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150 YEARS OF PATENT PROTECTION

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ABSTRACT

This paper examines three sets of explanations for variations in the strength of patent protection across sixty countries and a 150-year period. Wealthier nations are more likely to have patent systems, to allow patentees a longer time to put their patents into practice, and to ratify treaties assuring equal treatment of other nations. But they are also likely to charge higher fees and limit patent protection in some important ways. Countries with democratic political institutions are consistently more likely to have patent protection appear to be determined by historical factors. The origin of a country's commercial law appears particularly important in explaining the presence of restrictions on patentees' privileges and discriminatory provisions against foreign patentees.

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1. Introduction

A substantial political economy literature, dating back to the eighteenth century, exists on the determinants of property rights. Some forms of property rights have attracted extensive empirical scrutiny: for instance, a substantial legal and political science literature, and a growing number of economics studies, have examined the rights of creditors and debtors. The determinants of intellectual property rights, despite being well documented, have been the subject of relatively limited systematic empirical study. Understanding the determinants of intellectual property rights should complement empirical studies of other important classes of property rights.

Intellectual property rights are also of considerable practical interest. One of the foremost items on the technology policy agenda of recent U.S. administrations has been the harmonization of intellectual property protection across the world. Efforts to change domestic patent policy to conform to world standards (such as the adoption of a twenty-year patent term) have been controversial. Even more contentious have been American efforts to insure minimal levels of patent protection in developing nations, especially through the implementation of the 1993 Trade-Related Intellectual Property (TRIPs) agreement of the General Agreement on Tariffs and Trade. A greater understanding of the determinants of differences across nations in intellectual property regimes should help inform the policymaking process.

This paper examines the differences in the strength of patent protection in sixty countries over a 150-year period. It contrasts three explanations for the differences

across nations. First, the extent of patent protection may be determined by the relative economic strength of the nation. Second, the internal political situation—in particular, the degree to which power is centralized among a ruling elite—may play an important role. Finally, the historical origins of the nation's commercial legal system may be a determinant.

The paper finds evidence that is consistent with these views, but also suggests greater complexity. Relatively wealthier nations are more likely to have patent systems, to allow patentees longer to put their patents into practice, and to ratify treaties assuring equal treatment of patentees from other nations. But they also tend to limit patent protection in some important ways, whether through requirements that protect earlier innovators or through charging higher fees for patent awards. Countries with democratic institutions are consistently more likely to have patent protection and longer awards.

Even after controlling for these differences, however, differences in legal traditions are generally significant and persistent. To cite several examples, French family countries, while early to adopt patent protection, have consistently discriminated against foreign patentees. Civil law countries in general have greater restrictions on the rights of patent holders, including shorter "working periods" (the maximum period before the patent must be employed in practice) and a variety of other curbs (such as the prevalence of compulsory licensing provisions in German and Scandinavian nations). Fees are significantly higher in these nations as well (with the exception of the Scandinavian countries) than in common law countries. These differences persist despite

considerable changes in the institutional features of the patent system across nations and over time.

Two limitations should be acknowledged up-front. First, in an analysis covering so long a span of time, I am unable to observe all aspects of patent policy. In particular, while I can observe the structure of legal patent protection over time—including the length of protection, fees, and important limitations on the enforcement of patent rights—the implementation of these rights is not as clear. Chaotic conditions or corruption may preclude enforcement in certain conditions. As North [1990] points out, the effectiveness of property rights are interdependent with the smooth operation of many other societal institutions. Even in a stable society, the courts' willingness to enforce patent rights may vary dramatically: for instance, the share of cases won by patent holders increased dramatically in the United Kingdom in the 1830s [Dutton, 1994] and in the United States in the 1980s [Kortum and Lerner, 1998].

Second, I do not analyze alternative mechanisms for protecting intellectual property that may substitute to some extent for patent protection. These take at least two forms. First, there are reward mechanisms. As highlighted in papers by Wright [1983], Kremer [1998], and Shavell and van Ypersele [1999], in a number of historical instances nations have offered prizes or recognitions to discoverers of important inventors. Second, commercial law more generally may provide some degree of protection to innovators, such as the trade secret provisions in Anglo-American common law or the

rights against imitation sometimes found in Islamic law.[1] Despite these limitations, this work sheds light on a key element of technology policy.

There has been a limited amount of related literature on the determinants of patent policy. Most similar are Frame [1987], Rapp and Rozek [1990], and Ginarte and Park [1997a], who estimate equations explaining the strength of patent protection using a variety of economic and demographic variables. There are several substantial differences with this analysis. First, the earlier authors only use contemporaneous data (as far back as 1960 in the case of the latter paper). Second, the previous authors seek to explain a composite index of the strength of patent protection, rather than the specific features of the patent protection regime.[2]

The plan of this paper is as follows. The second section briefly reviews the three sets of hypotheses that motivate the analysis. I discuss the construction of the data set in Section 3. Section 4 presents the analysis. The final section concludes the paper.

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[1] For two legal cases that discuss and illustrate these alternative forms of protection, see *Kewanee Oil Co. v. Bicron Corp.*, 416 U.S. 470 (1974) and *Louis Mend v. Godo Construction Co., Ltd.*, Saudi Arabian Case No. 348/1400/H (1981).

[2] Frame [1987] employs as a dependent variable a tri-partite qualitative rating based on the three industry and government studies identifying nations with frequent patent infringement. Rapp and Rozek [1990] make a qualitative ranking on a zero-to-five scale using criteria identified by Grabow and Richards [1988]. Ginarte and Park [1997a] collapse 17 features of patent protection into a composite score. A number of other papers have used these indicators (e.g., Gould and Gruben [1996], Ginarte and Park [1997b], Maskus and Penubarti [1995]), typically to explain economic development or growth.

2. Hypotheses

The determinants of patent policy are not simple. As case studies of historical and current controversies make clear, a diverse array of actors seek to shape the intellectual property system, often with a very narrow agenda in mind.[3] Nonetheless, the literature suggests three broad hypotheses that may explain the variations in the extent of patent protection. This section briefly summarizes this literature.

A. *Patent Protection and the Stage of Development*

Much of the economics research into the determinants of the optimal degree of patent protection has focused on the nation's stage of development. Initial analyses of the degree of optimal patent protection focused on a single-country setting, while later work has considered more complex scenarios.

In the classic model of Nordhaus [1969], a policy-maker considered how to encourage an incremental (cost saving) innovation. The greater the degree of patent protection, he assumed, the greater the resources that a private firm will devote to pursuing the innovation and the greater the probability of a discovery (though the probability is declining with the amount spent on R&D). In determining the optimal level of patent protection, the policy-maker will seek to minimize the distortions associated with longer (or broader) patents, while still providing sufficient incentives to

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[3]To cite just one example, Walterscheid [1995] documents how the decision by the U.S. Congress to introduce a unique way of resolving the priority of patent applicants in the Patent Act of 1793 (many elements of which continue to this day) was driven by the lobbying by James Rumsey and John Fitch, who were locked in a dispute over the ownership of the rights to riverboat engine technology.

innovate. The analysis (see also Scherer [1972]) suggests that the degree of patent protection will be determined by the curvature of the R&D cost function near the optimal level of R&D spending, which may be interpreted as the ease of further discovery for a given additional expenditure. In settings where relatively modest investments are likely to lead to substantial discoveries, the analysis suggests that a weak patent policy is optimal. One implication discussed by Nordhaus is that nations who are technological followers, whose process of technological discovery is presumably easier, should have weaker levels of patent protection.

This insight has been corroborated in models that depict a world with both a developed and developing nation. A number of papers (e.g., Chin and Grossman [1990], Deardorff [1992], and Helpman [1993]) suggest that mechanistically transferring the intellectual property practices in place in the developed world to developing countries may be problematic. In particular, several works have argued that as long as a country is a net consumer of innovations developed elsewhere, it is likely to be worse off with strong intellectual property protection. The distortions introduced by monopoly pricing on the part of the intellectual property holders more than offset the spur to domestic innovation.[4]

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[4]In fact, the losses in social welfare in at least some cases may more than offset the gains in the developed countries that are providing the bulk of the innovations. Imposing strong patent policies in developing countries, these works suggest, can lead to a decline the welfare of the world as a whole.

This result may change, however, under a variety of conditions. Diwan and Rodrik [1991] show formally that if the developing country has the need for innovations that are different from those of the developed nation, strong intellectual property protection may be desirable. Otherwise, it may not be able to induce the developed nation to undertake innovations in this area. Surveys and clinical studies suggest other potential benefits, such as a greater ability to raise external financing and to enter into licensing agreements. Collectively, this literature suggests the desirability of examining how relative economic development affects intellectual property regimes.[5]

B. Patent Protection and the Political System

A second class of explanations highlight the extent to which intellectual property regimes (and property rights more generally) are a consequence of the allocation of political power within a society. Government policies may be designed to insure that the parties in control of the society retain power and can accumulate as much resources as possible. This section will highlight the implications for intellectual property rights.

It might be thought that the nature of the property rights would not be related to the political system. Even an absolute monarch might choose the institutional

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[5]At the same time, there are a variety of interesting empirical implications about patent policy that would be very difficult to test with this data set. Examples include the suggestions in Green and Scotchmer [1995] and Scotchmer [1996] regarding patent length. These papers consider a setting where a first-generation innovator interacts with one (or more) second-generation innovators. They suggest that subsequent patents in a technological area should be shorter in duration. Furthermore, patents in general should last longer when multiple firms undertake research in an industry rather than just one. Testing these suggestions seemed exceedingly challenging, particularly in light of the difficulty of compiling substantial information about the structure of R&D spending and the nature of inter-industry competition across a panel of nations.

arrangements that would maximize national income, even if he was only interested in maximizing his own wealth and not social welfare. Yet even a casual review of the accounts in Finer [1997] suggests that authoritarian regimes have tended to have weak property rights of all kinds.

North [1979] proposes one rationale for this seeming anomaly. He suggests that even the most authoritarian regime will be able to extract only part of the surplus generated by stronger property right regimes. Meanwhile, the costs associated with administrating the property rights regime are borne directly by the state (and hence the ruler). As a result, an authoritarian ruler may not to invest in the development of strong property right systems. This effect is likely to be exacerbated if threats to the regime lead the ruler to adopt a more "myopic" perspective (North and Weingast [1989]).[6]

C. Patent Protection and Legal History

A third hypothesis can be drawn from the recent works on the importance of legal structures in shaping financial development, as well as the body of literature on economic and political institutions more generally. These works emphasize the importance of "path dependence": the far-reaching implications of the initial design of a society's institutions.

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[6]Subtler interactions between the design of the patent system and the political environment may exist as well. To cite one example, Khan and Sokoloff [1998] attribute the high fees for patent protection in Great Britain prior to the 1852 patent reform (as Table 3 shows, the inflation-adjusted cost of British patents in 1850 was the greatest of any country or period in the sample) to the desire to restrict opportunities for new entrants to gain wealth or status.

A long tradition has highlighted the institutional rigidities that can lead to the persistence of legal structures. While a "functional" perspective might suggest that competition would lead societies to rapidly adopt the most efficient institutions, the historical record suggests otherwise. In particular, the writings of North [especially 1990] highlight the extent to which resistance to change is likely on the part of incumbent firms and regulatory officials who fear that their collusive arrangements will break down if policy reforms allow new rivals. For instance, North [1961] shows how repeated efforts to reform financial regulation in the early nineteenth century United States were blocked by established financial institutions, despite the very positive impact that these changes could have had on the workings of the capital markets and economic growth. More formally, Akerloff [1976] models how individuals' fears of penalties may lead a society to fail to adopt welfare-improving institutional improvements.[7]

In a recent set of studies, La Porta, Lopez-de-Silanes, Shleifer, and Vishny (henceforth LLSV) examine the determinants of commercial legal structures and their implications for financial activity and corporate ownership. They highlight that almost all nations' commercial legal codes fall into one of a few broad families, such as the common law tradition originally developed in Britain and the French, German, and Scandinavian civil law traditions. LLSV [1998] shows that there is a high degree of correlation between the legal family of a nation and the extent of protections afforded to equity investors and debt holders. Moreover, the authors argue, a nation's legal family

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[7]A number of other explanations have been offered for these rigidities, such as the difficulty of arranging collective action on the part of groups with different agendas (Olson [1982]).

appears to have substantial implications for the efficiency with which its financial system operates. While acknowledging that the failure of countries to rethink their legal systems is not without its puzzling aspects, they suggest that historical circumstances have a powerful effect on the development of financial law.

A similar argument might be advanced in the context of patent law. Just as Japan adopted many aspects of German commercial law regarding financial practices, so too many aspects of the Japanese patent system appeared earlier in Germany, including compulsory licensing provisions, minor ("utility model") patent awards, and the deferral of patent examinations at the applicant's request. The origin of a country's commercial law may have a profound effect on its patent policy today.

3. Constructing the Data Set

I employed as my sample the sixty countries listed in the International Monetary Fund's *International Financial Statistics* with the highest gross domestic product (GDP) in 1997. If the country was missing GDP data for 1997, I used the GDP and exchange rate for the most recent year for which such data were available (inflation-adjusting the result to insure comparability).[8]

I then determined the features of the patent system at 25-year intervals. I sought to determine this information as of mid-year 1850, 1875, 1900, 1925, 1950, 1975, and

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[8]In one case (Iraq), the volume had no data for the past five years. In this case, a consensus estimate from press accounts was used. In the second case (Taiwan), a country was not listed due to questions about its political status. In this case, data were obtained from government publications.

1999. I only determined the status of the country's patent system if it was an independent political entity as of that date. My rationale for this approach was that most colonies did not have independent patent policies. Most did not grant patents at all, simply registered patents granted by their colonial overseer without any formal review, or had patent systems that closely mirrored those of their colonizer. As a result of these omissions, this was not a balanced sample: the number of observations increased over time, as more nations became independent.

Determining what constituted an independent country was not always a simple matter. In some cases, colonies underwent prolonged independence struggles, and the exact date at which an independent government was established was difficult to determine (e.g., Saudi Arabia and Indonesia). In other cases, countries enjoyed a great deal of independence while under the official control or informal influence of another nation (e.g., Norway and Korea in the nineteenth century, Egypt in the 1930s and 1940s). In general, I sought to include a nation from the date that its independence was declared (conditional on it eventually becoming a widely recognized country).[9]

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[9]Two complications should be briefly discussed. First, an exception to the algorithm above was made for formerly independent countries that were the final stages of military occupation (e.g., West Germany in 1950). In many instances, independent patent systems had been adopted as a prelude to the relinquishment of military oversight. Second, in cases where a country was divided into several political entities, I used the patent policy (and other characteristics discussed below) from the most economically significant portion. For instance, in the case of Germany, I used Prussia's patent policy prior to German unification, and that of West Germany after World War II.

In order to undertake this analysis, I relied on guidebooks to the world patent systems. These handbooks—typically prepared for the use of inventors by patent lawyers and agents—have been frequently published since the early nineteenth century. In each case, I was able to identify at least five information sources published within five years of the seven dates at which I sought to characterize the patent system. These are listed in Appendix A. While not all information was available in all years for all nations (particularly data on patent fees and prior user rights), I was able to construct a variety of reasonably comprehensive measures.

Using a variety of sources summarized in Appendix B, I at least crudely characterized the nations' economic and political conditions. In each case, I sought measures that could be collected on a reasonably comprehensive basis. While most of the data sources are familiar to economists, one exception is the Cross-National Time Series (CNTS) database, the primary source of the political variables. Originally compiled by the Council on Foreign Relations in 1927, this database has been maintained by the Center for Comparative Political Research at the State University of New York-Binghamton for the past three decades. Available in electronic form from the Inter-University Consortium for Political Science Research, the database has been extensively used in political science research.

The variables employed in this analysis included:

- Population of the country (available for 99% of the 298 country-year observations).

- Per capita gross domestic product. In this case, as in the others, the variable was converted into current U.S. dollars using, if possible, a purchasing power parity-based deflator. It was then converted into 1998 dollars using the U.S. GDP deflator (back to 1889) or the U.S. consumer price index (for earlier years). (This was available for 91% of the observations.)

- The manner in which the effective ruler responsible for day-to-day management of the country (a monarch, president, premier, military leader, or other) was selected (direct election, indirect election, or non-elective) (100%).

- The characteristics of the legislative body. I employed whether the legislature was selected through an elective process and the CNTS ranking of the effectiveness of the legislative body (99%).[10]

- The incidence of substantial depreciation of the national currency. This measure was employed only in the regression analyses of patent fees. I identified instances where the currency had depreciated over the previous five years by five, ten, and/or one hundred times against the U.S. dollar. (This was found for 100% of the instances with an observation of patent fees.)

- The coincidence of the observation and a period of "nation building." It might be thought that in the chaotic circumstances surrounding the formation of many nations, the design of a patent policy was not immediately addressed. I identified observations where in the past five years, the nation had been established or had been reconstituted after being out of existence for fifty years or more (100%).

- The family into which the nation's commercial laws falls. As LLSV note, these definitions must inherently be somewhat crude in nature. I employed the classification in LLSV [1999], making two adjustments that reflected the panel nature of my data set. First, many legal systems classified by LLSV as communist previously were based in another legal tradition (e.g., Hungary and Poland). In the observations before the communist take-over, the countries were so classified. Second, some countries originally had legal systems that were quite distinct from any of the major families identified by LLSV (e.g., Japan before 1889, Korea before 1910, and Russia before 1917). These cases were lumped together in an "other" category (100%).[11]

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[10]The three political measures used in the regressions below were positively correlated, with correlation coefficients ranging between 0.5 and 0.65. The joint significance of the political variables continued to hold in almost all regressions when one of the three variables (the legislative effectiveness dummy variable) was deleted as an independent variable.

[11]The question of historical "path dependency" was also addressed in other ways below, such as the use of fixed effects for each nation.

Many of the variables must be approached with caution. Definitions were unlikely to be consistent across countries and time, and nations may have been tempted to give an excessively positive view of their economic conditions. Despite these substantial limitations, these variables can provide a general sense of the degree of the nations' development.

I sought to match the dates of these measures as closely as possible to the patent policy observation, using the same month or calendar year. For the nineteenth century, however, I relaxed these requirements: I employed an observation as long as it was within five years of the time when the patent policy was recorded. This was particularly true of the estimates of gross domestic product, which were frequently only periodically available.

4. Analysis of Patent Protection

A. *Summary Statistics*

Tables 1 through 5 summarize the key features of patent protection that I focused on in this paper. The first, and most crude, measure was whether the country had a patent system at all. While by 1999, 59 out of the 60 largest countries had patent protection, during the nineteenth and early twentieth centuries patent systems were far from universal. I also recorded if a modified form of patent protection was present: some affiliates of colonial powers made awards automatically, conditional on receiving a grant from their colonizer.

A related set of measures, also reported in Table 1, characterized the range of subjects for which patent protection could be obtained. I focused on a number of representative areas where considerable diversity existed: chemicals, food items, medicines, plants, and software. In each case, these were coded using a tri-partite scheme, indicating whether no protection was allowed, whether some protection was allowed but less than that offered other inventions, or whether full protection was extended to these classes. A variety of other special restrictions were denoted by lower-case footnotes.[12]

A second category was the duration of the patent grant. Table 2 reports the duration of patents awarded to domestic applicants, as well as the date when the award began (e.g., from the application or award date). In some cases, patent officials could lengthen the duration of patents deemed to be important: these instances were noted. In other cases, certain classes of patents, such as those involving pharmaceuticals, had shorter or longer protection period (noted as well). In each instance, I did not include cases where the patent extension was conditional on renouncement of important rights: e.g., where extensions were only granted when the patentee agreed to make the award generally available for licensing.

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[12]In recent years, as part of the implementation of the TRIPs agreement, a number of developing nations have agreed to eventually establish patent protection for certain classes of inventions (especially pharmaceuticals). In some cases, patent applications are currently being accepted, but will not be reviewed until an agreed-upon future date. In instances where such "mailbox" provisions are in place, the countries are coded as having some degree of patent protection for the category.

The third table reports the cost of the patent. The fee was calculated based on the longest patent, without any provision for extraordinary extensions. Some countries applied surcharges for particularly lengthy patent applications, ones with numerous illustrations, or for the privilege of having the review process expedited or kept secret. I assumed that the patent was a short application without these extra features. I also assumed that the patent was awarded for the entire country (*i.e.*, I ignored provisions for discounts for patentees who only wanted an award for a particular region, such as were offered British patentees prior to 1852). The table presents the value of the payments, discounted back to the date of the original patent application using the U.S. 10-year treasury yield, and expressed in 1998 U.S. dollars.[13,14]

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[13]This calculation presented a number of issues. The first was determining the period between the patent application and the award for the countries that based the award length (and the dates that payments were due) on the award date. In making the computations, for 1950 and afterwards, I assumed that awards occurred two years after the application date (one year after publication date). For 1900 and 1925, I assumed awards occurred one year after the application date (and publication date). For 1850 and 1875, I assumed awards occurred only a nominal period after application. A second problem was the selection of an appropriate discount rate. I chose to use the risk-free rate to reflect the bond-like nature of the commitment. Ideally, I would have discounted the payments in each nation using a country-specific risk-free rate. Obtaining this information for most observations proved to be impossible. Instead, I used the ten-year U.S. treasury yield in 1950, 1975, and 1999, an average long-term U.S. government bond yield for 1925, an imputed long-term government bond yield for 1875 and 1900 (the yield of a basket of long-term railroad bonds, less the average spread between this index's yield and that of long-term government bonds in the years between 1919 and 1936), and the yield on certain government obligations in 1850. Finally, I needed to express these fees in a common currency. The patent fees were converted into U.S. dollars using the exchange rate current at the time, and then converted into 1998 dollars using the U.S. GDP deflator (back to 1889) or the U.S. consumer price index (for earlier years).

[14]The apparent "spike" in a number of nations (e.g., Brazil) in 1900 reflects the patent controversy of the late nineteenth century discussed in more detail below. As a result of the debate, a number of nations raised the fees charged for patent grants in the late 1870s. These fees remained quite high in a number of instances until the hyperinflation that

The fourth table reports several measures of limitations on patent awards. Probably most important are provisions that patents were revoked or subject to compulsory licensing, if they were not reduced to practice ("worked") in a set period. The table presents the period in which domestic patentees had to work patents. Occasionally, when patentees could choose patents of different lengths, the minimum period in which the patent had to be worked differed. I recorded the working period for the patent of the longest duration (without any provision for extensions due to extraordinary circumstances). The table also reports a number of other restrictions on patent rights. In some cases, the government could declare patents invalid or force compulsory licensing for reasons other than non-working. These restrictions were recorded as being true in no, some,[15] or all cases. Other limitations were whether the awards made an exception for prior users of the patented technology or limited the patentees' ability to collect damages from infringers to a set amount. (Typically this was a nominal amount. In some cases, however, the cap would be raised or lifted entirely if the infringer was convicted for a second time.)

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followed World War I. When the nations subsequently reset their fees after these inflationary periods, the real cost of a patent was set much lower, reflecting the diminution of the anti-patent forces.

[15]In some cases, certain classes of patents were explicitly exempted from compulsory licensing or revocation. (I did not include instances where general terms are used, such as when licensing was restricted to when it was "in the public interest"). Since virtually all countries had provisions for the government to compulsorily license for its own use patents important for national defense on an emergency basis, I did not include these provisions. Since the structure of patent awards was in almost all cases a consequence of legislative statute or royal decree rather than a constitutional mandate, I did not include cases where the revocation or compulsory licensing of the patent could only be implemented through legislation or royal decree.

Table 5 presents measures of discrimination against foreign patentees. I first looked at the length of patent protection granted overseas applicants. In some cases, the duration of patent awards differed with the residence of original inventor (or whether the patent had been applied for or granted in another country previously). In other instances, such inventors had to apply for a special form of protection, termed a patent of confirmation, importation, or revalidation, which was often of a shorter duration than that provided domestic inventors. The table reports the difference between the length of the longest patent granted to foreign and domestic applicants (without any provisions for extensions due to extraordinary circumstances). The table also indicates other common means of discrimination against foreign applicants: higher fees, shorter extensions for extraordinary circumstances, and premature patent expirations if a foreign patent expired first. (The lower-case footnotes indicate more idiosyncratic forms of discrimination.) Finally, I recorded the membership of countries in two major international patent conventions agreed to prior to 1975 (in order to be able to exploit the panel features of the data for the analysis). These were the Paris Convention of 1883 and the Patent Cooperation Treaty of 1970. I noted any nation with a patent system that was not a signatory to these agreements.[16]

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[16]In addition, many countries required that applicants have a representative in the nation, and some required that the award be made to that representative. These requirements were not analyzed because they were routinely addressed, even in the early nineteenth century, through loose affiliations between patent agents. (See, for instance, the discussion in Dutton [1984].)

Table 6 presents cross-tabulations of a variety of these variables. Panel A summarizes the levels of five of the variables discussed above; Panel B, the p-values from tests of the significance of these differences.

From Panel A, the ebb and flow of patent protection documented by Machlup and Penrose [1950] and Penrose [1951] can be discerned. Beginning in the 1860s, a strong movement against patent protection emerged in many European countries. While only the Netherlands actually abolished its patent system, in a number of others patent protection was substantially restricted. The movement to restrict patent protection ebbed in the late 1870s, for reasons that Machlup and Penrose argue were largely independent of the merits of either side's argument. In the twentieth century, the patterns were less systematic until the final years of the century. For instance, many developing nations adopted relatively strong intellectual property systems at their formation, and then weakened them in the 1960s and 1970s. In recent years, a series of bilateral and multilateral agreements have led to a substantial degree of harmonization of the national patent systems, including an increase in the statutory protection afforded patentees in developing nations.

The tabulations also demonstrate a number of other relationships. Relatively wealthier countries were more likely to offer patent protection, but also to charge more for those awards. More democratic countries—those with elected heads and legislatures, as well as with more effective legislative bodies—were more likely to have a patent

system and to extend protection for longer periods. They also discriminated less against foreign patentees in terms of award length.

In addition, a number of differences across legal families were significant. Civil law countries were more likely to offer patent protection, while those not in the major legal families were much less likely to do so. Both the common and civil law nations were less likely to discriminate against foreign patentees (though as we will see below, there were important differences across sub-groups). These two differed, however, in their working provisions: common law countries typically allowed considerably longer than the mean period until the patent had to be put into practice, while civil law counties required significantly less time.

B. Regression Analyses

While these univariate comparisons are suggestive, the interpretation of the results must be cautious. The presence of one set of effects (e.g., changes in patent protection over time) could be leading to a variety of false inferences about other relationships. To address this concern, I examined each set of policy measures in regression analyses.

I first examined the presence of patent protection, both in general and for three economically significant technologies where considerable heterogeneity in patent policy existed. The dependent variable was constructed similarly in each case. If the country did not offer patent protection (either in general or for that particular area), it was coded

as zero. If the nation offered modified protection, the variable was coded as one. (In the general case, this coding was used for cases where the country did not have an independent system, but recognized those granted by another nation. In the area-specific analyses, this denoted cases where there was some, but not full, patent coverage offered: e.g., if chemical processes but not products could be patented.) Finally, in cases with full protection, the variable was coded as two. I employed an ordered logit specification.

As Table 7 reports, each of the three classes of independent variables discussed above was statistically significant. The nation's relative GDP was consistently positive and significant (at least at the ten percent confidence level). The measures of political freedom were jointly significant at the five percent confidence level in each case, with one of the individual political measures (typically the presence of an elected legislature) being significantly positive. The legal family measures were also jointly significant in each case. Two clear results were the greater propensity of French (and to a lesser extent, German) family members to offer patent protection in general, and the greater restrictions on pharmaceutical and chemical patents in German legal family countries. The Germanic nations' reluctance to allow patents in these areas may have reflected in their relative backwardness in these important technologies at the time that their national patent codes were first written [Penrose, 1951]. It is hard, however, to attribute these provisions' persistence to such an explanation. These effects were significant economically as well as statistically. Consider the left-most regression reported in Table 7. At the mean of the other independent variables, a switch from the absence to the presence of an elected national legislature raised the probability of having a patent system from 88% to 98%.

Table 8 examines the length of patent protection offered. Because of the substantial differences in the way that these technologies were treated, separate regressions were estimated again for pharmaceuticals and chemicals. In the first three columns, I estimated Tobit regressions: the dependent variable took on the value zero if no patent protection was offered, and the maximum number of years of protection if it was. In the last column, I estimated a difference regression. The difference in the length of patent protection across observations at twenty-five year intervals was regressed on the difference of the independent variables.[17]

The results were similar to those in the previous analysis. Once again, the political variables jointly had significant explanatory power, at least at the five percent confidence level. One of the measures of political democracy was significantly positive in each regression. For instance, in the leftmost regression, the presence of an elected national legislature raised the predicted length of patent protection (at the mean of the other independent variables) from twelve years after the application date to fifteen-and-a-half years. The legal family measures were also jointly significant. Similar to the analyses of the presence of patent protection, longer protection was offered in general in French legal family countries and shorter protection of pharmaceuticals in the German family. The measure of relative GDP, however, while still positive was uniformly statistically insignificant.

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[17]One complication with each of these regressions was that, as Table 2 shows, different countries measured patent awards in various ways. I used the assumptions discussed in Footnote 13 to express all patent award periods in years from the application date.

I then considered the cost of patent protection. I computed the net present value of patent protection as in Table 3. I sought to explain the logarithm of the cost level in ordinary least squares (OLS) regressions. My rationale for using logarithms was the likelihood that many changes, such as a doubling of country's GDP, would have a multiplicative rather than an additive effect on fees. I added two independent variables to the regressions: a measure of the nation's population (as fees may change with the absolute economic activity in a nation as well as with its relative standing) and a measure indicating whether the currency had rapidly depreciated against the dollar in recent years.[18] As in the analysis of patent duration, I undertook a difference analysis. Because the greater flexibility of the OLS specification, I also estimated a fixed-effects specification with dummy variables for each nation.

As Panel A of Table 9 reports, each of the three classes of variables had significant explanatory power. Relatively richer (but not larger) nations charged considerably more for patents than others, as did more democratic nations. Costs were considerably lower in countries in the English and Scandinavian legal families than elsewhere. Many of the variables associated with the presence of patent protection and longer patent awards in the previous two tables were associated with higher costs as well.

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[18]In some nations, patent fees fell rapidly in real terms during periods of hyperinflation, because the laws or administrative regulations setting the fees were not frequently revised. In the reported regressions, I used a dummy variable denoting whether the currency had depreciated by ten times or more against the U.S. dollar (controlling for currency revaluations). The results were robust to using the other currency depreciation measures discussed above.

The coefficients on the year dummy variables allowed me to also examine how the cost of patent protection changed more generally over time. Panel B reports several alternative "price indexes" of the change in the cost of a patent over time. The first of these was from a simple regression of the cost on dummy variables for each year. The second controlled for the mixture of nations, by adding a dummy variable that captured the average cost level in each nation. The final regression controlled as well for the population and real per capita GDP of each nation. These two terms adjusted for changing historical circumstances (though not for shifts in the features of the patents themselves). Each regression displayed a similar pattern: rising costs through 1900, a steady decline through 1975, and then a steep rise again. The magnitudes of the effects were quite different though. While the first two regressions suggested that the cost of a patent today was considerably higher than in 1850, the latter argued that the cost was only one-third the earlier level.

I then considered the presence of limits on patent rights. I first examined the working period: the period after the award that the patent had to be put in practice.[19] I also examined four other ways in which governments limited patent protection. These were restrictions that prevented the patentee from prosecuting prior users of the patented technology, allowed the government to license the patent compulsorily or revoke it

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[19]The patentee was almost invariably required to work the patent in the country of the award or in a small number of other countries with which the nation had reciprocal relations. I examined the robustness of the analysis in Table 10 to treating countries with more flexible working rules (e.g., those that allowed working in five or more other countries) as having no working requirements at all. The results were robust to these changes.

outright (for reasons other than failure to work the patent in the allowed time), and limited the damages that patentees could collect from infringers. Table 10 reports separate logit regressions that examined whether the first two of these restrictions were present, and then an ordered logit regression that analyzed how many of the four limitations were present.

The results suggested the primacy of family of legal origin in explaining this aspect of patent policy. While relatively wealthier countries were likely to give patentees longer to work their patents, they were more likely to restrict patentees through prior user rights. Countries with a democratically elected leader were more likely to have a longer working period as well (though the political variables were jointly insignificant even in this regression), but did not differ in the use of other restrictions. It was only the political family measures that were consistently significant. Common law countries were characterized by longer working periods and fewer other restrictions on patent holders. In some cases, families appeared to rely particularly on some of these rights, such as the French family's reliance on shorter working periods and prior user rights over compulsory licensing and other provisions. In other cases, such as the German and Scandinavian families, there was a heavy reliance on all forms of limitations on patent holders' rights.

A similar picture emerged from my analysis of legal provisions that discriminated against foreign patentees. I first looked at the participation of nations in two major conventions that sought to insure equal treatment of foreign patentees, the Paris

(International) Convention of 1883 and the Washington Convention (Patent Co-operation Treaty) of 1970. For each observation after the treaty signing, I denoted whether the nation was a participant in the agreement. (For sake of comparison to the other measures, Table 11 examines whether the country was *not* a participant in the convention.) I also examined whether four commonly encountered forms of discrimination against foreign patentees were present. (Even though the Paris Convention bound nations to eliminate many of these practices, they proved to be persistent.) These provisions were providing foreign awardees with patents of shorter duration, charging them more for a patent, terminating the patent if a particular (or any) foreign patent covering the same technology expired first, and granting shorter extensions to foreign patentees.

When I examined the participation in the two conventions, the economic and political measures had considerable explanatory power. Wealthier nations were more likely to have signed both these accords. The Washington agreement was also more likely to have been signed by countries with a democratically elected leader. But when the presence of legal provisions that discriminated against foreign patentees was examined, these variables ceased to have explanatory power. Instead, it was the legal family measures that were significant: in particular, the French family countries and those in no distinct legal family had significantly more discriminatory provisions.

5. Conclusions

This analysis examined the determinants of the strength of intellectual property protection over a 150-year period. It found evidence consistent with each of three broad classes of explanations for patent policy, but also suggested that there was considerable

complexity that defied easy explanation. Wealthier nations were more likely to have patent systems, to allow patentees a longer period to put their patents into practice, and to ratify treaties assuring equal treatment of other nations. But they were also likely to charge higher fees and limit patent protection in some important ways. Countries with democratic institutions were consistently more likely to have patent protection and to grant longer-lived awards. But many of the differences in patent policy could only be explained by the various legal traditions. This was particularly true when I examined the subtler policy instruments through which government can affect patent strength, such as the restrictions on patentee rights and the provisions that discriminate against foreign patentees.

As acknowledged in the introduction, this analysis had several limitations, which suggest the need for further research. The first of these is to understand the interaction between patenting and other forms of technology policy. To what extent did other policy tools—prizes, trade secrecy and other forms of legal protection, and government subsidies and procurement—substitute for and/or complement patent policy? Did shifts in judicial doctrine mirror those in statutory protection, or serve to dampen their impact? Given the difficulty of data collection, these important issues are likely to be only addressable through country-specific studies.

Another avenue for further research, which the author is currently pursuing, is to examine the impact of shifts in patent policy on patenting and innovation. One challenge facing cross-sectional studies of the impact of intellectual property on economic growth

is that unobserved factors can affect both, and lead to incorrect inferences. Analyzing the impact of changes in patent policy provides one way to address these concerns. This data set should allow for the examination of a variety of similar policy shifts, in a manner that should complement the studies of policy changes in single nations.[20]

More speculatively, these results suggest a number of questions for the theoretical literature on patent policy. To be sure, as discussed in Section 2C, a substantial literature on economic and political institutions in general has discussed why differences between nations may persist. The substantial majority of the recent economic literature on patent policy, however, has focused on how the institutional features of patent systems are responses by policymakers to the problem of maximizing innovative output. It may be desirable to complement these examinations with studies of the interaction between patent policy and the broader political environment, as well as of the seeming persistence of national patent policies over time.

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[20]Examples include Cockburn and Lanjouw [1999], Kortum and Lerner [1998], and Sakakibara and Branstetter [1999].

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Appendix A: Information Sources on Patent Policy

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Table 1. The presence of patent protection. The sample consists of the sixty largest countries (by gross domestic product) at the end of 1997, observed at 25-year intervals from 1850 to 1999. The table denotes whether the given country had patent protection at the beginning of a given year ("Y" denotes cases where such protection existed, "N" cases where it did not, and "R" that the country automatically recognized patents granted by another country, also noted). The footnotes denote whether patent protection was available in whole or part for a number of important technologies. Observations where the country was not an independent entity are filled in.

	1850	1875	1900	1925	1950	1975	1999
Algeria	███	███	███	███	███	$Y^{CC,FF,MM,a}$	$Y^{CC,FF,MM,a}$
Argentina	N	$Y^{CC,FF}$	$Y^{CC,FF}$	$Y^{CC,FF}$	$Y^{CC,FF,M}$	$Y^{CC,FF,M}$	$Y^{CC,FF,MM,P}$
Australia	███	███	███	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM,P}$
Austria	$Y^{CC,FF}$	Y^{CC}	$Y^{C,F,M}$	$Y^{C,F,M}$	$Y^{C,F,M}$	$Y^{CC,F,M}$	$Y^{CC,FF,M,PP}$
Bangladesh	███	███	███	███	███	$Y^{C,FF,M}$	$Y^{C,FF,M}$
Belgium	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,M}$	$Y^{CC,FF,MM,PP}$	$Y^{CC,FF,MM,PP}$
Brazil	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{C,F,M}$	Y^{C}	$Y^{CC,FF,MM}$
Canada	███	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,F,M}$	$Y^{C,F,M}$	$Y^{CC,FF,MM,P}$
Chile	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,M}$	$Y^{C,F,M}$	Y^{C}	$Y^{CC,FF}$
China	N	N	N	N	N	N	$Y^{CC,FF,MM,P}$
Columbia	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,F,M}$	$Y^{CC,FF,M}$	$Y^{CC,FF,M}$
Czech Republic	███	███	███	$Y^{C,FF,PP}$	$Y^{C,F,M,PP}$	Y	$Y^{CC,FF,MM}$
Denmark	N	$Y^{CC,FF,MM}$	Y^{CC}	Y^{CC}	$Y^{C,M}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$
Egypt	███	███	███	███	███	$Y^{CC,F,M}$	$Y^{CC,FF,M}$
Finland	███	███	███	$Y^{C,F,M}$	$Y^{C,F,M}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$
France	$Y^{CC,FF}$	$Y^{CC,FF}$	$Y^{CC,FF}$	$Y^{CC,FF,M}$	$Y^{CC,FF,M}$	$Y^{CC,FF,M,PP}$	$Y^{CC,FF,MM,PP}$
Germany	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	Y^{C}	$Y^{C,F,M}$	$Y^{C,F,M}$	$Y^{C,FF,M,PP}$	$Y^{C,FF,M,PP}$
Greece	N	N	N	$Y^{CC,FF,MM}$	$Y^{CC,FF,M}$	$Y^{CC,FF,M}$	$Y^{CC,FF,MM}$
Hungary	███	███	███	$Y^{C,F,M,PP}$	$Y^{C,F,M,PP}$	$Y^{C,F,M,PP}$	$Y^{CC,FF,MM,PP}$
India	███	███	███	███	$Y^{C,F,M}$	$Y^{C,F,M}$	$Y^{C,F,M}$
Indonesia	███	███	███	███	N	N	$Y^{CC,FF,MM}$
Iran	N	N	N	N	$Y^{CC,FF,M}$	$Y^{CC,FF,M}$	$Y^{CC,FF,M}$
Iraq	███	███	███	$Y^{CC,FF}$	$Y^{CC,FF}$	$Y^{CC,F,M}$	$Y^{CC,FF,M}$
Ireland	███	███	███	N	$Y^{C,F,M}$	$Y^{CC,F,M}$	$Y^{CC,FF,MM}$
Israel	███	███	███	███	$Y^{CC,FF,MM}$	$Y^{CC,FF}$	$Y^{CC,FF,MM,P}$
Italy	$Y^{CC,FF,MM}$	$Y^{CC,FF}$	$Y^{CC,FF}$	$Y^{CC,FF}$	$Y^{CC,FF,PP}$	$Y^{CC,FF,P}$	$Y^{CC,FF,MM,P}$
Japan	N	N	Y^{CC}	Y	Y	Y	$Y^{CC,FF,MM,PP}$
Kuwait	███	███	███	███	███	$Y^{CC,F,M}$	$Y^{CC,FF,M,SS}$
Libya	███	███	███	███	███	$Y^{CC,FF,MM}$	$Y^{CC,FF,M}$
Malaysia	███	███	███	███	███	R—UK	$Y^{CC,FF,MM}$
Mexico	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{C,FF,MM}$	$Y^{C,FF,M}$	$Y^{C,FF,MM}$	$Y^{CC,FF,MM,P}$
Morocco	███	███	███	███	███	$Y^{CC,FF,M}$	$Y^{CC,FF,M,SS}$
Myanmar	███	███	███	███	R—India	N	N
Netherlands	$Y^{CC,FF,MM,b}$	N	N	$Y^{CC,FF,MM}$	$Y^{C,F,M}$	$Y^{C,F,M,P}$	$Y^{CC,FF,MM,PP}$
New Zealand	███	███	███	$Y^{C,F,M}$	$Y^{C,F,M}$	$Y^{CC,F,M,P}$	$Y^{CC,FF,MM,PP,SS}$
Nigeria	███	███	███	███	███	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$
Norway	$Y^{CC,FF,MM}$	$Y^{CC,FF}$	$Y^{CC,F,M}$	$Y^{C,F,M}$	$Y^{C,F,M}$	$Y^{CC,FF,M}$	$Y^{CC,FF,M}$
Pakistan	███	███	███	███	$Y^{C,F,M}$	$Y^{C,FF}$	$Y^{CC,FF,M}$
Peru	N	$Y^{CC,FF}$	$Y^{CC,FF}$	$Y^{CC,FF}$	$Y^{CC,FF,M}$	$Y^{CC,FF}$	$Y^{CC,FF,M}$
Philippines	███	███	███	███	$Y^{CC,FF,MM}$	$Y^{CC,FF}$	$Y^{C,FF,M}$
Poland	███	███	███	$Y^{C,F,M}$	$Y^{C,F,M}$	$Y^{C,F,M}$	$Y^{CC,FF,M,PP}$
Portugal	$Y^{CC,FF,MM}$	Y^{FF}	$Y^{C,FF,M}$	$Y^{C,FF,M}$	$Y^{C,F,M}$	$Y^{C,F,M}$	$Y^{CC,FF,MM}$
Romania	███	N	N	Y^{CC}	$Y^{CC,F,M}$	Y	$Y^{CC,FF,MM}$
Russia	$Y^{CC,FF,MM,c}$	$Y^{CC,FF,MM,c}$	$Y^{C,F,c}$	N	$Y^{C,F}$	$Y^{C,F,M}$	$Y^{CC,FF,MM,P}$
Saudi Arabia	███	███	███	N	N	N	$Y^{CC,FF,MM}$

Country							
Singapore	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	R—UK	$Y^{CC,FF,MM}$
South Africa	[redacted]	[redacted]	[redacted]	$Y^{CC,FF,MM}$	$Y^{C,FF,M}$	Y^{CC}	$Y^{CC,FF,MM,P}$
South Korea	N	N	N	[redacted]	$Y^{CC,FF}$	$Y^{CC,FF,P}$	$Y^{CC,FF,MM,PP}$
Spain	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF}$	$Y^{F,M}$	$Y^{C,F,M}$	$Y^{C,F,M}$	$Y^{C,FF,M,P}$
Sweden	$Y^{CC,FF,MM}$	$Y^{CC,FF}$	$Y^{CC,F,M}$	$Y^{CC,F,M}$	$Y^{C,F,M}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$
Switzerland	N	N	Y	$Y^{C,M}$	$Y^{C,M,d}$	Y^{C}	$Y^{CC,FF,MM,PP}$
Syria	[redacted]	[redacted]	[redacted]	[redacted]	$Y^{CC,FF,M}$	$Y^{CC,FF,M}$	$Y^{CC,FF,M}$
Taiwan	[redacted]	[redacted]	[redacted]	[redacted]	$Y^{C,F}$	Y^{C}	$Y^{CC,F,M,P,S}$
Thailand	N	N	N	N	N	N	$Y^{CC,FF,MM}$
Turkey	N	N	$Y^{CC,FF,e}$	$Y^{CC,FF}$	$Y^{CC,FF,M}$	$Y^{CC,FF,M}$	$Y^{CC,FF,M}$
Ukraine	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	$Y^{CC,FF,MM}$
United Arab Emirates	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	N	$Y^{CC,FF,M}$
United Kingdom	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,F,M}$	$Y^{CC,F,M,P}$	$Y^{CC,FF,MM,P}$
United States	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM}$	$Y^{CC,FF,MM,P}$	$Y^{CC,FF,MM,P}$	$Y^{CC,FF,MM,PP,SS}$
Venezuela	N	N	$Y^{CC,FF}$	$Y^{CC,FF}$	$Y^{CC,FF,P}$	$Y^{CC,M}$	$Y^{CC,FF,M}$

Notes:

C = Chemical patents allowed under certain conditions.
CC = Chemical patents allowed.
F = Food patents allowed under certain conditions.
FF = Food patents allowed.
M = Medicinal patents allowed under certain conditions.
MM = Medicinal patents allowed.
P = Plant patents allowed under certain conditions.
PP = Plant patents allowed.
S = Software patents allowed under certain conditions.
SS = Software patents allowed.

a = Patents only awarded to foreign applicants; no domestic patents.
b = No railroad-related patents.
c = No weapons-related patents.
d = No textile process patents.
e = No electricity-related patents

Table 2. The length of patent protection. The sample consists of the sixty largest countries (by gross domestic product) at the end of 1997, observed at 25-year intervals from 1850 to 1999. The table denotes the duration of a patent award to a domestic entity carried to full term (not including any extension granted at the discretion of government officials). Observations where the country was not an independent entity are filled in; those where the country did not have a patent system are shaded.

	1850	1875	1900	1925	1950	1975	1999
Algeria						20 ap[a]	20 ap[a]
Argentina		15 aw	15 aw	15 aw	15 aw	15 aw	20 ap
Australia				16 ap***	16 ap**	16 ap**	20 ap
Austria	15 aw	15	15 pub	15 pub	18 pub	18 pub	20 ap
Bangladesh						16 prior**	16 prior**
Belgium	15	20 ap	20 ap	20 ap	20 ap	20 ap	20 ap
Brazil	5***	5***	15 aw	15 aw	15 aw*	15 ap	20 ap
Canada		15	18 aw	18 aw	17 aw	17 aw	20 ap
Chile	10 work***	10 work***	10 work**	10 aw**	15 aw*	15 aw*	15 aw
China							20 ap
Columbia	20	20	20 aw	50 aw	20 aw	12 aw	15 ap
Czech Republic				15 pub	15 pub	15 ap	20 ap
Denmark		5**	15 aw	15 aw	17 ap	17 ap	20 ap
Egypt						15 ap*,P[10]	15 ap*,P[10]
Finland				15 aw	20 ap	17 ap	20 ap
France	15 aw	15 ap	15 ap	15 ap	20 ap	20 ap	20 ap[27]
Germany	15 aw	15	15 ap	18 ap	18 ap	18 ap	20 ap[25]
Greece				15 ap	15 ap	15 ap	20 ap
Hungary				15 ap	20 ap	20 ap	20 ap
India					16 ap**	14 prior[7],b	14 aw[7],b
Indonesia							14 ap*
Iran					20 ap	20 ap	20 ap
Iraq					15 ap	15 ap	15 ap
Ireland					16 ap**	16 ap**	20 ap
Israel					16 ap	20 ap	20 ap
Italy	5**	15 ap	15 ap	15 ap	15 ap	15 ap	20 ap[38]
Japan		15 aw	15 pub**	15 pub**		15 pub[c]	20 ap[25]
Kuwait						15 ap*,P[10]	15 ap*,P[10]
Libya						15 ap*,P[10]	15 ap*,P[10]
Malaysia							15 aw[c]
Mexico	10 work***	10 work***	20 aw*	20 aw*	15 ap	15 ap	20 ap
Morocco						20 ap	20 ap
Myanmar							
Netherlands	15			15 aw	18 aw	20 ap	20 ap[25]
New Zealand				16 ap***	16 ap**	16 ap**	20 ap**
Nigeria						20 ap	20 ap
Norway	15 aw***	3***	15 ap	17 ap	17 ap	17 ap	20 ap
Pakistan					16 ap**	16 prior**	16 prior
Peru		10	10 aw	10 aw**	10 aw*	15 aw	20 ap
Philippines					17 aw	17 aw	17 aw
Poland				15 aw	15 ap	15 ap	20 ap
Portugal	15	15 aw*	15 aw	15 aw	15 aw	15 aw	20 ap
Romania				15 ap	15 ap	15 ap	20 ap
Russia	10 aw	10 aw	15 aw		15 ap	15 ap	20 ap
Saudi Arabia							20 aw
Singapore							20 ap
South Africa				14 ap***	14 ap***	16 ap**	20 ap*

South Korea					17 aw**	12 pub[d]	20 ap[P[25]]
Spain	15 aw	15 aw	20 aw	20 aw	20 aw	20 aw	20 ap
Sweden	15 aw***	3***	15 ap	15 ap	17 ap	17 ap	20 ap[P[25]]
Switzerland			15 ap	15 ap[P[10]]	15 ap[P[10],C[10]]	18 ap	20 ap
Syria					15 ap	15 ap	15 ap
Taiwan					15 ap	15 ap	20 ap[P[25]]
Thailand							20 ap
Turkey			15 ap	15 ap	15 ap	15 ap	20 ap
Ukraine							20 ap
United Arab Emirates							15 ap
United Kingdom	14***	14 ap***	14 ap***	16 ap**	16 ap**	16 ap**	20 ap
United States	14 aw**	17 aw	17 aw	17 aw	17 aw	17 aw	20 ap[P[25],e]
Venezuela		15 aw	15 aw	10 aw	10 aw		15 ap

Notes:

ap = Date of patent application.
aw = Date of patent award.
pub = Date of patent publication.
prior = Date of original ("priority") patent application.
work = Date at which patent is first worked in a given country (or end of compulsory working period).

* = Extension of patents are possible for up to five years.
** = Extension of patents is possible for more than 5, but 10 or less years.
*** = Extension of patent for more than 10 or an indefinite period is possible.
C = Chemical patents may be of a different length. Bracketed number indicates maximum possible length.
P = Pharmaceutical patents may be of a different length. Bracketed number indicates maximum possible length.

a = Patents only awarded to foreign applicants; no domestic patents.
b = Pharmaceutical awards cannot exceed lesser of seven years from the application date or five years from the award date.
c = Patents cannot last for more than 20 years from application date.
d = Patents cannot last for more than 15 years from application date.
e = Extensions also possible for patents delayed by interference procedures.

In some cases, nineteenth-century patent laws were ambiguous as to whether the award initiated with the application or award date. This reflected the fact that the gap between these two was typically very short.

Table 3. The cost of patent protection. The sample consists of the sixty largest countries (by gross domestic product) at the end of 1997, observed at 25-year intervals from 1850 to 1999. The table denotes the fee charged a domestic patentee for a patent award carried to full term (not including any extension granted at the discretion of government officials), expressed in 1998 U.S. dollars. (All payments are discounted at the ten-year U.S. Treasury yield or a proxy therefor.) Observations where the country was not an independent entity are filled in; those where the country did not have a patent system are shaded.

	1850	1875	1900	1925	1950	1975	1999
Algeria						NA	78[a]
Argentina		4704	6493	3205	226	144	2657
Australia				530	552	944	2774
Austria	3284	4665	11671	1403	2848	2523	5867
Bangladesh						NA	208
Belgium	4836	3185	5887	1242	2811	875	1398
Brazil	894	688	21070	2292	290	100	6657
Canada		719	1036	336	276	230	2067
Chile	941	711	6999	439	214	47	132
China							3371
Columbia	8234	5997	4117	10318	NA	NA	1204
Czech Republic				1888	437	673	2278
Denmark		143	8280	2393	2426	1808	4951
Egypt						240	67
Finland				382	3101	1489	4544
France	4189	3125	4933	1443	1711	1066	3597
Germany	37	19	22694	14076	5938	4367	6803
Greece				1782	616	169	2728
Hungary				272	1344	2451	2835
India					1355	194	206
Indonesia							1940
Iran					NA	205	0[b]
Iraq					NA	NA	NA
Ireland					2050	569	3541
Israel					1364	384	1377
Italy	857	2665	4341	1824	1024	412	3456
Japan			2356	1155	484	505	15150
Kuwait						NA	43
Libya						NA	NA
Malaysia							933
Mexico	6314	4632	2709	2132	223	194	1473
Morocco						NA	4401
Myanmar							
Netherlands	5352			4187	2410	7065	6062
New Zealand				564	582	243	874
Nigeria						NA	NA
Norway	0[b]	168	2682	1830	1277	2004	4300
Pakistan					1876	162	25
Peru		14711	8118	4072	NA	112	NA
Philippines					NA	280	24
Poland				2735	842	270	2569
Portugal	66	862	692	234	139	13	1517
Romania				6057	NA	917	3976
Russia	5433	4675	18941		4271	868	5280
Saudi Arabia							2762

Country							
Singapore	▓▓▓	▓▓▓	▓▓▓	▓▓▓	▓▓▓	▓▓▓	2963
South Africa	▓▓▓	▓▓▓	▓▓▓	906	565	205	22
South Korea	▓▓▓	▓▓▓	▓▓▓	▓▓▓	NA	NA	4757
Spain	6234	4601	21954	2989	474	90	2840
Sweden	0[b]	0[b]	3218	4266	2934	2023	2720
Switzerland	▓▓▓	▓▓▓	4235	1846	1626	2753	5111
Syria	▓▓▓	▓▓▓	▓▓▓	▓▓▓	NA	NA	383
Taiwan	▓▓▓	▓▓▓	▓▓▓	▓▓▓	NA	NA	2155
Thailand	▓▓▓	▓▓▓	▓▓▓	▓▓▓	▓▓▓	▓▓▓	5662
Turkey	▓▓▓	▓▓▓	2283	733	865	1324	2768
Ukraine	▓▓▓	▓▓▓	▓▓▓	▓▓▓	▓▓▓	▓▓▓	2992
United Arab Emirates	▓▓▓	▓▓▓	▓▓▓	▓▓▓	▓▓▓	▓▓▓	NA
United Kingdom	37237	10195	6612	4025	1631	1052	3787
United States	618	546	720	386	343	442	5840
Venezuela	▓▓▓	▓▓▓	2389	2227	NA	400	NA

Notes:

NA = No data on patent fees are available.

[a]Fee is only for foreign applicants; no domestic patents.
[b]Fee is only a nominal tax or publication costs (for domestic patentees only, in the case of Iran).

In making the computations, for 1950 and afterwards, it is assumed that awards occur two years after the application date (one year after publication date). For 1900 and 1925, it is assumed awards occur one year after the application date (and publication date). For 1850 and 1875, it is assumed awards occur only a nominal period after application.

Table 4. Limitations on patent protection. The sample consists of the sixty largest countries (by gross domestic product) at the end of 1997, observed at 25-year intervals from 1850 to 1999. The table denotes the "working" period: the number of years after the award when the patent may be licensed to third parties by the government or revoked if not employed in a given country. (Extensions for extraordinary circumstances may be provided, but are not reported.) The footnotes denote other important limitations on patent protection. Observations where the country was not an independent entity are filled in; those where the country did not have a patent system are shaded.

	1850	1875	1900	1925	1950	1975	1999
Algeria						$3^{CL,PU}$	$3^{CL,PU}$
Argentina		2	2	2	2	2^{CL}	2^{CL}
Australia				$4^{CL,R}$	3^{CL}	3^{CL}	3^{CL}
Austria	1^D	$1^{D,PU}$	$3^{CL,PU}$	3^{CL}	3^{CL}	$3^{CL,PU,R}$	3^{PU}
Bangladesh						$4^{CL,R}$	4^{CL}
Belgium	2	1	1^a	1	1	1	$3^{CL,PU}$
Brazil	2	2	$3^{CL,R}$	3^R	2^R	$3^{CL,R}$	3^{CL}
Canada		$3^{CLs,PU}$	$2^{CLs,PU}$	2^{CLs}	3^{CL}	$3^{CL,PU}$	3^{PU}
Chile	Discr.	Discr.	Discr.	1	None	None	None
China							$3^{CL,PU}$
Columbia	1	1	1	1	None	$3^{CL,R}$	3^{CL}
Czech Republic				3^{CL}	$3^{CL,R}$	$3^{CL,PU}$	$None^{PU}$
Denmark		1^{PU}	3^{PU}	3	3^{CL}	$3^{CL,PU}$	$3^{CL,PU}$
Egypt						$3^{CL,PU,R}$	$3^{CL,PU,R}$
Finland				3	3^{CL}	$3^{CL,PU}$	$3^{CL,PU}$
France	2	2	2	2	3^{CLs}	$3^{CL,PU}$	$3^{CL,PU}$
Germany	0.5^{PU}	0.5^{PU}	$3^{CL,PU,R}$	$3^{CL,R}$	3^{CL}	$Immed.^{CL,PU}$	$Immed.^{CL,PU}$
Greece				3^{CL}	3^{CL}	$3^{CL,PU}$	$3^{CL,PU}$
Hungary				$3^{CL,R}$	3^{CL}	$3^{CL,PU}$	$None^{CL,PU}$
India					3^{CL}	$3^{CL,R}$	3^{CL}
Indonesia							5^{PU}
Iran					5	5	5
Iraq					2	$3^{CL,R}$	3^{CL}
Ireland					$3^{CL,R}$	3^{CL}	3^{CL}
Israel					3^{CL}	$3^{CL,PU}$	$3^{CL,PU}$
Italy	1	2	2	2	3^R	$3^{CL,R}$	$3^{CL,PU}$
Japan			$3^{CL,R}$	3^{CL}	3^{CL}	$3^{CL,PU}$	$3^{CL,PU}$
Kuwait						$3^{CL,PU,R}$	$3^{CL,PU}$
Libya						3	$3^{CL,PU,b}$
Malaysia							3^{PU}
Mexico	None	None	$None^{PU}$	3	3	$3^{PU,R}$	3^{PU}
Morocco						3	3^b
Myanmar							
Netherlands	2			5^{CL}	3^{CL}	$3^{CL,PU}$	$3^{CL,PU}$
New Zealand				$4^{CL,R}$	$3^{CL,R}$	3^{CL}	3^{CL}
Nigeria						$3^{CL,PU}$	$3^{CL,PU}$
Norway	2^D	1^D	$3^{CL,D,PU}$	3^{CL}	3^{CL}	$3^{CL,PU}$	$3^{CL,PU}$
Pakistan					4	$4^{CL,R}$	$4^{CL,R}$
Peru		2	2	2	2	2^{CL}	3^{CL}
Philippines					3^{CL}	3^{CL}	2^{CL}
Poland				3	$3^{CL,R}$	$3^{CL,R,PU}$	$3^{CL,PU}$
Portugal	$7.5^{CL,R}$	$1^{CL,R}$	$2^{CL,R}$	$2^{CL,R}$	$3^{CL,R}$	$3^{CL,R}$	$3^{CL,c}$
Romania				$4^{D,R}$	4^{CL}	$3^{CL,PU}$	$3^{CL,PU}$
Russia	2.5	2.5	5		$3^{CL,R}$	$None^{CL,PU,R}$	$3^{CL,PU}$
Saudi Arabia							2^{PU}

Singapore						$4^{CLs,PU}$
South Africa			2^{CL}	3^{CLs}	3^{CL}	$3^{CL,PU}$
South Korea				3	3	$3^{CL,PU}$
Spain	1	1^{D}	2^{D}	3	3	3	$3^{CL,PU}$
Sweden	2^{D}	2	$3^{PU,R}$	3^{R}	$3^{CL,R}$	$3^{CL,PU}$	$3^{CL,PU}$
Switzerland			Immed.^{PU,R}	3^{CL}	3^{CL}	$3^{CL,PU}$	$3^{CL,PU}$
Syria				3	2	2
Taiwan				3	3	$4^{CL,PU}$
Thailand						$3^{CL,PU}$
Turkey			2^{D}	2	2	2	2^{PU}
Ukraine						3
United Arab Emirates						2^{PU}
United Kingdom	None	None	None^{CL}	$4^{CL,R}$	3^{CL}	3^{CL}	$3^{CL,PU}$
United States	1.5^{d}	None	None	None	None	None	None
Venezuela			2	2	2	2	3

Notes:

Discr. = Government can set working period at its discretion.
Immed. = Awardee must begin working patent immediately after award.
None = No compulsory working period.

CL= Government can demand compulsory licensing of patents for reasons other than non-working.
CLs= Compulsory licensing provisions only for some industries (typically pharmaceuticals).
D = Damages in patent infringement cases are limited to a fixed amount.
PU = Prior users of a patented technology cannot be sued for infringement.
R = Government can revoke patents for reasons other than non-working and failure to comply with compulsory licensing order.

a = Calculated from date first worked abroad.
b = Working can be in any country, any Paris Convention country, or in the country of origin.
c = Working can be in any European Community country.
d = Applies to foreign patentees only.

No data other than working requirements is reported for Libya, South Korea, and Taiwan in 1975. No data on prior user rights is reported for any country in 1925 and 1950 and Bangladesh and Ukraine in any year.

Table 5. Discrimination against foreign patentees. The sample consists of the sixty largest countries (by gross domestic product) at the end of 1997, observed at 25-year intervals from 1850 to 1999. The table denotes the duration (in years) of a patent award filled by a foreign entity carried to full term relative to that of a domestic entity (both not including any extensions granted at the discretion of government officials). The footnotes denote the presence of other important discriminatory provisions. Observations where the country was not an independent entity are filled in; those where the country did not have a patent system are shaded.

	1850	1875	1900	1925	1950	1975	1999
Algeria						$0^{NW,a}$	$0^{NW,a}$
Argentina		-5^D	$-5^{D,NP}$	$-5^{D,NP}$	$-5^{D,NP}$	$-5^{D,NW}$	0^{NW}
Australia				0^{NP}	0	0^{NW}	0
Austria	0^D	0^D	0^{NP}	0	0	0^{NW}	0
Bangladesh						$0^{NP,NW,b}$	$0^{NW,b}$
Belgium	$0^{D,c}$	$0^{D,c}$	0^D	0^D	0^D	$0^{D,NW}$	0
Brazil	0	0	0^D	0^D	0^D	0	0
Canada		0	$0^{D,NP}$	0	0	0^{NW}	0
Chile	$0^{E,d}$	-10^e	0^{NP}	0^{NP}	$0^{D,NP}$	$0^{D,NP,NW}$	0^{NW}
China							0
Columbia	0^D	0^D	$0^{D,NP}$	$0^{D,NP}$	$0^{D,NP}$	$0^{NP,NW}$	0^{NW}
Czech Republic				0^{NP}	0^{NP}	$0^{NP,NW}$	0
Denmark		$0^{E[-10]}$	0	0	0	0	0
Egypt						0^{NW}	0^{NW}
Finland				0	0	0^{NW}	0
France	$0^{D,c}$	0^D	0	0	0	0	0
Germany	0	0	0^{NP}	0	0	0	0
Greece				0	0	0^{NW}	0
Taiwan				0^{NP}	0^{NP}	$0^{NP,NW}$	$0^{NP,NW}$
Hungary				0	0	0^{NW}	0
India					0^{NP}	$0^{NP,NW,b}$	0^{NP}
Indonesia							0
Iran					$0^{D,NP}$	$0^{D,NW}$	$0^{D,F[+133100\%],NW}$
Iraq					$0^{D,NP}$	$0^{D,NP,NW}$	$0^{D,F[+67\%],NW}$
Ireland					0	0^{NW}	0
Israel					0	0^{NW}	0
Italy	$0^{D,F[50\%]}$	0^D	0^D	0^D	0	0^{NW}	0
Japan			0	0	0	0	0
Kuwait						$0^{NP,NW}$	$0^{NP,NW}$
Libya						$0^{NP,NW}$	0^{NW}
Malaysia							0^{NW}
Mexico	0	0	0^{NP}	0	0	0^{NW}	0
Morocco						0^{NW}	0^{NW}
Myanmar							
Netherlands	$0^{D,c}$			0	0	0^{NW}	0
New Zealand				0	0	0^{NW}	0
Nigeria						0^{NW}	0^{NW}
Norway	-10^E	0^D	0	0	0	0^{NW}	0
Pakistan					0^{NP}	$0^{NP,NW,b}$	$0^{NP,NW,b}$
Peru		0	0^{NP}	0^{NP}	0^{NP}	$0^{F[+26\%],NP,NW}$	0^{NW}
Philippines					0^{NP}	0^{NW}	0^{NW}
Poland				0	0	0^{NW}	0
Portugal	0^D	$-10^{E[-5]}$	0	0	0	0^{NW}	0
Romania				$0^{D,F[+100\%]}$	0^D	$0^{NW,d}$	0
Russia	$-4^{D,F[+100\%]}$	$-4^{D,F[+100\%]}$	$0^{D,NP}$		0^{NP}	$0^{F[+75\%],NP}$	0

Country							
Saudi Arabia							$0^{D,NP,NW}$
Singapore							0
South Africa			0^{NP}		0	0^{NW}	0^{NW}
South Korea					0^{NP}	$0^{NP,NW}$	0
Spain	$-10^{F[+200\%]}$	$-10^{F[+200\%]}$	-10	$-15^{F[+40\%]}$	-10	-10^{NW}	0
Sweden	-10^{E}	0^{D}	0	0	0	0	0
Switzerland			0	0	0	0	0
Syria					0	0^{NW}	0^{NW}
Thailand							$0^{NP,NW}$
Turkey			$0^{D,NP}$	$0^{D,NP}$	0^{D}	$0^{D,NW}$	0
Ukraine							0
United Arab Emirates							0^{NW}
United Kingdom	0	0^{D}	0	0	0	0	0
United States	$0^{D,F[+900\%],f,g,h}$	$0^{D,h}$	0^{h}	0^{h}	0^{h}	0^{h}	0
Venezuela			$0^{D,NP}$	$0^{D,NP}$	$0^{D,NP}$	$0^{D,NP,NW}$	$0^{NP,NW}$

Notes:

D = Duration of foreign patents is limited to that of patent abroad.

E = Extension of foreign patents is for a shorter period (difference in years is in brackets, unless discretionary).

F = Fees changed foreign patentees are higher (percentage differential in brackets).

NP = Country has not ratified the Paris (International) Convention of 1884 (only reported for 1900 or after).

NW = Country has not ratified the Washington Convention (Patent Co-operation Treaty) of 1970. Countries that ratified the agreement in its first effective year are included as having ratified the agreement in 1975.

a = Patents only awarded to foreign applicants; no domestic patents.
b = Award based on international priority date.
c = Applying for a subsequent foreign patent will invalidate the domestic patent.
d = The minimum difference. Length of foreign patent awards is discretionary.
e = Patents only awarded to domestic applicants; no foreign patents.
f = Fee for British citizens 1567% of domestic rate.
g = Working requirement for foreign patentees only.
h = Discrimination against foreign patentees though evidentiary rules in patent interference proceedings.

See Table 3 for a listing of those observations where no fee data are available.

Table 6. Cross-tabulation of national characteristics and patent policy. The sample consists of the sixty largest countries (by gross domestic product) at the end of 1997, observed at 25-year intervals from 1850 to 1999. Panel A of the table indicates for each group the percentage of observations which had a patent system and the mean of the duration (in years from time of application) of patents granted to domestic applicants, the net present value of the fee charged a domestic patentee for a patent carried to full term (in 1998 U.S. dollars), the "working" period (the number of years after the award when the patent may be licensed to third parties by the government or revoked if not employed, typically in a given country), and the difference (in years) of a patent award to a foreign entity carried to full term relative to that to a domestic entity (both not including any extensions granted at the discretion of government officials). Observations are divided by the date of the observation, the level of the country's per capita gross domestic product (expressed as a fraction of the country with the highest GDP in that year), whether the effective head of the nation was elected, whether the national legislature was rated as effective, whether the national legislature was elected, and the family of origin of the country's commercial legal code. Panel B presents the p-value of tests of the significance of these differences, based either on a chi-squared test (the existence of a patent system) or t-tests (all other variables).

	Patent System	Award Duration	Award Cost	Working Period	Foreign Difference
Panel A: Mean of Different Groups					
Year of Observation:					
1850	58.6%	13.4	4972	3.0	2.1
1875	64.5%	12.6	3350	3.3	2.0
1900	77.4%	16.3	7268	4.0	0.6
1925	84.6%	17.6	2251	3.2	0.6
1950	91.8%	16.9	1445	3.9	0.3
1975	89.8%	16.4	995	3.6	0.3
1999	98.3%	18.6	2946	4.0	0.0
Relative Gross Domestic Product:					
Top Quartile	92.5%	17.1	4516	4.3	0.2
Second Quartile	97.0%	16.5	2353	3.0	1.2
Third Quartile	89.6%	16.9	2576	4.2	0.7
Bottom Quartile	83.6%	16.6	1603	3.7	0.0
Effective Head Selection:					
Direct Election	98.0%	17.8	2677	5.4	0.2
Indirect Election	93.8%	17.0	2942	3.5	0.2
Not Elected	65.0%	15.2	3287	2.8	1.5
Legislative Effectiveness:					
Effective	94.2%	17.0	3007	3.8	0.4
Ineffective	81.0%	16.3	3075	3.4	0.9
No Legislature	43.6%	14.9	1709	3.3	1.5
Legislative Selection:					
Elected	92.1%	17.0	2987	3.7	0.4
Not Elected or No Legislature	50.9%	14.6	2804	3.1	2.0
Legal Family:					
English	83.6%	17.2	2296	5.3	0.0
French	86.1%	16.5	2881	3.2	0.9
German	91.7%	16.8	4594	2.5	0.0
Scandinavian	96.0%	15.5	2372	2.7	0.8
Communist	77.3%	17.7	2211	5.8	0.0
Other	27.3%	12.0	9683	3.3	2.7
Panel B: p-Values, Tests of Equality of Means					
1925 and Before vs. 1950 and After	0.000	0.000	0.000	0.350	0.001
Above Median GDP vs. Below	0.000	0.575	0.087	0.727	0.446
Effective Head Elected vs. Not Elected	0.000	0.001	0.551	0.034	0.000
Effective Legislature vs. Not	0.000	0.077	0.830	0.397	0.028
Legislative Elected vs. Not	0.000	0.006	0.868	0.388	0.000
English Family vs. All Others	0.869	0.227	0.219	0.001	0.036

Civil Law Families vs. All Others	0.006	0.216	0.405	0.000	0.036
Communist Family vs. All Others	0.352	0.273	0.469	0.019	0.276
Other Family vs. All Others	0.000	0.055	0.006	0.877	0.098

Notes:

The "patent system" tabulations include countries that automatically recognize patents granted by another nation as having patent protection; these observations are omitted from all other tabulations. The patent duration and patent fee calculations do not include any provisions for extensions by the government due to extraordinary circumstances. In making the calculations, for 1950 and afterwards, it is assumed that awards occur two years after the application date (one year after publication date). For 1900 and 1925, it is assumed awards occur one year after the application date (and publication date). For 1850 and 1875, it is assumed awards occur only a nominal period after application. All payments are discounted at the ten-year U.S. Treasury yield or a proxy therefor back to the application date. The working period is computed from the award date. It does not include any provisions for extensions due to extraordinary circumstances. Countries with no working provisions are recorded as having a working period that extends for the life of the patent; those where the working period is set at the government's discretion as having a working period of zero years.

Table 7. The determinants of patent protection. The sample consists of the sixty largest countries (by gross domestic product) at the end of 1997, observed at 25-year intervals from 1850 to 1999. In the first regression, the dependent variable is an indicator variable that takes on the value of zero if the country offers no patent protection, one if the country automatically recognized patents granted by another nation, and two if it has an independent system. In the second through fourth regressions, the patenting of pharmaceuticals, chemicals, and plants are examined. The dependent variable takes on the value of zero if the country has no patent system or does not allow patenting in this area, one if restricted patenting is allowed, and two if patenting is allowed. (Countries with systems of registering patents granted in other nations are not included in the second through fourth regressions.) The independent variables are a dummy that takes on the value of one if country had been formed in the past five years (or reformed after a gap of more than fifty years), the per capita gross domestic product (expressed as a fraction of the nation with the highest GDP in the year of the observation), and dummy variables for whether the effective head of the nation was directly or indirectly elected, whether an effective national legislature existed, whether an elected national legislature existed, the family of origin of the country's commercial legal code, and the year of the observation (not reported). All regressions employ an ordered logit specification. Standard errors in brackets.

	Dependent Variable			
	Any Patent Awards	Drug Patents	Chemical Patents	Plant Patents
Was nation recently formed?	-1.54 [0.87]*	0.16 [0.70]	-0.24 [0.68]	
Relative gross domestic product	2.07 [1.23]*	1.86 [0.59]***	1.21 [0.70]*	3.66 [1.04]***
Was effective national leader elected?	-0.25 [0.77]	0.10 [0.39]	-0.02 [0.47]	-0.41 [0.76]
Was national legislature effective?	0.89 [0.90]	0.85 [0.41]**	-0.09 [0.50]	0.10 [0.72]
Was national legislature elected?	1.83 [0.94]**	0.19 [0.52]	1.44 [0.59]**	21.63 [1.99]***
French commercial legal family?	2.53 [0.76]***	-0.33 [0.34]	0.99 [0.40]**	-0.09 [0.58]
German commercial legal family?	1.57 [0.95]*	-1.79 [0.44]***	-1.11 [0.45]**	1.20 [0.70]*
Scandinavian commercial legal family?	1.22 [1.19]	-0.71 [0.49]	0.27 [0.56]	-3.34 [1.26]***
Communist commercial legal family?	-0.52 [0.99]	-0.34 [0.56]	-1.41 [0.63]**	1.02 [0.81]
Other commercial legal family?	1.18 [1.35]	-1.14 [1.25]	-1.61 [1.09]	
Political dummies jointly significant?	***	**	**	***
Legal family dummies jointly significant?	***	***	***	***
Year dummies jointly significant?		***	***	***
Number of observations	266	263	263	229
χ^2-statistic	65.14	94.75	93.15	124.64
p-Value	0.000	0.000	0.000	0.000
Log Likelihood	-66.47	-240.04	-186.81	-72.39
Pseudo R^2	0.33	0.16	0.20	0.46

Notes:

* = Significant at the 10% confidence level; ** = 5% confidence level; *** = 1% confidence level.

Because the first plant patents were not granted until 1900, observations from 1850 and 1875 were not included. The "Was nation recently formed variable?" and "Other commercial legal family?" variables were not included in the regression because the small number of positive observations.

Table 8. The duration of patent protection. The sample consists of the sixty largest countries (by gross domestic product) at the end of 1997, observed at 25-year intervals from 1850 to 1999. In the first regression, the dependent variable takes on the value of zero if the country offers no patent protection and the maximum duration of patent protection (in years from time of application) provided domestic applicants if the country has an independent patent system. (Countries with systems of registering patents granted in other nations are not included in any of the regressions.) In the second and third regressions, the patenting of pharmaceuticals and chemicals are examined. The dependent variable takes on the value of zero if the country has no patent system or does not allow patenting in this area and the maximum duration of patent protection for this technology if the country has an independent patent system. The independent variables are a dummy that takes on the value of one if country had been formed in the past five years (or reformed after a gap of more than fifty years), the per capita gross domestic product (expressed as a fraction of the nation with the highest GDP in the year of the observation), and dummy variables for whether the effective head of the nation was directly or indirectly elected, whether an effective national legislature existed, whether an elected national legislature existed, the family of origin of the country's commercial legal code, and the year of the observation (not reported). In the fourth regression, the dependent variable is the difference in the overall patent duration variable between this and the next time period. The independent variables are similarly differenced. (The legal family and time periods dummy variables are not included in this regression.) The first three regressions employ a Tobit specification; the final one an ordinary least squares specification. Standard errors in brackets.

	Dependent Variable			
	Patent Length	Drug Patent Length	Chemical Patent Length	Patent Length Difference
Was nation recently formed?	-3.46 [1.89]*	-1.76 [3.43]	-2.69 [2.15]	1.44 [1.72]
Relative gross domestic product	2.55 [1.60]	7.36 [2.86]**	2.75 [1.81]	2.86 [2.10]
Was effective national leader elected?	0.41 [1.10]	-1.35 [2.03]	-0.33 [1.25]	1.98 [0.86]**
Was national legislature effective?	1.63 [1.13]	5.31 [2.07]**	1.71 [1.29]	0.50 [0.88]
Was national legislature elected?	3.49 [1.48]**	3.99 [2.72]	4.62 [1.69]***	-0.52 [1.14]
French commercial legal family?	2.60 [0.95]***	1.18 [1.70]	2.34 [1.08]**	
German commercial legal family?	1.23 [1.22]	-5.80 [2.25]**	-0.99 [1.39]	
Scandinavian commercial legal family?	-0.04 [1.38]	-0.68 [2.44]	-0.05 [1.56]	
Communist commercial legal family?	-0.87 [1.61]	-0.95 [2.90]	-2.92 [1.84]	
Other commercial legal family?	-3.88 [3.02]	-2.58 [6.22]	-3.18 [3.45]	
Political dummies jointly significant?	***	***	***	**
Legal family dummies jointly significant?	***	**	***	NA
Year dummies jointly significant?	***	***	***	NA
Number of observations	261	261	261	176
χ^2-statistic/F-statistic	100.89	101.17	93.50	2.09
p-Value	0.000	0.000	0.000	0.058
Log Likelihood	-773.06	-750.56	-784.59	
Pseudo R^2/Adjusted R^2	0.06	0.06	0.06	0.03

Notes:

* = Significant at the 10% confidence level; ** = 5% confidence level; *** = 1% confidence level.
NA = Not applicable.

The patent duration calculations do not include any provisions for extensions by the government due to extraordinary circumstances. In making the calculations, for 1950 and afterwards, it is assumed that awards occur two years after the application date (one year after publication date). For 1900 and 1925, it is assumed awards occur one year after the application date (and publication date). For 1850 and 1875, it is assumed awards occur only a nominal period after application.

Table 9. The cost of patent protection. The sample consists of the sixty largest countries (by gross domestic product) at the end of 1997, observed at 25-year intervals from 1850 to 1999. In the first and second regressions of Panel A, the dependent variable is the logarithm of the net present value of the fee charged a domestic patentee for a patent carried to full term (in 1998 U.S. dollars). (Countries with systems of registering patents granted in other nations or without an independent patent system are not included in any of the regressions.) The independent variables in the first regression are the logarithm of the nation's population (in thousands), a dummy that takes on the value of one if country's currency has depreciated more than ten times against the U.S. dollar in the past five years (adjusted for revaluations), the per capita gross domestic product (expressed as a fraction of the nation with the highest GDP in the year of the observation), and dummy variables for whether the effective head of the nation was directly or indirectly elected, whether an effective national legislature existed, whether an elected national legislature existed, the family of origin of the country's commercial legal code, and the year of the observation (not reported). In the second regression, dummy variables for each nation are added. In the third regression, the dependent variable is the difference in the level of patent cost between this and the next time period. The independent variables are similarly differenced. (The legal family dummy variables are not included in the second or third regressions; the time period dummies in the third regression. The difference in population is also in levels in the third regression.) All regressions employ an ordinary least squares specification. Standard errors in brackets. In Panel B, three price indexes for the cost of patent protection are included, in each case with 1850 normalized as 100. The first is unadjusted; the second is adjusted for the changing mixture of countries offering protection; and the third also controls for the changing wealth and population of nations.

Panel A: Regression Analyses

	Dependent Variable		
	Logarithm of Patent Cost		
	With Legal Family Dummy Variables	With Nation Dummy Variables	Difference in Patent Cost
National population	0.07 [0.09]	-0.29 [0.28]	0.003 [0.01]
Substantial currency depreciation?	-0.27 [0.59]	-0.21 [0.56]	329.05 [1394.67]
Relative gross domestic product	2.10 [0.49]***	2.86 [0.93]***	6079.47 [2534.87]**
Was effective national leader elected?	0.94 [0.34]***	1.47 [0.40]***	-413.06 [1087.17]
Was national legislature effective?	0.27 [0.35]	-0.32 [0.41]	745.82 [1082.39]
Was national legislature elected?	-0.32 [0.52]	-0.17 [0.56]	6579.51 [1768.58]***
French commercial legal family?	0.72 [0.30]**		
German commercial legal family?	1.05 [0.38]***		
Scandinavian commercial legal family?	-0.03 [0.41]		
Communist commercial legal family?	2.03 [0.51]***		
Other commercial legal family?	2.85 [1.23]**		
Political dummies jointly significant?	**	***	***
Legal family dummies jointly significant?	***	NA	NA
Year dummies jointly significant?	***	***	NA
Number of observations	211	211	150
F-statistic	5.22	2.97	3.99
p-Value	0.000	0.000	0.001
Adjusted R^2	0.25	0.38	0.11

Panel B: Price Indexes (1850=100)

	Simple Index	Adjusted for Mix of Nations	Adjusted for Mix of Nations and Growth
1850	100.0	100.0	100.0
1875	133.0	146.8	127.6
1900	585.9	646.2	551.2
1925	194.4	230.9	117.0
1950	118.3	155.9	53.2
1975	59.1	93.2	11.1
1999	165.5	269.3	33.3

Notes:

* = Significant at the 10% confidence level; ** = 5% confidence level; *** = 1% confidence level.
NA = Not applicable.

The patent fee calculations do not include any provisions for extensions by the government due to extraordinary circumstances. In making the calculations, for 1950 and afterwards, it is assumed that awards occur two years after the application date (one year after publication date). For 1900 and 1925, it is assumed awards occur one year after the application date (and publication date). For 1850 and 1875, it is assumed awards occur only a nominal period after application. All payments are discounted at the ten-year U.S. Treasury yield or a proxy therefor back to the application date.

Table 10. Limitations on patent protection. The sample consists of the sixty largest countries (by gross domestic product) at the end of 1997, observed at 25-year intervals from 1850 to 1999. In the first regression, the dependent variable is the "working" period: the number of years after the award when the patent may be licensed to third parties by the government or revoked if not employed, typically in a given country. (Countries with systems of registering patents granted in other nations or without an independent patent system are not included in any of the regressions.) In the second regression, the dependent variable is a dummy denoting whether earlier users of a patented invention have "prior user rights." In the third regression, the dependent variable is whether the government can compulsorily license the patent for reasons other than non-working. In the fourth regression, the dependent variable is the count of how many of four commonly encountered restrictions (the prior user and compulsory licensing measures reported in the second and third regressions, provisions for patent revocation for reasons other than non-working, and caps on the damages that can be collected by patentees in infringement cases) are present. The independent variables are the per capita gross domestic product (expressed as a fraction of the nation with the highest GDP in the year of the observation), and dummy variables for whether the effective head of the nation was directly or indirectly elected, whether an effective national legislature existed, whether an elected national legislature existed, the family of origin of the country's commercial legal code, and the year of the observation (not reported). The first regression employs an ordinary least squares specification; the second and third, a logit specification; and the fourth, an ordered logit specification. Standard errors in brackets.

	Dependent Variable			
	Working Period	Prior User Rights	Comp. Licensing Provisions	Count of Restrictions
Relative gross domestic product	2.42 [1.10]**	2.30 [1.00]**	0.35 [0.75]	-0.04 [0.79]
Was effective national leader elected?	1.49 [0.75]**	-0.02 [0.55]	-0.60 [0.52]	-0.56 [0.49]
Was national legislature effective?	-0.09 [0.77]	-0.94 [0.63]	0.78 [0.54]	-0.10 [0.54]
Was national legislature elected?	-0.67 [1.06]	0.49 [0.79]	0.87 [0.70]	0.84 [0.67]
French commercial legal family?	-1.39 [0.66]**		-1.40 [0.45]***	-0.41 [0.42]
German commercial legal family?	-2.58 [0.84]***		0.27 [0.61]	2.45 [0.65]***
Scandinavian commercial legal family?	-2.55 [0.93]***		-0.41 [0.62]	1.63 [0.62]***
Communist commercial legal family?	1.72 [1.18]			
Other commercial legal family?	-1.15 [2.87]			
Non-English legal family?		1.66 [0.42]***		
Communist or other legal family?			0.44 [0.84]	1.33 [0.72]*
Political dummies jointly significant?				
Legal family dummies jointly significant?	***	***	***	***
Year dummies jointly significant?		***	***	***
Number of observations	238	155	235	155
F-statistic/χ^2-statistic	2.16	59.42	85.31	67.60
p-Value	0.008	0.000	0.000	0.000
Log Likelihood		-77.57	-118.18	-156.96
Adjusted R^2/Pseudo R^2	0.07	0.28	0.26	0.18

Notes:

* = Significant at the 10% confidence level; ** = 5% confidence level; *** = 1% confidence level.

The working period is computed from the award date. It does not include any provisions for extensions due to extraordinary circumstances. Countries with no working provisions are recorded as having a working period that extends for the life of the patent; those where the working period is set at the government's discretion as having a working period of zero years. The compulsory licensing variable is coded as one even when only certain technology classes can be licensed, but not when the government reserves the right to license technology for national security purposes. Certain data—especially prior user rights in 1925 and 1950—are not available, so the regressions do not use the full sample.

Table 11. Discrimination against foreign patentees. The sample consists of the sixty largest countries (by gross domestic product) at the end of 1997, observed at 25-year intervals from 1850 to 1999. In the first regression, the dependent variable is a dummy that takes on the value of one if the country has not ratified the Paris (International) Convention of 1883. (Countries with systems of registering patents granted in other nations or without an independent patent system are not included in any of the regressions.) In the second regression, the dependent variable is a dummy that takes on the value of one if the nation has not ratified the Washington Convention (Patent Co-operation Treaty) of 1970. In the third regression, the dependent variable is the count of how many of four commonly encountered discriminatory provisions (when foreign patentees face shorter patent lengths, higher fees, termination of protection if a foreign patent expires first, and shorter extensions for extraordinary circumstances) are present. The independent variables are the per capita gross domestic product (expressed as a fraction of the nation with the highest GDP in the year of the observation), and dummy variables for whether the effective head of the nation was directly or indirectly elected, whether an effective national legislature existed, whether an elected national legislature existed, the family of origin of the country's commercial legal code, and the year of the observation (not reported). The first two regressions employ a logit specification; the third, an ordered logit specification. Standard errors in brackets.

	Dependent Variable		
	Paris Convention Non-Ratification	*Washington Convention Non-Ratification*	*Discriminatory Provisions*
Relative gross domestic product	-2.67 [0.90]***	-7.73 [2.12]***	-0.33 [0.94]
Was effective national leader elected?	-0.13 [0.52]	-3.50 [1.46]**	-0.66 [0.47]
Was national legislature effective?	-0.42 [0.52]	-0.28 [0.99]	-0.38 [0.52]
Was national legislature elected?	-0.79 [0.68]		-0.29 [0.73]
French commercial legal family?		-0.18 [0.75]	1.75 [0.56]***
German commercial legal family?		-0.96 [1.08]	-1.25 [0.96]
Scandinavian commercial legal family?		-1.00 [1.22]	0.27 [0.76]
Communist commercial legal family?			-0.22 [1.06]
Other commercial legal family?			3.82 [1.79]**
Civil law commercial legal family?	-0.53 [0.44]		
Communist or other legal family?	-0.63 [0.77]	-3.74 [1.33]***	
Political dummies jointly significant?		**	
Legal dummies jointly significant?		**	***
Year dummies jointly significant?	***	***	***
Number of observations	210	110	215
χ^2-statistic	32.92	76.28	91.40
p-Value	0.000	0.000	0.000
Log likelihood	-103.25	-36.63	-122.43
Pseudo R^2	0.14	0.51	0.27

Notes:

* = Significant at the 10% confidence level; ** = 5% confidence level; *** = 1% confidence level.

Countries that ratified the Washington Convention in its first effective year are included as having ratified the agreement in 1975. The first regression only uses observations from 1900 and after; the second, observations from 1975 and after. Due to the smaller sample sizes in these regressions, some independent variables are combined or omitted.