The Nature of Innovative Activity and the Protection of Intellectual Property: a post TRIPS perspective from Asia[1]

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Abstract: This paper examines trends in innovative activity in several major Asian countries during 1997-2011 as measured by their filings and grants of various types of intellectual property (IP). By almost all measures, there has been a remarkable increase in innovative activity in China. In fact, in 2011 China accounted for roughly 25% of global patent applications. However, several indirect measures suggest that the *quality* of this newly created Chinese IP is not (yet) world class. For example, relative to residents of other major Asian countries and the United States, Chinese residents tend to file IP applications in foreign markets at a much lower rate. Similarly, the ratio of royalty payments earned by Chinese residents to the number of patents granted to them is fairly low by international standards. Finally, the ratio of patent to utility model applications (typically granted for relatively minor innovations) in China is also relatively small.

JEL Codes: O31, O34, O53, O57, F63.

Keywords: Innovation, patents, trademarks, industrial designs, utility models, quality.

[1] We thank Reiko Aoki, Hal Hill, Colin McKenzie, Shujiro Urata, and participants at the Nineteenth AEPR Conference for helpful comments. All errors are our own.

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1. Introduction

The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) was perhaps the most important and controversial outcome of the Uruguay Round (1986-95) and international negotiations that led to its birth were rather contentious, with developing and developed countries expressing very different opinions about the need for a multilateral agreement on intellectual property rights (IPRs).[3]

TRIPS negotiations were driven by a deep-rooted sense of dissatisfaction in the United States with the state of IPR protection in the global economy, especially with the widespread imitation and piracy occurring in major developing countries (many of them Asian). Several major policy reports issued by leading US governmental organizations and agencies had raised concerns about the substantial losses being incurred by key US industries due to the lack of adequate IPR protection in foreign countries.[4]

Supported by the European Union and Japan, the US was successful in introducing IPRs into the multilateral negotiating agenda of the Uruguay Round. Major developing countries such as Brazil, India, and China were not the only ones opposed to the inclusion of any rules pertaining to IPRs into the multilateral trading system, there was widespread skepticism among academicians and other neutral observers regarding the merits of and the need for TRIPS. Indeed, it is fair to say that a shadow of skepticism hangs over TRIPS even today.

In a nutshell, TRIPS called for all members of the World Trade Organization (WTO) to adopt certain minimum standards with respect to the protection of IPRs and its main practical effect was to force developing countries to alter their IPR policies to bring them closer to those of rich countries such as the US. However, this adjustment was not expected to occur immediately. When TRIPS took effect on 1 January 1995, while developed countries were given only one year to ensure that their laws and practices TRIPS compliant, developing countries were given five years (until 2000). Least-developed countries had 11 years to achieve TRIPS compliance, until 2006 — which was then extended to 2013 in general, and to 2016 for pharmaceutical patents and trade secrets.

In this paper, we critically examine changes in the volume and the nature of innovative activity in major Asian economies during the post TRIPS era. At the outset, we note that our analysis is descriptive in nature and is not meant to imply that these changes in innovative activity were caused primarily by TRIPS, although it is difficult to believe that they were totally unrelated to TRIPS either. To limit the scope of the paper, we focus on countries that have been major contributors to innovative activity within Asia since the ratification of TRIPS: Japan, China, India, South Korea, Singapore, and Malaysia. Among these, we pay special attention to

[3] See Maskus (2000) and Maskus (2012) for comprehensive overviews of the economics of IPRs in a global setting.

[4] See, for example, United States International Trade Commission (USITC) (1988), US-Chamber of Commerce (1987), and the annual reports issued by the office of the United States Trade Representative (USTR).

China and India since the policy environment of these two large countries was significantly altered by TRIPS.

Wherever relevant, we provide a comparison of innovative activity in BRICS (Brazil, Russia, India, and China) countries. We also briefly discuss the observed variation in the nature of innovative activity within Asia as well as BRICs during the post TRIPS era. To this end, we examine not only the variation in the fields of technologies of patent applications across countries but also in the ratio of the number of patent applications to utility models (as well as industrial designs). It is worth noting at the outset that since our analysis abstracts from institutional factors, it cannot shed light on the role that differences in national innovation systems play in determining the level and nature of innovative activity in different countries.[5] In other words, our primary focus is on describing the variation in such activity across our chosen set of countries during the post TRIPS era. Perhaps future research can explore factors that help explain this observed variation.

2. The protection of intellectual property in the global economy post TRIPS

A commonly used index for measuring the degree of patent protection available in a country is the Ginarte-Park (GP) index. This index is the sum of scores earned by a country in five separate categories pertaining to patent protection: coverage, membership in international treaties such as TRIPS, duration of protection, enforcement mechanisms, and restrictions (such as compulsory licensing) that limit a patent-holder's control over its invention.[6] The scores range from 1 to 5.

The first column of Table 1 reports the Ginarte-Park index for selected Asian countries and the US during the post TRIPS era.

-Table 1 here -

As one might expect, the degree of patent protection in the US remains essentially flat at 4.88 (quite near the maximum possible value of 5.0) for the entire time period. Similarly, TRIPS had little effect on the degree of patent protection available in Japan, Korea, and Singapore.

As per Table 1, the sharpest changes in patent protection occurred in China and India: the value of the index for India increased sharply from 1.03 to almost 3.76 while that for China doubled from 2.12 to 4.21. These are large changes with important economic implications not just for India and China but also for the rest of the world.

[5] We thank our discussant Hal Hill for drawing attention to this important issue.

[6] This index was first published in Ginarte and Park (1997) and we thank Walter Park for providing us with an updated version.

2.1. Patent applications and grants

Global patent applications have grown rapidly during the post TRIPS era. Indeed, global patent applications in 2011 were roughly twice that in 1997.[7] Asia has been the single biggest driver of global patent applications during the post-TRIPS era: its share of global patent applications has hovered around 50% during 1997-2011. Over the same time period, North America's share increased slightly from roughly 20% to 25% whereas that of Europe fell from 20% to 15%.

Within Asia, the changes have been rather dramatic.[8] The big story, of course, has been the emergence of China. In 1997, Japan dwarfed the other Asian countries in terms of patent applications and grants but was overtaken by China in 2011. Indeed, so sharp and salient has been China's rise that patent filings in China during 2011 not only exceeded those in Japan but also the US, *making China the country with the largest number of patents filed (and granted) in 2011*. Roughly 25% of all patent applications filed in the world during 2011 were filed in China. The corresponding shares for the US and Japan were 24% and 16% respectively.

While these statistics pertaining to China's emergence are undoubtedly impressive, it is important to interpret them carefully. Count data on patent applications (and grants) tell us virtually nothing about the economic values or the qualities of the underlying technologies. Indeed, there is widespread recognition in the Chinese leadership that while number of patent applications in China has increased sharply along with investment in research and development (R&D), the quality of local patent applications remains relatively low. The first objective stated in the Chinese *Promotion Plan for the Implementation of the National Intellectual Property Strategy* is to "improve IP appraisal and assessment system… and *to shift the focus on IP quantity to IP quality*, and boost IP value."[9] Of course, the concern with patent quality is hardly unique to China: examples abound of trivial inventions that have been granted patents even in the United States.[10] Yet, using some additional data, we will argue below that this concern is especially acute for China.

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[7] Unless otherwise noted, the data for the various figures and tables contained in this paper were taken from the World Intellectual Property Organization (WIPO): http://ipstatsdb.wipo.org/ipstatv2/ipstats/patentsSearch (during Oct-Dec, 2013). While WIPO was established in 1967, we focus on the post TRIPS period to not only limit the scope of our study but also because the available data is more uniform across our chosen set of countries during this period and data uniformity is useful while conducting meaningful cross-country comparisons.

[8] We limit our discussion to China, India, Japan, Malaysia, South Korea, and Singapore since these countries account for over 90% of the patent applications and grants in a typical year.

[9] This report was accessed during Nov 2013 at http://english.sipo.gov.cn/laws/developing/201204/t20120410_667158.html.

[10] See Maskus (2012) for some examples of patents granted by the US that have attracted widespread criticism and helped fuel the concern that patent protection in the US has gone overboard.

Consider now the data on patents granted within Asia and the rest of the world. During 2011, nearly 1 million patents were granted world-wide with roughly 40% of them accruing to non-residents, a clear reflection of the globalization of contemporary innovation. Roughly 7.88 million patents were in force globally during 2011, over 25% of these being in the US.

From 1997 to 2011, the number of patents granted in Asia more than doubled. While more patents were granted in 2011 in all Asian countries, the sharpest increase was witnessed in China where the number in 2011 was almost *fifty times* that in 1997. This massive increase is even more impressive considering the fact that China's grant rate over this time period (of around 40%) was quite comparable to that of the Japan and US.[11]

Patent applications in Asian countries vary substantially at the industry level. For example, from 1998-2012, while digital communications was the most important industry in China (accounting for 9% of all patent applications), the chemical and pharmaceutical industries dominated in India accounting for 22% and 24% of applications respectively. Indeed, India is unique among Asian countries, and perhaps in the world, in exhibiting such a heavy reliance on a few industries as engines of innovation. There is substantial overlap between Japan and Korea in terms of the key industries that drive innovation in these economies. In both countries, the key industries driving innovation are: electrical machinery, audio-visual technology, computer technology, semiconductors, and optics.

Since TRIPS has increased patenting incentives of both residents and non-residents, we next examine variation within Asia with regard to the role played by residents of each country in driving patenting activity in order to roughly gauge the share of innovation that is indigenously generated.

Column 2 of Table 1 shows the residents' share of patent applications in Asian countries. From 1997 to 2011, the share of local residents in total patent applications filed in China surged from around 50% to roughly 80% while the increase in Malaysia was of an even higher order of magnitude. By contrast, in Japan, the share of local residents declined slightly, as it did in Asia overall. One could perhaps reasonably interpret the increase in the share of patents filed by residents in China as an indication of its enhanced ability to innovate.

2.2. Patenting activity within BRICs

Much attention has been paid to the rise of BRICs during the last few decades and their economic performance relative to each other. It is interesting to compare BRICs from the viewpoint of innovative activity. Figure 1 presents the raw data on patent applications in BRICs. This figure hardly needs explanation: China simply *dwarfs* the other BRICs countries in terms of patent applications filed during 1997-2011.

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[11] We calculated annual ratios of patent grants to patent applications (lagged by 1 as well as 2 years). The estimated grant rate was then calculated by averaging these two ratios.

The two BRICs countries other than China and India exhibit a fairly different pattern of innovation than leading Asian countries such as Korea and Japan. Over the time period under study, the major sources of innovation in Brazil were medical technology, civil engineering, furniture, and other special machines, with each of the industries accounting for roughly 6% of patent applications. For Russia, the important innovative industries were pharmaceuticals, medical technology, civil engineering, and food chemistry. The composition of industrial innovation in Russia seems to resemble that of India as opposed to, say, South Korea.

It is important to note that product to patent ratios differ markedly across industries and that such variation can drive statistics on the number of IP applications and grants across countries owing to underlying differences in comparative advantage.[12] For example, in the pharmaceutical industry the ratio of patents to products tends to be near one whereas it is very small in other industries such as electronics and telecommunications where a single consumer product can embody literally 100s of patents. Such cross-industry variation in product to patent ratios has important implications for the observed variation in patenting activity across countries. To the extent that innovation in a country such as India is highly specialized in the pharmaceutical industry, one would expect the total count of its patent applications to be lower relative to a country such as China or South Korea where the telecommunications industry is a significant source of innovative activity.

Focusing only on patent filings and grants in individual during the post TRIPS era only gives us an incomplete picture of the innovative capacity of a country since these measures do not tell us much about the *stock* of intellectual property created in a country. For example, while patenting activity in China has increased rapidly during the post TRIPS era, in 2012 Japan had roughly twice the number of patents in force than China. However, relative to other BRICs countries, China stands tall: in 2012, China had roughly twice the number of patents in force relative to Brazil, more than four times that of Russia, and more than *twenty times* that of India. Thus, there is little doubt that, at least among the lower and middle countries, China has truly emerged as a major player in the field of innovation.

2.3. Outward orientation of patenting: a measure of quality?

It stands to reason that firms have strong incentives to protect their most important inventions in foreign markets. As a result, we can obtain a rough gauge of the quality of a country's patent portfolio by examining the share of total patent applications that are filed abroad by its residents. If the residents of a country tend to file a small percentage of its patent applications abroad, it implies that a majority of domestic inventors do not find it worthwhile to seek patent protection in foreign markets, a position they are unlikely to take if their inventions are valuable and high quality.

As a benchmark, consider the behavior of US residents – widely perceived to be the most innovative country in the world. In 2000, 41% of all patent applications filed by the US residents worldwide were in foreign markets; in 2010 the analogous number was 44%. Table 2

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[12] We thank our discussant Rieko Aoki for raising this excellent point.

presents patent applications filed abroad by residents of Asian and BRICs countries as a share of their total applications.

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Over the relevant time period, Japanese residents started to file an increasing share of its patents abroad; the same is true of Korea, although to a lesser extent. Not only was the ratio of foreign to domestic patenting relatively small for China, it did not change much during the post TRIPS era. By contrast, India exhibited a stronger tendency to file patent applications in foreign markets. The share of foreign patent applications as a share of total resident applications by Chinese residents was also quite small relative to the other BRICs countries. While hardly conclusive, this evidence supports the view that the quality of most patent applications in China may not yet be high enough to merit protection in global markets.

Consider now the evidence from patents granted in foreign markets. In the year 2010, patents granted to US residents in foreign markets accounted for roughly 44% of their total number of patents. The corresponding percentages for Japan and Korea were 35% and 32% respectively. *By contrast, only 6% of the patents granted to Chinese residents worldwide during 2010 were granted by other countries*. Thus, an overwhelming percentage of patents granted to Chinese citizens in 2010 were granted domestically. It is worth pointing out that even residents of Brazil and India had a much higher rate of foreign patenting: in 2010, foreign patents accounted for approximately 61% of the total patents granted to residents of each country.

It stands to reason that the tendency to patent abroad is likely to be stronger for inventors residing in smaller countries. For example, from 1998-2011, roughly 80% of the total patents granted to Singapore residents were from abroad. It is possible that the large size of the Chinese market reduces the incentives of Chinese residents to seek patents in other countries. But this cannot be an important part of the story. The Chinese economy is highly export oriented and its firms have come to capture a large share of the global market in many industries. Why then would they not do the same in the context of innovation if it were possible for them to do so? Why would they leave “dollar bills lying on the pavement” by not patenting abroad if it was profitable for them do so?

Perhaps more fundamentally, the decision to file for a patent application in another country depends upon a comparison of the *marginal* benefit of doing so relative to its *marginal* cost. If an innovation is of high quality, it ought to be valued world-wide. It is conceivable that a large domestic market creates incentives for investing in innovations that are only valuable locally, perhaps due to idiosyncratic differences in consumer tastes across countries. If so, residents of countries with large domestic markets could show a domestic bias in terms of innovation and patenting. However, this argument in no way changes the marginal calculus determining patent application behavior in foreign markets. Furthermore, as Table 2 notes, during 2000-2010 residents of the largest market in the world (i.e. the US) had a rate of foreign patenting that was roughly *ten times* that of Chinese residents.

3. Trends in filings and grants of other types of IPRs

We next consider trends in filings and grants of industrial designs, utility models, and trademarks during the post TRIPS era.

3.1. Industrial Designs

An industrial design is an innovation pertaining to the functional, ornamental or aesthetic aspect of a good. Industrial designs differ from patents in several fundamental ways. First, while patented inventions are primarily technology-based, industrial designs generally have low technology content and can even be purely artistic innovations. Second, industrial designs tend to be much more market-oriented in the sense that industrial designers are generally motivated by consumer preferences when developing new designs. As a result, industrial designs are brought to market relatively more quickly. Under TRIPS, the minimum protection granted to industrial designs is 10 years (relative to 20 years for patents).

Global industrial design applications worldwide grew substantially during 1997-2011. Notably, the average growth rate over this time period was 9.3%, the highest of all the forms of IPRs investigated in this paper. Examination of regional data reveals that Asia has played a dominant role in driving world industrial design applications: *Asia's share of global industrial design applications rose from roughly 50% in 2000 to 84% by 2011*. In contrast to patents, North America accounted for a very small share of global industrial design applications through-out the time period (hovering around 5%). Asia’s rise seems to have come at the expense of Europe whose share dropped rather sharply from around 31% in 2000 to 8% in 2011. Figure 2 summarizes these observations.

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Consider now the variation within Asia. The foremost observation is that during 2011, China accounted for over 80% of all industrial design applications in Asia, a sharp increase from its share of 38% in 1997. In 2011, China's share was about 20 times that of Japan and 10 times that of South Korea. Notably, as in the case of patents and trademarks, Japan’s share of Asian industrial applications shrank over time.

China's growth in industrial design applications is also striking within the context of BRICs. In 2001, the size of China's industrial design applications was about 16, 18 and 24 times larger than Brazil, India and Russia respectively. These remarkable ratios increased further to astounding levels of 76, 63 and 124 in 2011. Thus, the scale of innovative activity in China is getting progressively larger relative to other BRICs, a development that could have serious implications for the relative per capita incomes of these countries in the long run.

3.2. Utility models

A utility model is an intellectual property right similar to a patent but it is granted for smaller inventions.[13] Although a utility model is granted only if an invention is novel, it does not necessitate a sufficiently large inventive step as compared to a patent. Indeed, utility models are sometimes called "petty patents". The approval process of utility model is often simpler and shorter, as patent offices in most countries do not review the substance of utility model applications prior to registration. Moreover, the term of utility model is typically shorter, mainly ranging from 7 to 10 years with preclusion of extension or renewal.

The number of global applications for utility models more than quadrupled over 1997-2011 from one hundred and fifty thousand to more than six hundred and seventy thousand. This translates into an average growth rate of 11.2% per year over this time period. Notably, the growth of utility model applications has been even more striking in recent years. While the average growth rate over 1997-2008 was 6.8%, that over 2008-2011 was a remarkable 28.8%.

The dramatic growth of global applications for utility models was driven predominantly, once again, by China. *While China accounted for about 33% of global utility model applications in 1993, its share had risen to 87.3% in 2011*. This reflects an average growth rate of utility model applications of 19.2% in China over 1997-2011, and an even more remarkable growth rate of 37.4% over 2008-2011. Within Asia, today China is undoubtedly the dominant receiver of utility model applications: it accounted for 91.3% of these applications in 2011. Within BRICs, Russia follows China with the second largest number of applications. Notably, Russia and Republic of Korea are also the third and fourth largest offices for utility model applications.

Compared to patents, utility model applications tend to be more locally concentrated: residents enjoy a dominant share of such applications across countries. For example, China's resident share of utility model applications during 2011 was 99.3% while for patent applications the corresponding share was 79%. Also, in 2011 China Hong Kong featured a low share of resident patent applications of about 1.3% whereas the share of resident utility model applications was 63.2%. This pattern is prevalent worldwide and partly reflects the fact that innovations seeking utility models are less likely to be world-class and hence not profitable enough to justify seeking protection overseas.

Our discussion above indicates that one might expect utility model applications to be granted at a higher rate than patent applications. This hypothesis is strongly supported by data. For example, the estimated grant rate worldwide for utility models was 76.8% over 1997-2011 whereas that for patents was 44.3%.[14] Asian countries or BRICs for whom data are available

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[13] Not all countries grant utility models. For example, the US does not. Among Asian countries that we focus on, utility models are granted by all except India and Singapore.

[14] Since utility model applications are approved or rejected within a few months, we estimated the grant rate without lagging applications relative to grants.

exhibit grant rates for utility model applications that exceed 70%, while the grant rates for patent applications tend to be generally below 50%.

3.3. Trademarks

A trademark is a word, phrase, symbol, and/or design used to distinguish a good or service of one firm from those of other firms. Once a firm has established a reputation for a high quality product, its trademark allows the firm to benefit from repeat purchases and word-of-mouth references as well as other forms of promotional activities. Unlike a patent, a trademark does not have any time limits: once established, a trademark can exist indefinitely.

The number of global applications for trademarks more than doubled during 1997-2011 from about two million to over four million. Like patents, the sharpest increase was observed in Asia where the number increased from about half a million to over two million. By contrast, the increase in North America was relatively modest. While evaluating these numbers, it is worth bearing in mind that some of the best known trademarks of the world – such as Coca Cola, Macdonald's, and Levis – have existed for a long time and fewer new applications may be filed in countries (such as the US) that already have a large stock of well-known trademarks.

Figure 3 shows the global variation in trademark applications during 1997-2011.

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Perhaps the most noticeable aspect of this figure is the sharp increase in Asia's share of global trademark applications and the noticeable decline in Europe's share. Around 1997, both continents' share of global trademark applications was roughly 1/3rd but in 2011, Asia's share exceeded 50% while that of Europe was below 20%. Over the same time period, North America's share declined from roughly 15% to under 10%.

Within Asia, China was once again the stand-out performer. When compared with BRICs countries, the observed increase in trademark applications in China is even more remarkable. While the number of trademark applications filed in all BRICs countries during 1997 was relatively similar (with most of them having fewer than 100,000 filings and China being below 200,000), such is no longer the case: in 2011, trademark applications in China were more than seven times that in India, the BRIC country with second largest number of trademark applications in 2011.

4. Other evidence on innovation

In this section, we examine how the productivity and efficiency of R&D as well as the nature of innovative activity have evolved in Asia during the post TRIPS era.

4.1. Productivity and Efficiency of R&D

While patents and trademarks granted measure the output side of the R&D process, it is also useful to examine the input side. Figure 4 presents data on R&D intensities (measured as R&D expenditures divided by gross domestic product (GDP)) during 1998-2006.

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Several useful observations can be made from this figure. First, R&D intensity increased in all countries. Second, the sharpest increase occurred in China where R&D intensity more than doubled during this time period. Third, and perhaps most noteworthy, Japan's R&D intensity in 2006 exceeded not only the other Asia countries but also that of the US.[15]

It is also instructive to consider the variation across countries in terms of the productivity of R&D. We constructed a rough measure of R&D productivity by dividing the average patent granted to residents of each country during (2005-2010) by its lagged average R&D expenditure (during 2003-2005). These data are presented in Colum 3 of Table 1 which shows that R&D productivity in South Korea has been much higher than that in other Asian countries. Surprisingly, South Korean productivity surpassed even that of US and Japan. It is important to interpret our metric of R&D productivity carefully since it totally disregards the quality of patents.

An alternative, and in some ways a preferable, measure of the efficiency of a country's R&D investment is the value of royalties payments received by it on world markets divided by its R&D expenditure. Since current royalty income results from past R&D and because data on royalty payments for countries of interest is available only since 2000, we constructed a measure of R&D efficiency by dividing the average royalty payments received by each country during (2005-2010) by its lagged average R&D expenditure (during 2003-2005). Table 1 also reports this measure of R&D efficiency for the six Asian countries as well as the US.

It can be seen that Singapore and US had the highest levels of R&D efficiency, which is perhaps not unexpected given their generally superior environment for R&D activities. Japan and South Korea also demonstrate moderately high levels of efficiency, although Japan's R&D performance seems lower than one might expect. The most striking observation, however, is that China actually had the *lowest* R&D efficiency level relative to other countries under study. Once again, this is in sharp contrast to the recent surge of patent applications in China, suggesting that many of these innovations might be of low quality.

We should note here that royalty payments are only one channel via which innovators profit from their intellectual property. For example, instead of licensing its technology internationally, a firm may decide to produce a newly created product itself and export it to world markets. In such a situation, the return on its investment in innovation would show up as export revenues as opposed to royalties and licensing fees.

4.2. Nature of innovation

Since patents are granted for substantial innovations while industrial designs, and certainly utility models for relatively minor ones, further insight into the nature of innovative

[15] However, given the size of the US economy, the absolute level of R&D expenditures in Japan during 2006 were less than half that of the US.

activity in Asia can be gained by considering how the ratio of patents to industrial designs as well as that to utility models evolved during the period of our investigation.

Figure 5 shows the ratio of patent to utility model applications during 1998-2011 for residents of countries that grant utility models.

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Perhaps the most striking observation is that the ratio of patent to utility model applications was the *lowest* in China and increased only marginally over time. This suggests that the Chinese pattern of innovation has been skewed in favor of minor innovations relative to major ones. Moreover, even Brazil and Russia had slightly higher ratios than China although Russia's ratio declined over time. Korea shows an upward trend in this ratio since 2006, an indication that it is likely shifting away from minor innovations to major ones. Finally, somewhat expectedly, Japan's ratio of patent to utility model applications was significantly higher than that of all other Asian countries; indeed its ratio in 2011 was more than *sixty times* that of China's. While differences in the ratio of patents to industrial designs between China and countries like Brazil and Russia were not significant, the gap between China and Japan was substantial. It seems patently clear that China has some distance to go before it transforms into a major generator of world-class innovations.

One may also look at the ratio of patent to industrial design applications of residents as an alternative way of capturing the nature of innovation. The calculated ratios for the time period 1998-2011 are depicted in Figure 6. Once again, we see some similar patterns. For example, China again featured the lowest ratio of all countries and the gap between it and Japan was, once again, sizeable.

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Although the count data on filings and grants of various forms of IPRs is fairly informative in many respects, it does not tell us much about the effects of TRIPS in the market place. We now discuss the recent literature that addresses this important issue.

5. Direct evidence on economic effects of TRIPS mandated reforms

As we discussed earlier, both China and India were largely opposed to TRIPS. The logic for their position was two-fold. One, strengthening IPRs would strengthen market power of rights holders and therefore raise local prices. Second, there was concern that strengthening IPR protection would hamper their ability to absorb foreign technologies thereby slowing down their technological progress and economic growth.

As Branstetter and Saggi (2011) note, TRIPS proponents countered that foreign firms are more likely to transfer technologies to markets where IPRs are better protected. Similarly, multinational firms might favor locations that offered stronger IPR protection, especially when locating subsidiaries handling recent technologies or conducting R&D.

Available empirical evidence supports the argument that TRIPS enforcement is detrimental to consumer welfare (in the short run). For example, Chaudhuri et. al. (2006) conducted a counterfactual analysis based on a structural model of the antibiotic sub-segment of the pharmaceutical market in India and found that the elimination of local brands in the year 2000 would have resulted in significant welfare losses for Indian consumers. An interesting result of their empirical analysis was that local consumers in India showed a preference for local brands over foreign ones, perhaps due to the better developed distribution networks of local firms. While their analysis was confined to the Indian market, their findings with respect to the effects of TRIPS enforcement on prices would apply to developing countries at large since many of them import pharmaceuticals from India.

Since most developing countries are net buyers of patented goods, one would expect TRIPs to be regressive in the sense that it would cause income to be transferred from developing to developed countries. How large might such transfers be? McCalman (2001) estimates what the net present value of patents held by developed countries would have been in 1988 had the developing countries in his sample complied with TRIPS. His results indicate that these transfers ran into billions of dollars with the US benefitting more than other developed countries, a finding that fits well with the prominent role played by the US during TRIPS negotiations. On the other side of the equation, he finds that large developing countries such as Brazil and India stood to lose the most, a finding that is once again consistent with the vociferous opposition to TRIPS shown by these countries during Uruguay Round negotiations.

During the post-TRIPs era, net inflows of foreign direct investment (FDI) have increased to all major Asian countries under study except Japan. The rate of increase, however, varies across countries. Over 1997-2011, India experienced the highest average growth rate of net FDI inflows (of 17.9%). This was almost twice as high as that of Korea, which ranked second with a growth rate of FDI of 9.6%. However, despite its slower growth rate of 7.5%, China received the largest amount of FDI inflows in Asia. China also tops Asian countries under study in terms of the magnitude of FDI stock (7.1 trillion in 2011), with Singapore following closely behind (6.3 trillion in 2011). Nevertheless, in 2011, the ratio of FDI to GDP for China was below that of Singapore, Malaysia and India in 2011. Moreover, this ratio has been constantly declining for China while it has been increasing in India.

The global stock of FDI has also grown dramatically during the last decade or so: it increased from roughly $2 trillion in 1990 to over $22 trillion in 2012 (United Nations Conference on Trade and Development (UNCTAD), 2013). While most FDI flows still occur primarily between industrial countries, from 1990-2012, the share of global stock of FDI residing in developing countries increased from 25% to just over 33% (Maskus and Saggi, 2013).

Policy-makers and analysts value FDI not only because it can supplement domestic investment but also because FDI is a major channel of international technology transfer (Maskus, 2012). When measured by the receipts and payments of royalties and licensing fees, much of the global activity in technology transfer is within developed countries and occurs within the boundaries of multinational firms: in a typical year over 80 percent of global royalty payments for international transfers of technology are made from subsidiaries to their parent firms.[16]

So dominant are multinational firms in the field of innovation that the R&D spending of some of the largest multinational firms exceeds that of many developing countries, even large ones. For example, in 2009 Toyota Motor Corporation invested more in R&D expenditures than India, a country of roughly 1.2 billion people (UNCTAD, 2010).

The relationship between FDI and IPR protection has received significant empirical scrutiny in the literature.[17] As the survey by Park (2008) notes, as far as US data is concerned, there appears to be a clear positive relationship between the degree of IPR enforcement in developing countries and investment by US firms whereas results derived from non-US data portray a more mixed picture.

Branstetter, Fisman, Foley, and Saggi (2011) study the impact of IPR reform on multinational production by focusing on the responses of US multinationals to IPR reforms by sixteen countries in the 1980s and 1990s.[18] Their most important finding is that US-based multinationals expanded the scale of their activities in reforming countries after they undertook IPR reforms. They also showed that industry-level value added increase after reforms, particularly in technology-intensive industries.

While much of the focus in the empirical literature has been on how stronger IPR enforcement can help attract FDI, less attention has been paid to how increased FDI might contribute to local innovation. In a recent paper, Branstetter et al. (2013) examine data on patents issued by the US to foreign residents and find that a majority of patents in China (as well as India) have been granted to researchers working for subsidiaries of multinational corporations (MNCs). They argue that this development and the general rise of international co-invention reflects an expanded international division of labor within global R&D networks, much like the slicing of the global production chain across the world.

They also compare the quality of patents (as measured by citations) granted to Chinese or Indian indigenous inventions with those granted to (a) co-inventions with inputs from advanced economies and to (b) co-inventions with inputs from advanced economies under the sponsorship of multinational firms. They find that co-invented patents tend to be of higher quality, as do patents developed under the sponsorship of MNCs.

In a recent paper Hu and Jefferson (2009) investigate the factors that help explain the surge in Chinese patenting observed during the post-TRIPS era. They find that the

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[16] From 1990-2012, the royalties and licensing fee receipts of multinational firms increased from $27 billion to $235 billion (UNCTAD, 2013).

[17] For a nuanced and detailed discussion of this literature, see Maskus (2000) and Maskus (2012).

[18] The Asian countries included in their sample were: China, Indonesia, Japan, Malaysia, Philippines, South Korea, and Taiwan.

intensification of R&D in China explains only a small percentage of the increase in patenting. Their analysis points to increased FDI as a significant explanatory factor behind increased Chinese patenting, along with the changes in Chinese patent law that took place in 2000 and China's accession to the WTO in 2001. Since the latter two factors were captured by year dummies (for 2000 and 2001) in their analysis, it is hard to be certain that the underlying factors were indeed patent reforms and China's WTO accession but it is difficult to imagine other more important and relevant policy changes in China during those two years.

6. Asian emergence and the current policy environment

The empirical evidence discussed in this paper indicates that the scale of innovative activity in China has increased dramatically during the post TRIPS era. India too has experienced an increase in such activity, although to a much smaller extent. These facts are noteworthy because prior to the ratification of TRIPS, frictions between the US and China and US and India over violations of IPRs were fairly common. For example, both countries were frequently listed under the Super 301 annual list of trading partners that were deemed, the eyes of the US government, to have engaged in unfair trading practices. Does the changing global landscape of innovation imply that international frictions over the enforcement of IPRs are a thing of the past? This is almost surely not the case although the nature of underlying problems seems to have evolved.

Through-out the 1980s and early 1990s, US-China frictions over IPRs had to do with the widespread imitation of US products and technologies by Chinese firms as well as the infringement of copyrights. While these issues have not entirely gone away, several new ones have emerged in recent years. One of the major complaints that the US government has expressed about the current policy environment in China has to do with its policy of forcing foreign firms to share their technologies as a precondition for access to the local market. Starting in 1994, China started to impose specific technology transfer requirements on foreign firms wishing to enter its local market. This policy of exchanging market access for technology is best understood in the context of China's "indigenous innovation policy", which was first promulgated in 2009 by the Chinese Ministry of Science and Technology (MOST) when it provided conditions that would determine whether or not new products in six major industries could be viewed as having been the result of indigenous innovation. Only products that were deemed to be indigenous would be included in the catalog of approved government procurement lists, thereby setting up conditions for potential preferential treatment of indigenous innovation.

As Maskus (2012) explains, this focus on indigenous innovation can easily run afoul of the national treatment obligation of TRIPS and raised substantial concern among foreign enterprises owning IPRs. In response to these concerns and other external pressures, MOST circulated a revised and weaker draft of the indigenous innovation policy in 2010. At this time, there is considerable uncertainty regarding the true nature and actual implementation of this policy. Rest assured, if discrimination against foreign innovators becomes widespread or systemic, one would expect the dispute settlement process of the WTO to play an active role in refereeing and clarifying this Chinese policy.

During the Uruguay Round negotiations (when China was not a member of GATT), India was a leading opponent of strengthening IPR protection in developing countries. But TRIPS came to pass and India had to significantly alter its patent regime in order to comply with TRIPS. Since developing countries had been given up to 10 years to make their IPR regimes TRIPS compliant, India's introduced significant patent reforms in 2005. Prior to these policy changes, India did not recognize product patents for pharmaceuticals. As a result, prior to the 2005 patent reforms, reverse engineering and imitation were rampant in India and were indeed the key drivers behind the development of India's robust pharmaceutical industry. The explicit recognition of product patents in 2005 made an imitation based development strategy unviable for Indian. The focus now seems to have shifted toward increased collaboration with multinational firms in order to participate more vigorously in the global R&D chain, with an eye towards moving from imitation to innovation.

In 2012, frictions between India and the pharmaceutical multinational Bayer flared up when India issued a compulsory license for Bayer's cancer drug Nexavar. This episode raised the possibility that India could try to use its substantial manufacturing capacity in the area of pharmaceuticals to break patents held by foreign firms thereby weakening its IPR regime while still maintaining TRIPS compliance. However, since then India has not issued any further compulsory licenses; in fact, the Department of Industrial Policy and Promotion recently rejected a request for compulsory licensing because the Indian generic producer (BDR Pharmaceutical) seeking the compulsory license had failed to try to obtain a voluntary license from the patent-holder (Briston-Myers Squibb), as is required under TRIPS rules.

7. Concluding remarks

The face of global innovation is changing, particularly within Asia. Like in world trade, the major story in the realm of intellectual property has been the emergence of China on the global stage. While the volume of patenting activity observed in China during the post TRIPS era is undoubtedly impressive, the same cannot be said, at least yet, of its quality. It is important to bear in mind that, owing to the public good nature of knowledge and the cumulative nature of the innovation process, an increase in the quality of innovative activity in China is not just in the interest of China but also the rest of the world.

What are the implications of the changes in global landscape in the area of intellectual property that have been witnessed during the post TRIPS era? Perhaps the most important is this: the scope for frictions among major nations such as US and China may have been reduced with the emergence of Chinese innovation and with the recognition among China's policy-makers that they need to improve the quality of local innovation. This implies that China now has a stronger interest in protecting intellectual property than it did two decades or so ago when TRIPS was ratified.

A similar argument applies to the US-India relationship. Today, the Indian pharmaceutical industry is warmer to the idea of stronger intellectual property protection than it has ever been in the past. It is clear that stronger IPR protection is necessary for the Indian industry to participate in global R&D in a manner that is commensurate with its technological capabilities. If this process is hampered, it is difficult to see how India can transform itself from simply being a “pharmacy to the world” to an engine of innovation in the pharmaceutical sector, an area where it has developed significant technological capacity. Till date, this capacity has not translated into any major new innovations, something that is more likely to happen if the Indian industry starts to collaborate more with major multinationals as opposed to merely playing an imitative role, as it has done in the past. Some of the emerging empirical evidence regarding the rise of international co-inventions suggests that this has indeed begun to happen.

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Table 1: IPR protection, R&D, and patent applications

	Ginarte-Park index				Patent Applications		National R&D	
					Resident Share		Productivity	Efficiency
Country	1995	2000	2005	2010	1997	2011	2003-05	2003-05
China	2.12	3.09	4.08	4.21	0.51	0.79	1.86	0.10
India	1.23	2.27	3.76	3.76	0.19	0.21	0.36	0.16
Japan	4.42	4.67	4.67	4.67	0.87	0.84	1.02	0.93
Malaysia	2.70	3.03	3.48	3.68	0.03	0.17	0.26	0.84
Singapore	3.88	4.01	4.21	4.21	0.05	0.11	0.20	1.87
South Korea	3.89	4.13	4.33	4.33	0.73	0.77	3.29	0.73
US	4.88	4.88	4.88	4.88	0.54	0.49	0.26	1.77

Source: Private email communication with Walter Park and WIPO Statistics Database.

Table 2: Patent applications filed abroad by residents

Country	2000	2005	2010
Brazil	15.9%	17.6%	26.3%
China	4.3%	4.6%	5.0%
India	23.6%	41.2%	40.5%
Japan	21.8%	30.6%	38.1%
Malaysia	8.9%	43.3%	36.5%
Russia	3.0%	8.3%	11.7%
Singapore	26.8%	70.0%	78.8%
South Korea	15.1%	24.9%	26.2%
US	41.3%	45.8%	44.1%

Source: WIPO Statistics Database

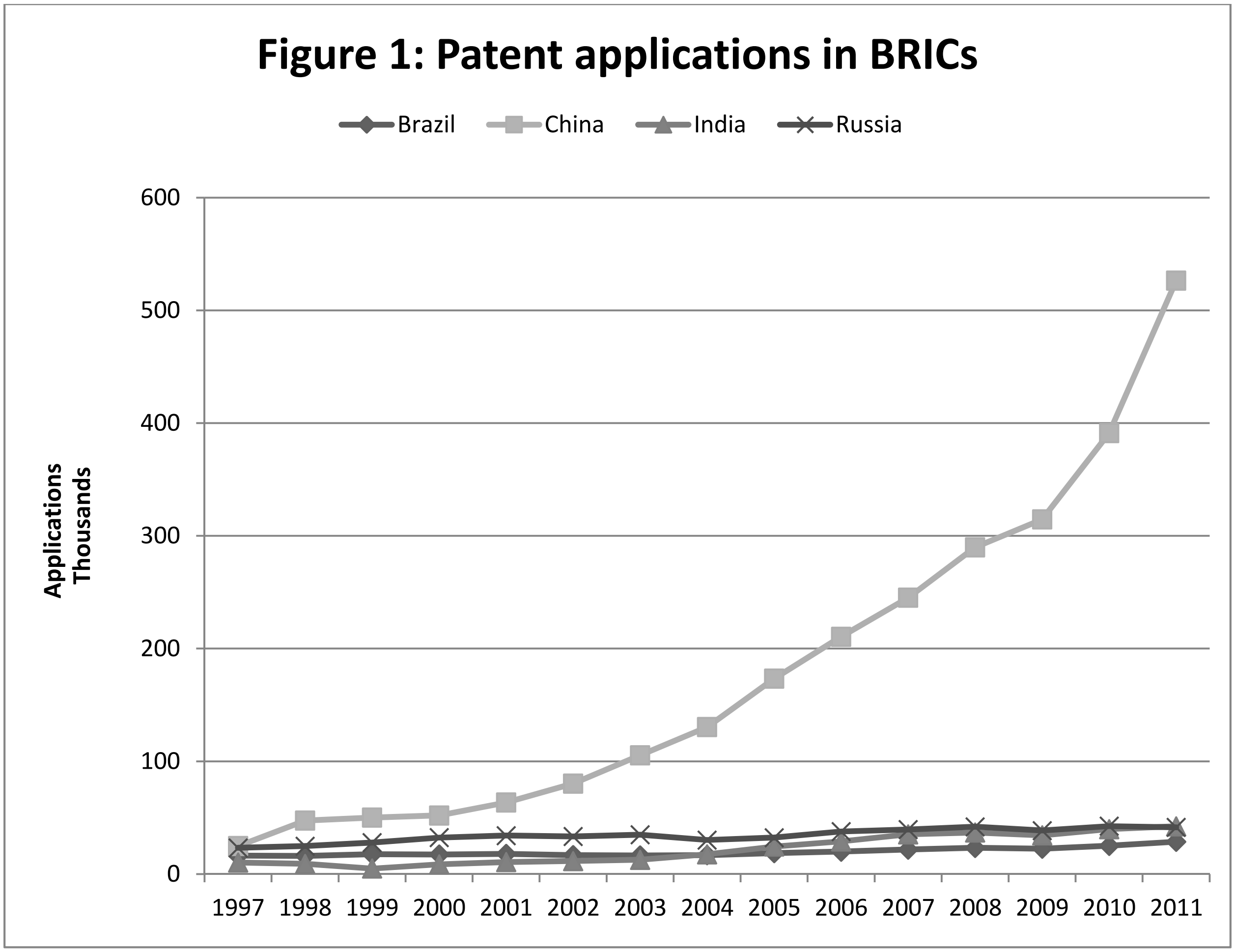
Figure 1: Patent applications in BRICs
Brazil
China
India
Russia
Applications
Thousands
600
500
400
300
200
100
0
1997
1998
1999
2000
2001
2002
2003
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2008
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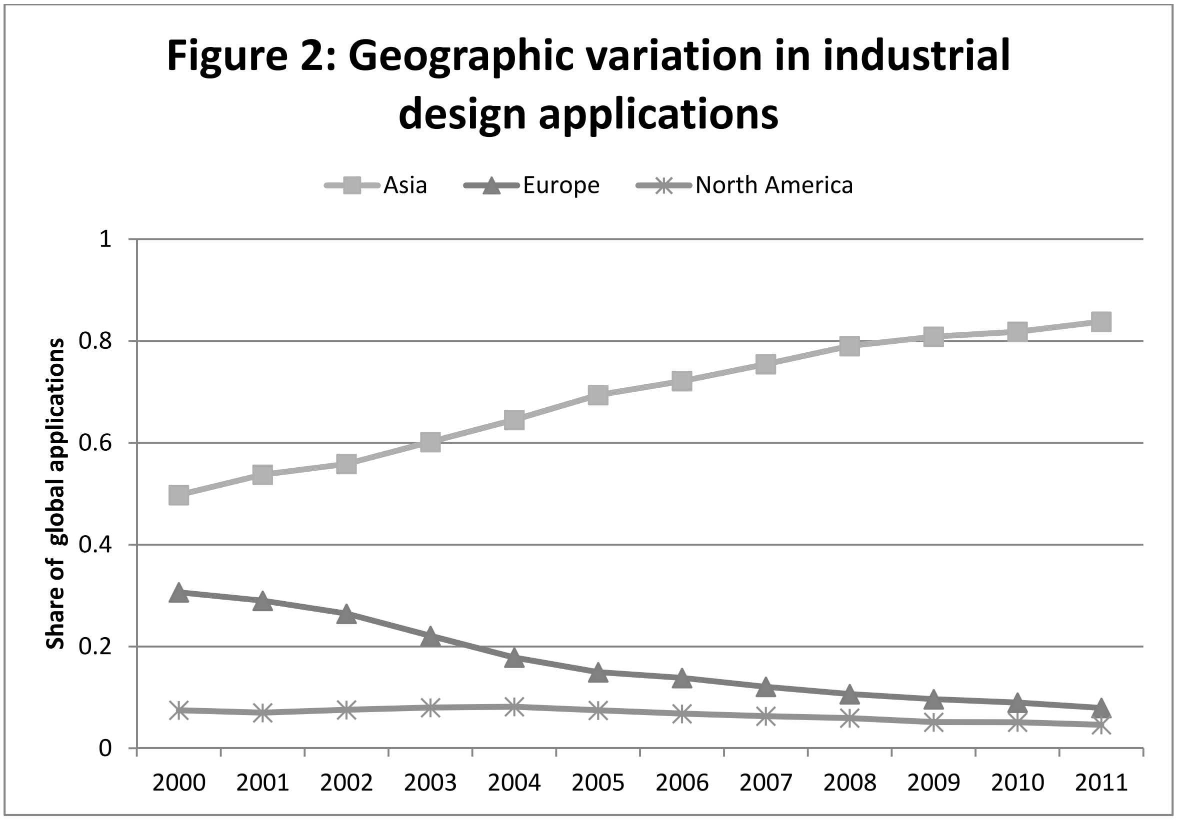
2011



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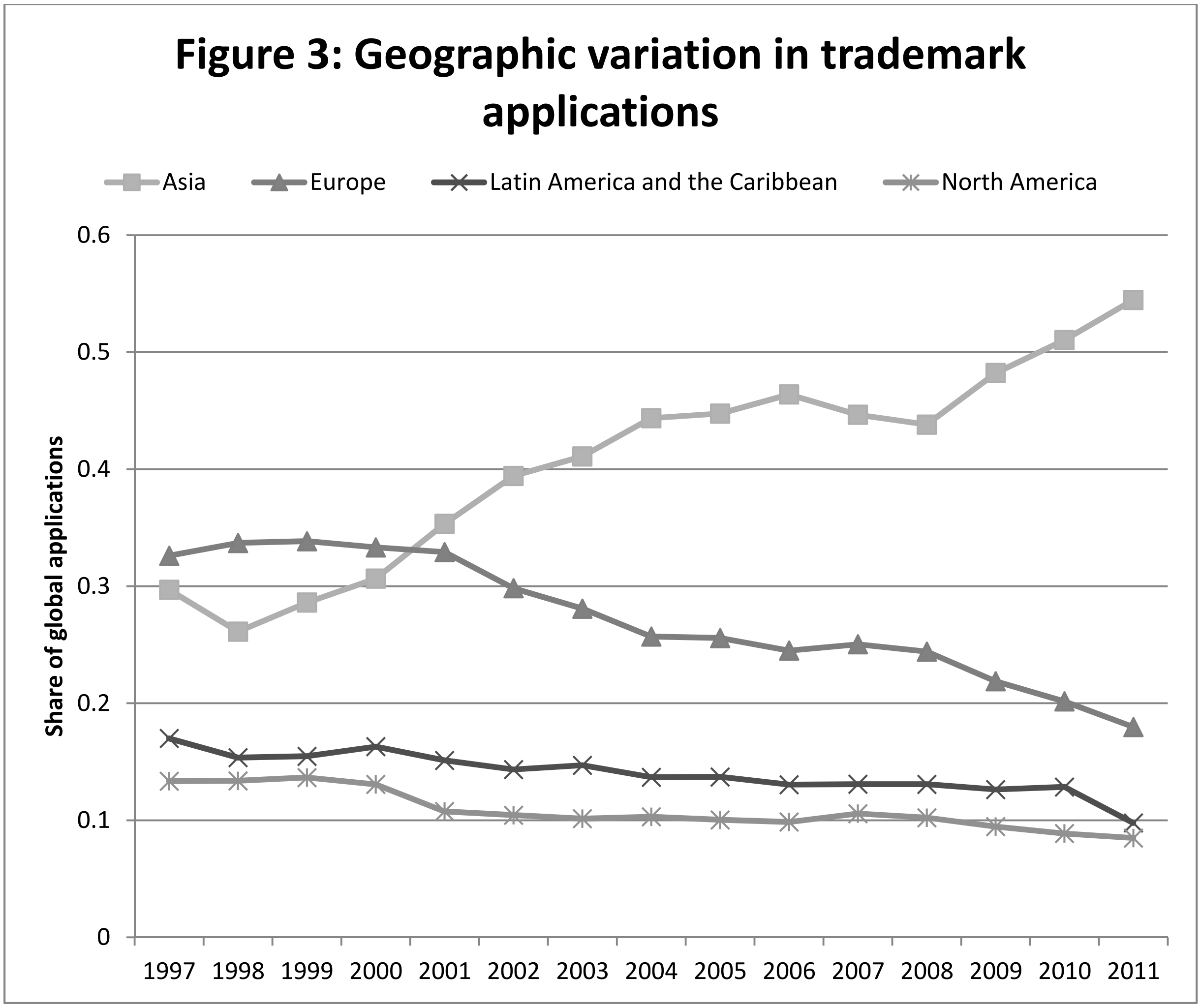

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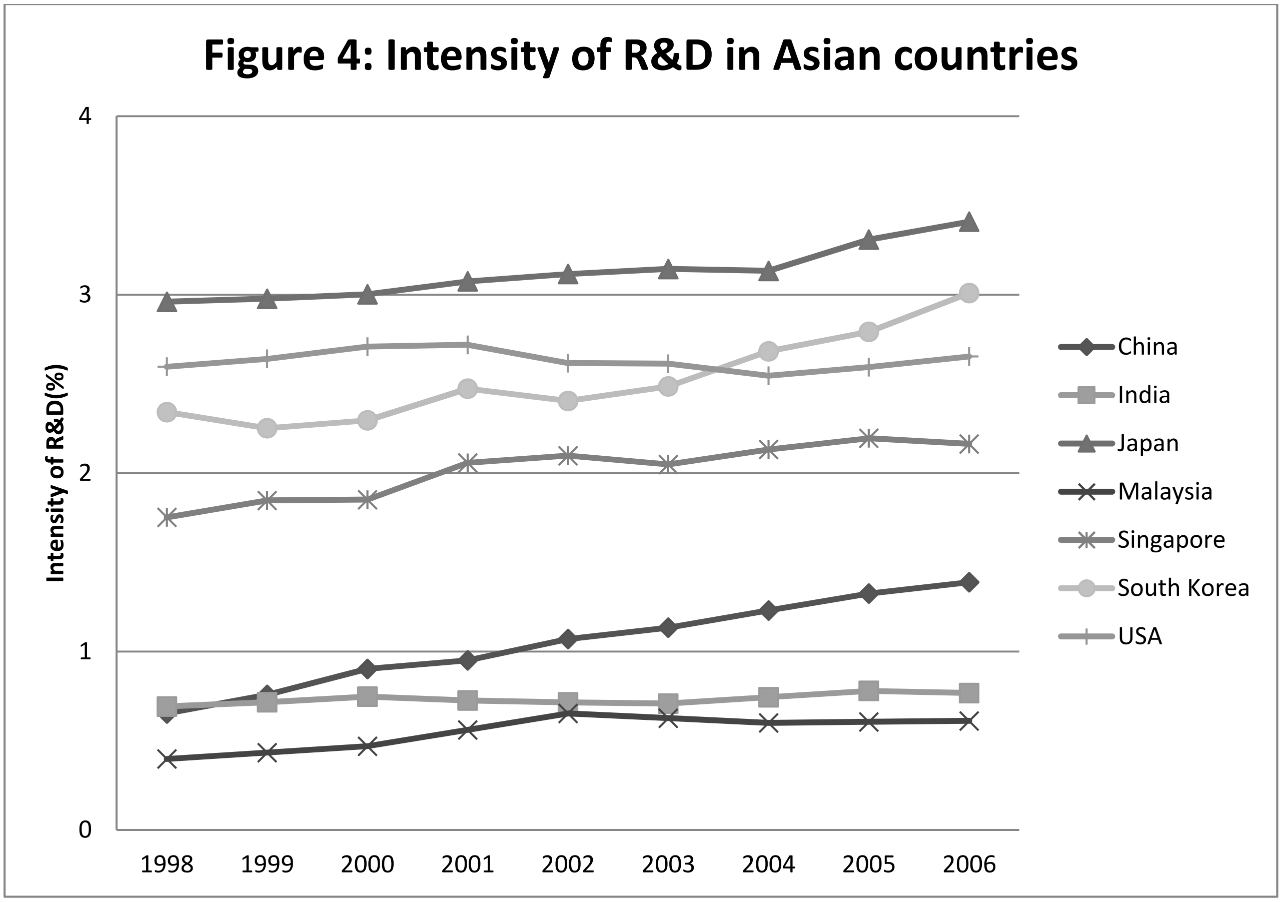
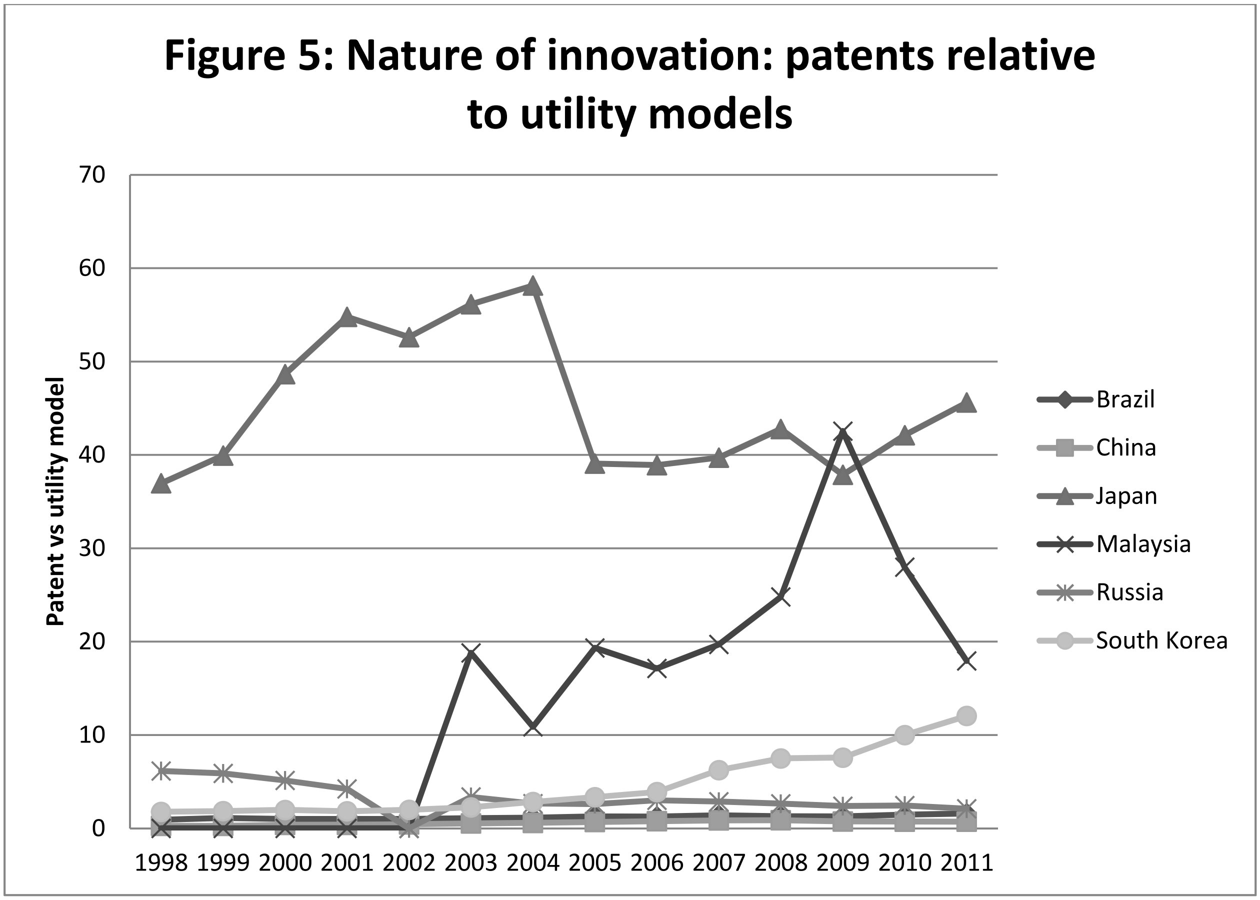
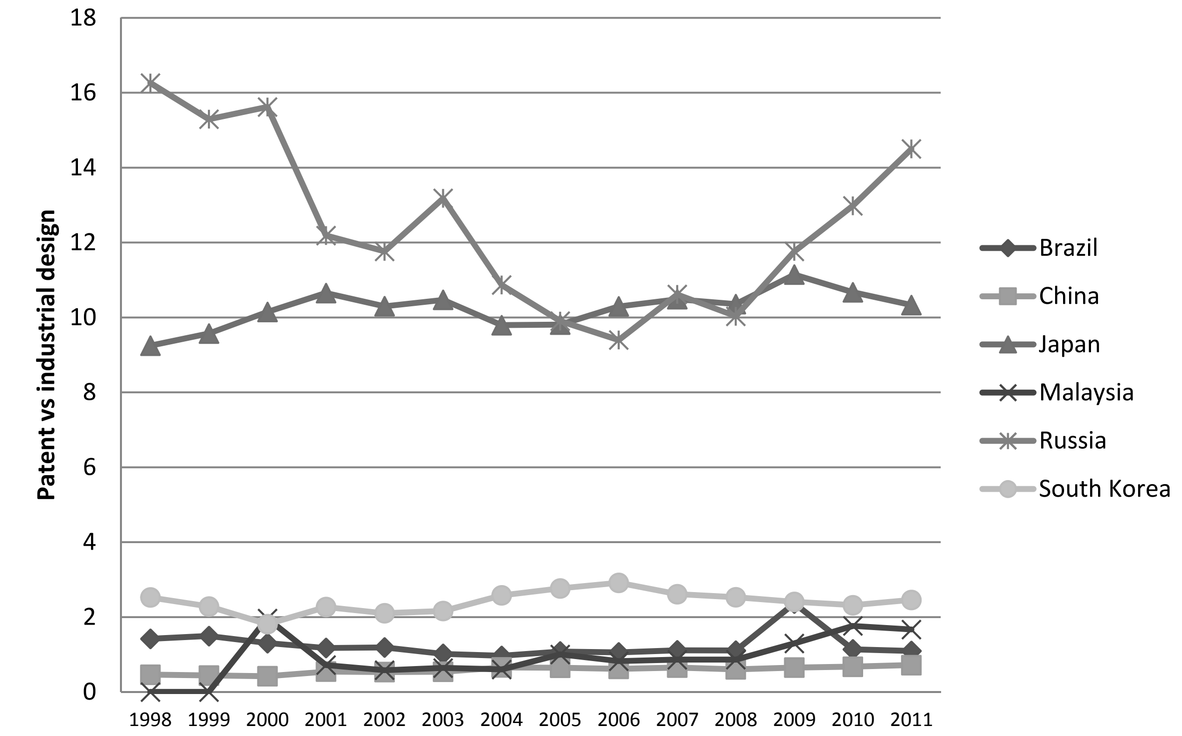


Source: World Development Indicators 2013



Source: WIPO Statistics Database

Figure 6: Nature of innovation: patents relative to industrial designs



Source: WIPO Statistics Database