Do Stronger Intellectual Property Rights Protection Induce More Bilateral Trade? Evidence from China's Imports

Titus O. Awokuse*

Department of Food & Resource Economics

University of Delaware

Newark, DE 19717, USA

Email: kuse@udel.edu

Hong Yin

Department of Economics

University of Delaware

Newark, DE 19717, USA

Email: iris_yin@yahoo.com

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Abstract

Most of the previous studies on the effect of IPR protection on international trade have been from the perspective of major industrialized nations. However, much of the current debate on the effects of IPR protection involves large developing countries with high threat of imitation. This study contributes to the literature by analyzing the impact of the strengthening of patent laws in China on its bilateral trade flows. We estimate the effects of patent rights protection on China's imports at the aggregate and detailed product categories for both OECD (developed) and non-OECD (developing) countries. The empirical results suggest that increased patent rights protection stimulate China's imports, particularly in the knowledge-intensive product categories. Furthermore, while the evidence in support of the market expansion effect is significant for imports from OECD countries, it is rather weak and mostly insignificant for imports from non-OECD countries.

Key words: Intellectual property rights, patent laws, international trade

JEL classification: F13, 034

1. Introduction

In the past two decades, the nature of the linkages between intellectual property rights (IPR) and international trade has been the source of much debate and controversy. Disagreements persist on whether stronger IPR stimulate or discourage trade. Two key developments contributed to the recent interest in this issue. In the political arena, the status of IPR as a form of trade barrier became an issue of greater global concern after the enactment of a special provision in the US Trade Act of 1988 which linked American trade policy to the prevailing IPR regimes in bilateral trading partner nations. In addition, IPR became even more important when increasing national disputes over IPR led to the multilateral World Trade Organization's (WTO) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs) in 1994. Since trade in knowledge-based goods is an important source of innovation and technology for low-income countries, it is not surprising that one of the main issues surrounding the IPR debate was centered on the need for greater IPR protection in developing countries. But despite the importance of IPR laws to developing countries, relatively limited empirical evidence exist on the impact of IPR regimes on bilateral trade flows with developing nations (Schneider, 2005).

This study contributes to the literature by analyzing the impact of the strengthening of patent laws in China on its bilateral trade flows. China's recent reform of its patent laws and its status as a large developing nation with strong threat of imitation makes it an interesting case study on the effect of patent protection on trade. As in previous studies, we also explore the possibility that the trade effect of patent protection may vary by product sectors and by the level of economic development in trading partner countries (Maskus and Penubarti, 1995; Smith, 1999). Since industrialized countries, i.e., major OECD countries, are the main producers of new technology, we expect that the strengthening of patent protection in China will have a stronger effect on bilateral trade (import) flows to China from OECD countries relative to import flows from non-OECD countries. The results from this study provide much needed empirical evidence on the current debate regarding policy reforms in IPR regimes and its effects on technology transfer and trade with China.

This paper differs from previous studies in several ways. First, this is the first empirical study based on one developing country which experienced significant changes in its IPR systems (including its patent laws) in the past two decades. Thus, this analysis from the perspective of a large developing country provides an alternative to most previous studies which usually emphasize export flows from a major industrialized nation to a diverse group of importers (Maskus and Penubarti, 1995; Smith, 1999; Rafiquzzaman, 2002). Second, in contrast to studies based on data from a single year, this study uses a panel data (1991-2004) which covers a more extended time period and allows for the consideration of the dynamic nature of the relationship between international trade and policy changes in patent regimes.

Third, we use an alternative measure of patent rights that may be more reflective of actual patent activities. Previous studies typically use patent rights indices or scores based on the works of Rapp and Rozek (1990) and Ginarte and Park (1998). These indices usually use a scoring method that is often arbitrary in the choice of weights on the importance of various criteria. Although useful in some cases, the index-based measures of patent rights may not adequately capture the dynamic nature of the interaction between changes in patent laws and standards over time and their potential impact on other economic variables (e.g., trade). When possible, it may be more instructive to use actual data on the number of patent applications over time as adopted in this study. Thus, we use annual patent applications from importing countries as a measure of the strength of patent rights protection in China. The growing number of foreign patents filed each year can be a good indicator of growing confidence of foreign firms in the patent rights protection offered in China. This measure of patent rights strength accounts for more variation across time and may be less susceptible to measurement errors.

The main finding from this study is that the strengthening of patent laws in China led to an increase in its import flows, particularly in knowledge-intensive goods. This paper's empirical results further support the hypothesis that the strengthening of patent laws has a market expansion effect in China. However, we also find that market expansion effect is only strong and significant for imports flows from major OECD countries, though the effect seems to be declining over the years. In contrast, the evidence for market expansion effect is much weaker for imports from non-OECD countries. Also, the results suggest that the effects of patent rights protection on import flows vary by different product sectors and are strongest in the knowledge-intensive sectors.

The rest of the paper is organized as follows. Section 2 contains a brief review of literature on the trade effects of IPR. Section 3 describes the model specifications and data sources. Section 4 provides a discussion of results and section 5 concludes the paper.

2. Patent rights protection and international trade: A Puzzle

2.1 What does theory predict?

Although the theoretical linkage between patent rights and innovation has received much attention, relatively fewer theoretical studies exist on the relationship between patent rights and international trade (Chin and Grossman, 1988; Helpman, 1993; Ethier and Markusen, 1996; Maskus and Penumbarti, 1997; Markusen, 2001; Qian, 2007). The existing theory suggest that the strengthening of patent rights protection could have two opposing effects on bilateral trade flows between countries: market expansion or market power effects (Maskus and Penubarti, 1995).

A market expansion effect may occur if the strengthening of patent protection discourages domestic firms from imitating the technologies embodied in imported goods. The resulting reduction in the production of competing domestically produced imitation goods should encourage foreign firms with better technologies to expand their exports to those markets as a result of increased net demand for their products. In contrast, a market power effect may occur if foreign firms respond to stronger patent laws in an importing nation by choosing to reduce their foreign market sales in that market and take advantage of higher unit price. The countervailing nature of the market expansion and market power effects implies that the direction of the impact of patent rights strengthening on trade is ambiguous (Maskus and Penumbarti, 1995; Smith, 1999). This ambiguity could be attributed to the complex interactions between local market demand, the degree of imitative production, and the nature of trade barriers (Maskus, 2000, p.113). Thus, the debate is on-going regarding the nature of the relationship between IPR and international trade. Since this is an empirical question, most of the previous investigations have been data-driven.

2.2 Review of previous empirical studies

In a seminal study, Maskus and Penubarti (1995) used an augmented version of the Helpman-Krugman model of monopolistic competition to estimate the effect of patent protection on international trade flows. Their results, based on 1984 bilateral trade data, show that the market expansion effect dominate the market power effect as they found that higher levels of patent protection have a positive impact on manufacturing exports of OECD nations to developing countries. Subsequent studies provide some qualifications on the evidence in support of market expansion effect. Smith (1999) further extends this line of inquiry by exploring the effect of the threat of imitation in the importing countries. The threat of imitation is weakest in countries with weak imitative abilities and strong patent laws and is strongest in countries with strong imitative abilities and weak patent laws. The market expansion effect is expected to be more pronounced in the market with high threat of imitation, while the market power effect should be more likely in importing countries with low threat of imitation. Using US manufacturing exports data, Smith (1999) showed that the link between patent rights protection and international trade depends on the ability of the importer to imitate the exporter's technology. She found empirical evidence supporting the market expansion effect for US manufacturing exports to countries with high imitation threat, but found the market power effect to be more prevalent for exports to countries with weak threat of imitation.

In a recent study based on Canadian exports data, Rafiquzzaman (2002) found similar results indicating that stronger patent laws induced more Canadian exports to countries with strong threat of imitation and less exports to those markets with weak threat of imitation. In addition, Fink and Braga (1999) examined the IPR and trade nexus using 1992 data for a cross-section of 89 countries and found that stronger patent rights increase bilateral flows of manufactured non-fuel imports. They noted that the positive link is weaker for trade in the high-technology sectors. Other studies on the relationship between patent rights and trade flows to developing countries draw similar conclusions (Lesser, 2001; Park and Lippoldt, 2003).

2.3 Patent rights protection in China

Among developing countries, China is particularly suitable as a case study for analyzing the impact of IPR reforms on bilateral trade flows. Although China is one of the largest economies in the world and operates a significant trade surplus with most other nations, it is a net importer of capital-intensive manufacturing products. For example, about 80% of China's imports are used as intermediate inputs in its growing manufacturing sectors (Tongzon, 2001). Surprisingly, China had no patent rights protection before 1985. However, since the establishment of its first patent law in 1985 and its substantial revision in 1992, China has undergone a gradual reform of its patent systems in order to achieve compliance with international laws. Although the 1985 version of China's patent law contained its most comprehensive requirements hitherto, it still lacked several important components.

In 1992, mainly due to the pressure from the United States, China's patent law was substantially amended to bring it closer to those of many industrial nations (Allison and Lin, 1999). The strengthening of China's patent laws was also accelerated by its membership in several IPR-related international treaties, such as the World Intellectual Property Organization (WIPO) in 1995. Most recently, the latest revision of China's patent law was made in 2000 as part of the preparations for China's entry into the World Trade Organization (WTO). Furthermore, as a recent member of the WTO, China has also made significant efforts toward aligning its IPR laws (i.e. patents, copyrights and trademarks) with the requirements of the TRIPS agreement and other major international IPR conventions (Maskus, 2004, 2006).

Since 1992, foreign patents have increased steadily with an annual growth rate of 19% (see Figure 1).[1] The majority of Chinese patents (invention patent applications) are filed by foreign firms and the most important foreign patentees are from Japan, the US, EU countries, and South Korea.

3. Econometric methods

3.1 Model Specification and Hypotheses

We apply a conventional gravity model of bilateral trade to estimate the effects of China's patent rights protection on its import flows. The gravity model has a long history in theoretical and empirical studies of international trade (Anderson, 1979; Bergstrand, 1989, 1990). Typically, it estimates bilateral trade flows as a function of exporter and importer characteristics and various determinants of trade, including factors that distort trades (e.g., tariff). The gravity model could be represented by the following equation:

$$IMPORT_{ijt} = \alpha(GDP_{it})^{\beta} (GDP_{jt})^{\delta} (DIST_{ijt})^{\gamma} (A_{ijt})^{\eta}\varepsilon_{ijt}, \qquad (1)$$

where i, j, and t are indexes for the source country, the destination country and year, respectively. $IMPORT_{ijt}$ denotes the imports of the source country to the destination country (China). Gross domestic product (GDP) is employed as a proxy for national income or market size. GDP_{it} and GDP_{jt} denote the GDP of the source and destination countries, respectively. The variable $DIST_{ij}$ measures the distance between the source and the destination countries. A_{ijt} represents trade distortion factors, and ε_{ijt} is a normally distributed error term with zero mean and constant variance.

[1] The figure is computed by the authors, based on the patent data collected directly from Chinese patent database CNPAT ABSDAT (http://www.sipo.gov.cn).

Equation (1) could be augmented with the inclusion of Chinese tariff rate ($TARIFF_{ijt}$) and a measure of patent rights protection in China ($PATENT_{ijt}$). After taking the natural logs, the resulting model is expressed as:

$$\text{Log}\,(IMPORT_{ijt}) = \alpha + \beta_1 \text{Log}\,(GDP_{it}) + \beta_2 \text{Log}\,(GDP_{jt}) + \beta_3 \text{Log}\,(DIST_{ijt}) + \beta_4 \text{Log}\,(1+TARIFF_{ijt}) + \beta_5 \text{Log}\,(PATENT_{ijt}) + \varepsilon_{ijt} \quad (2)$$

where β_1 and β_2 represent the income elasticities of import demand and the expected sign is positive. β_3 is expected to have a negative sign as distance is a proxy for transportation cost which should vary inversely with imports. for β_4 is the import tariff coefficient and the expected sign is negative indicating that higher tariff rate should discourage imports. As discussed previously, the existing theory suggests that the sign of the coefficient on the patents variable, β_5 is ambiguous. A positive sign on this parameter estimate will provide support for the market expansion effect while a negative sign will suggest support for the market power effect. Nevertheless, since China is commonly perceived as a large country with strong threat of imitation, it is reasonable to hypothesize that the market expansion effect will dominate such that stronger patent protection will result in more imports into China .

3.2 Model estimation and data issues

Hsiao (2003) argues that OLS estimates of equation (2) may yield biased estimates if certain specification issues are not adequately addressed. First, for a large and diverse cross-section of countries as in this study, OLS is subject to unobservable heterogeneity bias. A common remedy is the specification of a model that includes country-specific effects in the panel regressions. Hausman (1978) specification test result suggests that the random effects model is more appropriate than the fixed effects model. The random effects estimator, which accounts for the unobserved country-specific effects, requires the transformation of equation (2) so that each variable for each country is normalized such that the time-invariant country-specific effects are removed. The mean of unobserved and specific country effects is reflected in the single constant term.

Furthermore, for a cross-section of countries of various sizes as in this study and given the notable growth in China's bilateral trade, it is plausible to expect the presence of heteroskedastic errors. Likelihood ratio test for heteroskedasticity was applied and the null hypothesis of homoskedastic errors was easily rejected at the 5 percent significance level suggesting the presence of heteroskedasticity (Green, 2000). Hence, the parameter estimates reported in the tables are based on robust standard errors from Huber-White's heteroskedasticity-consistent covariance matrix.

In addition, there is the potential for simultaneity bias because the causal link between imports and some of the regressors may be bi-directional. For example, while import growth may affect GDP, the reverse is also possible. Furthermore, countries with higher per capita income tend to export more on average and have higher likelihood of producing patented knowledge-intensive products. If endogeneity problem exists, then an instrumental variable (IV) estimation method is more appropriate. Results from the Hausman test for the disaggregate product level data indicate that the null hypothesis of no simultaneity bias could not be rejected at the 5 percent significance level. Thus, in order to account for cross-sectional heterogeneity, a feasible generalized least squares (FGLS) estimation technique was applied to the data (Baltagi 2001, p. 79-80).

The analysis involves the estimation of equation (2) for both aggregated import and for twenty manufacturing product sectors, using a panel data set covering 1991-2004. In order to remove short-term cyclic fluctuations of patent filings, three-year averages were used.[2] The sample consists of 36 countries which include 21 OECD countries and 15 non-OECD countries. These are the top trading partners of China with significant number of patent applications over the estimation period. The summary statistics of variables used in this study are provided in Table 1.

Gross domestic product (GDP) of both source countries and China are taken from *World Development Indicators 2006.* Trade data ($IMPORT_{ijt}$) for the twenty product sectors are organized according to the 2-digit classification of the Standard International Trade Classification (SITC) and were obtained from the United Nations Comtrade database.[3] These sectors can be further grouped into knowledge-intensive products (mainly outputs from science-based industrial sectors) and non-knowledge-intensive products (mainly outputs from traditional or low-tech industrial sectors). All import values are deflated to 2000 constant US dollar using China's CPI index. As in previous studies, the tariff rate ($TARIFF_{ijt}$) is measured as the ratio of total import duties to the total value of imports (Maskus and Penubarti, 1995; Fink and Braga, 1999; Rafiquzzaman, 2002). The data on tariff duties were obtained from various issues of *China Statistical Yearbook*. The distance variable is measured as the distance in miles between capital cities of importing countries and China (http://www.indo.com/distance).

[2] The data used the following averages: 1991-1993, 1994-1996, 1997-1999, 2000-2002, and 2003-2004. Thus we have a total of 180 observations for model estimations.
[3] UN Comtrade database is available at http://unstats.un.org/unsd/comtrade.

3.3 Measurement of patent rights protection

In several previous studies, the strength of patent rights protection was measured using IPR indexes constructed by Rapp and Rozek (1990) and Ginarte and Park (1997). These popular IPR rankings are usually based on five components: (1) the extent of patent rights coverage, (2) membership in international treaties, (3) enforcement mechanisms, (4) duration of protection, and (5) provisions against loss of protection. While this approach for measuring IPR strength has its merits, it also has some limitations. For example, the indexes are based on laws on the books and may not accurately reflect dynamic changes in actual patent protection practices in these countries. The criteria used in constructing the indexes could be quite subjective with potential for large measurement errors and may not adequately reflect the effect of diversity in levels of economic development (Fink and Braga, 1999).

In contrast to other studies, we measure the strength of patent protection as the actual number of patent applications ($PATENT_{ijt}$) from importing countries. We assume that the steady and growing number of patent applications from industrialized countries in the last decade closely reflects the growing confidence of foreign firms in the improvements in China's patent rights protection. Thus, we employ patent applications from importing countries as a proxy for the strength of patent rights in China. Relative to the available IPR scores, this measure of patent protection provides more variations and less measurement errors from more subjective considerations in constructing IPR indexes. The data for patent applications were obtained directly from official Chinese patent database. This database is maintained by the State Intellectual Property Office (SIPO) of China (http://www.sipo.gov.cn).

4. Empirical results

4.1. All Countries Combined

Table 2 presents the empirical results for the estimated random effects model from equation (2) using data for all countries combined. The first row reports parameter estimates for aggregate imports while subsequent rows contain estimates for disaggregated 2-digit SITC product categories. In general, the coefficients on the control variables (incomes for exporters and China, tariff, and distance) have the expected signs and are significant at the 10 percent level. The remainder of the discussion of results will focus on the effect of the patent variable on imports. At the aggregate product level, the effect of foreign patents on imports has the expected positive but is statistically insignificant at the 5 percent level (see Table 1, first row). It is possible that the high level of data aggregation (product categories and level of development differences across countries) is hiding much of the impact of patents on imports. It may be more interesting to examine the effect of patents at a less aggregated product level.

At the disaggregated product sector level, the impact of patents appears to be relatively stronger. The results (shown in Table 2) indicate that strengthened patent rights protection have a positive and significant effect on imports in seven product categories and negative and significant effect for one sector (beverages and tobacco). This finding implies strong support for the market expansion hypothesis. Furthermore, the market expansion effect tend to be stronger and larger on average in knowledge-intensive sectors (i.e., electronics, instruments, machinery, pharmaceuticals, rubbers and transports) where the manufacturing process usually involves significant investment in research and development. The impact of patents on pharmaceuticals (where the patent coefficient equals 1.07) is the largest among the sectors. Since the majority of patents are filed by knowledge-intensive product sectors, it is not surprising to find that the impact of patents is relatively larger in these sectors. The results at the sector level are supportive of the theory that the market expansion effect is predominant in a large market with high threat of imitation (Smith, 1999).

A notable exception to the finding of market expansion effect is in the beverages and tobacco sector where the patent coefficient value is -0.716. This sector's negative and statistically significant estimate provides some evidence in support of the market power effect. This finding is consistent with Smith (1999) who also found evidence for market power effect of increased patent protection in the US exports of tobacco products.

4.2 OECD countries versus non-OECD countries

Next, we consider the possibility that the impact of patent protection on imports may vary by the level of economic development. OECD countries are the major sources of advance technologies and consequently majority of foreign patents in China are filed by those countries. In contrast to imports from non-OECD nations, technologies embodied in imports from OECD countries are on average more patent-related. Most developing (or non-OECD) countries still lack sufficient innovation ability to develop high level technologies which are worth patenting. Thus, we expect the effect of patent rights protection on imports to be more pronounced across all sectors for OECD countries, but should be relatively weaker and less significant for non-OECD nations. Using the World Bank Development Indicators classification scheme, the countries in our sample were divided into two groups: high-income OECD (developed) and low-income non-OECD (developing) countries.[4]

[4] The OECD countries used in the analysis includes: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Israel, Italy, Japan, Korea, Netherlands, New Zealands, Norway, Spain, Sweden, Switzerland, United Kingdom, USA.

Table 3 contains the results from the estimation of equation (2) for high-income OECD (developed) countries only. In general, the evidence indicate that patent protection have a positive impact on China's imports, further confirming the support for a market expansion effect. At the aggregated product level, the model fits improved significantly from the combined countries results in Table 2. The patent coefficient (0.343) is positive and statistically significant. Similarly at the disaggregated product sector level, the estimated patent coefficients are positive and significant for nine sectors and negative and significant for one sector (i.e., beverages and tobacco). The market expansion effect is more pronounced in knowledge-intensive sectors: nine of the knowledge-intensive sectors are significant. For knowledge-intensive sectors, the estimated patent coefficients range from 0.574 in plastics to 0.926 in instruments. These results show again that the effects of patents on imports vary not only between knowledge-intensive sectors and non-knowledge-intensive sectors but also within these two categories. Similar to previous results, the beverages and tobacco sector has a negative and statistically significant estimated patent coefficient value of -1.310, suggesting evidence for market power effect of increased patent rights protection in this secto.

The variations in the effects of patents across product sectors can be attributed to various reasons. For instance, the propensity to obtain patents for a product varies across different industrial sectors, due to different technology opportunities, and market conditions. In some industries firms have alternative means to appropriate the returns to their investment, such as lead-time advantages or brand name reputation, or their technologies may be difficult

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The non-OECD countries are: Argentina, Brazil, Chile, Czech, Hungary, India, Indonesia, Malaysia, Mexico , the Phillipines, Poland, Russia, Singapore, South Africa , Thailand.

to imitate or reverse engineer. In this case, firms may not seek IPR protection but rather rely on natural protection of their innovations. Furthermore, within the knowledge-intensive sectors, patent protection are generally considered to be very important for those industries where their technologies are relatively easy to imitate, such as chemicals, pharmaceuticals and computer industries In contrast, patent protection are viewed to be of moderate importance in other industries (e.g., metals, machinery and transports) where the technologies are relatively more difficult to imitate (Park and Lippoldt, 2003).

Table 4 presents the empirical results for non-OECD (developing) countries. This group of countries includes the most important emerging economies, such as India, Brazil, South Africa and Southeast Asian countries. As expected, the effect of patents on trade is significantly weaker for these non-OECD countries. For example, at the aggregate product level, the estimated patent coefficient is not statistically significant at conventional levels. In sharp contrast to the results for OECD countries (see Table 3), only two disaggregated product categories have statistically significant patent coefficients: pharmaceuticals (1.09) and wood products (-1.20). In the former case, a comparison of the estimated patent coefficients across OECD and non-OECD countries suggest that while 1% increase in total patent filings leads to a 1. 09% increase in pharmaceutical imports from non-OECD (developing) countries; it only led to 0.532% increase in imports from OECD (developed) countries.

This finding confirms earlier conclusions in previous studies which suggest that firms in rich industrial nations may respond to increase in patent protection by significantly increasing their level of FDI or licensing as an alternative mode of entry instead of just increasing international trade. As discussed in Smith (2001), there might be simultaneous effects of patents on imports, FDI and /or licensing for developed countries. Hence, the patent coefficients tend to be smaller as some of the market expansion effect is offset by FDI or licensing.[5] In contrast, when the effect is significant, large developing countries appear to increase trade volumes to a country with stronger patent protection.

4.3 The dynamic effect of patents on trade

The results discussed above reflect the average effects of patents on import flows into China over the years 1991-2004. However, there were significant reforms in patent laws during these years. In order to better understand how the effects of patents on imports varied, this section analyzes the data by patent regimes that coincide with major patent policy reforms in China. To properly identify the different patent regimes in China, we use five elements used in computing IPR scores (Ginarte and Park, 1997) as a reference. Beginning with China's first patent law in 1985, China's patent policy could be classified into three different patent regimes: (1) substantial revision of patent law in 1992 (this includes the extension of coverage to pharmaceuticals and chemicals; and the explicit specification of standard duration of protection); (2) joining the WIPO in 1995 (most important membership in international agreements); and (3) WTO accession in 2001(conformity with TRIPs agreements).

Based on these points of major patent policy changes, the data was divided into three sub-periods as follows: pre-WIPO period (1991-1995), pre-WTO period (1996-2000), and post-WTO period (2000-2004). In our view, the most important period is the pre-WIPO period as China' s patent laws were considered to be comparable to the world standard only

[5] According to *World Investment Report 2005* (UNCTAD, 2005), multinational firms in developing countries are less transnationalized than their counterparts in the developed countries. Our results here seem to support this view. However, due to the constraint of data, further analysis of the effect of patents on FDI can not be carried out at the this point.

after 1992. To assess how the trade effects change over different patent regimes, we estimate equation (2) for the three sub-periods separately, both for the OECD and non-OECD countries.

Table 5 contains the results from the estimation of equation (2) using pooled annual data for each of the three sub-periods reported separately for both OECD (developed) and non-OECD (developing) countries.[6] For developed countries, there is a clear pattern showing that patents have a very significant effect on China's imports in the pre-WIPO period (1991-1995) when the initial wave of patent laws were established. However, in subsequent years, the effect of patents on imports notably declined. During the first period of 1991-1995, the patent coefficients are not only more significant but also larger. For example, 16 out of 20 product categories have statistically significant patent coefficients with values close to or larger than 1. This indicates that the market expansion effect was very strong during the earlier years when China began to strengthen its patent laws. The weakening of the effect of patents on imports from developed nations could be explained by the increasing role of FDI in China in recent years. China's further revision of its patent laws to conform with the TRIPs agreement sent a signal to foreign firms of its willingness to further strengthen and enforce its patent laws. Previous studies have shown that foreign firms tend to respond to stronger patent rights by shifting from exporting commodities to establishing foreign affiliates and increasing licensing and FDI sales (Park and Lippoldt, 2003). This is especially true in the case of China, a large developing nation with high threat of imitation.

In contrast, for non-OECD (developing) countries, patents have a weak effect on imports across the three IPR regimes. At the aggregated level, while patents have a significant effect on imports during the first time period, the estimates became much smaller

[6] For brevity, only the estimates of patent elasticity of imports are reported.

and statistically insignificant in subsequent sub-periods. At the sectoral level, the results are mixed. In most sectors, the effects of patents on imports are not significant over the three periods. Relative to the results for China's imports from OECD countries, increased patent protection have a significant effect in much fewer sectors and no consistent pattern exists for these non-OECD countries. It is only in the case of food imports where patents have a significant effect in all three sub-periods.

In recent years, several large developing countries have benefited from globalization and the accompanying internationalization of knowledge generation via offshore research and development (R&D) by multinational corporations in developing countries (e.g., India, Thailand, and Malaysia). The internationalization of R&D not only facilitates the transfer of technology to the host countries, but could also generate spillovers which may stimulate domestic innovation in host countries. Although past studies have shown that spillovers from developed countries to developing countries are substantial (Coe and Helpman, 1995; Coe, Helpman, and Hoffmaister, 1997; Keller 2002), empirical evidence is still sparse. The results from current analysis suggest that China's imports from developing countries are not significantly patent-related.

5. Conclusion

Although several studies have investigated the effect of IPR protection on international trade from the perspective of major industrialized nations, to our knowledge, no previous analysis have examined this issue from the perspective of a developing nation with strong threat of imitation. In this study, we examine the impact of patent rights protection on China's aggregate and sectoral imports. Specifically, the analysis provides empirical evidence for addressing these three questions of interests: (1) to what extent do the effects of patent protection vary across various manufacturing product sectors? (2) does the impact of patent protection differ between OECD (developed) and non-OECD (developing) countries? (3) to what extent does the impact of patents vary across time as the strength of China's IPR protection increased? This analysis provides new insights on these empirical questions.

The empirical results suggest that exporters respond positively to the strengthening of patent laws in China. This finding further confirms the results from earlier studies which found evidence in support of the market expansion effect of stronger IPR protection in countries with strong threat of imitation. In general, our results show that the market expansion effect is more pronounced in knowledge-intensive sectors than in non-knowledge intensive sectors. Although the effects of patents on imports from OECD countries are positive and statistically significant, the evidence for non-OECD countries is rather weak and insignificant in many cases. These results are consistent with the fact that OECD countries are the major producers of knowledge-based outputs and are the major exporters of patent-sensitive products. Nevertheless, an examination of the dynamics of recent changes in patent regimes in the past fourteen years indicates that the impact of patent rights protection on trade appears to have weakened over time. This result may be reflecting the increasing role of FDI by multinational corporations as the preferred alternative to international trade in commodities (Smith, 2001). Recent data shows that China is a leading destination of FDI from industrialized nations to developing and transition economies.

Overall, this study shows that IPR reforms in China tend to attract more knowledge-intensive imports and thus facilitates technology transfer to China. However, it should be emphasized that while the implementation of stronger IPR regimes is necessary, it is not a sufficient condition for trade expansion and economic growth. In addition to stronger IPR protection, other complementary factors such as higher levels of R&D expenditures, quality legal institutions, and improved physical infrastructure are also needed for narrowing the technology gap between China and most developed countries.

Given the diversity in size and economic structure of developing economies, current empirical evidence for China should not be automatically generalized to all developing countries. Nevertheless, an important policy insight from this empirical analysis is that a large developing nation with strong threat of imitation could reap increased bilateral trade benefits from harmonizing and strengthening its IPR laws to conform with international standards as China has done in recent years. Future research would be beneficial in unraveling the complex interactions between trade, FDI, licensing and IPR protection. As more industry and firm level data become available, future analyses may be able to provide more definitive conclusions on the trade effects of IPR protection.

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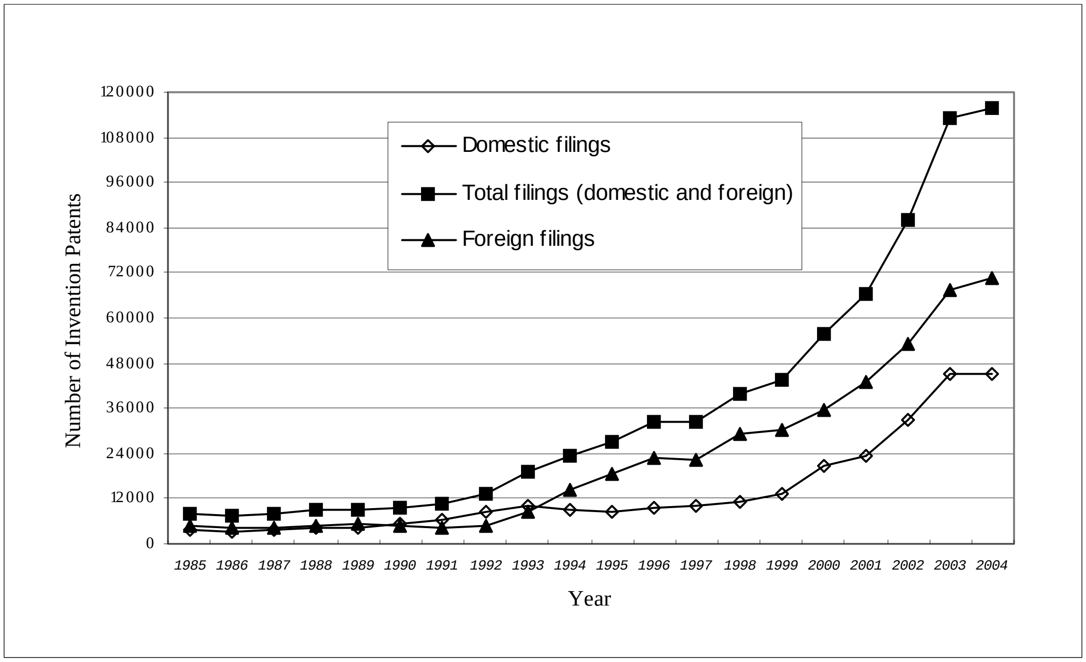

Figure 1. Patent Filings in China from 1985-2004

Source: Chinese patent database, CNPAT ABSDAT (http://www.sipo.gv.cn)

Table 1. Summary statistics of main variables

	In Levels			
Variables	Mean	Std.Dev.	Min	Max
IMPORTS	430652.5	904085.9	0	8994883
(All products, in 100 millions 2000US$)				
GDPIM	7.10E+11	1.60E+12	3.64E+10	1.08E+13
(GDP of importing countries, in 100 millions 2000 US$				
GDPC	1.02E+12	3.67E+11	4.86E+11	1.72E+12
(GDP of China, in 100 millions 2000 US$)				
TARIFF	1.03	0.0098	1.02	1.06
(Average tariff rate)				
DIST	5015.6	2512.4	598.0	11957.0
(Distance between China and Importing countries)				
PATENT	894.6	2947.3	0	33187
(Number of patents filed by importing countries)				

Table 2. Estimation results of Gravity equations, with all the countries included

Product Sectors	GDPIM (Importing)		GDPC (China)		TARIFF		PATENT		DIST		CONST		R^2
ALL PRODUCTS	0.843	***	1.525	***	-22.556	***	0.080		-0.832	***	-45.298	***	0.625
	(6.010)		(8.870)		(3.260)		(1.080)		(2.980)		(7.300)		
APPARELS	1.492	**	3.592	***	-6.713		0.168		-3.919	***	-94.308	***	0.663
	(3.910)		(5.030)		(0.200)		(0.960)		(7.060)		(4.010)		
BEVERAGE,TOBACCO	2.891	***	6.228	***	82.253	*	-0.716	**	-1.583		-223.314	***	0.377
	(4.630)		(6.460)		(1.830)		(2.190)		(1.580)		(6.580)		
CHEMICALS	0.940	***	3.506	***	10.109		0.165		-1.644	***	-91.599	***	0.306
	(3.350)		(4.500)		(0.290)		(1.150)		(3.220)		(3.910)		
ELECTRONICS	0.761	**	3.957	***	34.658		0.464	***	-2.893	***	-90.879	***	0.475
	(2.420)		(5.000)		(0.980)		(2.720)		(4.470)		(3.820)		
FOOD	1.066	***	3.000	***	12.990		-0.151		-1.002		-86.015	***	0.184
	(3.030)		(3.970)		(0.380)		(0.860)		(1.570)		(3.770)		
FURNITURES	0.823	*	4.602	***	42.119		0.600	**	-2.437	***	-120.874	***	0.525
	(1.970)		(6.220)		(1.230)		(2.570)		(3.460)		(4.700)		
GLASS	1.265	***	2.997	***	-9.955		0.275		-3.234	***	-75.544	***	0.495
	(3.370)		(3.440)		(0.220)		(1.420)		(4.920)		(2.790)		
INSTRUMENTS	0.883	***	3.600	***	11.341		0.580	***	-2.170	***	-91.949	***	0.524
	(2.980)		(5.050)		(0.370)		(3.420)		(3.310)		(4.080)		
IRONS	1.872	***	2.969	***	-78.888	*	-0.017		-2.398	***	-93.117	***	0.420
	(5.120)		(3.450)		(1.870)		(0.100)		(4.170)		(3.410)		
LEATHER	2.316	***	2.518	***	-23.199		-0.293		-1.818	**	-99.206	***	0.335
	(4.130)		(3.220)		(0.610)		(1.140)		(2.180)		(3.650)		
MACHINERY	0.761	**	1.828	**	-13.663		0.574	***	-1.691	**	-40.784	*	0.402
	(2.610)		(2.300)		(0.390)		(3.990)		(3.050)		(1.690)		
METALS	0.859	**	3.443	***	-11.412		0.142		-1.673	***	-87.731	***	0.281
	(2.890)		(4.410)		(0.320)		(0.880)		(2.790)		(3.680)		
PAPER PRODUCTS	1.183	**	3.066	***	1.265		0.083		-2.246	***	-81.814	***	0.371
	(2.590)		(4.130)		(0.040)		(0.390)		(3.000)		(3.300)		
PETROLUM, COAL	1.731	**	4.560	***	-36.868		-0.076		-4.555	***	-118.767	***	0.375
	(2.780)		(4.540)		(0.720)		(0.230)		(4.970)		(3.510)		
PHARMACEUTICALS	0.415		1.626	*	-7.186		1.070	***	-0.970		-38.864		0.458
	(1.010)		(1.730)		(0.150)		(3.750)		(1.220)		(1.280)		
PLASTICS	1.358	***	3.226	***	6.268		0.024		-2.428	***	-88.624	***	0.412
	(4.470)		(4.230)		(0.180)		(0.160)		(4.480)		(3.820)		
RUBBER	0.810	*	3.843	***	-3.896		0.629	***	-3.251	***	-90.326	***	0.571
	(1.790)		(5.460)		(0.120)		(2.610)		(4.790)		(3.480)		
TEXTILES	1.309	***	1.991	***	3.772		0.037		-2.346	***	-54.529	**	0.382
	(4.410)		(2.720)		(0.110)		(0.240)		(4.500)		(2.410)		
TRANS. EQUIPMENT	1.017	**	2.262	***	-36.446		0.626	***	-1.879	**	-59.818	**	0.431
	(2.380)		(2.790)		(0.990)		(2.630)		(2.510)		(2.140)		
WOOD PRODUCTS	1.124	*	3.249	***	20.880		-0.113		-3.255	***	-79.239	**	0.318
	(1.800)		(3.490)		0.500		(0.370)		(3.620)		(2.370)		

*Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level. t-statistics are computed based on the robust standard error and reported in parentheses. Dependent variable is Log (IMPORTS).

Table 3. Estimation results of Gravity equations, with OECD (developed) countries

Product Sectors	GDPIM (Importing)	GDPC (China)	TARIFF	PATENT	DIST	CONST	R2
ALL PRODUCTS	0.591 ***	0.691 ***	-15.251 **	0.432 ***	-0.484 **	-20.927 ***	0.855
	(3.850)	3.760	(2.090)	(4.160)	(2.550)	(2.940)	
APPARELS	1.189 ***	1.270	-2.676	0.488	-1.776 **	-41.567	0.615
	(2.810)	(1.460)	(0.070)	(1.020)	(2.540)	(1.590)	
BEVERAGE,TOBACCO	4.072 ***	6.646 ***	73.904	-1.310 **	-0.782	-269.136 ***	0.500
	(4.860)	(5.280)	(1.440)	(2.140)	(0.740)	(5.890)	
CHEMICALS	0.744 ***	2.728 ***	16.623	0.355	-0.741 **	-73.755 ***	0.328
	(3.050)	(3.220)	(0.390)	(1.260)	(2.230)	(3.090)	
ELECTRONICS	0.454	1.904 **	31.145	0.809 **	-0.835 **	-44.912 *	0.406
	(1.490)	(2.240)	(0.740)	(2.340)	(2.410)	(1.820)	
FOOD	0.692 **	2.277 ***	2.912	0.256	0.234	-68.515 ***	0.200
	(1.910)	(2.600)	(0.070)	(0.660)	(0.410)	(2.740)	
FURNITURES	0.922 **	2.821 ***	18.435	0.745	-0.228	-92.700 ***	0.562
	(2.310)	(3.500)	(0.550)	(1.590)	(0.330)	(3.820)	
GLASS	1.430 ***	2.585 ***	-4.667	0.036	-1.082 ***	-85.266 ***	0.477
	(5.650)	(2.690)	(0.100)	(0.130)	(4.840)	(3.090)	
INSTRUMENTS	0.374	2.092 ***	-2.528	0.926 ***	-0.346	-53.265 **	0.457
	(1.490)	(2.700)	(0.070)	(3.080)	(1.060)	(2.410)	
IRONS	1.206 ***	1.885 *	-32.860	0.599	-1.618 ***	-57.302 **	0.515
	(3.060)	(1.970)	(0.720)	(1.450)	(2.960)	(2.000)	
LEATHER	1.005 *	1.562	-11.279	0.431	-1.080	-48.353	0.307
	(1.780)	(1.470)	(0.270)	(0.740)	(1.060)	(1.480)	
MACHINERY	0.535 *	0.798	-12.267	0.829 **	-0.344	-19.086	0.371
	(1.840)	(0.910)	(0.280)	(2.490)	(0.920)	(0.750)	
METALS	0.631 **	2.082 ***	5.588	0.683 **	-0.675 *	-56.193 **	0.432
	(2.270)	(2.600)	(0.140)	(2.110)	(1.680)	(2.430)	
PAPER PRODUCTS	0.391	1.183	23.010	0.832 *	-0.497	-28.247	0.354
	(1.060)	(1.270)	(0.590)	(1.730)	(0.700)	(1.070)	
PETROLUM, COAL	1.474 **	2.724 **	24.455	0.500	-1.259	-94.121 **	0.400
	(2.450)	(1.760)	(0.390)	(0.680)	(1.390)	(2.030)	
PHARMACEUTICALS	0.508 *	1.981 **	31.343	0.584 *	0.163	-58.466 **	0.286
	(1.620)	(1.990)	(0.680)	(1.620)	(0.440)	(2.080)	
PLASTICS	0.908 ***	1.793 **	4.960	0.574 **	-1.243 ***	-50.349 **	0.502
	(4.200)	(2.110)	(0.120)	(2.110)	(3.220)	(2.090)	
RUBBER	0.767 ***	2.332 **	11.523	0.797 ***	-0.823 *	-69.109 ***	0.636
	(3.240)	(3.320)	(0.360)	(2.600)	(1.860)	(3.400)	
TEXTILES	0.909 ***	1.233	6.642	0.541	-1.650 ***	-32.002	0.475
	(2.720)	(1.450)	(0.170)	(1.510)	(3.050)	(1.280)	
TRANS. EQUIPMENT	1.000 ***	0.627	-19.911	0.885 **	-0.217	-30.266	0.498
	(2.900)	(0.650)	(0.480)	(2.030)	(0.460)	(1.060)	
WOOD PRODUCTS	0.755 *	0.658	19.007	0.543	-0.594	-23.343	0.402
	(1.950)	(0.650)	(0.410)	(1.330)	(0.770)	(0.780)	

*Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level. t-statistics are computed based on the robust standard error and reported in the parentheses. Dependent variable is Log (IMPORTS).

Table 4. Estimation results of Gravity equations, with non-OECD (developing) countries

Product Sectors	GDPIM (Importing)	GDPC (China)	TARIFF	PATENT	DIST	CONST	R^2
ALL PRODUCTS	0.941 ***	2.181 ***	-31.417 ***	-0.023	-0.999 **	-63.765 ***	0.323
	(2.770)	(7.080)	(2.840)	(0.200)	(2.090)	(6.360)	
APPARELS	1.836 ***	7.352 ***	-16.798	-0.476	-6.349 ***	-185.436 ***	0.745
	(2.860)	(5.230)	(0.290)	(1.490)	(9.280)	(4.310)	
BEVERAGE,TOBACCO	1.247	7.486 ***	84.606	-0.964	-2.164	-210.674 ***	0.208
	(1.040)	(3.520)	(0.950)	(1.390)	(1.180)	(3.440)	
CHEMICALS	1.294 *	3.999 **	3.305	0.235	-2.587 *	-106.392 **	0.266
	(1.730)	(2.130)	(0.050)	(0.390)	(1.980)	(2.020)	
ELECTRONICS	0.947	6.591 ***	39.569	0.220	-4.988 ***	-150.734 ***	0.566
	(1.100)	(4.280)	(0.700)	(0.440)	(3.740)	(3.410)	
FOOD	1.465 *	3.296 *	29.311	-0.239	-2.198	-94.569 *	0.230
	(1.620)	(1.820)	(0.460)	(0.400)	(1.500)	(1.880)	
FURNITURES	0.536	7.322 ***	72.829	0.340	-4.613 ***	-170.931 ***	0.555
	(0.590)	(4.430)	(1.080)	(0.700)	(4.400)	(3.200)	
GLASS	2.322 ***	2.572	-12.722	0.843	-5.961 ***	-69.319	0.667
	(3.390)	(1.400)	(0.150)	(1.490)	(5.700)	(1.340)	
INSTRUMENTS	1.347 *	5.816 ***	29.374	0.148	-4.245 ***	-147.707 ***	0.543
	(1.600)	(4.130)	(0.570)	(0.310)	(3.100)	(3.640)	
IRONS	3.172 ***	1.976	-132.628 *	0.495	-3.116 **	-92.190	0.428
	(3.990)	(0.950)	(1.670)	(0.810)	(2.510)	(1.520)	
LEATHER	4.056 ***	2.937 *	-36.336	-0.676	-3.046 *	-144.240 ***	0.433
	(3.930)	(1.830)	(0.490)	(1.240)	(1.900)	(2.890)	
MACHINERY	0.989	2.789	-14.057	0.538	-3.034 **	-61.841	0.344
	(1.260)	(1.530)	(0.230)	(0.940)	(2.380)	(1.190)	
METALS	0.271	4.799 **	-33.929	-0.037	-2.068	-105.531 **	0.185
	(0.320)	(2.510)	(0.490)	(0.060)	(1.380)	(2.000)	
PAPER PRODUCTS	1.347	5.271 ***	-28.497	-0.411	-3.790 *	-132.144 ***	0.464
	(1.330)	(3.130)	(0.470)	(0.760)	(2.560)	(2.640)	
PETROLUM, COAL	2.389 **	5.761 ***	-119.305	-0.099	-7.856 ***	-138.413 **	0.506
	(1.670)	(3.010)	(1.300)	(0.160)	(4.310)	(2.410)	
PHARMACEUTICALS	1.675 **	1.665	-63.323	1.091 *	-3.162 **	-52.877	0.416
	(1.930)	(0.780)	(0.640)	(1.790)	(2.090)	(0.850)	
PLASTICS	1.724 **	3.592 **	14.961	0.284	-3.298 **	-101.400 *	0.377
	(2.060)	(2.010)	(0.240)	(0.490)	(2.370)	(1.950)	
RUBBER	1.351	5.280 ***	-23.751	0.694	-5.898 ***	-121.307 **	0.626
	(1.180)	(3.240)	(0.370)	(1.280)	(5.140)	(2.350)	
TEXTILES	1.484 **	1.843	4.600	0.148	-2.706 **	-51.905	0.260
	(2.170)	(1.090)	(0.070)	(0.270)	(2.160)	(1.050)	
TRANS. EQUIPMENT	0.822	3.694 **	-56.283	0.815	-3.252 *	-82.514	0.362
	(0.740)	(2.050)	(0.850)	(1.450)	(1.910)	(1.490)	
WOOD PRODUCTS	0.230	7.955 ***	15.930	-1.200 *	-5.552 ***	-165.106 **	0.403
	(0.160)	(3.680)	(0.200)	(1.700)	(2.960)	(2.460)	

*Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level. t-statistics are computed based on the robust standard error and reported in the parentheses. Dependent variable is Log (IMPORTS).

Table 5. Changing effects of patents on imports: estimated patent coefficients of different patent regimes

Product Sector	Subsample:OECD Countries			Subsample:non-OECD Countries		
	1991-1995	1996-2000	2001-2004	1991-1995	1996-2000	2001-2004
ALL PRODUCTS	0.886 *	0.102	0.005	0.749 **	0.097	0.067
	(1.750)	(0.860)	(0.070)	(2.560)	(1.260)	(1.050)
APPARELS	0.933 *	0.377	0.162	-0.235	-0.293	0.095
	(1.710)	(0.970)	(0.710)	(0.440)	(0.760)	(0.440)
BEVERAGE,TOBACCO	-1.051	0.078	0.334	-0.303	-1.046 **	-0.082
	(1.480)	(0.090)	(0.600)	(0.650)	(2.120)	(0.130)
CHEMICALS	1.901 *	0.531	-0.241	0.698 *	-0.238	0.086
	(1.800)	(1.440)	(1.350)	(1.720)	(0.700)	(0.870)
ELECTRONICS	1.781 *	0.910 **	0.157	0.315	0.168	0.295
	(1.730)	(2.150)	(1.130)	(0.710)	(0.340)	(1.210)
FOOD	1.281	0.162	-0.393 *	0.598 **	-1.023 **	-0.325 *
	(1.360)	(0.370)	(1.800)	(2.140)	(2.300)	(1.980)
FURNITURES	1.062 *	1.176 *	-0.037	0.580	0.412	0.299
	(1.650)	(1.850)	(0.160)	(1.020)	(0.640)	(0.780)
GLASS	1.139	0.057	-0.241	-0.075	0.739 *	0.619 **
	(1.060)	(0.170)	(1.350)	(0.140)	(1.610)	(2.250)
INSTRUMENTS	1.527 *	0.968 ***	0.520 ***	0.489	0.035	0.046
	(1.600)	(2.690)	(2.690)	(1.160)	(0.120)	(0.180)
IRONS	1.650 **	0.521	-0.113	0.668	-0.156	0.914 **
	(2.270)	(1.350)	(0.970)	(1.170)	(0.300)	(2.320)
LEATHER	1.263 *	0.085	-0.349	-0.277	0.024	-0.591
	(1.640)	(0.180)	(0.880)	(0.760)	(0.040)	(1.060)
MACHINERY	1.930 **	0.085	0.070	0.210	-0.243	0.179
	(2.000)	(0.180)	(0.510)	(0.410)	(0.710)	(1.140)
METALS	1.444 *	0.654 *	-0.109	0.306	-0.380	0.027
	(1.740)	(1.840)	(1.280)	(0.770)	(0.920)	(0.150)
PAPER PRODUCTS	1.036 **	0.705 *	0.057	-0.261	-0.207	0.158
	(2.100)	(1.610)	(0.370)	(0.440)	(0.590)	(0.680)
PETROLUM, COAL	0.725 *	-0.335	-0.058	-0.579	-1.023 **	-0.219
	(1.960)	(0.390)	(0.160)	(0.880)	(2.300)	(0.410)
PHARMACEUTICALS	1.399 *	0.402	0.267	0.665	0.031	1.216
	(1.740)	(1.020)	(1.180)	(1.480)	(0.050)	(1.550)
PLASTICS	1.409 *	0.539 *	0.142	0.218	-0.647	0.216 *
	(1.670)	(1.610)	(1.040)	(0.560)	(1.590)	(1.680)
RUBBER	1.415 **	0.568 *	0.107	0.486	-0.001	-0.005
	(2.510)	(1.770)	(0.630)	(1.210)	(0.000)	(0.010)
TEXTILES	1.814 **	0.163	-0.122	0.131	-0.219	0.023
	(2.270)	(0.440)	(1.180)	(0.320)	(0.730)	(0.180)
TRANS. EQUIPMENT	1.332 *	0.995 **	0.498	1.057 *	0.333	0.338
	(1.750)	(2.420)	(1.360)	(1.610)	(0.620)	(0.880)
WOOD PRODUCTS	0.059	0.753	0.090	-0.222	-0.502	-0.255
	(0.070)	(1.330)	(0.510)	(0.570)	(0.720)	(0.810)
Observations	105	105	84	75	75	60

*Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level. t-statistics are computed based on the robust standard error and reported in the parentheses. Dependent variable is Log (IMPORTS). Other variables are all in logs.