-century patent law reform in Mexico also brought substantial change to the duration and cost of patent protection. Like the 1878 Spanish law, in 1890 Mexico doubled the term of patent protection from ten to twenty years and moved towards reducing the burden of patenting fees. Until 1890, the Mexican Development Ministry charged foreigners patenting fees that were between 30-150% higher than those charged to Mexican applicants, although both fell within the broad range specified in the 1832 legislation (see Table 2). Fees for both groups of applicants, however, were relatively high, as we will see below. Although the 1890 law narrowed the possible range of patent fees, it did not substantially alter the costs for either Mexican or foreign applicants.[27] In 1896 the one-time fee was replaced by progressive taxation; all

[26] The reform effort began shortly after Porfirio Díaz first took office in 1876; see Soberanis, 1989, p. 132; Sánchez Flores, 1980, pp. 224-225. There are indications in the patent record that patents were conferred in the 1880s *de facto* along the lines of the 1890 law although the 1832 legislation remained *de jure*.

[27] What mattered to most foreign applicants was of course the dollar (or pound or franc or mark) value of the Mexican peso fee. Because the silver-based peso depreciated substantially against foreign currencies

patentees paid escalating fees ($50, $75, and $100 pesos) to extend protection for each successive five years of the twenty year term, and this reform cut the initial patenting fee (due to receive conferral) by roughly fifty percent for all applicants. Finally, patenting fees were dramatically reduced in the 1903 law, to $5 pesos for a one year provisional patent and $35 pesos for the remaining nineteen years of the full term. In short, relatively high fees persisted until they were moderated in 1896 and reduced dramatically in 1903.

Until 1890 the intent of patent legislation in Spain and Mexico was roughly convergent. Both wished to take advantage of new technologies and diverse activities that had been developed elsewhere. Their governments were not overly concerned with the natural rights of inventors to the "fruits of their genius," nor even with stimulating domestic invention (although these arguments can be found in some liberal rhetoric). Instead, both systems sought primarily to encourage investment in innovation, and especially in the introduction of new machines, new processes, or new economic activities from abroad. "Patents of introduction" would permit entrepreneurial Spaniards or Mexicans to claim exclusive rights to foreign advances, while compulsory working clauses and other regulations sought to encourage direct commercialization. If patent monopolies were limited solely to the original inventor, nationals would be unable to claim any kind of use-rights to foreign technologies without negotiating some form of purchase or licensing with the foreign proprietor. Mexico, however, abandoned this orientation in 1890 and moved instead in the direction of the nineteenth century U.S. legislation by favoring investment in invention over investment in innovation. This did not mean, however, that Porfirian officials believed the time was ripe to call forth the inventive genius of Mexicans. Rather, they believed that this reform was a necessary condition to increase incentives for foreigners to bring their new machines and processes to Mexico.[28]

III. Law and Patenting Behavior

WHAT, then, were the likely implications of Spanish and Mexican patent law? Their goal, of course, was to create a kind of property—the exclusive right—that would

until 1903, the real cost of paying Mexican fees also fell for foreign applicants. This is captured in the analysis in section III, below.

[28] See, for example, the statements made successive Mexican Ministers of Development in the *Memoria* of the Secretaría de Fomento: 1892 volume; 1901-04 volume, p. cxxxii; 1908-09 volume, p. lxxxiii.

increase incentives for individuals to invest in the inherently risky and uncertain activities of invention, introduction, and innovation. We can examine the implications of the patent system on two levels: first and most directly, in the patent records themselves, and second, in patterns of investment in invention and innovation. The first is relatively straightforward; the second more problematic, and will be taken up briefly in the last section of this paper.

Annual series of patents conferred in Spain and Mexico provide the primary evidence for the first relationship, with two adjustments; FIGURES 1 and 2 present the data for each country. [29] First, the series of total patents in each country is divided in two, one representing all patents solicited or awarded to nationals, the other representing all patents solicited or awarded to foreigners. These were two populations responded to patent law reform in different ways, at least in the Mexican case.[30] Second, although figures 1 & 2 present total annual patenting levels, patenting *per capita* series are used in the analyses below, as these better represent patenting behavior—the propensity to patent—than the raw patenting series.[31]

Because we are only examining here the relationship between law and patenting behavior, we do not yet have to worry about whether the patent data actually reflect investment in inventive and/or innovative activity. We need only recognized that patents were an investment for those who sought them, and sometimes a considerable one, given fees and other administrative costs. Like investment in any form of property rights, we would expect that legal reforms that increased the potential benefits of

[29] Patent *applications* show inventors' *interest* in acquiring patents and reflect their perception concerning the changing benefits and costs of patent protection. *Conferred* patents are a function of three factors: applications (public interest in acquiring patents), the criteria of patentability (the degree to which some percentage of applications are denied), the cost of patents (the percentage of applicants who, though applicable, fail to make the necessary payment), and of administrative processes (especially the extent to which it may take a year or more for applications to be approved and conferred). Ideally we would compare applications in Spain with applications in Mexico. However, we only have reliable and comparable data for conferral. Moreover, both countries utilized simple registration systems. See the appendix for a complete description of the patent series, their sources and construction.

[30] Work in progress by the authors examines differences in patenting behavior for those patentees resident in-country compared to non-residents. It is likely that this latter division is more significant than the domestic-foreign division we analyze here.

[31] For nationals, patents are calculated per million residents. For foreigners, the per capita figures are calculated as the number of foreign patents per two-year cumulative patents issued abroad, in the source country(ies) of most foreign patents. In the Mexican case, U.S. citizens took 50-80% of all patents, so the ratio is foreign patents in Mexico to the sum of the previous two years of patents issued in the United States (representing the pool of foreign patents available for patenting in Mexico). For Spain, most foreign patents came from France, Britain, Germany, and the U.S.. The U.S. patent series is taken from the *Annual Report* of the United States Commissioner of Patents and French, British, and German series from Sáiz, 1999, appendix.

holding patent rights and that decreased the cost of acquiring and holding them would have induced higher levels of investment.[32]

Given our discussion of the Spanish and Mexican patent systems in the nineteenth century in section II, we would expect these shifts in the patenting trend to occur after signficant legal reforms in each country. In Spain, the only significant change in the specification of patent law came in 1878, when the new law formally increased the transparency and enforceability of patents, made explicit provisions for foreign patentees (and in 1884, by joining the Paris Convention, gave foreign inventors priority rights over their inventions in Spain), and dramatically reduced patenting fees.[33] We would expect that the 1878 reforms would have substantially increased potential patentees' interest in investing in Spanish patent rights, and that the Spanish patenting trends (both nationals and foreigners) would exhibit at least an upward shift and perhaps also an accelerated growth trend thereafter.

Did legal change in Spain increase interest in seeking Spanish patents among both Spaniards and foreigners? If it did, the relationship is a weak one. As FIGURE 1 illustrates, patenting by both groups underwent two broad cycles, one running from the beginning of our series until about 1864 and the second from the mid 1870s until 1914. Patenting grew faster in the first period than it did in the second, although this is in part due to the extremely low levels of annual patenting in the 1820s. TABLE 3 presents average annual growth rates for the subperiods. The depression of patenting between 1864 and 1874 and its recovery thereafter coincides closely with broader political events in Spain and not with the new law of 1878. The sustained collapse of patenting levels began immediately after the fall of O'Donnell's Liberal Union in 1863 with the beginning of the 1864 financial crisis. There was a brief recovery following the implementation of the Constitution of 1869 and renewed depression with the political chaos of 1873. Following the Restoration in 1874, however, patenting grew steeply through the rest of the decade before settling into a sustained and stable growth pattern over the next three decades. The most dramatic change can be seen in the large increase of foreign patents taken between the downturn of 1864-74 and the resumption

[32] By increasing the strength of patent rights we mean reforms which may have enhanced all or some of the following: the *specification* of what constitutes patentability; the *transparency* of patent rights and their administration; provisions supporting the *tradability* (e.g. through licensing, or assignment) of patent rights; and provisions affecting the *enforceability* of patent rights.

[33] Note that these were the *formal* changes made in the statutory law. The impact of formal law on the nature of the patent right depended of course on the administrative and adjudicatory procedures adopted by patenting agencies and especially on the way in which the courts adjudicated patent disputes (including opposition, infringement, and nullification suits).

of steady growth after 1880. The evidence suggests that investment in patent rights reacted strongly to the broader atmosphere of political stability and certainty, growing by a factor of almost ten within a decade. It might be argued that the new patent law of 1878, with its greater specification and lower costs, played an instrumental role in attracting larger numbers of patent investors than before even though the sharp recovery from the post-1864 depression clearly predated patent reform. In other words, it may have been that without the new law of 1878, the observable late-century patenting growth of 6% per year for nationals and about 5% per year for foreigners would have resumed at a lower level, say closer to the 200 applications per year of 1877 than the 500 of 1879.

The evidence from our data on patent applications suggests that the legal reforms of 1878 may have attracted greater numbers of patentees, leading to a sustained higher level of patenting thereafter. On the other hand, the growth of patenting is in fact slower after 1878 than before and it is not at all clear that high patenting levels after 1878 are not primarily due to the post-restoration combination of political stability and general economic growth through 1914 and perhaps especially to the larger supply of foreign patents available for patenting in the Spain. We will explore the possible implications for this shift in the next section.

In Mexico, the most significant institutional change came with the new law in 1890, although other reforms which should have affected the relative benefits and costs of patent rights occurred on a de facto basis in 1883 and 1887 and de jure in 1896 and 1903. These reforms fall in two categories with important implications for our *a priori* expectations of patenting behavior. In each reform patenting fees underwent change: upwards in 1887 and downwards in each of the other years.[34] The initial minimum cost of patenting underwent its greatest change in the legal reforms of 1896 (from $100 pesos to $50) and 1903 (from $50 to $5 pesos). We would expect that decreasing costs would result in an increase in the level of patenting, and vice versa.

Secondly, the new laws of 1890 and 1903 substantially altered the specification of Mexican patent rights. Both laws substantially increased the specification of administrative and adjudicatory procedures with apparent implications for the transparency and enforceability of patent rights for any and all patentees. In addition,

[34] As noted above, differential fees were charged to Mexicans and foreigners before 1890, and the peso depreciation also altered the dollar burden of patent fees to most foreigners. Annual series of the minimum initial fees take into consideration both the de facto and de jure institutional reforms as well as the peso depreciation, and are used in the regression analysis presented below.

the rights of foreign inventors were strengthened through the period. The 1890 law made explicit provision for patenting by foreign inventors, the 1896 reform removed the compulsory working clause, and in 1903 Mexico joined the Paris Convention, giving foreign patentees de jure equal protection and priority rights. We would expect that potential foreign patentees would be increasingly likely to invest in Mexican patent protection following these reforms.

Does patenting behavior in Mexico reflect the expected impact of these legal changes? The patent evidence suggests that each of the legal reforms had little or no impact on the propensity of *foreigners* to seek and acquire Mexican patents, and that changes in the cost of patent rights--but not other aspects of the specification—did have an affect on *Mexicans'* propensity to invest.

As in Spain, the experience of patenting in Mexico by both Mexicans and foreigners can be divided in two broad phases (FIGURE 2 and TABLE 4). In the first, running from the beginning of our data in the early 1850s until 1877, patenting by both groups was extremely low and highly erratic—not surprising during an era of rather extreme political instability and conflict. Total annual patents conferred by the government rarely exceeded ten and fell to zero in several years. In contrast, the patenting trends of both groups began a long period of steady growth in 1878, with annual averages at 13.3% for foreigners and 7.5 for Mexicans. Also like the Spanish experience, the onset of late-century sustained growth pre-dated significant legal reform and followed instead on the heels of the restoration of political stability in national government—in this case, shortly after the beginning of the government of Porfirio Díaz in 1876. It would be difficult to argue, in other words, that substantial patent law reform in the 1890s was responsible for the onset of sustained late-century patenting growth.

Thus far, the behavior of Mexican and foreign patentees was largely similar. Their experience diverges, however, during the era of Porfirian growth. For foreign patentees, the successive legal reforms of the 1880s through 1903 apparently made little difference. The trend of foreign patenting per capita is steadily upward at over 13% per year (see TABLE 4), with relatively little fluctuation and no shift in level or trend apparent to the eye. The only short-term depressions in patenting by foreigners correspond not to years of legal reform but to years of recession in the Mexican and North Atlantic economies: 1893-94 and 1907-08. There is little change in the slope of the patenting trend before or after the 1890, 1896, or 1903 reforms. Chow test

breakpoint analyses of the years of legal reform also show no significant results for these years.[35]

In contrast, while the propensity of Mexicans to seek patents also underwent rapid growth over the first ten years of the Porfirian era, Mexican patenting stagnated for roughly a decade thereafter (ca. 1887-1897) before resuming steady growth until the onset of revolution in 1910. What accounts for this decade-long stagnation in patenting by Mexicans? It is not coterminous with new laws of 1890 and 1903 which partially redefined and largely strengthened the rights of inventors and patentees. Instead, it correlates closely with changes in the cost of acquiring patent protection: with a 34% increase in the fees charged Mexicans beginning in mid-1886 and with the 50% decrease in initial patenting fees beginning in late 1896. The single largest one-year jump in patenting by Mexicans takes place, furthermore, between 1903 and 1904 when the initial fee fell from $50 pesos to just $5. Mexican patentees, it seems, cared little about the legal specification of patent rights, expect for their initial cost. Again, the Chow test confirms these conclusions.[36]

Why did the patenting fees matter so much to Mexicans and not to foreigners? The relative burden of the initial fees on the two groups can be seen in TABLE 5. Mexico's patenting fees likely presented a large obstacle to potential domestic patentees, as fees ranged between two and three times annual per capita income until the fee reductions of 1896 and 1903 (Column C). Given the skewed nature of income distribution in Porfirian Mexico and the lack of effective capital markets for all but the politically connected, this likely meant that patenting was prohibitively expensive for most Mexicans.[37] In contrast, the burden of Mexican fees was substantially lower for foreign applicants (column G).

Formal modeling of patenting behavior as a function of economic and institutional variables provides one more way to examine the relationship between patenting and legal reform.[38] Our hypothesis is that the propensity to patent, measured

[35] None of the years of legal reform return significant results, nor do multiple subperiods (1878-1890-1903-1910 or 1878-1890-1896-1903-1910). The only point of structural change found significant in the Chow test is the one in the full series (1853-1910) which is readily visible in figure 2: 1878.

[36] Significant results at the 1% level or above are found for the single years 1896 and 1903 within the 1878-1910 period and for the subperiod division 1878-1887-1896-1903 (F=6.69, probability = 0.00016). The results worsen notably if 1890 is added.

[37] See Maurer and Haber, 2002.

[38] This exercise does not assume that every patentee was motivated by the prospects for material gain, but only that most were, and so we would expect the aggregate trend to be correlated with these economic and institutional conditions. This assumption is supported by Schmookler, 1966; Dutton, 1984; Sokoloff, 1988; and Khan, 1995 among others.

by yearly patenting per capita, would respond favorably to economic growth (the demand for new technologies in the domestic economy), to the supply of knowledge (in the case of domestic invention), or the supply of patentable inventions abroad (in the case of foreign patentees), and to institutional reforms which strengthened patent rights and reduced their cost.

In Spain, regressions that examine the impact of these kinds of variables on patenting per capita rates generally support this logic. TABLE 6 offers the results for Foreigners patenting in Spain. First, patenting by foreigners responds positively to both economic conditions (proxied by Spanish foreign trade) and to the level of patenting abroad.[39] Second, the coefficients for both the effect of the new law of 1878 and the political turmoil of 1864-1874 are significant, suggesing that the new law had a large positive influence on foreigners' propensity to patent in Spain, and that the political situation preceding the new law significantly dampened their enthusiasm to do so. For Spanish patentees the results are very similar (TABLE 7). Domestic patenting is procyclical, and both political conditions and the specifications of patent law seem to have mattered to their decision to invest in Spanish patent protection.

The Mexican data present a striking contrast to the Spanish case. In Mexico, the regressions suggest that during the era of patenting growth (1878-1910) foreign patentees responded closely to economic growth and to the supply of foreign inventions available for patenting there, but they apparently cared little about any aspect of the specification of Mexican patent rights. The results in TABLE 8 are unambiguous: the variables capturing economic demand for new technologies and the supply of foreign inventions available for patenting in Mexico are significant in each specification. On the other hand, none of the variables capturing aspects of Mexican patent law are significant in any specification. These results confirm our more general discussion above.

In contrast, Mexican patentees in Mexico apparently cared about at least one aspect of patents' specification: their cost. The regression results in TABLE 9 suggest that without considering institutional issues, economic demand for new technologies does not explain the 1878-1910 patenting trend (although the correlation is very strong

[39] Note that the coefficients to these two variables become insignificant when used together due to multicolinearity effects.

for the 1878-87 and 1898-1910 subperiods).[40] Only when variables capturing aspects of Mexican patent law are added does trade become significant. The various legal variables suggest that cost mattered, but little else did. This becomes particularly clear in the dummy variables for the three legal reforms. The 1890 law, which supposedly strengthened patentees' rights, also sustained high fees (at 200% of Mexico's per capita income) and so yields a negative and significant coefficient in specifications 5-7. In general, the regression confirms our conclusion above that by reducing fees Mexico attracted more domestic patentees. Conversely, there is little support for the assertion that stronger patent rights attracted more patentees. This formal modelling cannot answer, however, whether all this meant that legal reforms actually induced more investment in domestic invention. We will return to this below.

We have argued in section II above that patent systems in many late developing countries were distinct from those in the early industrializers. Those in the former group tended to emphasize commercial innovation and promoted technology transfer through the use of patents of introduction, compulsory working clauses, and other provisions. The foregoing analysis of the relationship between legal change and patenting behavior largely ignored these provisions. What were the implications of these provisions in Spain and Mexico?

The evidence available in the patent records support only tentative observations on several points. First, patents of introduction constituted a minority of total patents conferred in both countries. In Spain, patents of introduction comprised between 30 and 50% of all patents through midcentury. However, as total patent numbers grew rapidly thereafter, the number of applications for introductions held steady, falling quickly to 10% or less of all patent applications by the end of the 1870s.[41] In Mexico, less than seventy patents of introduction were conferred through the century, concentrated in two three-year periods (thirty-three conferred 1855-57 and eighteen in 1863-65). Although these introduction patents comprised a significant percentage in these periods (38% of all conferred patents 1853-1865), they were otherwise nearly absent and only three were issued between 1865 and their abolition in 1890. Mexicans and foreigners each took roughly half of all patents of introduction. Notably, in both countries, the prevalence of introduction patents nearly disappeared at the same time

[40] We would ideally include in this model a variable to capture the supply of knowledge in Mexico, such as the number of engineers, but such data does not exist for the full period.
[41] Sáiz, 1999, p. 140 gráfica 13.

that the respective national economies (and international trade) began growing most rapidly.

Second, compulsory working clauses were apparently ignored in Mexico and enforced in Spain. There is no evidence in the patent records or related sources that Mexico's compulsory working clause of 1843-1896 was ever enforced. Unlike Spain, there was never an established mechanism for ascertaining whether an invention had been "put in practice;" perhaps the intent was to use the courts to adjudicate nullification suits based on non-working. If so, we have found no evidence or references to such suits.[42] In Spain, by contrast, the law provided for specific mechanisms to establish the working of an invention and procedures for declaring patents invalid if not worked. As a consequence, between 1851 and 1878 almost 50% of all patents were declared expired on this basis.[43]

Were patents of introduction an effective means of attracting foreign technology that would not otherwise have come? Probably not, especially given the importance of economic demand as indicated in our rough modeling exercises, above. On the other hand, there is little evidence in the patent records that patents of introduction in any way discouraged foreign inventors from seeking protection in either country.[44]

Did patents of introduction allow nationals instead of foreigners to play a more active role in the introduction and innovation of novel technologies? Did they provide a legal tool with which domestic entrepreneurs could claim a monopoly right to the technological creativity of foreigners and commercialize it at home? Perhaps, although the evidence in inconclusive. There is some evidence that in Spain, introduction patents were especially used in the early decades after 1820, and that Spaniards took protection on several technologically prominent inventions of foreigners (and likely many less prominent ones). These included Alexander Graham Bell's telephone, patented in Spain as an introduction by a Spaniard one month before Bell sought protection there as the inventor, and apparently commercialized by the Spanish patentee in several homes and businesses in Barcelona shortly thereafter.[45] In Mexico, there are also cases of

[42] There is no reference to such suits, for instance, in the sample of several dozen court cases concerning patent rights for which I do have records.
[43] Sáiz, 1999, p. 197 gráfica 28.
[44] If they did, we would expect that when Mexico abolished patents of introduction in 1890 there would have been a significant upward shift in foreign patenting, which was not the case, as we noted in the analysis above.
[45] Bell, however, successfully registered modifications that effectively carved a comercial space for local investment; Sáiz, 1999b, p. 138 n. 195. In the Catalan heart of Spain's textile industry, local

Mexicans taking an introduction patent for a foreign invention and, some years later, taking an invention patent for a related technique. Such experiences—though few and far between—suggest a process of introduction, stimulation, adaptation, and subsequent domestic innovation, all supported by the particular specification of patent law—just the objective of such provisions. If, however, a domestic holder of a patent of introduction delays the ability of the foreign inventor to commercialize the technology, and the foreign inventor is interested in direct investment, has deeper pockets than the domestic introducer, and is thus better able to finance the innovation and diffusion of the new technology, then the patent of introduction has posed an obstacle to technological progress. Which scenario predominated is as yet unclear from several anecdotal cases. In either case, the presence or absence of protective tariffs would have decisively shaped incentives to either commercialize or to import.

Finally, were compulsory working clauses an effective way to promote commercial innovation? In Mexico, the answer has to be no, given the failure to enforce. In Spain, it is more difficult to say. The rate at which patents were revoked for failure to work suggests that this clause effectively denied holders of foreign patents from using them as exclusive import franchises, as was possible in Mexico. More definitive conclusions on these issues must await more focused case studies.

IV. Conclusions: Law, Patents, and Investment in New Technology

HOWEVER CLOSE the relationship between the legal specification of patent rights and patenting behavior—our primary focus in the previous section—the relationship between law and investment in new technologies is more tenuous. Patent statistics only weakly reflect investment in *inventive activity*; even less do they reflect actual levels of investment in *innovative activity*.

If, as we concluded in the previous section, the specification of patent law is only weakly related to the propensity to patent in late-developing countries, then its relation with inventive or innovative activity must also be very weak, at best. Lets examine the foreign and domestic cases separately. There is little reason to expect that the specification of Mexican patent law would influence the rate of *inventive activity*

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entrepreneurs widely used patents of introduction to protect investment in new and imported machines; see Sáiz, 1999a.

abroad.[46] Most inventive activity there was geared initially to opportunities in the domestic (U.S.) market, even if it developed substantial foreign interests as well. In cases where foreign markets did provide an important motivation for invention, the absence of any relationship between patent law and foreign patenting (in the foreign country) suggests that those foreigners who sought patents abroad cared little about the exact nature of patent protection. For the vast majority, sales was their business.[47] Acquiring foreign patent rights around the globe served two possible functions: it enabled sales at monopoly prices and it prevented competitors from acquiring monopolies. In neither case was holding a foreign patent likely *necessary* to motivate pursuit of these sales opportunities.

Did patent law influence domestic inventive activity? We saw above that the relatively weak relationship between legal reform and domestic patenting suggests that patent law may have induced greater numbers of Mexican patentees. If so, did this also mean it induced more investment in inventive activity? In other words, as legal reform expands patenting (box B in FIGURE 3), does it also expand invention (box A), or does patenting (box B) simply expand to encompass more of the existing level of invention (box A)?[48] At present we do not have enough evidence to answer this question.

What about patent law and investment in *innovative activity*—in the commercial use of new technologies? Here we are primarily concerned about the question of technology transfer. Did the particular specification of Spanish and Mexican patent law through the nineteenth century promote the introduction and innovation of foreign techniques? More specifically, did laws which included patents of introduction and compulsory working clauses yield greater investment in this area, or does the evidence suggest that a patent system geared more toward protecting inventors' rights (like Mexico after 1890) yielded greater investment than otherwise?

Again, our patent data shed direct light only on investment in patents and only indirectly on investment in commercial innovation. The patent data make possible several observations. First, the use of patents of introduction virtually disappeared in both countries during the era of most rapid economic (and presumably technological)

[46] This is likely even if we consider patent protection in the rest of the world relative to U.S. invention. Penrose concurs (Penrose, 1951).
[47] See, for example, Wilkins, 1970 and 1998.
[48] Note that the fact that several thousand Mexican inventors invested in patents protection through the period is not in itself sufficient evidence: everyone wants to be a monopolist, especially when a monopoly can be had cheaply, as after 1903. The question is whether there would have been less investment in inventive activity by Mexicans absent patent protection.

growth after midcentury. In Spain, this occurred well before any institutional change affecting patents of introduction.[49] In Mexico it also significantly predated their legal abolition in 1890. While there is some evidence that patents of introduction may have allowed some Spaniards and a few Mexicans to acquire monopoly rights to exploit a novel foreign technique—perhaps to a significant degree in pre-1850 Spain—these cases were relatively few and played little or no role during the era of late-century economic growth. Second, compulsory working clauses were effectively applied in Spain through the century, but not in Mexico. Such provisions, we should note, were essentially negative: they likely played little role in promoting innovation but, when applied, they may have prevented non-worked patents from restraining competitive innovation or from protecting an import monopoly. Finally, there is little indication in the patent records that Mexico's adoption of a pro-invention patent system after 1890 effectively promoted higher levels of investment in technology transfer. If it did, we would expect this to be reflected in higher levels of foreign patenting (few would forsake the opportunity of acquiring a cheap and effective monopoly). As we noted above, however, there is not such indication in the patenting trend.

So where does this leave us? Although we know that patenting, domestic invention, technology transfer, and the commercialization of new productive technologies all accelerated in nineteenth century Spain and Mexico (at least beginning sometime after midcentury), there is relatively little indication in the evidence utilized here that patent law had much influence over the investment behind these trends. Ultimately, firmer conclusions will need to be based on detailed case studies of specific technologies, industries, and sectors. These will provide a more effective way to examine and test the relationship between patent law, patent rights, and—most importantly—actual investment in invention, importation, and technological innovation in Spain and Mexico.

[49] Although Spanish law continued to offer them through the century, the priority right which foreign inventors gained with the new law of 1878 and Spain's adhesion to the Paris Convention in 1884 limited the degree to which third parties could apply for introduction patents.

APPENDIX. *Patenting Levels and Classes: Data Sources and Classification*

1. Spain (Patricio Sáiz)

The most important source for research on the Spanish Patent System is provided by the original files in the Archives of the *Oficina Española de Patentes y Marcas* (OEPM) in Madrid. This documentation contents administrative data (application, grant, dates, compulsory working facts, licences, etc.) as well as technical descriptions and drawings. Between 1826 and 1878 there were more than 5,000 patents recorded, which have been indexed and widely analyzed in Sáiz, 1999b. From 1878 to 1914 we have around 60,000 applications, indexed and studied by a research team (directed by J. P. Sáiz and F. Cayón) within the framework of an agreement between the OEPM and the *Universidad Autónoma de Madrid*. More information and access to both databases can be found at http://www.oepm.es. Our work to complete and disaggregate the Spanish series of applications and grants according to nationality and residence was still underway when this paper was written. Further work on this data is now available in Sáiz, 2005b and at http://www.oepm.es. From 1886 onwards it is also possible to obtain data from indirect sources such as the *Boletín Oficial de la Propiedad Industrial* (OEPM, 1886-nowadays) and some other publications (see WIPO, 1983 or Federico, 1964).

2. Mexico (Edward Beatty)

BECAUSE no single source contains data on all patents issued in Mexico through the long nineteenth century, I reconstructed a patenting series based on multiple sources, cross-checking listings to separate conferred patents from applications and to fill gaps in the coverage of each source.

For the period 1850-1890 I began with the catalogue compiled and published by Soberanís ("Catálogo de patentes"), which contains all patents for which files exist in the national archives. However, this excludes many patents for which no documentation remains, and for others fails to distinguish between applications and conferrals. I remedied these problems by compiling all patent conferrals listed in the annual volumes of Dublán and Lozano's *Legislación Mexicana* and those published in the various volumes of the *Memorias* of the Development Ministry from 1857 through the 1890s.

For the period 1890 to October 1903 I compiled all conferred patents from the daily editions of the *Diario Oficial de la Federación* (totally roughly 4,300 newspaper

editions). For each patent, the database includes the name(s) of the inventor(s), a brief description of the patent, the date of issue, and the patent number. Most patents also contain information on the residence and nationality of the patentee as well as on patent renewals, terms, fees, and classifications. Finally, I compiled a catalogue of patents issued between 1903 and 1910 from the monthly editions of the *Gaceta Oficial de Patentes y Marcas*, published by the Patent Office within the Development Ministry. Yearly totals for 1904-1910 are taken from the summaries published by the Mexican Patent Office.

Distinguishing foreign from Mexican patentees was far from straight-forward. Published notices of patent conferrals before 1904 did not note the nationality of patentees, but fortunately the original letters of applications, published separately in the *Diario Oficial*, frequently referred to nationality. After compiling this data and adding it to the database, those still lacking nationality (just over 50%) who had non-Spanish surnames were cross checked with listings of patentees in the U.S. Patent Office's *Annual Report of the Commissioner of Patents*. As a result, nationality is definitely known for 85% of all patentees before 1904. The remainder were classified as Mexican if they had Spanish surnames, and as generically foreign if they did not. As patentees from Spain were rare, and Mexican patentees with non-Spanish surnames were few, this appears justified.

Official totals for Mexican and foreign patentees after 1904 show Mexican patenting at nearly twice their pre-1904 levels. These counts apparently designated foreigners as Mexican if they did not provide information on nationality in the patent applications. To correct this I took the percentages of Mexican and foreign patents from one sample of roughly 2,400 patents conferred between 1904 and 1910 (24.6% Mexican and 76.4% foreign) and applied these percentages to the total number of patents conceded for those years. These percentages roughly match the average distribution for the 1890-1903 period, but they hide any yearly variation in the distribution that might have existed after 1904.

TABLE 1

Features of Spanish Patent Law, 1820-1914

	Pre-1878	Post-1878
Conferral	Registration	Registration
Invention	"A new machine, aparatus, instrument, process, or mechanical or chemical operation."	"A new machine, aparatus, instrument, process, or mechanical or chemical operation of the applicants own invention."
Introduction	Same, but not necessarily new, if not yet established in Spain.	Same, but not necessarily new or of own invention, if not yet established or practiced in Spain.
Compulsory working	Yes, w/in 1 year. (two years between 1820-26)	Yes, w/in 2 years. (extended to 3 yrs in 1902)
Term	Inventions – 5, 10, or 15 years depending on the payment; Introductions – 5 years (w/ moderate extentions poss.)	Inventions – 20 years Introductions – 5 years
Cost	250 pesetas for 5 years; 750 for 10 years; 1500 for 15 years. 750 pesetas for Introductions.	Annual payments: 10, 20, 30, 40 pesetas & etc. to 200 at 20 years.
Foreign patentees	Pre-1878: same rights as nationals, without priority.	1884: Terms of Paris Convention.

Source: The original legal texts published in Sáiz, 1996.

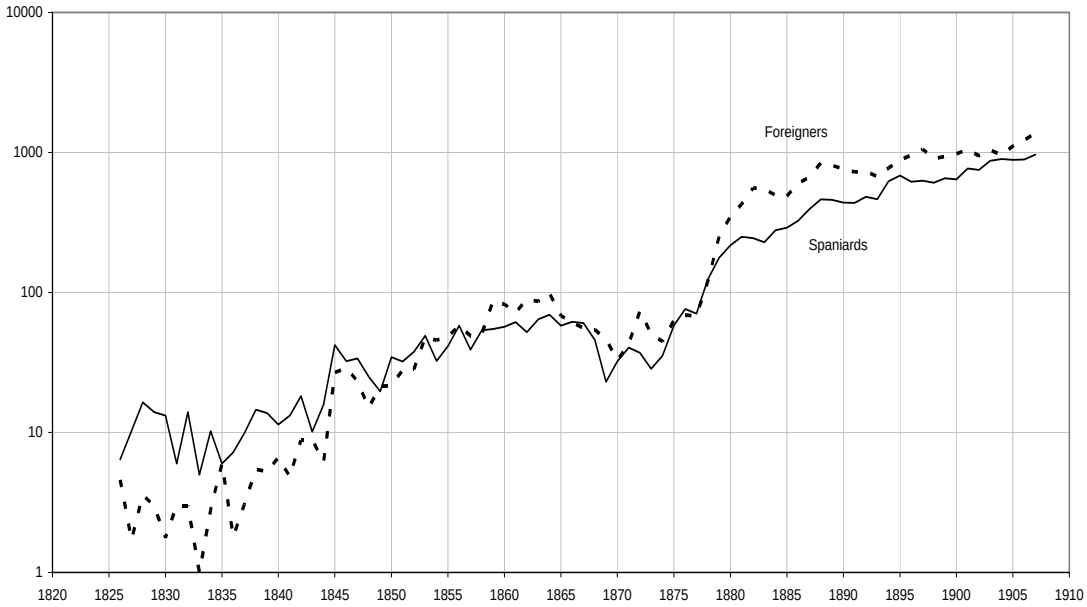
TABLE 2

Features of Mexican Patent Law, 1820-1910

	Pre-1890	Post-1890
Conferral	Registration	Registration
Invention	"He who invents or improves any industry in the Mexican Republic."	"Every discovery, invention, or improvement of a new industrial product, a new method of production or the new application of known methods to obtain an industrial result or product."
Introduction	"The introducer of any branch of industry that is of great importance in the judgement of congress."	No.
Compulsory working	Added in 1843 (term indeterminate).	Yes, w/in 5 years. Abolished in 1896.
Term	Inventions – 10 years; Improvements – 6 years; Introductions – indeterminate.	20 years; extendable for 5 additional.
Cost	From $10 to $300 pesos; criteria unspecified, with differential fees charged *de facto* to nationals and foreigners; see text.	1890: $50-150 pesos; 1896: 5-year installments of $50, $50, $75, and $100. 1903: $5 pesos for first year; $35 for remainder.
Foreign patentees	No mention.	1890: Explicit inclusion; 1903: Terms of Paris Convention.

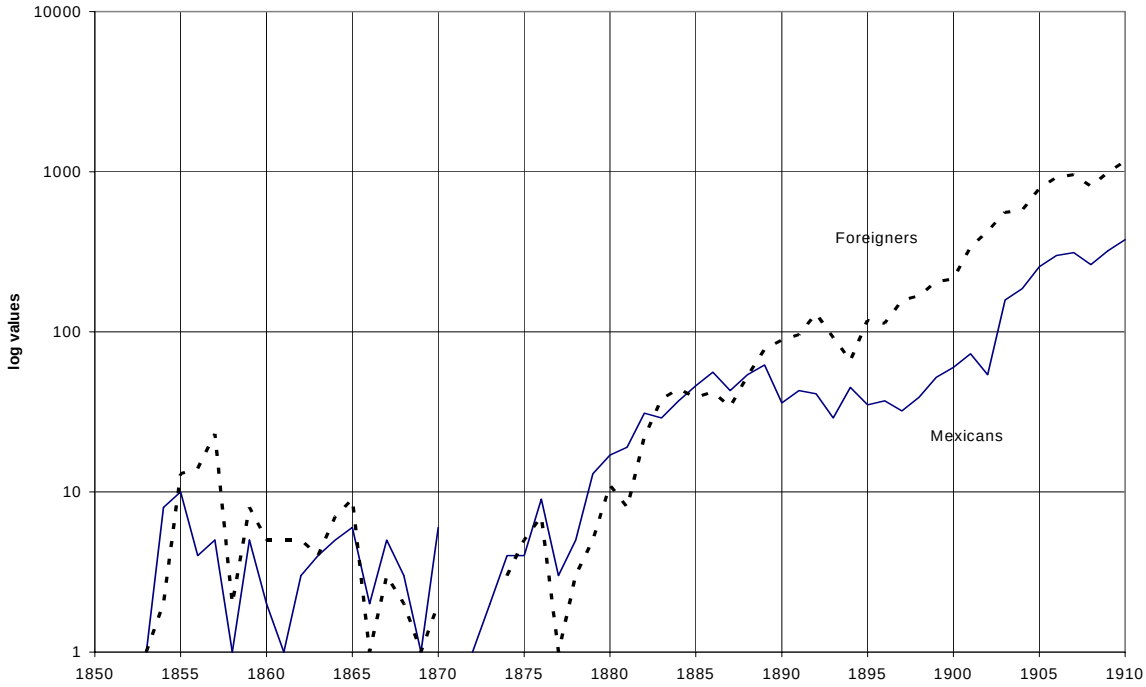
Source: Dublán and Lozano, *Legislación Mexicana*, vol. 2, pp. 427-428; vol. 4, p. 706; vol. 6, pp. 219-220; vol. 20, pp. 179-183; vol. 26, p. 213; vol. 35, pp. 864-879.

Figure 1: Patents Conferred to Spaniards and Foreigners in Spain, 1820-1910



Notes: see text and appendix for sources.

Figure 2: Patents Conferred to Mexicans and Foreigners in Mexico, 1853-1910



Notes: see text and appendix for sources.

Table 3:

Patenting in Spain: Growth Trends in Patents Conferred to Spaniards and Foreigners

(Average Annual growth; R2 in parentheses)

	Spaniards	Foreigners
1826-1907	6.3% (0.91)	8.4% (0.93)
1826-1864	6.2% (0.80)	11.5% (0.90)
1878-1907	6.0% (0.93)	4.9% (0.73)

Notes: growth trends calculated using OLS regressions of the log of total patent applications on a time series. See the appendix for the source of patenting data.

Table 4:

Patenting in Mexico: Growth Trend in Patents Conferred to Mexicans and Foreigners

(Average annual growth; R2 in parentheses)

	Mexicans		Foreigners	
1853-1878	-0.3%	(0.001)	-14.7%	(0.60)
1878-1910	7.5%	(0.67)	13.3%	(0.94)
1878-1886	22.7%	(0.86)		
1878-1890			19.5%	(0.83)
1887-1896	-5.6%	(0.46)		
1891-1910			12.6%	(0.93)
1897-1910	19.3%	(0.90)		

Notes: growth trends calculated using OLS regressions of the log of total patent applications on a time series. See the appendix for the source of patent data.

Table 5:

Patenting Costs in Mexico for Mexicans and Foreigners, 1880-1905

	For Mexican Applicants			For Foreign Applicants			
	A	B	C	D	E	F	G
	Fee in Current Pesos	Mexican Per Capita Income	Fee as % of Mex. PCI	Fee in Current Pesos	Current U.S. Dollars	U.S. Per Capita Income	Fee as % of U.S. PCI
1880	50	37	135%	150	137	205	67%
1885	25	40	63%	30	25	203	12%
1890	100	50	200%	150	125	201	62%
1895	100	58	172%	100	52	200	26%
1900	50	85	59%	50	24	290	8%
1905	5	135	4%	5	2.5	382	1%

Sources and Notes: See text and appendix for source of and comments on the Mexican peso fees. Mexican per capita income estimated from the figures for 1875, 1895, and 1910 in Coatsworth, 1990, p. 117. Fees converted to U.S. dollars using the exchange rate in INEGI, 1994, series 20.6. U.S. per capita income estimated from *Historical Statistics of the United States*, 1975, series F-2.

Table 6:

Patenting in Spain by Foreigners: Determinants of Per Capita Patent Conferrals 1848-1907.

(t-statistic in parentheses)

	(1)	(2)	(3)	(4)	(5)	(6)
N	60	60	60	60	60	60
R^2	.68	.61	.68	.93	.93	.80
Adj R^2	.68	.60	.67	.92	.93	.79
d	0.31	0.27	0.31	1.16	1.16	0.59
constant	-13.06	-13.58	-13.08	-4.76	-5.34	-11.79
	(-16.44)	(-13.83)	(-14.43)	(-6.27)	(-6.92)	(-15.69)
trade	1.23		1.21	-0.005	0.179	1.358
	(11.12)		(3.56)	(-0.026)	(0.904)	(5.030)
foreign		0.98	0.02	-0.026	-0.089	-0.219
patents		(9.52)	(0.06)	(-0.183)	(-0.642)	(-0.948)
law 78				1.62	1.43	
				(13.52)	10.20	
pol					-0.222	-0.775
					(-2.34)	(-5.897)

Notes: Dependent variable: Log of patents taken by Foreigners in Spain per 2-year cumulative sum of patents taken in France, Britain, Germany, and the US. Trade = log of current value of Spanish imports plus exports; Foreign patents = 2-year cumulative sum of patents issued in France, Britain, Germany, and the US; Law 78 = a dummy variable, taking "0" before the reform and "1" thereafter; pol = a dummy variable, taking "1" during the years of political disruption, 1864-74, and "0" otherwise.

Table 7:

Patenting in Spain by Spaniards: Determinants of Per capita Patent Conferrals 1848-1907.

(t-statistic in parentheses)

	(1)	(2)	(3)	(4)
N	60	60	60	60
R^2	.79	.90	.92	.88
Adj R^2	.78	.90	.92	.87
d	0.24	0.56	0.55	0.43
constant	-11.44	-3.27	-4.738	-10.316
	(-12.33)	(-2.81)	(-4.06)	(-13.93)
trade	1.891	0.646	0.889	1.758
	(14.68)	(3.72)	(5.03)	(17.24)
law 78		1.603	1.203	
		(8.31)	(5.56)	
pol			-0.470	-0.923
			(-3.27)	(-6.30)

Notes: Dependent variable: Log of patents taken by Spaniards per million Spanish population (population figures from Estadísticas Históricas de España). Trade = log of total current value of Spanish imports and exports; law 78 = a dummy variable, taking "0" before the reform and "1" thereafter; pol = a dummy variable, taking "1" during the years of political disruption, 1864-74, and "0" otherwise.

Table 8:

Patenting in Mexico by Foreigners: Determinants of Per capita Patent Conferrals 1878-1910.

(t-statistic in parentheses)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
N	32	32	32	32	32	32	32
R^2	.97	.97	.97	.97	.97	.97	.97
Adj R^2	.96	.96	.96	.96	.96	.96	.96
d	2.05	2.08	2.05	2.05	2.19	2.14	2.10
constant	-35.24	-32.77	-34.72	-34.63	-33.02	-33.89	-34.70
	(-17.15)	(-11.30)	(-12.96)	(-12.55)	(-9.40)	(-10.35)	(-10.89)
trade	1.21	1.138	1.208	1.198	1.285	1.243	1.145
	(9.18)	(7.83)	(8.92)	(8.43)	(3.36)	(3.32)	(3.16)
uspat	1.307	1.215	1.267	1.276	1.000	1.122	1.372
	(3.54)	(3.24)	(3.19)	(3.30)	(1.53)	(1.82)	(2.41)
fee		-0.002			-0.002		
		(-1.20)			(-1.12)		
pvala			0.006			0.659	
			(0.31)			(1.04)	
pvalb				0.006			
				(0.33)			
law90					-0.186	-0.212	-0.049
					(-0.66)	(-0.72)	(-0.19)
law96					0.018	-0.239	0.146
					(0.07)	(-0.56)	(0.70)
law03					-0.001	-4.687	-0.010
					(-0.01)	(-1.04)	(-0.06)

Notes: Dependent variable: Log of patents taken by Foreigners per 2-year cumulative US patents. Trade = log of total current value of imports plus exports between Mexico and the United States (see Beatty, 2000); uspat = 2-year cumulative series of U.S. patents (e.g. 1888=1887+1888); fee = annual series of peso fees charged foreigners converted to U.S. dollars at the going exchange; pvala = patent term/patent fee; pvalb = pvala + the legal dummy variables; law90, 96, and 03 = dummy variables, taking "0" before the reform and "1" thereafter. OLS regression.

Table 9:

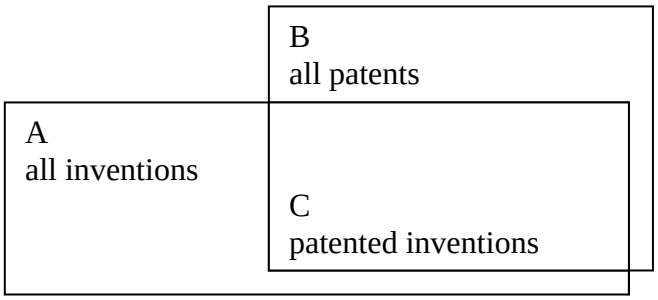
Patenting in Mexico by Mexicans: Determinants of Per capita Patent Conferrals 1878-1910.

(t-statistic in parentheses)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
N	32	32	32	32	32	32	32
R^2	.86	.86	.87	.86	.90	.90	.90
Adj R^2	.85	.85	.85	.84	.88	.88	.88
d	2.04	2.09	2.35	2.30	2.28	2.30	2.26
constant	23.57	23.44	-3.816	-0.280	-21.09	-20.35	-17.63
	(1.94)	(1.91)	(-1.34)	(-0.06)	(-4.94)	(-5.52)	(-4.65)
trade	-1.019	-1.020	0.280	0.084	1.287	1.222	1.077
	(-1.76)	(-1.73)	(1.78)	(0.32)	(5.13)	(5.86)	(4.96)
fee		-.009			-0.003		
		(-0.25)			(-1.13)		
pvala			0.317			0.899	
			(4.58)			(1.37)	
pvalb				0.190			
				(2.96)			
law90					-0.980	-1.047	-0.932
					(-4.75)	(-5.05)	(-4.24)
law96					-0.505	-0.480	-0.225
					(-1.75)	(-2.01)	(-1.21)
law03					0.843	-2.211	1.074
					(3.42)	(-0.93)	(6.77)

Notes: Dependent variable: Log of patents taken by Mexicans per million Mexicans (population figures from INEGI, 1995). Trade = log of total current value of imports plus exports between Mexico and the United States (see Beatty, 2000); fee = annual series of peso fees charged Mexicans; pvala = patent term/patent fee; pvalb = pvala + the legal dummy variables; law90, 96, and 03 = dummy variables, taking "0" before the reform and "1" thereafter. First-order serial correlation model.

FIGURE 3: Inventions and Patents



Note: A minus C = unpatented inventions

B minus C = non-invention patents

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