

Appendix for “Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from U.S. Firm-Level Panel Data,” by Lee Branstetter, Ray Fisman, and C. Fritz Foley

This Appendix contains three sections. The first provides a complete explanation of the criteria used to select the patent reforms examined in the paper, the second describes what the reforms have in common, and the third details the key features associated with each reform.

A.1 Construction of the Sample

In constructing our sample, we started with the work of Maskus (2000), who used the *National Trade Estimates Reports on Foreign Trade Barriers* and other publications to identify a series of significant patent reforms. Since this set of reforms does not appear to be exhaustive, we consulted two additional sources. Qian (2004) provides a list of countries that made substantial changes to patent law as it applies to the pharmaceutical industry. Ginarte and Park (1997) provide a time varying index of the strength of patent law, and it is possible to use an updated version of this index to identify countries that appear to undergo reforms.¹ These sources identify 42 reforms that took place during the 1982-1999 period that is covered in our sample.

Table A-1 displays a list of these reforms and indicates which source identifies each reform with the letters “M,” “Q,” and “G,” respectively referring to Maskus (2000), Qian (2004), or Ginarte and Park (1997). The shaded reforms are the ones we examine in our empirical analysis.

Unfortunately, a large number of reform episodes are excluded from our analysis as a consequence of data limitations. Our identification of the impact of IPR reform on technology transfer and the R&D spending of affiliates and patent filings in a fixed effects framework requires that we observe activity prior to and following reform. Therefore, reforms that occurred prior to 1982 or after 1999 cannot be included in our sample. Even though India’s patent reform occurs in 1999, which is within our window of observation, the lack of post reform data prevents us from identifying effects using this reform.

Many reforming countries contain only a handful of affiliates that file BEA reports. In our analysis, the calculation of the high patent use dummy is based on a comparison of the extent to which parents of affiliates in a particular country make use of the U.S. patent system. In order to ensure that such a comparison is meaningful for each reform episode we examine, we require that there be at least 20 affiliates in manufacturing that report in the pre- and post reform period and that can be matched to patenting entities in the NBER patent citation database.² Many small reforming countries like Bolivia and formerly

¹ We thank Walter Park for providing us with an updated version of the data used in the cited paper.

² In response to a referee’s request, we experimented with an alternative cutoff of 10 affiliates rather than 20. While this required us to examine a slightly larger group of patent reform episodes, it did not result in any substantial change to our empirical results.

communist countries like Russia do not contain enough U.S. multinational affiliates to be included in the sample.³

These data restrictions exclude all but 18 countries from the initial list of reforms we considered. Two other countries, Canada and Singapore are also excluded, because of the limited nature of patent reform in those countries. We think it is unlikely that the typical U.S. multinational would have experienced enough of a real change in the IPR environment to change its technology transfer activity. That being said, the main results are robust to the inclusion of affiliate data from these two countries.

Singapore is host to a sufficiently large number of affiliates that the 1994 patent reform in that country is of interest to us. However, a careful study of this patent reform indicates that it had relatively little impact on the effective strength of IPR protection along the dimensions we consider. Prior to this reform, patent rights in Singapore were governed by the patent statute of the United Kingdom, reflecting Singapore's colonial history. Firms that had obtained patent grants in the UK could simply register them in Singapore, thereby effectively obtaining an extension of their UK patent grant to Singapore's sovereign territory. The patent reform of 1994 created a separate Singaporean patent law, but it was one very closely modeled on the U.K. law it replaced. Leong (1996) provides a detailed comparison of the two statutes, and it is clear from this study that the differences between them are minor. Direct communication with the author of this study, a professor at the National University of Singapore and an advocate and solicitor of the Supreme Court of Singapore, confirmed that from the standpoint of a multinational firm that sought patent protection in the U.K. as a matter of course (as many U.S. firms did for their more valuable inventions), the effective change in the operating environment in Singapore was quite limited. If this is the case, then it would be inappropriate to treat the Singaporean reform as if it were as substantive and wide-ranging as the reforms included in our study.

Characterization of the Canadian reform of 1987 is more complicated. It appears to create an expansion of patent rights along two of the dimensions we emphasize in the text. In addition to some minor procedural changes, the Canadian reform broadened patent protection to include product patents for pharmaceuticals and foodstuffs; these classes of invention were only eligible for process patents before reform. It also changed the term of protection from 17 years from the grant date to 20 years from the filing date. However, closer investigation reveals countervailing institutional factors that undercut the impact of both of these changes on firm behavior.⁴ First, direct price controls for pharmaceuticals were implemented along with product patents, limiting the ability of drug companies to

³ To give the reader a sense of how limited FDI is in some of these countries, there are no affiliates that can be linked to parents with patent data in Bolivia or Mali, only 1 in Nicaragua and Paraguay, 2 in Cyprus, and 5 in El Salvador.

⁴ The 1987 reform also ratified Canada's accession to the Patent Cooperation Treaty. However, this did not have a major effect on patenting by U.S. firms in Canada. As a wealthy OECD country with substantial U.S. multinational activity, Canada was already a natural jurisdiction in which U.S. multinationals would seek patent protection. This appears to be true of foreign patenting in Canada in general – one observes little change relative to trend with the implementation of this reform.

derive economic rents from their Canadian patents.⁵ Second, the new law continued to allow for the compulsory licensing of drug patents under a fairly broad range of circumstances. Third, the typical lag between the filing of a patent application in Canada and its grant by the Canadian Intellectual Property Office is such that the effective increase in the term of patent protection under the new law, from the issue of the patent to its expiration, was fairly modest.⁶ At least some well-regarded Canadian economists have suggested that the impact of the 1987 reform was quite modest, and we concur with this judgment.⁷ Compared to the reforms included in our sample, the Canadian reform of 1987 appears to be far less substantive, and the impact of reform – to the extent that it exists – would be concentrated in the pharmaceutical and foodstuffs industries. On this basis, we exclude the 1987 Canadian reform from consideration. However, we note that the main results of our paper are robust to the inclusion of Canadian affiliates in the pharmaceutical and foodstuffs industries and in fact to the inclusion of all Canadian affiliates.

This leaves us with 16 substantive reform episodes in countries and time periods for which we have sufficient data to estimate the impact of the change on firm behavior. Focusing on this limited number of reforms has allowed us to learn about their details. However, it is important to note that caution must be exercised in applying our results, which are based on only a subset of all reforms, to other contexts.

It is also worth briefly describing some key features of other reforms in advanced countries noted by Qian (2004) including reforms in Austria (1987), Denmark (1983), Finland (1995), Greece (1992), Iceland (1996), and Norway (1992). Although these reforms are excluded from our sample because they are not host to a sufficient number of reporting affiliates, the nature of the reforms undertaken in these countries is distinctive.⁸ All of these countries had reasonably well developed patent systems, with a legal or administrative framework (or both) under which patent disputes could be resolved, well before the reform dates. In each of these countries, reforms extended patent protection to pharmaceutical products. The effective change in patent protection outside the pharmaceutical industry, which accounts for only a small fraction of affiliate activity, was quite limited. In addition, at the time of reform each of these countries also regulated drug prices, keeping them at levels that were typically a small fraction of the prices found in the much less regulated American market. The increased pricing power that stronger patent rights might, in principle, confer on pharmaceutical manufacturers was largely undercut by these regulatory constraints. These considerations suggest that this set of

⁵ Indirect price controls already existed in Canada, but the new patent law set up a new regulatory authority with the explicit mandate to prevent drug companies from charging “excessive” prices for their patent-protected products.

⁶ Correspondence with the Canadian Intellectual Property Office suggests that a pendency lag on the order of two years would not be unusual.

⁷ McFetridge (1997) goes so far as to suggest that the 1987 reform may have reduced the cost of patent protection for drugs and related products, but the actual level of protection did not change.

⁸ In response to a referee’s request, we incorporated data from Austria, Denmark, Ecuador, Finland, Greece, Norway, and Panama, as well as data from Canada. Our main results are robust to the use of this expanded sample.

reforms would be unlikely to have a large impact on overall levels of intrafirm technology transfer.

A.2 Broad Attributes and Timing of Reforms

A.2.1 Broad Attributes of Patent Reform

We consider five broad attributes of patent reform, which we discuss in turn:

- Expansion of eligible inventions
- Expansion of patent scope
- Expansion of patent length
- Improvement in patent enforcement
- Improvement in patent administration

Expansion of eligible inventions. Many of our reforms extended product patent protection to pharmaceuticals, veterinary drugs, agro-chemical products, and foods. Most of the reforming countries in the sample did not have national health insurance systems that imposed strict regulations on drug prices and availability. As a consequence, stronger product patent protections should give patent holders greater ability to exercise market power and larger incentives to transfer technology.⁹

Expansion of patent scope. Increases in the breadth of patent protection offered by a single patent are also common in our sample, and these take a variety of forms. Some countries formally adopted the concept of infringement through equivalence. Under this legal doctrine, any invention that is functionally equivalent to that described in an existing patent is presumed to infringe on the previous patent. In its absence, minor variations of chemical composition or mechanical operation can allow an infringer to effectively copy an existing invention without penalty. Another common change in patent scope in our sample is associated with the shift from single-claim to multi-claim patent systems. This change allows for broader and more effective use of claims within a patent document to demonstrate the novelty of the invention and to describe attributes that are separate but related. Finally, many nations' patent laws prior to the 1990s explicitly contained a wide range of circumstances under which patent holders could be compelled to license their technology to domestic producers, often under conditions that favored domestic producers. Other regulations limited the right of patent holders to block parallel imports of patented items or imports of patent-infringing items.¹⁰ From the patent holders' perspective, these were very serious abridgements of patent rights. Many of the reforms we study included provisions that sharply restricted the range of situations in which compulsory licenses could be imposed or strengthened the ability of patent holders to block unauthorized imports of patented goods, expanding patent scope along

⁹ Taiwan, for example, introduced a national health care insurance system in the late 1990s, but this was long after the patent system had been reformed.

¹⁰ Parallel imports are imported items purchased from one country then sold in another where the items' patent holder may seek to use patent protections to sell the items at a higher price. An example is imports of prescription drugs from Canada for resale in the U.S. This practice is restricted by U.S. law, but many nations have maintained few restrictions on such activity.

yet another dimension. An expansion in the scope of patent rights affects all classes of inventions and is therefore of particular interest to us.

Expansion of patent length. Increases in the number of years of protection offered by a patent are common in our sample. In most cases, the term of protection was extended to twenty years from the date of application. Like expansions of patent scope, increases in patent length affected all classes of inventions in the countries in which they were adopted. However, the actual impact of this kind of reform is unlikely to be uniform across all categories of inventions. In the fastest-moving technological areas, including inventions related to information technology, it is often the case that the technological content of a patent is rendered obsolete long before the patent expires. Despite this caveat, there are broad classes of inventions in which the technological frontier does not advance as quickly and for which this expansion of patent length is likely to be important.

Improvement in patent enforcement. The ability of firms to earn rents associated with having patent rights depends on the commitment of the reforming country government to enforce those rights, and many reforms include significant steps aimed at improving enforcement. Indicators of improvement include the establishment of stronger penalties for patent infringement, reversal of the burden of proof in patent infringement lawsuits from the patent holder to the alleged infringer, changes in judicial guidelines for determining infringement that favored patent holders, the establishment of specialized courts or regulatory bodies to handle patent disputes, and the expansion of legal remedies available to the patent holder when the relevant legal authority determined that infringement had taken place. Like expansions in patent scope and patent length, these reforms typically apply to all classes of invention. In some countries, legal and procedural reforms sparked a sharp increase in intellectual property litigation, as incumbent patent holders were equipped with the legal tools necessary to successfully prosecute infringers.

Improvement in patent administration. In practice, administrative reforms have often accompanied improvements in the enforcement of patent rights. Indicators of this kind of reform include the establishment of a new administrative organization to run the patent system, an increase in resources to hire patent examiners, an administrative commitment to reduce examination lags, and the abolition of administrative procedures that delayed patent grants and/or increased uncertainty regarding the timing and content of the eventual patent grant. This kind of reform also affects all classes of invention.

Table A-2 indicates whether or not reforms in the individual countries in the sample include changes in each of the five broad attributes described above. We believe that reforms strengthened patent rights along all five dimensions in six of the sixteen reforms. An additional nine of the sixteen reforms include stronger policies in four of the five attributes. While differing in their details, there are important similarities among the fifteen of our sixteen reforms in which reform is expanded along at least four out of five dimensions. Each individual reform is discussed in detail below.

In two of the reforming countries in the sample, China and Argentina, substantial anecdotal evidence suggests that various problems have limited the impact of the legal and procedural changes that were introduced. Even though reforms in China have produced what is, on paper, one of the strongest patent regimes in any large developing country, the nearly universal perception of foreign managers is that the capacity of local firms to imitate even relatively advanced technology has advanced as least as fast as have government efforts to enact and enforce appropriate IPR laws. Despite the efforts of the central government, many managers regard China as a relatively insecure operating environment in terms of IPR.

On paper, Argentina expanded patent protection along at least two of the five dimensions we consider, but substantial anecdotal evidence from managers calls into question the degree to which these reforms were effectively implemented. In the interests of being inclusive in our analysis of patent reforms, we include the reforms that took place in China and Argentina in our sample. However, we recognize that these reforms are arguably less substantive than the others we consider, and we note that the empirical results reported in the paper are robust to removing these countries from the data set.

A.2.2 – Timing of reforms

In discussing the issue of the timing of reforms, it is important to acknowledge that reform of the IPR system has been an ongoing process in many countries. The dates assigned to each country mark a particularly significant stage in this process – a widely recognized turning point in the evolution of the system. Since identification in the empirical analysis comes from differences in the timing of reforms, the analysis is testing if multinational technology transfer changes when these discrete shifts in policy occur.

We consulted a wide range of sources concerning the timing of reforms. We have supplemented Maskus (2000), Qian (2004), and Ginarte and Park (1997) with a close reading of other secondary sources and extensive interviews with patent lawyers based in the reforming countries, multinational managers with extensive experience in IPR-intensive industries in the reforming countries, and consultants specializing in international IPR issues. There is a fairly strong consensus concerning the date of the most significant turning point in the extent of IPR protection across our sources. Section A.3 below, which provides further institutional detail on the individual patent reforms, explains the cases in which there were multiple stages of reform and presents our rationale for assigning dates as we have.

In two cases, we choose dates that differ from those proposed by Maskus (2000). Reflecting the opinion of the experts we consulted, the date assigned to Taiwanese patent reform is 1986, for reasons discussed at length in the section below that discusses Taiwan. Likewise the date assigned to Japanese patent reform is 1987.

Another timing issue that deserves consideration is the question of when one should expect to see any effects of IPR reform on technology transfer. Domestic inventors, when confronted with a radical change in the IPR environment, might plausibly take

some time to generate a measurable response in terms of innovative input and output. The new IPR regime generates incentives to engage in kinds of innovative activity that they may not have undertaken before. In contrast, U.S. multinationals are likely to respond to reforms soon after they occur. Most of these firms already possess a portfolio of technologies that is employed around the world. Conversations with multinational managers and country-based patent experts strongly suggest that the cost of upgrading the technological intensity of affiliate activity in response to a significant reform is relatively low and that the deployment of technology can be quite rapid. The results in Table VI of the paper are consistent with these claims since they provide evidence that technology transfer increases rapidly within a few years after reform.

Section A.3 Detailed Discussion of Individual Patent Reforms

Argentina (1996)

The patent system was governed through the mid-1990s by an 1864 law that explicitly excluded pharmaceutical products from protection and that allowed for the nullification of patents under a wide range of circumstances. It also empowered any party that created a minor modification of an existing patent to obtain a compulsory license of the original patent. Executive Decree 260, issued in 1996, consolidated previous patent laws, restricted the range of circumstances under which patents could be nullified, and authorized the National Intellectual Property Institute (INPI) to approve pharmaceutical patents. By providing patent protection to pharmaceutical products, the new law expanded patent rights to an important class of inventions. By restricting the range of circumstances under which patents could be nullified, the new law had the effect of expanding patent scope by providing a more secure claim to the region of product space purportedly protected by a patent grant than had been available under the old regime. However, the effects of these reforms were undercut in several ways. Local firms were given until November 2000 to come into full compliance with the obligation to honor pharmaceutical patent rights. The law also specifically permitted parallel imports of pharmaceutical products, and considerable ambiguity remained regarding the grounds under which the government could require compulsory licensing. Furthermore, laws passed in December 1996 appear to have compromised the security of product data submitted to the Argentine government for product registration purposes, allowing local competitors to benefit strategically from these data.

Brazil (1997)

Patent protection was expanded to include pharmaceutical, food, and agro-chemical products. The scope of patents was effectively expanded through the incorporation into the patent law of the concepts of contributory infringement and infringement by equivalence. A “pipeline” provision allowed firms to patent innovations ineligible for protection under the old regime -- innovations that had been patented in other countries more than a year ago.¹¹ Although the new Brazilian law retained provisions allowing for

¹¹ International patent conventions have traditionally allowed an inventor up to 12 months to choose the countries in which she would seek patent protection and initiate the patent application process. This period typically dated from the application for patent protection in the first country chosen by the inventor. After

compulsory licensing of patented inventions in some situations, these provisions were substantially weaker than similar provisions in the older patent statute. Conversations with Brazil-based patent attorneys suggest that there is little evidence the provisions for compulsory licensing have been exercised since 1997. The term of patent protection was extended to twenty years from the date of application. The reform introduced guidelines for judges to use in the determination of damages as a result of infringement. Judges were also provided with additional means to stop illicit activities including powers to grant preliminary injunctions to seize infringing products and close down infringing production.¹² These features considerably enhanced the enforcement of patent law and expanded the enforceability of patent rights across all classes of inventions.

Chile (1991)

New legislation extended product patent protections to pharmaceuticals, which had been eligible for only process patents under the old regime. Given the absence of stringent government price controls on pharmaceutical products, this was a meaningful development for drug manufacturers. A provision was included that allowed drug manufacturers to seek retroactive patent protection for their products that had been ineligible for patent protection under the old regime. The new law clarified the prosecution procedure and remedies for infringement for the major classes of intellectual property, including trademarks as well as patents. It established uniform length of patent protection for all inventions (15 years), effectively lengthening patent protection for some inventions relative to the prior regime.¹³ Finally, it established a new legal body, the Industrial Property Appellate Tribunal, to review patent decisions, and formally adopted the Paris Convention, bringing Chile's provisions for international patenting to global standards.

China (1993)

China introduced a patent statute in 1993 which seemed to substantially strengthen a patent system first introduced in 1984. It explicitly granted protection for chemical products and processes, restricted the granting of compulsory licenses, extended the term of protection from 15 to 20 years, and established specialized IPR courts to handle intellectual property disputes. However, discussions with multinational managers based in China have led us to a more qualified assessment of China's IPR regime. While acknowledging the efforts made by the central government to improve patent enforcement and the resolution of some disputes on terms favorable to patent holders, many interviewees pointed out that the capacity of Chinese firms to copy even relatively advanced Western technology has advanced as least as fast as the efforts of the government to enforce existing laws. This high and growing imitative capacity of Chinese firms has posed special challenges for foreign firms in technology-intensive

this 12 month period expired, the invention would be effectively regarded as part of the public domain in all countries in which the inventor had not explicitly sought protection. Since there is no global patent system, protection must be sought in each country.

¹² From the perspective of multinational pharmaceutical companies, the Brazilian reform process took a step backward in 2000, when the Health Ministry took administrative steps to block the granting of new pharmaceutical product patents. According to our sources, these difficulties persist to the present.

¹³ Under the previous regime, patents could be taken out for a range of periods, then extended to fifteen years, but the extension would only be granted if it did not run counter to the "national interest."

industries – challenges that do not exist in other countries where the local capacity for effective imitation appears to be less developed. Local governments also do not always seem to apply Chinese law following the intentions put forth by the central government. For these reasons, many foreigner managers continue to regard the IPR environment in China as relatively insecure. Even in the aftermath of China’s WTO accession, American businesses, while generally praising China for complying with its WTO obligations, have repeatedly and consistently singled out the security of intellectual property rights as the most problematic area.

Colombia and Venezuela (1994)

These countries are both members of the Andean Pact, and they reformed their patent systems together with other Andean Pact states in 1993. Legal changes took effect in 1994. The reforms extended patent protection to agro-chemical and pharmaceutical products, reversed the burden of proof in cases of alleged patent infringement, and lengthened the term of patent protection to twenty years. The reforms also granted protection to industrial secrets and narrowed compulsory licensing requirements. These reforms fell short of the reforms in Mexico and Brazil, however, in that there was no provision protecting old innovations that had not been eligible for protection under the previous regime, and the laws allowed for parallel imports in some cases. The new laws also retained restrictions on biotechnology inventions, denial of patents for “essential” drugs, working requirements that are more stringent than those of other states, and provisions for compulsory licensing under certain circumstances.¹⁴

The Colombian government launched a major modernization of the Colombian government agency in charge of patents in 1992-93, which significantly improved the enforcement and administration of the patent system. In Venezuela, the creation of SAPI, an intellectual property rights office, also improved patent administration, but this body did not begin operations until 1997. Foreign corporations have complained that the fines associated with patent infringements in Venezuela are far too low. Bills to update and increase financial penalties have stalled in the national legislature for years.

Indonesia (1991)

Prior to 1991 Indonesia had no patent law. There were thus no legal grounds for patent protection for any class of invention for any length of time. The initial patent law, enacted in 1991, conformed to international standards in many ways. Notably, it provided for both process and product patent protection for pharmaceutical and chemical inventions. Despite the significant change associated with the reform, the law was subject to a number of criticisms. The regime included a relatively short period of protection of 14 years, it did not block unauthorized imports in certain specific product categories, and it contained ambiguities regarding working requirements and patent cancellation. A number of these criticisms were addressed in an amendment of the patent law in 1997, which extended patent protection to twenty years, explicitly outlawed the use of an invention by other parties when the patent was pending, and deleted limitations

¹⁴ Colombian Law 100 established a policy of promoting generic pharmaceuticals at the expense of multinational producers, partially reversing the potential benefits of stronger patents. However, this policy does not appear to be enforced in all medical plans.

on the right to prevent unauthorized importation of patented products. Patent protection was also extended to food and beverage products. Nevertheless, conversations with Indonesia-based legal practitioners suggest problems with enforcement of patent rights throughout this period.

In assigning a reform date, we have chosen 1991 since this was the year in which the most substantive change occurred. Surveys of foreign managers also indicate a date in the early 1990's; there was a widespread perception of substantial improvement in IPR protection prior to the 1997 amendment. Respondents to the World Economic Forum's survey, used in the *World Competitiveness Report*, raised their subjective ranking of IPR protection in Indonesia by nearly 30% between 1990 and 1995.

Japan (1987)

The patent reform process in Japan has been universally recognized by patent law practitioners as representing a fundamental change in the approach of that country to intellectual property rights over the last twenty years. This reform process occurred in several steps. While Japan adopted product patent protection for pharmaceutical products well before the beginning of our sample period, important limitations remained in the Japanese patent system. The first significant reform, analyzed in detail in Sakakibara and Branstetter (2001), took place in 1987. This reform replaced Japan's single-claim patent system with a multiple-claim patent system. This feature of the reform applied across all classes of inventions. The reforms also introduced a provision extending the duration of patent protection for pharmaceuticals whose approval was delayed by the regulatory authorities. Sakakibara and Branstetter show that intellectual property litigation trends and changes in the patent grant-to-application ratio suggest substantive changes in the use and enforcement of patent laws. Coincident with this reform of its patent statute, the Japanese government also took steps to improve the administration of the patent system and reduce the relatively long and variable lag in the processing of applications to the Japanese Patent Office. A second significant reform occurred in 1994, with the extension of patent length to twenty years from filing date and the replacement of Japan's pre-grant opposition system with a German style post-grant opposition system. A third significant legal reform occurred in 1998, with the formal adoption by the Japanese Supreme Court of the doctrine of equivalents. Maskus (2000) views the implementation of a post-grant opposition system as a significant change in Japanese patent law and practice. However, conversations with Japan-based patent attorneys suggest that the shift to a legal regime offering strong patent protections probably began with the reforms of 1987. Some exercise of judgment is clearly called for in dating a turning point for Japanese patent protection, but we have chosen to set it at 1987, focusing on the same reform considered by Sakakibara and Branstetter (2001).

Mexico (1991)

In 1991, the existing IPR regime was effectively abolished and a completely new legal system with a new administering institution was established. While the implicit goal of the previous IPR regime had been to limit the ability of patent holders to control access to their patented technology, the goal of the new regime was to ensure adequate protection to incumbent patent holders. Patent protection was expanded to cover pharmaceutical

and chemical products, which had been ineligible for patenting under the old regime. Previous regulations on technology licensing were abolished, allowing licensing terms to be determined at the discretion of the contracting parties. Legal tools were introduced to aid in the prosecution of patent infringement, including inspections of the facilities of potential infringers, the seizure of goods and closure of facilities involved in infringement, and the effective prohibition of parallel imports. Discussions with IP law practitioners and multinational managers confirm that the provisions of the new law were, generally speaking, effectively enforced.

Philippines (1997)

On paper, reforms in the Philippines appear similar in many ways to those in Turkey, described in further detail below. A new patent statute in 1997 extended patent protection to micro-organisms and microbiological processes. Patent scope was expanded by granting patent holders the unconditional right to block imports of their inventions and by relaxing earlier provisions on the registration of patent licensing agreements. The length of patent protection was increased from 17 years to 20 years, and a new entity was created to administer and help enforce the patent system. While acknowledging these improvements relative to past practice in the Philippines, foreigners suggested that the resource constraints of Filipino courts, including the 48 IPR courts designated to handle IPR disputes in an expedited fashion, placed constraints on the effectiveness of enforcement relative to other countries.

Portugal (1992)

The 1992 reform extended product patent protection to pharmaceutical products, although this change was implemented in the context of a national health insurance system that constrained pricing power of pharmaceutical manufacturers. The reform also increased patent length from 15 to 20 years from date of application across all classes of invention, and formally adopted the European Patent Convention (often referred to as the Munich Convention). This convention had a number of procedural, legal, and administrative requirements that entailed expansion of Portuguese patent scope and improvements in patent administration.

South Korea (1987)

Reforms were brought about with the passage of a considerably stronger law in 1986 that was implemented in 1987. These reforms extended product patent protection to medicines and agro-chemical products. The new statute also aimed to improve the resolution of patent disputes, with the explicit goal of improving the administration and enforcement of patent rights across all classes of inventions.¹⁵ An event study of the impact of reform on South Korea's patent infringing pharmaceutical manufactures suggests that the market anticipated effective implementation of this law, and the subsequent decline of these firms indicates that this expectation was largely met.¹⁶ A marked increase in IP litigation in South Korea after the reforms suggests that inventors sought to take advantage of their new rights. The reforms of 1987 were followed by

¹⁵ We are grateful to Professor Sung Jun Kang of Korea University in Seoul for his careful and clear explanation of the various steps of patent reform in postwar Korea.

¹⁶ See La Croix and Kawaura (1996).

further reform of the patent statute in 1990 that expanded the scope of intellectual property covered by a single patent grant by replacing South Korea's single-claim patent system with a multiple-claim patent system and allowed for patent protection for foods. This, in turn, was followed by a reform that extended patent protection for all classes of invention to 20 years from date of application. We follow the lead of Maskus (2000) in assigning the date of patent reform for South Korea as 1987, which coincides with the earlier legal change. Qian (2004) chooses 1986, the year of passage of the statute. This statute was formally enacted on December 31, 1986.

Spain (1986)

Integration with the EU (then known as the EC) required fundamental changes in 1986 in order to bring Spanish patent laws and administrative practices up to the level of other European countries. Among other mandated changes, this reform involved the introduction of patent protection for pharmaceutical, chemical, and food products, although complete implementation of these protections was delayed until 1992. The previous patent law also contained a number of provisions for the compulsory licensing of patented technology to Spanish firms if stringent working requirements were not met, and these provisions were relaxed under the new regime. Furthermore, the new law shifted the burden of proof in patent infringement cases from the patent holder to the alleged patent infringer.

Taiwan (1986)

In 1986, significant revisions to the patent statute of Taiwan were passed. These revisions extended patent protection to pharmaceutical and agro-chemical products. In addition to expanding the range of patentable inventions, the reform established a new specialized court for the resolution of patent disputes and strengthened the penalties for patent infringement. The reform also reversed the burden of proof in process patent infringement cases. Heretofore, it had been quite difficult for incumbent patent holders to prove infringement and thereby receive legal remedies. The new statute made this easier. These features of the new patent law applied to all classes of invention. Evidence of the new regime's effectiveness has been presented by Yang and Tsou (2004) and Lo (2005), who show that IPR-related lawsuits increased markedly after the new law was implemented.

The reforms of 1986 were followed by further reforms in the early 1990's. These reforms lengthened the term of patent protection from 15 to 20 years and also adopted international practices with regard to patent priority, making it easier for foreigners to obtain protection in Taiwan. Maskus (2000) identifies these later reforms as being the significant changes in the patent system. However, extensive conversations with Taiwan-based patent attorneys suggest that the key turning point in the postwar evolution of Taiwan's system was in 1986. The recent evidence of Yang and Tsou (2004) and Lo (2005) also indicates that this is the case.

Thailand (1992)

Thailand passed legislation, effective in September 1992, that extended patent protection to pharmaceutical products and agricultural machinery and increased the length of patent

protection to 20 years. Proponents of strong IPR did not think that this statute went far enough and within months pushed the Thai government to establish administrative measures designed to further strengthen protection for pharmaceuticals, narrow the scope of compulsory licensing provisions, and restrict the authority of the new Pharmaceutical Patent Board, an entity which could compel the disclosure of sensitive cost and pricing information. A specialized patent court for adjudicating intellectual property disputes was established soon after these reforms. Because the majority of these reforms were enacted in 1992, we set 1992 as the reform date.

Turkey (1995)

At least on paper, Turkish reforms were far-reaching. Prior to 1995, the Turkish patent regime was based on an Ottoman Empire-era law passed in 1879. This law, grounded in 19th century French patent law, was essentially a system of automatic registration that did not involve any significant examination of the substance of the patent application. Patent protection for pharmaceutical products or processes was specifically excluded, and Turkey was not a party to most of the international agreements and treaties regarding patents. The reforms of 1995 effectively replaced the old patent statute and system with a very different regime and created a new entity, the Turkish Patent Institute, to administer the law. The new statutes extended the term of patent protection for all classes of inventions from 15 to 20 years, allowed for process and product patents in pharmaceuticals, strengthened the penalties for patent infringement in all classes of invention, and ratified Turkey's accession to the major international patent conventions and treaties. Although Turkish patent law was changed in the mid-1990s, some reforms were phased in and full compliance with the law was not required until 1999. The incentives of multinational firms to transfer technology may have responded slowly to this reform as a consequence of its implementation plan.

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Table A-1 Patent Reforms, 1982-1999

Country	Source	Sufficient FDI Data	Remarks on Reform
Angola	G	No	
Argentina*	M	Yes	Issues regarding implementation
Austria	Q	No	
Bolivia	Q	No	
Brazil	M,Q,G	Yes	Significant
Canada	Q,G	Yes	Limited nature of reform
Chile	Q	Yes	Significant
China*	M,Q,G	Yes	Issues regarding implementation
Colombia	Q,G	Yes	Significant
Cyprus	G	No	
Denmark	Q	No	
Dominican Republic	G	No	
Ecuador	Q,G	No	
El Salvador	G	No	
Ethiopia	G	No	
Finland	Q,G	No	
Ghana	Q,G	No	
Greece	Q	No	
Grenada	G	No	
Guatemala	G	No	
Hungary	Q	No	
Iceland	Q	No	
India	M	Yes	Occurs in last sample year
Indonesia	M,Q,G	Yes	Significant
Japan	M,G	Yes	Significant
Jordan	G	No	
Korea	M,Q,G	Yes	Significant
Mali	G	No	
Mexico	M,Q,G	Yes	Significant
Nicaragua	G	No	
Norway	Q	No	
Paraguay	G	No	
Peru	Q,G	No	
Philippines	M,G	Yes	Significant
Portugal	Q	Yes	Significant
Romania	Q	No	
Singapore	G	Yes	Limited nature of reform
Spain	M,Q,G	Yes	Significant
Taiwan	M,Q,G	Yes	Significant
Thailand	M,Q,G	Yes	Significant
Turkey	M,Q,G	Yes	Significant
Venezuela	Q,G	Yes	Significant

Notes: This table provides the initial list of reforms considered, the sources that identify each reform, and whether there is sufficient data to include the reform in our sample. *Despite the presence of legal and institutional reforms in Argentina and China that are associated with an improved IPR environment in many countries, conversations with multinational managers suggest that the full impact of IPR reform has been undercut by countervailing features of the institutional environment in these countries. For details, please see the treatment of Argentina and China in section A.3. Our results are robust to the removal of these reform episodes from our sample.

Table A-2 Broad Attributes of Patent Reforms

Attributes of Reform	Expansion of eligible inventions	Expansion of patent scope	Expansion of patent length	Improvement in patent enforcement	Improvement in patent administration	Countervailing features of institutional environment
Argentina*	X	X				X
Brazil	X	X	X	X	X	
Chile	X		X	X	X	
China*	X	X	X	X		X
Colombia	X	X	X	X	X	
Indonesia	X	X	X	X	X	
Japan	X	X	X	X	X	
Mexico	X	X		X	X	
Philippines	X	X	X	X	X	
Portugal	X	X	X		X	
South Korea	X	X	X	X	X	
Spain	X	X		X	X	
Taiwan	X		X	X	X	
Thailand	X	X	X	X		
Turkey	X		X	X	X	
Venezuela	X	X	X		X	

Notes: This table indicates whether or not reforms in each country we consider include each of the five broad attributes described in the text. *Despite the presence of legal and institutional reforms in Argentina and China that are associated with an improved IPR environment in many countries, conversations with multinational managers suggest that the full impact of IPR reform has been undercut by countervailing features of the institutional environment in these countries. For details, please see the treatment of Argentina and China in section A.3. Our results are robust to the removal of these reform episodes from our sample.