The Friendship Commission Public Policy Series

Presents

How Japan's Patent System Encourages Incremental Innovation

Lessons from Japan for U.S. Patent Reform: Policy Implications of a Pre-Grant Disclosure System

A Japan Information Access Project Working Paper

by

Dr. Keith Maskus and Ms. Christine McDaniel
Department of Economics
University of Colorado at Boulder

Presented for Discussion at
The Friendship Commission Public Policy Series

Session IV
Technology Policy and Antitrust

April 13, 1999 (Revised 6/1/99)
Japan Information Access Project
Washington, DC

Session IV: Lessons from Japan for U.S. Patent Reform: Policy Implications of A Pre-Grant Disclosure System continues the Friendship Commission Public Policy Series. The Series, a collaborative initiative of the Japan-U.S. Friendship Commission and the Japan Information Access Project, will present future sessions on various security, technology, economic, and social issues. For more information, contact the Japan Information Access Project.

About the Series

The Friendship Commission Public Policy Series provides a forum for research and discussion among leading American scholars, policymakers, and business leaders. The Series' mission is to engage a dialogue among scholars, policy professionals, and citizens on critical issues between the United States and Japan. The goal is to apply policy-relevant discourse to academic research in order to foster an enlightened perspective on global issues and their domestic impact.

About the Sponsors

The Japan-U.S. Friendship Commission is an independent Federal agency dedicated to promoting mutual understanding and cooperation between the United States and Japan through: the issuing of grant programs in Japanese studies in the U.S.; policy-oriented research; public affairs and education; the study of the United States, and the arts. The U.S. Congress established the Commission in 1975. See: http://www2.dgsys.com/~jusfc/commissn/commissn.html.

The Japan Information Access Project, founded in 1991, is a trusted member of the U.S. policy community interested in Japan and Asia. The Project is a nonprofit research center strengthening international understanding of Japanese and Northeast Asian science, technology, finance, security and public policy. Through a range of programs and publications, the Project educates its members and the public to use knowledge of Japan and Asia to increase national strategic competitiveness and security.

Disclaimer. This report does not imply any endorsement by the Japan-U.S. Friendship Commission, Japan Information Access Project, nor the University of Colorado at Boulder.

About the Authors

Christine McDaniel is a research associate at the University of Colorado at Boulder. Her dissertation is entitled *Legal and Institutional Features of Patent Systems and Impacts on Diffusion and Innovation: Evidence from Japanese and U.S. Aggregate and Industry Data.* Her adviser is **Professor Keith E. Maskus**. Dr. Maskus is a Professor of Economics at the University of Colorado, a research fellow at the Institute for International Economics (IIE), and associate editor of *Review of International Economics*. In the fall, Ms. McDaniel will join the U.S. International Trade Commission (USITC) as an International Economist. She has worked on a variety of empirical trade and applied microeconomics projects at the USITC, Overseas Development Council, and the Long Term Credit Bank of Japan. She holds a BS in Economics and a BA in Japanese Studies from the University of Illinois, Urbana-Champaign.

For More Information

Japan Information Access Project
2000 P Street, NW, Suite 620, Washington, DC 20036
(202) 822-6040/fax (202) 822-6044
E-mail: access@nmjc.org
Website: http://www.nmjc.org/jiap

Additional copies of this report can be ordered for US$10 plus $2 shipping and handling (DC residents must add 5.75% sales tax). Please send all orders, prepaid to the address above.

Lessons from Japan for U.S. Patent Reform: Policy Implications of a Pre-Grant Disclosure System

April 13, 1999 (Revised June 1, 1999)
Japan Information Access Project

Working Paper Table of Contents

This Working Paper has been posted on the Japan Information Access Project's website at
http://www.nmjc.org/jiap

I. *Executive Summary*

As the United States considers patent reform legislation, much of the debate over one aspect of that reform–adopting a pre-grant disclosure rule in place of the current post-grant disclosure–centers on the legal benefits of such a system. Further analysis of the economic benefits between the two patent regimes provides another framework for understanding which regime best fosters innovation. Such an analysis is presented in this Working Paper's empirical examination of the postwar Japanese patent system alongside that country's productivity between 1960 and the early 1990s.

During this period, while Japan excelled at manufacturing process technologies, it was clearly at a deficit compared with the level of original scientific research in the industrialized West. The study featured in this Working Paper provides empirical analysis that shows how effectively Japanese patent policies of that time promoted technology diffusion and encouraged "follow on," or incremental innovation over fundamental, or original innovation.

The result was a patent system well suited to help Japan close its technology deficit, but not, as this Working Paper suggests, appropriate nor advisable for an advanced technology country. The significance of these findings to the U.S. pre-grant disclosure debate becomes more compelling when examining a patent system's inherent dichotomy and how it can be manipulated.

Patent systems serve two conflicting purposes: to encourage inventive activity by providing exclusive rights to inventors, *and* to facilitate assimilation of new technologies into the broader economy through disclosure and licensing rules. As a result, patent systems can be devised to favor one purpose over the other, as demonstrated in postwar Japan's successful technology "catch up" efforts.

Within any system of mutually exclusive objectives, a balance must be achieved. To the extent a patent system diffuses knowledge and generates useful adaptive inventions, it contributes positively to growth. To the degree it safeguards exclusive technologies, it can compromise positive growth (from incentives for invention) with negative growth (due to limited access to information). This trade-off can influence a country's industrial growth and economic development. Until the findings presented in this Working Paper, this trade-off and its impact on Japan's productivity had not been studied empirically.

The study's empirical analysis shows that the postwar Japanese patent system favored technology diffusion and incremental innovation. The system's allowance of numerous narrow claim filings, many of which were never patented, fostered something like a secondary innovation that simply built on fundamental technologies. This was done to promote technological "catch-up" and diffusion through incremental innovation.

As a result, for more than 30 years applications for utility models (incremental inventions based on fundamental technical knowledge from a patent application and quickly applied in commercial use) built heavily on past domestic and foreign patent applications. Thus, narrow claim requirements and pre-grant disclosure were effective in promoting technological diffusion and had a positive impact on technical progress, as the study found in aggregate data and in industries including chemicals, machinery, and physics.

The study's findings suggest that together, Japan's early disclosure and narrow claim requirements increased technology diffusion and contributed to technological "catch up" with the West. At the same time, the study concludes that by using pre-grant disclosure to promote imitative forms of R&D, a patent system can actually inhibit incentives for fundamental invention. Based on these findings, adoption of a pre-grant disclosure rule for technology leaders such as the United States appears inappropriate and inadvisable without safeguard mechanisms to ensure against imitation without proper compensation to patentee.

This Working Paper presents the methodology, measurements, and empirical findings that support the following recommendations for consideration with respect to U.S. patent reform:

- *It is not advisable for the United States to adopt a pre-grant disclosure requirement without adequate mechanisms to ensure against imitation and guarantees for proper compensation for patentees*
- *The United States should recognize the growth advantages of "follower strategies"*

Additionally, the study's examination of competitive elements in Japan's patent system found that since undergoing sweeping reform in 1995, the system has continued to evolve in tandem with the country's competitive circumstances. So as Japan has developed fundamental and globally competitive technologies, it has tightened pre-grant publication rules and reduced utility model application filings. The study suggests it is likely Japan will use its patent system to protect original technologies in the future, rather than encourage information sharing.

Indeed, as the Japanese patent system becomes more rigorous and filings more substantive, innovation becomes more vulnerable to anti-competitive abuses by rights owners. Thus, a reconsideration of competition rules and enforcement in the IPR arena is advisable for Japan, as this process bears potential for making competition policy an exclusionary device facing foreign enterprises. Based on these findings, this Working Paper supports the following recommendations for consideration:

- *The United States should monitor emerging patent and competition regimes in Japan and elsewhere*
- *The United States should contribute to shaping potential WTO competition agreements to favor international cooperation*

This Working Paper includes research on the Japanese patent system and productivity growth, and insight on how that research can shed light on the U.S. patent reform debate.

II. *Background*

The Japanese Patent System, Pre-1995

In 1993, Japan signed a number of international and bilateral agreements that significantly revised the Japanese patent system (JPS).[1] The agreements were designed to encourage Japan to conform to modern patent practices and standards. Although many features of the Japanese system resembled the European system, its implementation had differed greatly. The differences were reflected in longer patent pendency and a disproportionately greater number of patent applications in Japan.

Beginning in 1995, these agreements began to be implemented. Prior to these changes, the JPS supported a number of unique features that specifically encouraged technology diffusion and sharing. The data analyzed for this Working Paper are taken from statistics generated before these important legal and procedural changes. Both anecdotal and now empirical analyses show that the pre-1995 JPS clearly promoted diffusion and incremental innovation.

Subject Matter and Claims

Until 1988, the Japan Patent Office (JPO) required patent applications to cover only a single invention claim.[2] There is no such requirement in the United States, where claims must be novel and non-obvious. Although single claims are no longer a legal requirement, Japanese patent officers and firms still seem to favor narrowly defined applications.[3]

Japan has an extensive system of utility models, which are incremental inventions of a small and applied nature that build on prior fundamental technical knowledge and are quickly embodied in commercial uses. There is no direct counterpart to utility model protection in the United States. In the United States, industrial designs correspond more closely to design patents, which protect the appearance of a product rather than its functional aspects. The functional aspects of a product or invention are the exclusive realms of the patent. The primary difference from protection in the United States is that utility models and industrial designs in most foreign countries need only be novel, whereas in the United States, industrial designs must be novel and non-obvious.

These features of the JPS have generated large numbers of patent and utility model applications and have limited the scope of protection for any particular patent. The Japanese file five times as many patent and utility model applications with the JPO as Americans file with the U.S. Patent and Trademark Office (USPTO), and nine times as many as Europeans file with the European Patent Office (EPO). Having low novelty standards and recognizing only narrow claims encourages small and incremental inventions while limiting incentives for R&D into fundamental technologies.

In this context, an important feature of the Japanese patent system (JPS) was its reliance on utility models and industrial designs. The required level of inventiveness of a utility model

[1] "Mutual Understanding on Intellectual Property Rights between the Japanese Patent Office and the U.S. Patent and Trademark Office" (entered into force on January 20, 1994, and commonly referred to as the "Framework Agreement").

[2] In 1987, Japan's industrial property law was amended to eliminate the "single claim requirement" on patent and utility model applications. The former law encouraged several narrow applications, often centered on one novel invention. As shown below, this revision contributed to the decline in utility model applications.

[3] Aoki, 1997; Kotabe, 1992; USTR, 1997.

and the scope and duration of protection have been less than those for a standard patent in Japan.[4] Further, industrial designs only needed to demonstrate novelty and not inventiveness in Japan to earn patent protection. This system has essentially allowed firms in Japan to receive utility model protection and design patents on technologies that were only slightly modified from the original invention.[5]

The single-claim requirement has allowed firms in Japan to invent around original patent applications more easily by virtue of limiting the extent of what might be infringed by followers. In addition, this requirement has provided an incentive for "cluster filing" patent applications. This procedure involves filing myriad accompanying applications along with every principal application. Thus, it prohibits competitors from obtaining similar patents, and forces cross-licensing.[6] The single-claim requirement coupled with cluster filing has enabled firms in Japan to "box in" the original inventions embodied in existing applications, effectively forcing the original applicant to cross-license its technology to those firms filing opposition claims. The opposing firms were often the same firms that filed applications on technologies invented around the original claim.[7]

First-to-File

In granting patents, Japan, as well as nearly all other countries except the United States, follows a first-to-file rule. This rule eliminates many lawsuits regarding the identity of the original inventor and induces rapid disclosure as firms are forced to file sooner than they might otherwise elect under the alternative priority rule.[8] However, numerous opportunities for conflict exist under the first-to-file procedure and, as a result, firms often resort to licensing.

Firms are under pressure in Japan to file as early as possible. This heightens the possibility of similarity among patent claims and induces firms to issue licenses to settle differences in these claims.[9] In addition, if two or more applications relating to the same invention are filed on the same date, applicants are required to reach an agreement among themselves as to who will obtain the patent or else none would receive it.[10]

This aspect of Japan's patent policy illustrates how the JPS encourages voluntary agreements and discourages confrontation. It is claimed that the first-to-file rule has served well those Japanese firms that can patent around original inventions and have large patent staffs to get through the system more quickly. Accordingly, it has poorly served original inventors and small firms.[11]

---

[4] Boulware et al, 1994.

[5] The 1994 amendments to Japan's industrial property laws streamlined the utility model application process by effectively eliminating the examination, thereby ending the need for publication of the application and opposition procedures, and shortening the length of protection from fifteen years to six years from the application filing date (Aoki, 1997). The reduced term of protection coupled with increased registration and maintenance fees have reduced the expected value of a utility model, causing applications to decline in favor of patents.

[6] Doane, 1994.

[7] Ordover, 1991.

[8] *Ibid*.

[9] Wineberg, 1988.

[10] Article 39, Section 2, Japan Patent Law.

[11] Wineberg, 1988.

Pre-grant Disclosure, Pre-Grant Opposition, and the Pendency Period

Patent systems require disclosure of patentable technologies through public media. The sooner the disclosure (particularly if it occurs prior to patent grants) and the more detailed the technical specifications, the easier it becomes for rival firms to learn technologies and develop patentable improvements. In this way, liberal disclosure rules promote technology diffusion. Moreover, narrow patent claims and rapid disclosure requirements encourage filing of large numbers of applications for slightly differentiated technologies or products, resulting in substantial cross-licensing among industry groups and rival firms, providing yet another avenue for rapid and widespread diffusion.

Western patent attorneys regard a patent as a contract between the inventor and the patent office (a governmental body). Inventors disclose their technologies to the public, and in exchange receive so many years of exclusivity. In the United States, disclosure occurs only *after* protection is granted. In Japan, there is no such contract or understanding, only disclosure without any guaranteed protection until the patent is granted.

Exposure of the patent application to public inspection before it is granted allows firms to make investment decisions with less uncertainty while preventing duplication of investments in particular R&D projects. Inventions that become public knowledge sooner are quickly diffused into the research and scientific community in Japan.

Before 1995 in Japan, competitors were allowed to not only inspect, but also to oppose the application (the U.S. system does not have a pre-grant opposition rule). While the patent was under review, the JPO permitted patent applications for improvements on this potentially patentable invention. During the review period, there was no requirement for original inventorship. Thus, the pre-grant disclosure and opposition period permitted Japanese firms (and those that tracked Japanese pre-grant filings) to extract technological knowledge from patent applications and file follow-on utility model and industrial design applications.

Under Japanese patent law, third parties could oppose a patent application during the disclosure period on the basis of novelty requirements, non-obviousness, and industrial applicability. The original applicant had only a few months to provide an adequate response or the application was rejected. The pre-grant opposition procedure has been termed a "loophole" in the JPS, which was often specifically directed toward foreign patents covering critical technologies.[12] These opposition proceedings were costly for the original applicant, opened the pending patent to further technology discovery, and lengthened dramatically the pendency period. All of these factors potentially decreased the value of patents ultimately awarded. Large Japanese firms maintained sizeable patent staffs that specialized in pre-grant oppositions, which gave these firms a significant advantage in subsequent licensing agreements.[13]

Patent Term Limits

Before 1995, the duration of a patent in Japan was the shorter of 15 years from the date of publication for opposition or 20 years from the filing date. The average lag between the date an application was filed and a patent was issued was one to three years for a Japanese firm while it was seven to eight years for a foreign firm. Given the long pendency periods and examination delays combined with the term of protection beginning with the date of filing,

[12] See U.S. Senate Subcommittee Hearing on Foreign Commerce and Tourism, June 10, 1988.
[13] Lindgren and Yudell, 1994.

the average term of protection was relatively short under the Japanese patent system. Linking the length of the patent to the filing date effectively allowed the JPO, as well as rival firms, to dictate the length of protection through delaying the examination process.

Royalties and Licensing

Under Japanese patent law, during the early disclosure period competitors could use inventions in patent applications without paying royalties until the patent was issued. Given that rivals could file utility model applications around the original invention during this period, Japanese firms were able to earn patents on small additions to fundamental technologies.

The system could yield situations where the original inventors reaped little reward for their novel inventions. For example, a Japanese firm might slightly modify an original invention during the early disclosure period and receive a utility model or industrial design patent while paying no royalty fees to the original inventor. In addition, if a rival filed an industrial application for an invention based on a patent application that was under disclosure, the rival was later subject to lesser royalty fees if the original invention received a patent.[14] In this way, the JPS rewarded firms that reverse engineered and modified inventions while penalizing original inventors.

Translation

Until 1993, the Japanese Patent Office (JPO) required all patent applications to be filed in Japanese, and the JPO did not allow applicants to go back and correct any translation errors. According to one U.S. patent attorney in an interview, this language requirement not only increased costs to foreign applicants, but also often forced them into filing narrow scope claims, thereby reducing the breadth of the patent.

III. *Data Patterns of Japanese Patenting and Technology Use*

Empirical Analysis

In reviewing official Japanese data from 1960 to 1993, it is clear that the number of Japanese domestic patent and utility model applications far exceeded the number of foreign applications (See Figure 1). This is unusually high in an international context. For example, in 1992 the share of resident applications (the ratio of resident applications to total applications) in Japan was 94 percent. In the United States the resident share was 53 percent, in the United Kingdom 71 percent, in South Korea 58 percent, in France 78 percent, and in Germany 82 percent. During this 33-year period, the percentage of domestic applications in total applications in Japan rose from around 75 percent to 92 percent. This reflects a rising relative use of the JPS by domestic firms.

Foreign patent applications in Japan rose sharply in the 1960s to a peak of nearly 30,000 in 1970 before leveling off at around 25,000 per year. In contrast, domestic patent applications rose sharply until 1987, when they leveled off above 300,000. This reduction in the growth of patenting partially reflects the elimination of the single-claim requirement in 1987.[15]

[14] Ordover (1991). See also Curci and Takura (1995), Helfgott (1990), Kintner and Lahr (1982).
[15] It is also consistent with a general slowdown in patenting in OECD countries (Evenson, 1984).

However, as noted above, there still seems to be a tradition to have fewer claims in a single patent. Thus, a single technology continues to correspond to more patents in Japan.

The number of domestic applications for utility models tripled between 1960 and 1987 before falling sharply. This is presumably because the elimination of the single-claim requirement in patents reduced the relative attractiveness of utility models. Foreign applications reached a high of around 2,400 in 1970 before declining to current levels below 1,000 per year. Domestic applications are about 98 percent of total applications for utility models.

Despite the high ratio of domestic-to-foreign applications for patents and utility models, Japan has been a significant net absorber of foreign technologies. As shown in Figure 2, the ratio of payments to receipts of royalties and license fees in Japan's "technology balance of payments" exceeded 4.0 in 1973. This ratio, however, declined to near-balance by 1993, indicating Japan's rising relative position as a technology supplier.

Figure 3 plots the ratio of aggregate patent applications to aggregate utility model applications, comparing domestic activity with foreign activity in Japan. Figure 4 plots this ratio by industry from 1962 to 1993. The ratio is suggestive of relative technology content in application types because patent applications embody more novel inventions than utility models. The latter are modifications or incremental innovations based on existing inventions.

In the aggregate data, the foreign ratio exceeds the domestic ratio by a factor of 14. The foreign ratio exceeds the domestic ratio by roughly 17 times for agriculture, food, and drink; chemistry and metallurgy; mechanical engineering and machinery; and transportation and construction. The foreign ratio is larger by roughly eight times for electricity, physics, electronics, and measurement.

These ratios show that the relative technology content of foreign applications was much higher than that of domestic applications, illustrating Japan's state of catching-up during most of the postwar period. It is interesting to note that domestic utility model applications were on average 95 times higher than foreign utility model applications. This suggests that foreign applicants perceived a low expected return to utility model grant and thus were less likely to apply.

IV. *Empirical Evidence of Technology Diffusion*

The Impact of Pre-Grant Disclosure and Narrow Claim Requirement

There have been many descriptive studies on the diffusion-promoting features of the JPS.[16] *This Working Paper is the first effort to provide empirical evidence of how Japan's early disclosure rules and extensive system of utility models from 1960 through 1993 led to incremental innovations and possibly to imitative technology strategies.*[17] Standard economic analysis suggests important insights into Japanese patenting behavior.

A measure of a country's economic performance that captures two important aspects of productivity growth—allocating accumulated resources to high-productivity activities and adopting and mastering catch-up technologies—is total factor productivity (TFP) change.

[16] Ordover (1991), Wineberg (1988), Takenaka (1992), and Rosen and Usui (1994).
[17] See Maskus and McDaniel (1999) for further analysis.

The standard definition of TFP change is the annual variation in the aggregate output not explained by input changes. Thus, an analysis of the effect of patent activity on TFP change is instructive in understanding the effect of the JPS on Japan's catching-up phase. (See Appendix for details on how the TFP index is constructed).

An analysis of the patent data supports the notion that the weak novelty requirements for utility models coupled with the pre-grant disclosure rule allowed firms in Japan to file follow-on utility applications based on technology learned from invention patent applications published prior to the grant date. Learning through modification of technologies in patent applications resulted from both domestic and foreign inventiveness, though the impact from domestic patent applications far outweighed that of foreign applications. Such incremental innovation at the purely domestic level occurred in most industries, while follow-on invention based on foreign patent applications was most detectable in the chemistry and physics industries.

Also, there is a clear, statistically significant correlation between the number of utility model applications that were invented around published patent applications and productivity growth in Japan. No such correlation exists in data from the United States, where there is no early disclosure or other explicit diffusion-promoting mechanisms.

The conclusion to be drawn from this data analysis is that the Japanese patent system effectively encouraged incremental innovation in Japan as a technology diffusion mechanism. The emphasis on encouraging follow-on innovations through the patent system was one important component of postwar Japanese technology policy.

The features of this technology-diffusion-through-patent policy are:

1. The Japanese patent system encouraged filing of utility models covering follow-on developments that were invented around published patent applications.

The weaker novelty requirement of utility models (relative to patents) coupled with the early disclosure rule allowed firms to follow a technology strategy that encouraged filing of follow-on utility model applications. These applications were based on technologies learned from patent applications published prior to their grant date. It was common for Japanese firms to file utility model applications that were slightly altered versions of existing patent applications, perhaps modified to their own manufacturing processes.

At the aggregate level, learning through modification of technologies in patent applications occurred in both Japanese and foreign patents (see Table 1). At the industry level, analysis reveals that such imitation from foreign patent applications to domestic utility model applications occurred most prominently in the chemical industry as well as in physics and telecommunications (see Table 2). The chemical industry finding corroborates observations by industry representatives interviewed for this study, who claimed that the biotechnology industry was hard-hit by the early disclosure rule in Japan. One biotechnology industry representative reported that imitation was rampant in this industry from the 1960s through the late-1980s.[18] The nature of biotechnology lends itself to imitation, since it is easy to change the amino acid sequence, only a bit, and claim a separate patent.

Data show that the electric power, transportation, and construction industries were affected in an earlier period (1962-76). The construction, electricity, and daily-necessities industries (e.g., fish, food, and drink) were affected in the later period (1977-93). Thus, for these

[18] Personal interview, February 10, 1999 with biotechnology industry representative.

industries, technology diffusion in Japan, as promoted by the legal features of the patent system, flowed from foreign patent applications to domestic follow-on utility model applications. At purely the domestic level, there is evidence of this imitation from patent applications to follow-on utility models in almost all industries (See Table 3).

2. Japan's early disclosure rule enabled technology spillovers.

Japan's pre-grant publication of patent and utility model applications also enabled technology spillovers. Overall, the data indicate that applications for patent protection raised productivity growth. Table 4.1 shows that the data support the hypothesis that patent and utility model applications contributed positively to TFP growth in Japan although only the effect of utility applications was statistically significant, while patent applications had no effect on TFP growth in the United States. These findings support the observation that utility model applications in Japan directly raised productivity growth and that there was an important indirect impact of patent applications by stimulating utility model applications.

The finding that application for protection contributed positively to technical change in Japan but not in the United States supports the notion that Japan's pre-grant disclosure rule served as a mechanism for technology diffusion. That is, the laying open of patent and utility model applications in Japan enabled technology spillovers. Thus, patent applications bore information about novel inventions while follow-on utility model applications were likely to get through the JPO and into the manufacturing process more quickly.

3. Patent grants bore no statistical significance to total factor productivity growth in either country.

Once protected through a patent grant, the use of a technology becomes more insulated. It is reasonable to assume that a patent serves to inhibit technology diffusion. Overall, however, the data show no significant exclusionary impacts of patent grants alone in either Japan or the United States. As shown in Table 4.2, the effects of both patent grants and utility model grants on TFP growth in Japan were negative. The effect with the U.S. data was also negative but to a lesser magnitude. However, there was no statistically significant effect in either country.

In Japan's case, this is most likely because any exclusionary effect of patents was dominated by the diffusion effect of early disclosure. That is, once the patent is granted, the technology had already been disseminated throughout the economy. Thus, the diffusion effect of the patent system may have outweighed any exclusionary effect of the actual granting of patents. In the U.S. case, it appears that patent grants do not have a sufficiently exclusionary effect on productivity.

The strong licensing incentives of the JPS may also have contributed to the diffusion effect, particularly after the patent grant date. That is, once a patent was granted, the grantee encountered the strong licensing incentives of the JPS and chose to license the technology to rival firms. Because licensing promotes diffusion while maintaining incentives to engage in R&D, licensing may have been a significant channel of technology transfer among Japanese firms, thereby lessening the exclusionary effects of patent grants.

V. *Japan's Changing Technology Status*

From Information Sharing to Innovation

The postwar JPS focused as it was on encouraging incremental innovation and information diffusion, played a positive part in promoting technical change in the economy. It is reasonable to suggest that the system was dynamically pro-competitive in the limited sense analyzed here. It is impossible, however, to claim from these results that overall competition was enhanced. Such a study would require extensive consideration of industrial policies, market structure, and forms of commercial entry and exit that go beyond the scope of this project.

It is also not possible to claim further that the Japanese economy was made better off or worse off as a result of these characteristics of the JPS. The thesis is only that certain features of the JPS were important in fostering technology dissemination into the Japanese economy. This policy stance seems reasonable for a nation in a technology-follower position, as Japan was for much of the period under consideration.

Japan's technology dynamism has changed, and indicators suggest Japan's technological development is becoming more focused on pursuing fundamental innovations and less on encouraging follow-on technologies. As mentioned above, Figure 2 plots the ratio of payments to receipts of royalties and license fees in Japan and the United States. This ratio, referred to as a "technology balance of payments," suggests that Japan was a significant net absorber of foreign technologies until around 1993, when this ratio declined to a near-balance, indicating Japan's rising relative position as a technology supplier.

Figure 5 plots Japan's share of patent applications in the United States over the period 1965 to 1995. This share rose from 2.4 percent to 20 percent over this period. Recently, approximately 20 percent of all applications in the United States have come from Japan. Finally, Figure 6 plots the ratio of private research and development to gross domestic product for Japan and the United States over 1970 to 1993. The difference between the two countries' ratios steadily decreased over this period. These statistics suggest that Japanese firms are becoming more active in the patenting arena, as well as increasing their R&D efforts, both indicative of their advancing technological development.

As these figures demonstrate, the structure of Japan's technology progress has changed. Japan now focuses more resources on the development of fundamental technologies that can achieve global patents that may be licensed internationally. In this context, it becomes doubtful that a continued emphasis of the patent system on providing easy access to new information and encouraging small innovations that build on the inventions of prior firms makes sense. Japan almost surely has negotiated the transition from follower to competitive leader, at least in terms of major industrial sectors. In turn a system that is more protective of basic invention commands wider interest among Japanese firms, consonant with foreign firms looking to patent there.

VI. *Intellectual Property Rights, Competition Policy, and the Reform of the Japan Patent System*

JPS Evolution Toward Entrepreneurial Innovation

As Japan emerges as a technology leader, it likely will shift even more toward a patent regime that tilts the balance in favor of invention over diffusion. Recent press releases from the Japanese government indicate that Japan is indeed now trying to promote innovative and entrepreneurial economic activity. Thus, it can be assumed that the Japanese Patent Office is exploring ways to "modernize" its practices, as discussed below.

Strong intellectual property rights (IPR) can play an important role in pursuing a dynamically pro-competitive economy. By defining the terms or boundaries of property within which exclusive use pertains, IPR protect incentives to improve product quality and technological processes. Clear and transparent access to IPR also provides adequate returns to invention and also encourages new entry and technology adaptation.

However, protective systems also embody risks that patent owners (foreign or domestic) will act in an anti-competitive manner using the market power embodied in stronger intellectual property rights. For this reason, mature intellectual property systems permit recourse to competition policies to promote competition even as they encourage greater invention.[19] In the IPR arena, competition policy essentially empowers antitrust authorities, such as the Japan Fair Trade Commission (JFTC), and courts to ensure that the exclusive limits of patent grants are not exceeded by rights owners.

In the United States, technology licensing agreements are subject to review for anti-competitive impacts under a broad rule-of-reason doctrine, as evidenced by the recent Intel case. Vertical distribution arrangements are generally considered permissible attempts to enhance exploitation of a patent or trademark, but horizontal distribution or licensing agreements may come under stronger scrutiny for their potential "cartelization" effects. Many countries reserve the rights to issue non-exclusive compulsory licenses to counteract the perceived abuses of intellectual property rights. Numerous other forms of competition mechanisms arise regarding IPR as well.

Although Japan already has an extensive legal system of competition policies in place, it has been criticized for a lack of effective enforcement efforts. Thus, Japan may take the opportunity implicit in strengthening its patent system to consider further the linkages between patents and competition rules. These changes cannot be separated conceptually because IPR and competition policies are two sides of the same policy goal, which is to enhance dynamic competition.

In this context, following recommendations are suggested for the JPS.

1. Japan Should Widen the Scope of Patent Protection.

Raising novelty standards and encouraging patent officers to recognize broader claims will discourage incremental inventions and promote more fundamental inventions, which suit Japan's innovation agenda. This, in turn, will provide stronger incentives for R&D on fundamental technologies. Pre-grant disclosure, the narrow scope and low novelty standards

[19] Maskus (1998) and UNCTAD (1996).

still found in the JPS allow firms in Japan to "invent around" a patented invention. Encouraging wider scope claims would also inhibit "cluster filing" of patent applications and the subsequent private coercion of cross licensing. These changes should widen the scope of protection for inventions and increase the flexibility of firms to choose both circumstances under which to license their technologies and their licensing partners.

2. Japan Should Decrease Costs of Securing and Maintaining Patents.

Almost all interviewees said that the two biggest problems with the JPS—pre-grant opposition and required submission in Japanese—were addressed reasonably in the 1993 U.S.-Japan IPR Framework Agreement. However, according to one patent attorney, it remains problematic and costly for firms to file in Japan.[20] For example, there are extra costs to request a speedy examination process. For an extra fee, applicants can file the English application first, though within three months they must file the Japanese translation. This essentially allows the applicant to buy more time to make translation changes, which is an improvement over the prior system. In this way, the applicant can go back and demonstrate that there were translation errors, if any. However, the additional costs are considered burdensome. More broadly, delays in the examination process and in court procedures could be reduced.

3. Japan Should Improve Judicial Enforcement.

The Japanese court system has been ineffective at promoting litigation as a way to receive compensation for economic damages.[21] The courts can be instrumental in insuring such compensation by recognizing the economic damages caused by patent infringement. As stated in a JPO press release, due to low levels of compensation awards in Japan, it remains worthwhile to infringe patents. Expansion of relief measures would help to deter potential infringers.[22] This situation will become more important as the scope of protection broadens, implying that infringement (as opposed to legal imitation) would rise at unchanged levels of penalties.

Expecting Japanese courts to move toward a more effective system of litigation and enforcement is a more realistic proposal today than it was 20 years ago. An interview with a patent attorney who often deals with Japan acknowledged that Japan still is not a litigious society, partly for cultural reasons. Nevertheless, a handful of Japanese firms on the forefront of technology realize that it is in their interest aggressively to protect their technology.

Accordingly, these firms have chosen to use U.S. courts, seen as more efficient and punitive than Japanese courts. For example, in an effort to defend its patents on single-use cameras, Fuji Photo File Co., Ltd. recently asked the U.S. International Trade Commission (USITC) to issue a general exclusion order against imports of infringing cameras produced or marketed by 28 companies, some of which were Japanese firms.[23] Last year, Mitsubishi Chemical Corporation brought a patent infringement case to the USITC against 12 companies regarding use of its patented organic photoconductor drums. Four of the responding firms are Japan-based.[24] To some extent, private use of U.S. courts by Japanese firms to protect their

[20] Personal interview with patent attorney for multinational chemical firm, February 16, 1999.
[21] Dinwiddie, 1995. Effective January 1, 1999, Japan has changed its statute on patent damages in ways that move it closer to U.S. law on reasonable royalties and lost profits, see Gould and Sato (1999).
[22] *Ibid.*
[23] U.S. ITC Investigation #337-TA-406. (Case pending as of 5-30-99).
[24] U.S. ITC Investigation #337-TA-411. (Case pending as of 5-30-99).

American rights against Japanese rivals should deter infringement by changing competitive realities. It may also have a demonstration effect within the Japanese judicial system that would expand effectiveness of those courts. However, the American courts cannot be relied on to ensure adoption of adequate protection mechanisms within Japan.

4. Japan Should Improve Its Test-Data Protection.

A special issue arises in the pharmaceutical industry. One American industry representative claimed that Japan's weak system for test-data protection diminishes incentives for development of patentable formulations on the part of Japanese pharmaceutical firms.[25] Although pre-grant opposition and translation issues were addressed in the 1993 Agreement, other mechanisms are being used to encourage diffusion and imitation in this industry, including lack of data protection, a long approval and regulation process, and regulated prices for innovative drugs. It could be argued that Japan's pharmaceutical industry is in the catching up phase, suggesting that its firms may benefit from the system. Over the long term, however, such weak protection mechanisms will act as a drag both on domestic pharmaceutical R&D in Japan and on foreign marketing of new pharmaceutical products there.

The Ministry of Health (MOH), Japan's counterpart to the U.S. FDA, must approve all drugs before they go to market. Patent protection and MOH approval are necessary steps a firm takes prior to taking its drug to market. But in order to file with MOH, the firm's complete dossier is laid open to MOH and published in the official gazette. Because there is no data protection in Japan, a rival firm can begin developing a bio-equivalent drug immediately. The publication of the dossier before the drug is approved and lack of data protection likely promotes diffusion and imitation in the Japanese pharmaceutical industry. The Pharmaceutical Research and Manufacturers' Association (PhrMA) maintains that this lack of data protection violates the TRIPs Agreement, Article 39.3, which is a reasonable interpretation.[26] Finally, low prices for new drugs in Japan illustrate the lack of appropriate and adequate reward for innovation in this industry.

5. Japan Should Maintain Open and Transparent Competition Rules in IPR.

As discussed above, a stronger patent system calls for consideration of competition maintenance in the event of anti-competitive licensing and distribution practices. This is consistent with foreign pressure on Japanese authorities generally to promote competitive opportunities for international enterprises within Japan. In doing so, however, Japan should ensure that any competition mechanisms and their enforcement are not structured in a way that excludes foreign enterprises from effective access to the improved patent system. It is not a prediction of this paper that Japan intends to use its competition system to offset any relative advantages that foreign firms could enjoy from a more protective patent regime. The claim here is simply that it would be a mistake for Japan to erect competition rules that could disadvantage such firms in their acquisition and fair exploitation of patent rights.

---

[25] Personal interview with pharmaceutical industry representative, February 10, 1999.

[26] Article 39.3 of the TRIPS Agreement reads, "Members, when requiring, as a condition of approving the marketing of pharmaceutical or of agricultural chemical products which utilize new chemical entities, the submission of undisclosed test or other data, the origination of which involves a considerable effort, shall protect such data against unfair commercial use. In addition, Members shall protect such data against disclosure, except where necessary to protect the public, or unless steps are taken to ensure that the data are protected against unfair commercial use."

VII. *U.S. Policy Recommendations*

1. Insight for U.S. Patent Reform

The post-war economic systems of the Japan and the United States were so different it would be highly questionable to conclude that the features of the JPS emphasized here would have operated similarly in the U.S. Rather, the objective has been to assess the growth impacts of one system that was designed to promote technology catch-up. The broad conclusion is that it was effective in this task, but Japan's changed technological position raise fundamental questions about its future advisability. In turn, Japan may be expected to undertake further strengthening of its patent regime. However, despite the weak links between the empirical analysis and the U.S. patent system, some issues come up that may be informative for American policymakers.

2. The United States Should Not Adopt Pre-Grant Disclosure Without Adequate Safeguard Mechanisms for and Compensation to Patentees.

Eliminating mandatory pre-grant opposition in Japan was considered by some U.S. observers to be one of the biggest achievements of the 1993 U.S.-Japan Framework Agreement. The data also suggest that there may have been strong Japanese economic interests in this modification. The U.S. Congress is currently considering whether to adopt limited pre-grant disclosure (such consideration evidently is required by the Framework Agreement) as part of a reform of the American patent system.

Although the research for this Working Paper cannot be considered definitive on this point, it does suggest that it would likely be a mistake for the U.S. to adopt early disclosure without consideration to safeguarding patentee rights. The results broadly indicate that the U.S. patent system does not result in growth-limiting exclusionary access to new technologies. Accordingly, it seems that any pro-competitive gains from an American pre-grant disclosure rule would be slight, while there is a risk that such a rule would diminish incentives for basic invention. In other words, early disclosure would have the opposing effects of increased technology diffusion and decreased R&D incentives. Without safeguard mechanisms to ensure against weakened R&D initiatives, given the innovative status of most U.S. industries, the benefits of maintaining strong R&D incentives seem to outweigh any diffusion effects.

This essential point is buttressed by the following observations. First, the USPTO and industry representatives claim the average pendency period is less than 22 months. The USPTO is currently working to decrease the average examination period to 18 months.[27] Once achieved, such rapid examinations would remove the force of an argument for an early disclosure rule. A speedy and efficient examination process makes more sense in the U.S. context than does mandatory rapid disclosure and it achieves the same result of relatively quick dissemination of protected information.

Second, the absence of early disclosure gives American firms "lead time" (e.g., in terms of finishing commercialization) before they file abroad. Should the U.S. adopt the 18-month disclosure rule, firms would have only 18 months to decide if they want to go through with

[27] U.S. Senate Hearing, 1988, Committee on Commerce, Science and Transportation, Subcommittee on Foreign Commerce and Tourism, "Effect of the Japanese Patent System on American Business," S. Hrg. 100-874, June 24, 1988. See also "Public Hearing on Issues Associated with Implementation of Eighteen-Month Publication of Patent Applications," USPTO, February 15, 1995.

the patent or keep it as a trade secret and perhaps license out the technology. In many industries, such as chemicals and biotechnology, applicants usually do not know within 18 months the scope of the patent that would be awarded. Hence, early disclosure would force applicants to assess the value of a trade secret vis-a-vis a patent with incomplete information.

An industry spokesperson claimed in an interview that the pre-grant disclosure debate in the United States was used to pit small firms against large multinational firms.[28] In general, large firms would realize any benefits from early disclosure because they tend to patent abroad more often than smaller firms, have larger patent staffs, and tend to get through the patent office more quickly. Yet some of the patent attorneys representing such firms were, in interviews, opposed to early disclosure for some of the reasons stated above. Thus, U.S. industry appears to be somewhat split over this debate.

3. The United States Should Monitor Japanese Regime Changes.

The 1993 Framework Agreement and Japan's emerging interest in promoting innovative economic activity are indicative of changes that should improve competitive opportunities for U.S. firms in the Japanese market. A patent modification that encourages fundamental innovation over follow-on innovation and protects the rights of the original inventor is in the interest of many American firms.

Accordingly, the United States has a commercial interest in the evolution of the Japanese system, both in terms of patent rights and competition rules. Assuming that Japan strengthens its patent protection and adopts the other measures suggested above, the main issue would become whether that country's authorities adopt transparent and effective competition policies that ensure wide and non-discriminatory access to foreign enterprises. Competition authorities should be encouraged to discipline patent (and trademark) exploitation that results in abusive horizontal and vertical arrangements and works to preclude entry by Japanese and international firms. To the extent that such discipline is lacking or competition mechanisms are applied in a discriminatory fashion, American authorities could assert their concerns on a bilateral basis.

The United States has a long (and varied) history of attempts to maintain competition in the exploitation of IPR. This experience could be shared through information exchanges and the like. This observation applies not only to Japan, which has an extensive set of competition rules in place already, but also (and with greater force) to emerging countries that currently are implementing stronger IPR and competition regimes.

4. The United States Should Shape Potential WTO Competition Agreements to Favor International Cooperation.

It is beyond the scope of this paper to discuss the potential form and costs and benefits of competition policy agreements that may emerge from the next round of multilateral trade negotiations. This is an enormously complex issue. Within the present context, however, some relevant observations can be made.

The TRIPS Agreement in the Uruguay Round left it up to individual countries to implement and enforce competition rules that could be employed to discipline abuses of IPR, so long as such disciplines would not unduly frustrate the intended benefits of stronger rights to

[28] Personal interview, February 11, 1999. See also "Industry Registers Hope for Patent Reform Law," *New Technology Week*, February 1, 1999.

inventive firms.[29] It remains to be seen how this provision will play out in practice. However, given the fact that a large share of global patents is granted to multinational enterprises from the United States, the European Union, and Japan, those firms are likely to be the targets of competition actions, which will take place increasingly across borders. For example, while American firms may reasonably expect to see Japanese competition enforcement aimed at IPR-related anti-competitive practices on the part of Japanese firms, they should equally anticipate being the subject of such programs in that country. This process will also become more prevalent in the United States and the EU, with competition actions aimed at both domestic and foreign enterprises (and their joint operations). In turn competitive strategies facing international competitors could be strongly altered.

In this context, the potential for strategic abuse on the part of policymakers is significant. It follows that cooperative agreements to share information about market concentration, effective competition, and the cross-border effects of IPR exploitation would enhance each country's ability to conduct a coherent competition regime. Such an approach could even extend to joint enforcement actions to the extent that abusive use of patent licensing extends significantly across borders.

These questions deserve more study but they are sufficiently well understood as to provide a basis for working toward a multilateral agreement that emphasizes international cooperation. Because TRIPS envisions the application of competition rules to IPR, but leaves such application to the discretion of individual members, it opens the way for thinking about a cooperative international regime.

5. The United States Should Recognize the Growth Advantages of Follower Strategies.

The main conclusion from this study is that technology-follower nations may find growth prospects enhanced by patent systems that, while fully consistent with TRIPS requirements, emphasize prospects for follow-on invention of an incremental nature. The Japanese experience may not translate well to other countries because of differences in education, firm structure, and other factors, but it does suggest a system of utility models, narrow claims, and liberal disclosure may accelerate technical change. In this sense, the inherent interests of countries tend to graduate toward stronger patent systems as they develop more sophisticated technological capabilities. From the standpoint of development policy, it makes little sense to insist that poorer nations quickly adopt patent regulations that are as protective as those in the United States.

[29] See Articles 8:2, 30, 31, and 40 of the TRIPS Agreement.

VIII. *Acknowledgements*

The authors would like to thank Dr. Eric Gangloff and the Japan-U.S. Friendship Commission for their generous support of our research on patent systems and competition policy. Sincere thanks to Mindy L. Kotler and the staff of the Japan Information Access Project for making this research accessible to the policy community. A special thanks is offered to numerous Japanese and American sources in Washington that wish to remain anonymous.

IX. *Disclaimer*

This report does not imply any endorsement by the Japan-U.S. Friendship Commission, the Japan Information Access Project, nor the University of Colorado at Boulder.

X. *Authors*

You may contact the authors of this study through the
Economics Department
University of Colorado at Boulder
Boulder, Colorado 80309
Phone: (303) 492-6394
Fax: (303) 492-8960

Email - Ms. McDaniel: christine.mcdaniel@colorado.edu
N.B.: Ms. McDaniel will join the U.S. International Trade Commission in August 1999
Email - Dr. Maskus: keith.maskus@colorado.edu

SELECTED BIBLIOGRAPHY

Aoki, Reiko. "Recent Trends in the Japanese Industrial Property System." Manuscript, SUNY, Stony Brook. Prepared for the conference: Intellectual Property: Japan and the New Asia, Japan Information Access Project, Washington, D.C., 1997.

Boulware, Margaret, Jeffrey Pyle and Frank Turner. "An Overview of Intellectual Property Rights Abroad." *Houston Journal of International Law* 16 (1994): 441-507.

Christensen, Laurits, Dianne Cummings, and Dale Jorgenson. "Economic Growth, 1947-1973: An International Comparison." In *Productivity: International Comparisons of Economic Growth*, Vol. 2, edited by Dale Jorgenson, 203-295. Cambridge: MIT Press, 1995.

Coe, David, Elhanan Helpman, and Alexander Hoffmaister. "North-South R&D Spillovers." *Economic Journal* 107 (1997): 134-149.

Curci, Frank and Tamotsu Takura. "Selected Aspects of Japanese Intellectual Property Law." *Transnational Lawyer* 8 (1995): 63-85.

Doane, Michael. "TRIPS and international intellectual property protection in an age of advancing technology." *The American University Journal of International Law and Policy* 9 (1994): 465-497.

Dinwiddee, Scott. "A Shifting Barrier? Difficulties Obtaining Patent Infringement Damages in Japan." *Washington Law Review* 70 (1995): 833-58.

Evenson, Robert. "International Invention: Implications for Technology Market Analysis." In *R&D, Patents, and Productivity*, edited by Z. Griliches, 89-123. National Bureau of Economic Research, 1984.

Foster, Richard and Masao Ono. *The Patent and Trademark Laws of Japan*. Tokyo: Asahi Press, 1966.

Gould, David and William Gruben. "The role of intellectual property rights in economic growth." *Journal of Development Economics* 48 (1996): 323-350.

Gould, James W.; Sato, Tsutomu, 1999. "Japan Ups the Ante in Patent Litigation," The New York Law Publishing Company IP Worldwide.

Helfgott, Samson. "Cultural Differences between the U.S. and Japanese Patent Systems." *Journal of the Patent and Trademark Office Society* 72 (1990): 231-238

International Monetary Fund, various years, *International Financial Statistics Yearbook* (Washington, D.C.).

International Labor Organization, various years, *International Labor Yearbook* (Washington, D.C.).

Japanese Patent Office, various years, *Japanese Patent Office Annual Reports* (Tokyo, Japan).

Johansen, Soren. "Statistical Analysis of Cointegration Vectors." *Journal of Economic Dynamics and Control* 12 (1988): 231-254.

Jorgenson, Dale and M. Kuroda. "Productivity and international competitiveness in Japan and United States." In *Productivity Growth in Japan and the United States*, edited by Charles Hulten, 29-55. Chicago: University of Chicago Press, 1990.

Keller, Wolfgang. "Trade and the Transmission of Technology." Manuscript, University of Wisconsin, 1995.

Kotabe, Masaaki. "A Comparative Study of U.S. and Japanese Patent Systems." *Journal of International Business Studies* 23 (1992): 147-168.

Lindgren, John and Craig Yudell. "Articles Protecting American Intellectual Property in Japan." *Santa Clara Computer and High Technology Law Journal* 10 (1994): 1-34.

Maskus, Keith. "The International Regulation of Intellectual Property." *Weltwirtschaftliches Archiv* 134 (1988): 186-208.

Maskus, Keith and Christine McDaniel. "Impacts of the Japanese Patent System on Productivity Growth," forthcoming in *Japan and the World Economy,* 1999.

McDaniel, Christine. "Early Disclosure and Technology Diffusion: Evidence from Japanese and U.S. Aggregate and Industry Data." Manuscript, University of Colorado, 1999.

Nadiri, M. Ishaq and Ingmar Prucha. "Comparison and Analysis of Productivity Growth and R&D Investment." In *Productivity growth in Japan and the United States*, edited by Charles Hulten, 29-55. Chicago: University of Chicago Press, 1990.

Nakamura, Shinichiro. "Explaining Japan and U.S. TFP Difference." *The Economic Studies Quarterly* 43 (1992): 326-36.

OECD. *Methods Used by OECD Countries to Measure Stocks of Fixed Capital National Accounts: Sources and Methods*, No. 2. Paris: OECD, 1993

Ordover, Janusz. "A Patent System for both Diffusion and Exclusion." *Journal of Economic Perspectives* 5 (1991): 212-229.

Pantula, Sastry, Graciela Gonzales-Farias, and Wayne Fuller. "A Comparison of Unit-Root Test Criteria." *Journal of Business and Economic Statistics* 12 (1994): 449-459.

Papovich, Joseph. "New and Unresolved U.S.-Japan Intellectual Property Rights Issues." Manuscript, Office of the U.S. Trade Representative, Washington, D.C., 1997. Prepared for the conference: Intellectual Property: Japan and the New Asia, Japan Information Access Project, Washington, D.C., 1997.

Plosser, Charles and G. William Schwert. "Money, Income and Sunspots: Measuring Economic Relationships and the Effects of Differencing." *Journal of Monetary Economics* 4 (1978): 637-660.

Romer, Paul. "Two Strategies for Economic Development: Using Ideas and Producing Ideas." In Summers, L. and S. Shah, eds*., Proceedings of the World Bank annual conference on development economics*, edited by Lawrence Summers and Shakhar Shah, 63-91. Washington, D.C: World Bank, 1993.

Solow, Robert. "Technical Change and the Aggregate Production Function." *Review of Economics and Statistics* 39 (1957): 312-320.

United Nations Conference on Trade and Development (UNCTAD*), The TRIPS Agreement and Developing Countries*. Geneva: United Nations, 1996.

U.S. Senate Hearing, Committee on Commerce, Science and Transportation, Subcommittee on Foreign Commerce and Tourism. "Effect of the Japanese Patent System on American Business." S. Hrg. 100-874, June 24, 1988.

United States Trade Representative. "The 1997 National Trade Estimate Report on Foreign Trade Barriers." Office of the United States Trade Representative, Washington, D.C., 1997.

Wineberg, Arthur. "The Japanese Patent System: A Non-Tariff Barrier to Foreign Business?" *Journal of World Trade Law* 22 (1988): 11-22.

Appendix 1: Estimation Techniques and Results

The following discussion reviews procedures for estimating total factor productivity (TFP) growth, data sources, and the testing procedure for the paper's central hypotheses.[30]

The first proposition is that the weaker novelty and non-obviousness requirements of utility models, relative to those of patents, allowed firms to file utility applications based on technology learned from patent applications published prior to patent grant in Japan. That is, the JPS encouraged filing of utility models covering follow-on developments that were invented around published patent applications. Therefore, the first hypothesis relates to incremental innovation.

Hypothesis One*:* The number of utility model applications may be explained by the number of previously filed patent applications in Japan. Stated in econometric terms, (A) domestic patent applications Granger-cause domestic utility model applications, controlling for foreign patent applications, in a positive direction; and, (B) foreign patent applications Granger-cause domestic utility model applications, controlling for domestic patent applications, in a positive direction. The residency distinction among applicants is useful for assessing whether such follow-on developments were invented around published domestic or foreign applications. The aggregate test of this hypothesis is useful for evaluating the overall impact, while the sectoral level test is useful for assessing which industries were most affected.

The next proposition is that Japan's pre-grant disclosure rule has served as a mechanism for technology diffusion in that the laying open of patent and utility model applications enabled technology spillovers. The U.S. data provide the counterfactual as the U.S. system is absent pre-grant disclosure. This motivates the second hypothesis, regarding the diffusion effect of patents.

Hypothesis Two: Controlling for utility model grants and patent grants, utility model applications and patent applications Granger-cause TFP growth in a positive direction in Japan. Similarly, controlling for patent grants, patent applications do not Granger-cause TFP growth in a positive direction in the United States.

The final proposition is that once protected, use of technology becomes more insulated, serving to inhibit technology diffusion. This focuses on the exclusionary effect of patent grants, which would serve to diminish growth.

Hypothesis Three: Controlling for utility model and patent applications, utility model grants and patent grants Granger-cause TFP growth in a negative direction in Japan and the United States.

Total Factor Productivity

The standard definition of TFP growth is the annual variation in aggregate output not explained by input changes. Japanese TFP has been studied many times in the literature. For example, following the bilateral model of Jorgenson and Kuroda (1990), Nakamura (1992) identified technical change and scale effects as sources of productivity growth and found technical change to be the dominant source of Japan's TFP growth while scale effects mainly

[30] This section draws heavily from McDaniel (1999).

contributed to U.S. productivity growth. However, the structure of the patent system has not received attention as a determinant of such growth.

The calculation of TFP begins with a conventional production function of the form:

$$Q_t = A_t \cdot F(L_t, K_t) \qquad (1)$$

where Q is GDP, A is total factor productivity, L is a measure of labor services in natural units and K is a measure of capital services. In order for the coefficients to sum to unity and thus reflect percentage shares in GDP growth, the TFP growth model is constrained to be a standard Cobb-Douglas function. In log terms, equation (1) is expressed in terms of total factor productivity:

$$\ln TFP_t = \ln Q_t - s_{Lt} \cdot \ln L_t - s_{Kt} \cdot \ln K_t \qquad (2)$$

where s_L and s_K are elasticities of output with respect to physical capital and labor, respectively. Under the assumptions of constant returns to scale and competitive factor markets, these elasticities equal the income shares of their respective factors.[31] The growth of TFP over the period (t-1) to (t) is then

$$\Delta \ln TFP_t = \ln TFP_t - \ln TFP_{t-1}$$

$$= (\ln Q_t - \ln Q_{t-1}) - s_{Lt}^{*} (\ln L_t - \ln L_{t-1}) - s_{Kt}^{*} (\ln K_t - \ln K_{t-1}) \qquad (3)$$

where s_{Lt}^{*} and s_{Kt}^{*} are the average income shares of labor and capital for periods (t) and (t-1).

Data on real GDP in yen terms were taken from various issues of *International Financial Statistics* of the International Monetary Fund. All price deflators come from this source as well, with the base year defined as 1990. Annual figures on total employment and wage bill were taken from various issues of *International Labor Yearbook* of the International Labor Organization.

One standard construction of a physical capital stock variable employs the perpetual inventory method. Data on aggregate real gross fixed capital formation, taken from the *International Financial Statistics*, receive declining weights (reflecting depreciation) over a span of 15 years. The depreciated investment flows are summed to compute the capital stock:

$$K_T = \sum_{t=0}^{14} (GFKF_{T-t}) \cdot (0.877)^t \qquad (4)$$

Here, K_T is the capital stock in time period T in 1990 prices and GFKF is gross fixed capital formation (including public and private residential buildings, plant and equipment, and changes in stocks, expressed in 1990 prices using the wholesale price index).

Note that as the time lag approaches 14 years, the inherent contribution of that period's investment to the overall capital stock available in a given year diminishes. Thus, this is an approximation of the true capital stock. However, given the wide range of life- spans for different types of capital it is difficult to develop a completely accurate measurement. For example, although most forms of capital, such as basic manufacturing and non-manufacturing machinery and equipment, have an average life span of eight to 13 years, other types of

[31] It is common in the Japanese productivity literature to assume constant returns to scale in aggregate data, while allowing for increasing returns to scale in industry data (Christensen, Cummings, and Jorgenson (1995); Nadiri and Prucha (1990)). We stay within this tradition by assuming constant returns in our aggregate growth approach.

capital, such as vehicles and dwellings, have life spans of five and 45 years, respectively.[32] The data series on capital formation begins in 1946, leaving the assumption that World War II left Japan with no capital in use in 1945. Thus, the 14-year lag required in the capital-stock computation resulted in the estimated TFP series to begin in 1960.

Figure 7 plots the resulting TFP growth estimates for 1960-1993 for Japan and the United States and Table 5 reports means and standard deviations for these indexes.[33] Japanese TFP growth was more volatile that U.S. TFP growth, and over the period 1960-1989, the Japanese average (1.8660) surpassed the U.S. average (1.4694). Yet, over the entire period, the U.S. average (1.3901) was only slightly higher than the Japanese average (1.3807). Each country's TFP change sharply declined following the oil shock of 1973. Thereafter, Japan displayed positive productivity change until 1992, and U.S. TFP growth was positive except for the early 1980s and 1991. Data for the late 1980s and thereafter attest to the beginning of the well-known productivity slowdown that many OECD countries began experiencing in that decade.

Concordance

Use of Japanese industry-level patent data required developing a concordance between the Japanese Patent Classification and International Patent Classification. Table 6 describes this concordance.[34] The regression analysis incorporates a dummy variable to account for the years of the shift, namely 1977 and 1978.

Time-Series Analysis

The testing of these propositions involves constructing Granger Causality tests with time-series data. Such tests require estimating vector auto-regressive (VAR) models with stationary series. Tables 7 and 8 report the model specifications and results. The data set used to estimate the models contained patent and utility model applications and grants, registered by domestic and foreign residents, TFP, R&D, and capital imports, in Japan and the United States. Table 9 lists acronyms for the variables. Table 10 indicates the results of unit root tests on the log level series. The Weighted Symmetric test and Augmented Dickey-Fuller (ADF) test did not reject the hypothesis of a unit root in most of the patent and utility model applications and grant series, nor in TFP series. However, at least one test indicated a unit root for each of the patent and utility model series for both the Japanese and U.S. data.[35] The null hypothesis of a unit root was rejected for nearly all the differenced series, and results clearly indicated that each country's TFP series had a unit root. There was some ambiguity on the point between the two tests, so to avoid spurious regression analysis, the estimated VARS include first-differenced series.

Under circumstances in which most series have a unit root but a few do not, it is standard procedure to take first differences of all series to achieve stationarity.[36] Optimal lag lengths

[32] OECD, 1993.
[33] The sharp decline of TFP growth for Japan in 1966 is due to an evident data error in *International Financial Statistics* in reported GDP. Other sources do not report this downward shift. Correcting for this problem resulted in a value that still generated a large outlier for productivity growth. Incorporating a dummy variable for 1966 for Japan avoids inference errors.
[34] The double counting of textiles appears inconsequential as the results from the concorded data match the results of the split data (not reported).
[35] The Weighted Symmetric test is recommended over the ADF test because it has (sometimes only slightly) higher power (Pantula, Gonzales-Farias, and Fuller, 1994).
[36] Plosser and Schwert, 1978.

(not reported) in the unit root tests were chosen initially by a modification of Akaike Information Criteria (AIC), which is based on the unconditional likelihood and avoids size distortions for the WS and DF tests, as described Pantula et al (1994).[37] Thus, in general the modified AIC-suggested lag length or longer determined the order of the VARs, while Durbin-Watson and Q-test results confirmed that the residuals from the chosen lag lengths were free of auto-correlation. Estimation of Models A and B and the cointegration tests incorporated such lag lengths.

Cointegration tests among the series (to determine whether an error correction term must be included in the VAR estimation in order to avoid omitted variable bias) may be accomplished with Johansen's (1988) maximum likelihood or Engle-Granger techniques. Table 11 reports Johansen cointegration test results for the patent and utility application variables in Model A, applicable to Hypotheses One. There was evidence of cointegration among foreign patent applications, domestic patent applications, and domestic utility applications at the aggregate and at most industry levels; however, the Engle-Granger cointegration test revealed evidence of cointegration at the aggregate and each industry level (not reported). Table 12 reports Johansen cointegration test results for the variables in Model B, applicable to Hypotheses Two and Three. These results indicated cointegration among the relevant patent activity variables and TFP growth for the Japanese and U.S. patent model specification of Model B, though not for the Japanese utility model specification of Model B. However, Engle-Granger cointegration tests revealed evidence of cointegration for each of the three cases (not reported). Accordingly, the VAR estimation for each specification of Model A and B included an error-correction term.

Thus, the VAR equations included lags of dependent and independent variables, all in first-differenced forms, and the error-correction terms as regressors. Estimations of Model B included specifications that accounted for control variables for technology creation and diffusion. In particular, these control variables included measures of aggregate Japanese real research and development spending along with real imports of capital goods, defined as general machinery, electrical machinery, and transport equipment. The latter variable served to control for technology transfer through trade.[38] Neither of these variables was significant in any specification of Model B with the Japanese or U.S. data, and their inclusion did not affect the results of the Granger causality tests. Accordingly, regressions with these variables included are not reported. Finally, Model B with Japanese data includes a dummy variable for the year 1966 because of the implausible measure for GDP in that year.

Empirical Results

Each of the hypotheses is tested with Granger-causality tests. These are joint F-tests of the significance of the lagged variable in question and the error-correction term. Table 1 presents the causality tests for Hypothesis One at the aggregate level, and Table 2 presents the tests at the industry level. The restriction being tested on Model A is that the coefficients on the domestic (and then foreign) patent applications and error-correction terms are not significantly different from zero. The row listed "Prob" indicates the significance level with

[37] The modified AIC discussed here avoids size distortions associated with such selection criterion, and consequently, prevents the need for sequential tests that previous authors favor. For example, Ng and Perron (1995) analyze methods for selection of the truncation lag, and report results that favor methods based on sequential tests over those based on standard information criteria because the former show less size distortions and have comparable power.

[38] Keller (1995), Coe et al (1997).

which the null hypothesis of no causation may be rejected and the final row indicates the significance for the reverse hypothesis.

The aggregate level results clearly demonstrate that prior domestic patent applications were Granger-causal to domestic utility applications, and that prior foreign patent applications were Granger-causal to domestic utility applications, which supports Hypothesis One. The net collective impact of domestic (foreign) patent applications was 0.3238 (0.0181), and positive and significant at the 5 percent (10 percent) level. Interestingly, the result held for both domestic and foreign patent applications although the impact of the domestic applications far outweighed that of foreign applications.

The industry level results show that domestic patent applications were Granger-causal to domestic utility applications, as reported in Table 2, in most industries. Specifically, Hypothesis One is supported at the domestic level for industries (with net collective impact in parentheses) including chemistry (2.3311), machinery (0.8494), transportation and construction (0.2189), and physics (0.8230). Also, industry analysis shows that foreign patent applications were Granger-causal to domestic utility applications for the industry chemistry and physics, with a net collective impact of 0.6273 and 0.6098, respectively, as reported in Table 3.

These findings support the notion that the weak novelty requirements for utility models coupled with the pre-grant disclosure rule allowed firms in Japan to file follow-on utility applications based on technology learned from invention patent applications published prior to the grant date. Learning through modification of technologies in patent applications resulted from both domestic and foreign inventiveness, though the impact from domestic patent applications far outweighed that of foreign applications. Such incremental innovation at the purely domestic level occurred in most industries, while follow-on invention from foreign patent applications was most remarkable in the chemistry and physics industries.

Table 4.1 presents the causality test results for Hypothesis Two at the aggregate level. The three panels report the results of the three separate restrictions on Model B. The data support the hypothesis. Panel (1) shows the data do not reject the null hypothesis that patent applications, controlling for patent grants, do not Granger-cause TFP growth in a positive direction in Japan. Nor did the data reject the opposite case. Panel (2) shows the data reject the null hypothesis at the 10% significance level that utility applications, controlling for utility grants, do not Granger-cause TFP growth in a positive direction in Japan, as expected. The data did not reject the opposite case. Finally, Panel (3) shows the null hypothesis that patent applications do not Granger-cause TFP growth in the United States is not rejected, as expected. In fact, the results indicate that TFP growth is Granger-causal to domestic patent applications in the United States, and in the negative direction.

Coupled with the results from the first hypothesis, these findings suggest that domestic patent applications directly contributed to technical change and also that there was an important indirect impact through stimulating later utility applications in Japan. That applications for protection contributed positively to technical change in Japan and not in the United States support the notion that Japan's pre-grant disclosure rule has served as a mechanism for technology diffusion. That is, the laying open of patent and utility model applications in Japan enabled technology spillovers. Thus, patent applications bore information about novel inventions while follow-on utility model applications were likely to get through the JPO and into the manufacturing process more quickly.

Table 4.2 presents the causality test results for Hypothesis Three, which tested for an exclusionary effect of protected inventions on TFP growth. There was no support for this hypothesis. Panel (1) reports that the data did not reject the null hypothesis that patent grants, controlling for patent applications, do not Granger-cause TFP growth in a negative direction in Japan; the data did not reject the opposite either. Panel (2) reports that the data did not reject the null hypothesis that utility grants, controlling for utility applications, do not Granger-cause TFP growth in a negative direction in Japan. Nor did the data reject the opposite case. Finally, panel (3) reports that the data did not reject the null hypothesis that utility grants, controlling for utility applications, do not Granger-cause TFP growth in a negative direction in Japan. Nor did the data reject the opposite case. Panels (1) and (2) in Table 4.2 show that the effects of both patent and utility grants on TFP growth in Japan were negative, -4.4144 and –4.8478, respectively. Panel (3) shows that this effect with the U.S. data was also negative but to a lesser extent (-1.2286). Yet there was no statistically significant exclusionary effect in either country.

Thus, there is no evidence to suggest an exclusionary impact of patent or utility grants alone, in Japan or the United States. In Japan's case, this is likely because any exclusion effect is dominated by the diffusion effect of early disclosure. That is, once the patent is granted, the technology has already been disseminated throughout the economy. Thus, the diffusion effect of the patent system may outweigh any exclusionary effect of the actual granting of patents. In the U.S. case, it appears that patent grants do not have a sufficiently exclusionary effect on productivity.

Appendix 2: Tables

Appendix 3: Figures