

Do Intellectual Property Rights Matter to Taiwan's Exports? A Dynamic Panel Approach

Abstract

This article analyzes whether and how Taiwan's exports are sensitive to national differences in intellectual property rights (IPRs) protection and the degree of imitation threat from the dynamic perspective. Applying a longitudinal IPR index developed by World Economic Forum (WEF) and employing the technique of generalized method of moments (GMM) on dynamic panel model to control for endogeneity problem and panel unit root, the empirical results show that the strength of importing country's IPRs protection overall has a positive impact Taiwan's exports, supporting the standpoint of market-expansion that stronger IPRs protection will induce more trade. Under various classification systems to differentiate the degree of threat-of-imitation across countries, both positive and negative export effect of IPRs are found in Taiwan's case. However, the pattern of threat-of-imitation – trade nexus seems to contradict with theory predictions. Moreover, high-tech exports are found be more IPRs sensitive than non high-tech exports.

Keyword: Intellectual Property Rights, Trade, Threat of Imitation, Dynamic Panel

JEL classification: F13, O24, Q17

1. Introduction

Since the Agreement of Trade-Related Intellectual Property Rights (TRIPS), a foundation of the World Trade Organization (WTO), was made to set minimum standards of intellectual property rights (hereafter IPRs) protection to be provided by each WTO member, how to strengthen and harmonize the means for protecting IPRs had stimulated great attention in the arena of international economic policy in past decades. Actually, IPRs laws and the enforcement of existing laws differ remarkably across countries due to national differences in economic development and trade policy, the divergence for effects of strengthening IPRs between North and South countries seems to have widened in recent years. Some developing countries argue that an extension of international IPRs harm their technological progress and economic growth. Alternatively, developed countries use the trade policy as a main vehicle for strengthening IPRs across bilateral or multilateral negotiations, implying that stronger IPRs do in fact influence international trade flows.¹

Do national differences in IPRs affect international trade flows? The importance of the international pattern of IPRs for trade has stimulated wide interest for economists. Despite the practical and conceptual importance of this subject, limited empirical studies on IPRs and trade conclude a mixed result that the trade flow might increase or decrease, depending on two contradictory effects of strengthening IPRs – the market expansion effect and the market power effect. The market expansion effect denotes a positive relation between IPRs and trade. The demand curve a foreign firm faces will increase in a country with relatively stronger IPRs, because the strong IPRs reduce the possibility of imitation in the importing country. It therefore increases the trade flow toward countries with relatively stronger IPRs. The market power effect alternatively reduces the elasticity of demand facing the foreign firm and decreases exports toward countries with strong IPRs, because the holder of patents is ensured the exclusive rights to innovations by stronger IPRs. Due to strong IPRs protection, the firms owning patented technologies or products in a foreign market may exercise their monopoly power by restricting export volumes and raising prices. More importantly, there remains little systematic evidence on

¹ For interrelationships among IPRs, regulatory systems, and economic structure, see Maskus (1998).

the dynamic relationship between IPRs and trade due to the limitation and availability of IPRs indices. From the standpoint of international trade policy, whether the recent TRIPS agreement to strengthen and harmonize national IPRs can induce a trade growth?

Although several studies have assessed the trade effect of IPRs protection, most studies focus on developed economies, while empirical studies investigating the issue for developing countries or newly industrialized economies (NIEs) from the perspective of exporters are quite limited. It is recognized that IPRs should affect trade flows in innovative goods that exported from developed countries. However, one may argue that firms export goods that are not novel or low-technology would be less likely to care about the protection degree of IPRs in the country they are exporting to. That is, the market power and market expansion paradigm is applied only to technological leader. However, this issue becomes emergently important for NIEs, e.g. Israel, Korea, Taiwan, and so on, because their exports of high-tech products have accounted a large share in the global market. As most Taiwan's high-tech firms produce goods under contracts for large multinational corporations, which then market the resulting product under their own brand names, the destinations' IPRs protection should also affect the magnitude of exports from Taiwan. Indeed, NIEs have conducted more and more R&D efforts and registered surging patents in the past decade, implying that the studies on IPRs and trade for NIEs, such as Taiwan, is also important and worth investigating. Alternatively, theoretical arguments claim that the degree of threat-of-imitation plays an important role on whether market expansion effect or market power effect exercises. How to group threat-of-imitation usually refers to importing countries' degree of economic development of R&D capability. U.S. locates in the world technology-frontier, implying that any importing country in the rest of the world perhaps exhibits some degree of threat of imitation. However, from the view of NIEs, such as Taiwan, it is noteworthy that they might not have any kind of imitation threat if the importing country is on the technology frontier, which has stronger R&D ability than Taiwan. Therefore, compared with developed countries, whether the relationship between threat-of-imitation and trade performs a different pattern for NIEs is an interesting issue and it is worth further exploring.

It is well recognized that technological opportunity is an important determinant of technical

change and it deeply influences firms' innovation behaviors.² In industries with a high technological opportunity, the pace of technological change is very rapid, the technological environment faced by firms is relatively fertile, and there are more potential new technologies to patent. Therefore, high-tech exports should rely more on host countries' IPRs protection to appropriate economic rents. Alternatively, driven by a rapid pace of technological change and short product life cycles, high-tech firms may tend to rely more heavily on lead time, design secrets, and manufacturing or design capabilities than on patents. A patent could be a less effective mechanism for appropriating returns to R&D as surveyed by Cohen *et al.* (2000), implying that foreign patent rights might play less role on protecting firms' exports. Fink and Maskus (2005) suggested that the impact of IPRs on trade in high-tech goods is limited, possibly due to the difficulties of imitating such products. The question that is there a positive or negative relationship between IPRs and high-tech products trade needs more empirical evidence. Whether the IPRs-export nexus is different between high-tech and non-high-tech exports is also an interesting and important question, while it seems to be less well discussed in previous studies.

Since the economic development of Taiwan overwhelmingly relies on international trade and the export-led growth indeed has played as a successful strategy during the past decades (Chu, 1988), the impact of foreign IPRs protection on exports is an important concern. This paper aims to provide empirical evidence on how Taiwan's high-tech and non-high-tech exports are sensitive to national difference in IPRs protection and their changes. Furthermore, the study attempts to contribute in line with the empirical literature by providing the following three distinct types of empirical evidence.

First, this study uses longitudinal data of Taiwan's exports to 51 countries during the 1997-2003 period and employs a longitudinal and consistent IPRs index surveyed by World Economic Forum (WEF) to investigate the dynamic process between IPRs and trade. Indeed, the protection of IPRs is inherently a dynamic process, involving both a secular evolution within one country over time and the need for new standards of protection (Maskus, 1998). However, previous empirical studies,

² The concept "technological opportunity" has been coined to capture the vitality of the underlying sciences and technologies as the sources of technical progress that firms drawn upon during innovation (Palmberg, 2004).

except for Co (204), Al-Mawali (2005), Falvey *et al.* (2006), and Yang and Woo (2006), use only cross-sectional and pre-1990 data. This panel data study allows us to control for unobserved heterogeneity both across countries and time. The empirical analysis can provide a clearer and more dynamic portrait, yielding to an insightful viewpoint on the importance of IPRs on trade after the implementation of TRIPS Agreement in 1995.

Second, most previous studies assume that the strength of IPRs is exogenous, ruling out countries' behavior when they decide the enforcement strength of IPRs laws. If a country's imports are simultaneously determined with the strength of IPRs protection, then the estimated impact of IPRs on trade is inconsistent due to the causality relation between IPRs degree and trade.³ To deal with the endogeneity problem and panel unit root issue, two potential sources of bias which were not well dealt with in most previous studies, this study employs the econometric technique of Generalized Method of Moments (GMM) for dynamic panel data model to execute the estimation.

Third, one of the features differentiating our study from existing works on the IPRs-trade nexus is focusing on one of NIEs, Taiwan, rather than developed countries. Under the circumstance toward vertical disintegration of global high-tech goods, NIEs have upgraded their technological capabilities and exported a growing share of high-tech products in the global market. Therefore, the issue of IPRs-trade nexus is also worth focusing on from the perspective of NIEs. Thus, this work enables us to investigate the IPRs-trade nexus from an alternative perspective and reexamine the role of threat-of-imitation on affecting trade. Moreover, this study separates Taiwan's exports into high-tech and non high-tech exports and then examine whether there is difference on IPRs-trade nexus between high-tech and non high-tech exports. Taiwan's high-tech products has accounted for an extremely large share in the global market. Due to the rapid pace of technological change and difficulties on imitating, high-tech products would be more or less IPRs-sensitive than non high-tech products in international trade is explored in this study. In addition, the degree of imitation threat encountered by high-tech and non high-tech exports might vary across/within countries and therefore we also discuss the potential differences on the relation between

³ On exploring the relationship between enforcement of IPRs and economic growth, Gould and Gruben (1996) argue that a country's membership in an international convention may qualify for lowering this endogeneity problem.

threat-of-imitation and trade for high-tech and non-high exports.

The paper is organized as follows: Section 2 reviews the theoretical and empirical literature on IPRs and trade, to describe the channels through which a variation in IPRs could influence trade flow. The essential point of this review is the inconclusive prediction that the amount of trade flow could increase or decrease with the imposition of stronger IPRs. Given the ambiguity, we go on in the third section to specify an econometric model of bilateral trade, borrowing from the Gravity model, and describe the data. Section 4 presents the empirical results of panel data model. We proceed to adopt the GMM approach for dynamic panel data model to conduct an estimate to investigate the dynamic IPRs-trade nexus in section 5. In section 6, we discuss the role of imitation threat on the relation between IPRs and trade for both high-tech and non high-tech exports. Concluding remarks and policy implication are provided in the final section.

2. Intellectual Property Rights and Trade

The theoretical literature discussing IPRs-trade nexus is ever-increasing. Recent theoretical articles, such as Brown (1991), Schwartz (1991), and Taylor (1993), have used more sophisticated modeling or descriptive frameworks to explore this issue and yielded different results, but they did provide some guidance: the strengthening of IPRs has two simultaneously contradicting powers on trade: trade might be increased through the market expansion effect and decreased through the market power effect (Maskus and Penubarti, 1995).⁴

As explained previously, the market expansion effect has a positive impact on stimulating trade, because the strengthening on IPRs reduces the ability of importing countries' firms to imitate technologies embodied in imported products and raises the infringement cost. Alternatively, the market power effect decreases exports toward countries with strong IPRs, arising from the holder of the innovative goods can execute their market power by restricting export volumes and raising prices. Because the market expansion and market power effects are countervailing, the predicted effect of IPRs on trade, *ceteris paribus*, depends on the relative importance of these two

⁴ Taylor (1993) argues that there is a cost-reduction effect in larger markets that raises exports if a stronger patent reduces the need for foreign firms to undertake R&D to deter local imitation.

enhancements. These two effects might act simultaneously, while Maskus and Penubarti (1995) argued that it seems possible that the market expansion effect tends to be more dominant in larger countries with highly competitive local imitative firms. However, the market power effect is stronger in small countries with limited imitation capacity.

Despite the link between IPRs and trade being important, the empirical literature on this issue is limited. Empirical studies investigating the IPRs-trade relationship began in the 1990s and concentrated on cross-sectional studies: Ferrantino (1993) used a gravity approach to examine aggregate U.S. export patterns in relation to national membership in IPRs treaties and suggests that arm's-length trade is unaffected by variations in IPRs. Maskus and Penubarti (1995) explored the relationship between the manufacturing exports of OECD countries and the strength of patent rights in large and small developing economies. The results indicate that increasing patent protection has a positive impact on bilateral trade. Smith (1999) assessed whether, how, and to what extent U.S. exports are sensitive to national differences in patent rights. She found that the stronger patent rights of importing countries increase U.S. exports to these high-threat markets. Alternatively, a strengthening of patents in weak threat-of-imitation countries reinforces monopoly power and reduces U.S. exports to these markets. Smith (2001) analyzed how foreign IPRs affect US exports, affiliate sales and license. Empirical findings show that stronger foreign IPRs increase US exports, especially across countries with stronger imitative abilities, through the market expansion effect. Alternatively, stronger foreign IPRs decrease US exports to countries with weak imitative abilities through market power effect. Rafiquzzaman (2002) took the exports of ten provinces in Canada to 76 countries in 1990 as a sample to analyze the relationship between IPRs protection and exports and found that exports increase with improvement of in IPRs no matter what degree of development of the importing countries.

Recent studies turned to pay attention on the IPRs-trade nexus for R&D-intensive products: Smith (2002) analyzed the effect of foreign patent rights on U.S. bilateral exports upon three highly-disaggregated drug industries during the 1970-90s. The findings show that strong patent rights enhance the market power of U.S. drug exporters across countries with weak imitative abilities, while stimulating the market expansion across countries with strong imitative abilities.

Liu and Lin (2005) employed the technique of pooling estimation to investigate the relation between foreign patent rights and the exports of three high-tech industries in Taiwan during the 1989 to 2000 period. Their analyses show that both market expansion and market power effects do exist in Taiwan's case. Fink and Primo-Braga (2005) used the trade flow of high-tech products among 89 countries to investigate the importance of IPRs on high-tech trade and find no significant effect of IPRs on high-tech trade.

Panel data studies on IPRs-trade nexus were emerging in more recent years. Different from previous studies, Co (2004) examined whether exports are affected by importers' patent regimes using US export data to 71 countries from 1970 to 1992. Her panel study finds that IPRs protection has no significant impact on R&D-intensive goods that is similar to that found by Fink and Primo-Braga (2005) for high-tech trade. Al-Mawali (2005) provided evidence on the effect of IPRs protection on bilateral intra-industry trade flow rather than one-way trade. The findings suggest that IPRs and imitation abilities separately are not important factors in determining intra-industry trade flow, while the interaction between them is important. Despite the panel data model is applied in this study, this two-period panel analysis can provide little insight for the dynamic IPRs-trade nexus. Yang and Woo (2006) firstly extended this research line to agro-trade. Their panel data study showed that whether a country adheres to IPRs agreements has no discernible impact on planting seeds that are imported from the U.S., implying that the strengthening of IPRs would not induce more agro-trade. Falvey *et al.* (2006) used panel data to estimate a gravity equation for manufacturing exports from five advanced countries to 69 countries over the period 1970-1999. They use an alternative technique of threshold regression to determine whether the impact of IPRs protection on trade depends upon the level of development, imitative ability and market size of the importing country. Their analyses confirm the importance of importers' imitative ability rather than IPRs protection on trade.

The above reviews suggest that the relationship between IPRs and (high-tech) trade is ambiguous, depending on the imitation threat of importing countries. One more important point drawn from the literature, we find few empirical panel data studies on discussing the IPRs-trade nexus, indicating that the dynamics of IPRs-trade relation is not well understood. Whether the

enforcement of TRIPS induces more trade? Most panel data studies investigate the relationship between IPRs and trade by using data for pre-TRIPs period, attributing to the limitation on IPRs variable, such as the data viability of Ginarte and Park's (1997) IPRs index.⁵ In an attempt to bridge this gap in the existing literature, this study adopts a consecutive and consistent IPRs index measured by WEF to analyze the dynamic relation between IPRs and trade.

[Insert Table 1 about Here]

3. Empirical Model and Data

To investigate the effects of IPRs on exports, we apply the commodity version of gravity model that is widely adopted in previous related studies, because it provides a flexible general equilibrium framework consistent with a variety of general equilibrium trade models.⁶ The gravity model expresses bilateral trade flow as a function of exporter and importer characteristics, including income per capita, population (market size), distance (transportation cost), (non)trade barriers, and factors that augment or distort trade. Of course, the national differences in IPRs is the main variable of interest that might increase or decrease trade flow. Adopting the specification by indexing the Taiwan as the source country to examine bilateral trade from the Taiwan perspective, the empirical model is specified as:

$$EXP_{it} = \beta_0 (PGDP_{it})^{\beta_1} (POP_{it})^{\beta_2} (DIS_{it})^{\beta_3} (OPEN_{it})^{\beta_4} (TB)^{\beta_5} (NTB)^{\beta_6} (IPR_{it})^{\beta_7} u_{it} \quad (1)$$

where EXP_{it} represents Taiwan's total exports to country i in year t and measured by US million dollar.

The basic gravitational variables that appear as independent variables in this study include the per capita GDP of country i in US dollars ($PGDP$) and the population of the importing country in thousands (POP) that is used to capture the notional economies of scale. Both the $PGDP$ and POP are obtained from the IMF World Economic Outlook Database and are expected to have a positive impact on trades. Term DIS is the geographical distance (kilometers) between the capital city of

⁵ The Ginarte and Park (1997) IPRs index are only available for years of pre-1990, 1995, and 2000.

⁶ Detailed theoretical foundations of the gravity model and nesting of trade theories, see Anderson (1979) and Bergstrand (1985).

country i and Taipei, the capital city of Taiwan. It represents a natural rather than a policy-driven distortion, because the transport cost increases as the distance increases. The term *OPEN* denotes the degree of trade openness of county i , and it is measured as the trade volume to GDP ratio and it is expected to exhibit a positive coefficient. The trade barriers variable (*TB*) is measured by the average tariff rate and was obtained from the Global Competitiveness Report of World Economic Forum (WEF). Tariff is widely recognized as the main distorting force of trade flows that a higher tariff usually induces a decrease on imports. As for the non-tariff barrier (*NTB*) is the degree of hidden import barriers of importing countries as measured by WEF. One point worth pointing out is that the index ranges from one to seven points and a lower value represents a higher degree of non-tariff barrier. Therefore, the estimated coefficient for the *NTB* variable is expected to be positive. Lastly, *IPR* represents the importing country's strength of IPRs protection. It is the main factor we concern that it might reduces or augments trades, depending on the contradicting forces of market expansion and market power effects; u_{it} is assumed to be a log normally-distributed error term.

How does one measure the notional differences in IPRs? Rapp and Rozek (1990) and Ginarte and Park (1997) developed indices to measure the degree of patent protection. Unfortunately, these indices cannot be adopted in this study, because the dataset we use is the 1997-2003 period, while these indices are only available as late as in 1990 and for years 1995 and 2000. The lack of a consecutive and consistent IPRs index prevents the insightful analyses on the dynamic relation between IPRs and trade. The IPRs protection index measured by WEF serves as an excellent alternative index, because this comprehensive index of IPRs is a consecutive and consistent index for a larger pool of countries. Actually, the WEF index has been adopted in previous studies and is proved to be highly correlated with Ginarte-Park index (e.g. Nunnenkamp and Spatx, 2003).

Taking natural logs of Eq. (1), the resulting econometric specification is:

$$\begin{aligned} \ln EXP_{it} = & \beta_0 + \beta_1 \ln PGDP_{it} + \beta_2 \ln POP_{it} + \beta_3 \ln DIS_{it} + \beta_4 \ln OPEN_{it} \\ & + \beta_5 \ln TB_{it} + \beta_6 \ln NTB_{it} + \beta_7 \ln IPR_{it} + \varepsilon_{it} \end{aligned} \quad (2)$$

The IPRs index of WEF is constructed by the survey results. The WEF survey is related IPRs

protection in general. The question of the WEF survey is that whether IPRs protection is “weak or nonexistence” (score 1) or “equal to the world’s most stringent” (score 7). Thus, this index ranges from 1 to 7 and a higher value of the index indicates a stronger level of protection. The estimates on the coefficient for the *IPR* variable can provide insights on the incidence of market expansion and market power, and so there are no priori expectations as to whether IPRs increase or decrease trade flows. Moreover, in order to investigate whether there are differences on the IPRs-trade nexus between high-tech and non high-tech export, equation 2 can be modified as equations 3 and 4 for high-tech exports and non high-tech exports, separately

$$\begin{aligned} \ln HIGH_{it} = & \beta_0 + \beta_1 \ln PGDP_{it} + \beta_2 \ln POP_{it} + \beta_3 \ln DIS_{it} + \beta_4 \ln OPEN_{it} \\ & + \beta_5 \ln TB_{it} + \beta_6 \ln NTB_{it} + \beta_7 \ln IPR_{it} + \varepsilon_{it} \end{aligned} \quad (3)$$

$$\begin{aligned} \ln NHIGH_{it} = & \beta_0 + \beta_1 \ln PGDP_{it} + \beta_2 \ln POP_{it} + \beta_3 \ln DIS_{it} + \beta_4 \ln OPEN_{it} \\ & + \beta_5 \ln TB_{it} + \beta_6 \ln NTB_{it} + \beta_7 \ln IPR_{it} + \varepsilon_{it} \end{aligned} \quad (4)$$

where terms *HIGH* and *NHIGH* represents high-tech exports and non high-tech exports from Taiwan. The high-tech industries include Electronic Components, Chemical Materials, Information, Communication, Visual Electronics, Machinery, Transport Equipment, Electric & Electronic Machinery, Chemical Products, and Precision Instrument.⁷

The trade flow we focus on in this study is Taiwan’s exports to 51 countries during 1997-2003.⁸ Taiwan is a small open economy that is highly exposed to international markets, revealing the potential importance of trades on the Taiwan economy. Therefore, the export-led strategy of growth was adopted as the main driving force for the island’s economic growth as long as the 1960 and it was widely recognized as a successful strategy for Taiwan’s economic development (Chu, 1988). Figure 1 displays the time trend of Taiwan’s exports, high-tech exports, and non high-tech exports since the 1990. The value of Taiwan’s exports increased steadily, except for years 1998 and 2001, from US\$ 67.214 billion in 1990 to US\$ 189.393 billion in 2005, experiencing an average

⁷ This definition of high tech industries used here is (1) high value added; (2) complexity of technique; (3) high ratio of technical staff and R&D inputs, and is constructed by the Ministry of Finance of Taiwan.

⁸ To harmonize with the availability of IPRs index, 51 countries are included in the sample. The value of exports to the sample countries accounted for about 90% of Taiwan’s exports during the sample period.

export growth of 7.25% per year. The amount of exports decreased in 1998 and 2001 were mainly influenced by the Asian financial crisis and the 911 terror attack in US, respectively. The increasing trend of exports shows the great effort for promoting exports in Taiwan, which indeed plays as the major attribute of economic growth. At the same time, much of the recent increase comes from the high-tech exports. The amount of high-tech exports has increased more than four times - from US\$ 29.144 billion in 1990 to US\$ 120.179 billion in 2005. In terms of the share of high-tech exports to total exports, it rose steadily from 43.36% in 1990 to 64% in 2000 and then kept this weight stably. One point worth noting is that the ratio of high-tech exports outpaced the non high-tech export ratio since 1995, suggesting that the exports contribution by high-tech industries is emerging important for Taiwan. Therefore, whether there are differences on the IPRs – trade nexus between high-tech and non high-tech exports is also entering as a main issue to be examined in this study.

[Insert Figure 1 about Here]

As for the definition, basic statistics, and data sources of the right-hand side variables used in this paper, they are summarized in Table 1.

[Insert Table 1 about here]

Before turning into the econometric analysis, it is useful for us to have a rough understanding about the relationship between IPRs and trades through a simple graphical analysis. If stronger IPRs, measured by the WEF index, indeed induce more trade through market expansion effect, then it can be expected that the time path of Taiwan's exports to a country should show a similar trend as that country's IPRs protection strength. Alternatively, if the market power effect dominates, the time path of IPRs index will exhibit an opposite trend to that of importing countries imports.

To illustrate the potential impact of IPRs protection on trades, the trends of imports for some Taiwan's major trade partners are shown in Figure 2. The upper panel of Figure 2 shows that the time trend of Taiwan's exports to U.S. and Japan appears to have the similar trend that steadily increased from 1997 to 2000 and then decreased, while the time trend of IPRs seems to be a random walk. As for China and Korea, both their import from Taiwan appears an ascending trend, while the time trend of their IPRs index seems not to have a similar trend. Drawing from the graphical analysis, the degree of IPRs protection overall seems to have less influence on trade

when other factors are not controlled for. In order to further investigate the IPRs – trade nexus, a more comprehensive econometric analysis is carried out in following sections.

[Insert Figure 2 about Here]

4. Panel Data Model Analysis

The panel data contain both cross-sectional and time-serial features. Thus, to estimate equation 2, the relationship between IPRs and trade flow, this study first conducts the estimates of pooling model that presents the cross-sectional characteristics. To deal with the unobservable individual effect in a panel data model, we carry out both random effect and fixed effect models that treats the individual effect as a random variable and fixed parameter, respectively. A Hausman test is then performed to judge which model is more accurate.

Table 2 displays the estimates of the pooling data model. Comparing the results obtained from total, high-tech, and non high-tech exports equations, one can clearly find that the sign and impact of the estimated coefficients are quite similar. The coefficients of per-capita GDP and population are both positive and significant at the 1% statistical level in all specifications, implying that one country that has a higher per capita income and larger population relative to other countries imports more products from Taiwan. The distance has a negative and significant impact on imports from Taiwan, consistent with the prediction of the gravity model. Increased shipping distance represents a higher transportation cost of trade, and so it might decrease the volume of imports from Taiwan for country *i*. The impacts of *OPEN* are significantly positive in all estimates, indicating that the more open country imports more products. Moreover, the effects of tariff and non tariff barriers are statistically significant and exhibits a sign as expected, while the impact of non-tariff barrier seems to be less influential for non high-tech trade.

[Insert Table 2 about Here]

The main concern of this study is to examine whether Taiwan's exports are sensitive to the national differences in IPRs protection and whether the IPRs effects vary between high-tech and non high-tech exports. The estimated results in Table 2 reveal that the IPR variable is associated with a positive and statistically significant coefficient in all regression when the degree of imitation

threat is not controlled for. Since the signs are positive, this result tends to support that the market expansion effect is prevailing as argued by Maskus and Penubarti (1995) and it is consistent with most of previous cross-sectional studies. Moreover, the impact of IPRs on high-tech exports is higher than that for non high-tech exports. The elasticity of IPRs on high-tech and non high-tech exports are 1.819 and 1.701, respectively, meaning importing country's IPRs protection increases 1% will induce about 1.8% increase on Taiwan's exports, no matter high-tech or non high-tech exports, to that country.

The estimates in Table 3, whereby estimated by GSL or by within-estimator which removes the individual effect by subtracting cross-sectional means from each panel, yield the random effect and fixed effect estimates. The χ^2 values of Hausman tests are significant at the 1% statistical level, implying that the FE model is more appropriate. Due to the fact that both RE and FE models have their potential bias, we report both these estimates while focus on discussing the FE estimates.

[Insert in Table 3 about Here]

Before finding out whether the IPRs regimes of countries have a substantial impact on Taiwan's exports from the point of time dimension, there are two points worth noting drawing from Table 3. First, the coefficient for population turns to be negative but not statistically significant in FE estimates. In general, a large population is usually associated with a larger country size, which is likely to lead to more diversified production and higher level of self-sufficiency and should lower trade flows and imports. One alternative possibility is that most of larger countries are poorer country, such as China and India. Second, the tariff seems to exhibit an insignificant influence on Taiwan's non high-tech exports.

Turning to focus on the estimates of the IPRs variables, the sign and significance of the coefficients of the IPRs variables in the table 3 can be used to identify the time-dimensional IPRs-trade nexus that is less well analyzed in previous studies. The estimates obtained from both RE and FE models show that the coefficients for the IPRs variable are positive and significant at a conventional statistical level, tending to provides the evidence that Taiwan's export to the importing countries increased as the strength of importing countries' IPRs protection increased

during the 1997-2003 period, after controlling for other influences. Moreover, the estimated IPRs impact for high-tech exports is higher than that of non high-tech exports, revealing that high-tech exports seem to be more IPRs sensitive relative to non high-tech exports. This finding is very important to Taiwan's trade policy, because high-tech exports account for a large share of 64% of Taiwan's exports as noted previous.

It is noteworthy that the estimates for the trade effect of IPRs might be inconsistent when the importing country's IPRs protection is assumed to be an exogenous rather than endogenous variable. Moreover, the Durbin-Watson statistics shown in the bottom of table 3 seems to reveal that there exists a first-order autocorrelation problem. We then deal with the possible econometric problems that might generate biased estimators.

5. GMM for the Dynamic Panel Model

Do stronger IPRs protections really stimulate trade flows of Taiwan's exports? Two econometric problems emerge with regard to the traditional panel data model. First, the time dimension of the panel data might be non-stationary due to the existence of a unit root. Second, the potential of an endogeneity between trade flows and the measure of IPRs protection may exist because the enforcement of IPRs is probably influenced by other factors such as economic development and technological specialization.

Concerning the first problem, the Durbin-Watson tests obtained in table 3 seem to reveal that there exists the first-order autocorrelation problem. We now resort to the formal panel unit root test developed by Im *et al.* (2003) and the ADF-Fisher test for dependent variable of exports. Table 4 show that the statistics for both the two tests are smaller than the critical value at the 10% statistical level, indicating that the null hypothesis that there is a panel unit root is not rejected.

[Insert Table 4 about Here]

To control for the panel unit root problem and get rid of the possible endogeneity for IPRs degree, this study employs a within-firm estimate obtained by the GMM method for the panel dynamic model developed by Anderson and Hsiao (1982), Arellano and Bover (1995), and Ahn and Schmidt (1995). Using the setting of linear regression models with predetermined rather than

exogenous right-hand side variables, this approach provides asymptotically efficient estimators even under a weak assumption on the disturbance and it is robust in the presence of heteroscedasticity across countries and shows a correlation of disturbances within countries over time.

Table 5 presents the estimates of the GMM estimates of dynamic panel data model by using the lagged IPRs index as instrumental variable. These results might provide the most plausible estimates. We first look at the p-value of the Sargan statistic (also known as Hansen's J-statistic) in the bottom of table 5, which tests the joint null hypothesis that the model is correctly specified and that the instruments are valid.⁹ The value of Sargan statistics is lower than 10% critical value for all estimates, indicating that GMM estimates for dynamic panel data model are well-behaved.

[Insert Table 5 about Here]

Compared the estimates obtained by GMM technique for dynamic panel and that in Table 4, it can be seen clearly that the results are quite similar. Turning to the IPRs effect we concern, the coefficients for IPRs variable are all positive and statistically significant at 1% statistical level in all estimates, indicating that a stronger IPRs protection would induce more exports from Taiwan to that importing country. This result overall supports the market expansion effect from the dynamic standpoint and it contributes new insights on the dynamic relation between IPRs and trade, because previous panel studies found that IPRs protection has no discernible impact on trade, e.g. Co (2004), Al-Mawali (2005), and Yang and Woo (2006).

To determine the dynamic trade effect of strengthening IPRs, we can calculate IPRs elasticities with respect to the trade growth. In case of total exports, when the degree of IPRs protection increases 1% and keeps other variables at the means, it will induce a growth of 11.85% for Taiwan's exports. One important point worth noting is that this trade effect of strengthening IPRs for high-tech and non high-tech exports are substantially different. The calculated elasticities are 11.64% for high-tech and 7.51% for non high-tech, revealing that the IPRs effect for high-tech is about 55% higher than that of non high-tech exports. From the standpoint of trade dynamics,

⁹ Formally, the Sargan statistic is a test that the over-identification restrictions are asymptotically distributed $\chi^2_{(n-p)}$, where n is the number of instruments and p is the number of parameters.

Taiwan's exports structure has changed from labor-intensive products toward high-tech products. The higher estimated IPRs elasticity of high-tech exports indicates that the TRIPS agreement to strengthen and harmonize national IPRs seems to be beneficial for Taiwan's trade and then it might contribute to the export-oriented economic growth in Taiwan.

In sum, the empirical findings show that the strengthening IPRs of importing countries indeed increase Taiwan's exports to those countries in cross-sectional, time-dimensional, and dynamic estimates, supporting the market expansion hypothesis. This result is consistent with the previous study on Taiwan's high-tech exports carried out by Liu and Lin (2005) whilst contradicts with findings in Co (2004) and Fink and Primo-Braga (2005) for high-tech trade.

6. Threat-of-imitation and (Non) High-tech Trade

The imitation cost may vary substantially between high-tech and non high-tech products, implying that the effect of market expansion and market power may differ for high-tech and non high-tech exports when they suffer the same degree of imitation threat. The theoretical literature has emphasized the role of threat-of-imitation on trade. The relationship between threat of imitation and market expansion and market power is summarized in table 6. As shown in table 6, a strong threat of imitation occurs when the importing country's IPRs protection is weak and its imitative ability is strong, while the situation that the importing country's IPRs protection is strong and its imitative ability is weak is regarded as a weak threat of imitation. When both IPRs protection and imitative ability are strong or weak, the threat of imitation is unclear and resulting in an ambiguous effect on trade. This section investigates the relation between threat-of-imitation and Taiwan's exports, high-tech, and non high-tech exports

[Insert Table 6 about Here]

Smith (1999) argued that the effects of patent laws on trade flow could vary, depending on the importing nation's economic development level and related threat-of-imitation might to be correlated to the degree of economic development. She defines a set of development dummy variables to assess IPRs' interactions by classifying the level of development of countries into four

categories.¹⁰ Moreover, Smith (1999) also adopted a R&D intensity of 0.5% as the critical value to group high and imitative abilities. Most existing studies investigating the IPRs–trade nexus concentrate on developed countries, such as U.S. From the standpoint of U.S. that is the technology frontier country, how to define the importing country’s imitative ability seems to be ambiguous. Because the exporting country we study is Taiwan, a newly industrialized economy, it seems to be plausible to group importing countries into strong and weak imitative abilities by comparing their degree of economic development or R&D intensity with Taiwan.¹¹

How to classify groups of threat-of-imitation might affect the estimated threat-of- imitation effect substantially, we therefore use various classifications to categorize threat-of-imitation groups, in order to obtain robust estimates for the relation between threat-of-imitation and trade. We divide the importing countries into two groups according to their degree of economic development or R&D intensity. The ‘strong imitative ability’ is defined as GDP per capita is higher than US\$8,356, GDP per capita is higher than Taiwan, R&D intensity is high than 0.5%, or R&D intensity is high than Taiwan. Alternatively, we classify the importing countries into ‘strong IPRs protection’ and ‘weak IPRs protection’ groups by IPRs index that whether the value is higher than score 4 or the mean. It enables us to have eight classificatory methods to group the importing countries into four categories as suggested by Smith (1999): weak imitative ability and strong IPRs protection, weak imitative ability and weak IPRs protection, strong imitative ability and strong IPRs protection, and strong imitative ability and weak IPRs protection. These four groups are denoted by threat-of-imitation dummies G1, G2, G3, and G4, respectively. The countries we select and the degree of threat-of-imitation are summarized in the Appendix.

To examine the relationship between threat-of-imitation and trade, the following equation is the empirical model and is modified from equations 2-4 by replacing the IPRs variable by four threat-of-imitation dummies and their interactive terms with IPRs variable.

¹⁰ The classification is based on the World Bank categorization of income (in U.S. dollars) per capita as follows: High income: above 8356; Upper middle income: 2,696-8,355; Lower middle income: 675-2,695, and the low income (below 675) group.

¹¹ Liu and Lin (2005) define the importing country’ imitative ability by that whether it R&D intensity is higher or lower than that in Taiwan.

$$\begin{aligned}
\ln Y_{it} = & \alpha_0 + \alpha_1 G_{1it} + \alpha_2 G_{2it} + \alpha_3 G_{3it} + \alpha_4 \ln Y_{i,t-1} + \beta_1 \ln PGDP_{it} \\
& + \beta_2 \ln POP_{it} + \beta_3 \ln DIS_{it} + \beta_4 OPEN_{it} + \beta_5 TB_{it} + \beta_6 NTB_{it} \\
& + \beta_7 G1_{it} IPR_{it} + \beta_8 G2_{it} IPR_{it} + \beta_9 G3_{it} IPR_{it} + \beta_{10} G4_{it} IPR_{it} + \varepsilon_{it}
\end{aligned} \tag{5}$$

where Y denotes total exports, high-tech exports, or non high-tech exports. Note that the constant term has been divided into four parts and the later three terms are known as the intercept shift term, representing the difference among different groups of threat-of-imitation. Does the difference in threat-of-imitation affect exports volume through market expansion and market power effects? The four interaction variables indicate the sensitivity of the Taiwan exports to the strength of national IPRs within each threat of imitation group. Positive values of the parameters of these interaction terms confer market expansion and negative parameters indicate the IPRs confer market power. According to Smith's (1999) predictions, the sign for coefficient β_7 should be negative and the sign for coefficient β_{10} should be positive. While the estimated interaction effects for groups 2 and 3 (β_8 and β_9) are undetermined, depending on the relative strength of market expansion and market power effects.

Now we consider the link between threat of imitation and export sensitivity to IPRs and examine whether there are differences in the trade effect of threat-of-imitation between high-tech and non high-tech exports. To explore whether the market expansion (power) effect of IPRs applies across countries that pose strong (weak) imitative threats, we implement similar econometric techniques of GMM for dynamic panel model used in obtaining table 5 and report the estimates on the new interaction variables in table 7.¹²

[Insert Table 7 about Here]

The results in table 7 are ordered from left to right to reflect an increasing threat of imitation of the average country in each group. The estimated coefficients indicate the effect of national differences in IPRs across importers within each threat-of-imitation group.

According to the theoretical predictions, the market expansion effect should increase gradually

¹² To save space, the estimates on other variables are not reported here. The values of Sargan statistics are lower than 10% critical value in all estimates.

when the degree of threat-of-imitation increases. That is, β_7 should be negative and β_{10} should be positive. As shown in table 7, the estimates among total, high-tech and non high-tech equations are quite similar, indicating the effect of threat-of-imitation does not vary for Taiwan's high-tech and non high-tech exports. The parameter sign for the strong threat-of-imitation group (G4) appears opposite sign in different classifications. This inconsistent result is attributed to the fact that there are few countries being classified into group 4 and the samples vary across different classification system,¹³ suggesting that both the classification system of importing countries and estimated trade effect of threat-of-imitation should be dealt with and interpreted more carefully when the sample countries are limited.¹⁴

Now we turn to focus on the Taiwan export sensitivity to differences in IPRs across countries within a given group. It is noteworthy that all estimates lead to puzzling asymmetries in the sign of coefficient with respect to the degree of threat-of-imitation, compared with theory predictions. Suggested by theory literature and evidence from developed countries, such as Smith (1999, 2001), the estimated coefficient for the interaction terms should tend to be negative in groups 1 and 2. That is, one may expect Taiwan's export to be biased against those importers with "relative" strongest IPRs within the group that poses a weak imitative threat (group 1). In other word, the market power effect of IPRs applies across low-threat importers. However, our estimates on the interaction terms for groups 1 and 2 appear a statistically positive impact on Taiwan's exports to those importing countries, meaning that the market expansion effect dominates the market power effect in weak imitative abilities groups when their strength of IPRs protection is enhanced. This result indicates that the market expansion strategy might be widely applied by Taiwanese firms to sell their products in countries with weakest and moderate threat of imitation (usually developing countries), contradicting with previous studies.

Theory predictions also suggest that the market expansion effect applies across countries with the strongest threat of imitation (group 4), implying that the coefficient for the interaction term

¹³ There are usually only two countries being classified into this category. See the appendix table.

¹⁴ Falvey *et al.* (2006) employ the technique of threshold regression as an alternative approach to classify groups of threat-of-imitation.

G4*IPR should be positive. Drawn from the results in table 7, the estimate confirm remarkably well with the interpretations suggested by the theory literature in classification 1 that categorizes strongest threat-of-imitation as the one similar to that suggested by Maskus and Penubarti (1995). In contrast, the estimates obtained from classifications 4-8 exhibit a significant negative coefficient for the G4*IPR variable. Why the estimated trade effect for the group with strongest threat of imitation differs when we adopt different classification standards and which one is correct? Indeed, the inconsistent results arise from the fact that here are few countries being classified into group 4 (usually 2 countries) and the samples vary across different classification system, resulting in a sensitive result. Therefore, we cannot obtain an affirmative answer whether market expansion applies across countries with strongest threat of imitation for Taiwan's exports.

Concerning group 3 that poses strong imitative ability and strong IPRs protections (usually developed countries), how their enhancement of IPRs protection affects Taiwan's exports toward them? One can expect the effect of IPRs to be ambiguous for importers in group 3, since either the market power or market expansion effect may apply. Among the classification systems, our estimates obtain a consistent result of significant negative impact. This result is consistent with Liu and Lin (2005) that there exists a market-power effect for Taiwan's high-tech exports to group 3 countries (advanced economies). According to the argument in Smith (1999), it can be interpreted as following: when IPRs protection is sufficiently stringent to protect against infringements by importers with strong imitative abilities, then Taiwanese firms that own patented technologies or products in a foreign market may execute their monopoly power by restricting export volumes. This study also finds that elasticity for high-tech exports is higher than that of non high-tech in all estimates. This result is reasonable because the high ranking of Taiwan's patents in developed countries is composed of high share of high-tech patents.¹⁵

Combined with findings in Liu and Lin (2005), such a concern of market-power effect might has been observed, while this aforementioned interpretation does not seem to be convincing that

¹⁵ However, the negative coefficient can be interpreted from an alternative point. Since most group3 members are developed countries that have a higher GDP per capita or R&D intensity than that of Taiwan (such as classifications 3, 4, 7, and 8), the enhancement of IPRs might stimulate their domestic innovations and lower fake goods imported from developing countries.

Taiwanese firms do in reality worry about the threat of imitation when they export to advanced markets such as Japan and U.S. Indeed, most of Taiwan's exports to advanced economies use technologies developed in these countries; and, that most of these exports are related to the "subcontracting" work Taiwanese manufacturers do for the firms of these advanced economies. The negative impact may arise from the competition effect of products exported from other NIEs or produced by local firms in these advanced countries. Therefore, do Taiwanese firms indeed execute their monopoly power by restricting exports to advanced economies is worth further investigating.

7. Concluding Remarks and Policy Implications

The theoretical literature suggests that the impact of patent laws on trade is ambiguous. Several empirical works have contributed evidence on the sensitivity of exports to national differences in IPRs for developed countries, while there are few studies discussing the experiences of developing countries. More importantly, the protection of IPRs is inherently a dynamic process, meaning that the clarification about the dynamic relation between IPRs and trade is worth exploring while is never well investigated due to the availability of a longitudinal IPRs index. By applying the IPRs index developed by World Economic Forum (WEF) and employing the technique of GMM on dynamic panel model, this work contributes the empirical evidence on the relationship between IPRs and trade for NIEs, Taiwan, attempting to shed some light on the issue.

Based on the data of high-tech and non high-tech imports from Taiwan for 51 countries during 1997-2003 and employing the technique of GMM on dynamic panel model, the dynamic nature of our estimates could control for potential endogeneity and panel unit root, helping place these results into a better perspective. The empirical results find that overall the national differences in IPRs protection do exist a significant positive influence on Taiwan's exports after controlling other country characteristics. In other words, the market expansion strategy is more prevailing for Taiwan's exports to both developed and developing countries. Moreover, the positive trade effect of IPRs is stronger for high-tech than non high-tech exports.

By employing various classification systems to differentiate the degree of threat-of- imitation

across countries, the role of threat-of-imitation emphasized in theoretical arguments is examined in this study. We find that both market expansion and market power do exist in Taiwan's case and the market expansion strategy tend to be more prevailing, while the Taiwan evidence on the link between empirical evidence and theory on threat-of-imitation and trade seems to be contradictable with developed countries' experience. Particularly, there is a significantly negative export effect of IPRs to advanced countries is found in this study. Does this estimate really come from the market power effect or it is arisen from competition from other competitors? This interesting and important question is worth further investigating.

Some key policy implications are inspired from the results. First, given the circumstance that high-tech exports have become one of major driving forces of Taiwan's economic growth and foreign IPRs protections indeed exhibit a positive impact on Taiwan's exports, the Taiwan government should keep on encouraging firms to improve their technological capability through tax and non-tax measures in order to improve the international competitiveness of Taiwanese high-tech products in the global market.

IPRs protection is actually positively associated with trade and then the degree of law enforcement should play the key role in protecting patented imports. Therefore, the agreement of TRIPS, aiming to harmonize the mean of IPRs protection, is beneficial to Taiwan from the dynamic point. For example, the trade between strait surged extremely rapid and now China has become Taiwan's major trade pattern. However, it is well known that the enhancement of patent protection is extremely weak in China and it can lead to the erosion of high profits for foreign innovating firms as local firms produce fake goods and set a lower price even though foreign firms have filed the patent in China. If China strengthens the enforcement of IPRs protection, it will stimulate further growth of Taiwan's exports to China.

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Table 1 Variable Definition, Basic Statistics, and Data Sources

Variable name	Definition	Mean	Standard Error	Data Source
<i>EXP</i>	The Value of exports from Taiwan to country <i>i</i> (US\$ million)	2395.230	5825.410	Bureau of Foreign Trade, Ministry of Economic Affairs, Taiwan http://www.trade.gov.tw/index.asp
<i>PGDP</i>	Per capita gross domestic product of destination country (US\$)	15494.862	10245.931	IMF World Economic Outlook Database
<i>DIS</i>	Geographic distance between Taiwan and country <i>i</i> (km)	14021.416	26615.953	GIS Research Center at Feng Chia University, Taiwan
<i>POP</i>	Population of destination country (thousand)	88745.233	220471.364	IMF World Economic Outlook Database
<i>IPR</i>	The degree of IPRs protection of destination Country. It ranges from 1-7 and a higher value denotes a stronger protection	4.667	1.177	The Global Competitiveness Report, World Economic Forum
<i>OPEN</i>	Openness Degree: the ratio of the sum of imports and exports to GDP. (%)	70.056	53.585	IMF World Economic Outlook Database
<i>TB</i>	Trade Barrier: average tariff rate of destination country	6.700	6.408	The Global Competitiveness Report, World Economic Forum
<i>NTB</i>	Non Tariff Barrier: hidden import barriers of destination country. It ranges from 1-7. 1= an important problem, 7=not an important problem.	5.017	0.992	The Global Competitiveness Report, World Economic Forum

Note: The means and standard errors are calculated by pooling data for the 1997-2003 period.

Table 2 IPRs and Trade (Pooling Data Estimates)

	Total	High-tech	Non High-tech
Constant	-11.662*** (1.289)	-14.674*** (1.248)	-9.969*** (1.530)
lnPGDP	0.629*** (0.092)	0.806*** (0.089)	0.409*** (0.109)
lnPOP	1.087*** (0.040)	1.137*** (0.039)	1.056*** (0.048)
lnDIS	-0.597*** (0.057)	-0.593*** (0.055)	-0.629*** (0.067)
lnOPEN	0.758*** (0.088)	0.810*** (0.085)	0.568** (0.105)
lnTB	-0.352*** (0.104)	-0.407*** (0.100)	-0.323*** (0.123)
lnNTB	0.744** (0.349)	0.897*** (0.337)	0.656 (0.413)
lnIPR	1.870*** (0.255)	1.819*** (0.274)	1.701*** (0.303)
R ²	0.799	0.829	0.716
Number of Obs.	357	357	357

Note: Figures in parentheses are standard errors. *** and ** represent statistical significance at the 1% and 5% levels, respectively.

Table 3 IPRs and Taiwan's Exports (Within Estimates)

	Total Exports		High-tech		Non High-tech	
	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects
Constant	1.888 (1.761)		-3.075* (1.498)		-1.473 (2.037)	
lnPGDP	0.226*** (0.047)	0.166*** (0.049)	0.286*** (0.050)	0.202*** (0.052)	0.148*** (0.049)	0.114** (0.051)
lnPOP	0.804*** (0.080)	-0.351 (0.678)	0.814*** (0.077)	-0.713 (0.720)	0.782*** (0.094)	-0.535 (0.702)
lnDIS	-0.593*** (0.126)	dropped	-0.587*** (0.121)	dropped	-0.632*** (0.150)	dropped
lnOPEN	0.435*** (0.102)	0.397*** (0.116)	0.423*** (0.106)	0.360*** (0.123)	0.337*** (0.109)	0.319*** (0.119)
lnTB	-0.334*** (0.068)	-0.267*** (0.072)	-0.422*** (0.072)	-0.329*** (0.076)	-0.108 (0.071)	-0.060 (0.074)
lnNTB	0.806*** (0.171)	0.661*** (0.175)	0.849*** (0.181)	0.650*** (0.186)	0.810*** (0.178)	0.709*** (0.181)
lnIPR	0.521*** (0.134)	0.252** (0.140)	0.576*** (0.142)	0.262* (0.148)	0.405*** (0.140)	0.242* (0.144)
R ²	0.706	0.980	0.736	0.980	0.621	0.979
Hausman test		52.798***		74.978***		31.341***
D-W test	0.061***	0.860***	0.074***	0.979***	0.043***	0.739***

Note: Figures in parentheses are standard errors. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Dropped indicates that the variable is a time-invariant variable that is dropped out of the estimation because fixed effects estimation cannot estimate variables that do not change over time.

Table 4 Panel Unit Root Tests

Method	Statistic	Probability
Im, Pesaran and Shin W-statistic	0.396	0.665
ADF-Fisher Chi-square	104.745	0.406

Note: the null hypotheses assume individual unit root process.

Table 5 IPRs and Trade (GMM for Dynamic Panel Data Model)

	Total	High-tech	Non High-tech
lnEXP(-1)	0.683*** (0.020)		
lnTEXP(-1)		0.688*** (0.020)	
lnNTEXP(-1)			0.727*** (0.017)
lnPGDP	0.086*** (0.011)	0.079*** (0.014)	0.102*** (0.011)
lnPOP	0.280*** (0.019)	0.302*** (0.020)	0.197*** (0.011)
lnDIS	-0.456*** (0.026)	-0.488*** (0.025)	-0.383*** (0.023)
OPEN	-0.007 (0.035)	-0.035 (0.038)	-0.033 (0.030)
TB	-0.238*** (0.026)	-0.331*** (0.041)	-0.038** (0.016)
NTB	0.864*** (0.073)	1.003*** (0.117)	0.457*** (0.081)
IPR	0.374*** (0.034)	0.373*** (0.029)	0.275*** (0.024)
Sargan test (df)	25.522(34)	24.861(34)	25.310(34)

Note: Figures in parentheses are standard errors. *** and ** represent statistical significance at the 1% and 5%, respectively.

**Table 6 The Relationship between Threat of Imitation and Market Expansion and
Market Power Effects**

	Weak Patent Rights	Strong Patent Rights
Weak Imitative Abilities	2. Moderate Threat of Imitation; Ambiguous Effect (+/-)	1. Weak Threat of Imitation; Market Power Effect (-)
Strong Imitative Abilities	4. Strong Threat of Imitation; Market Expansion Effect (+)	3. Moderate Threat of Imitation; Ambiguous Effect (+/-)

Data Source: Smith (1999), p.156.

Table 7 Threat-of-Imitation and Taiwan's Exports (GMM for Dynamic Panel Data Model)

	Group 1 Weak Imitative Abilities, Strong IPRs	Group 2 Weak Imitative Abilities, Weak IPRs	Group 3 Strong Imitative Abilities, Strong IPRs	Group 4 Strong Imitative Abilities, Weak IPRs
Classification 1				
Total	0.278 (0.194)	0.288 (0.079)***	-0.320 (0.066)***	0.804 (0.241)***
High-tech	0.487 (0.196)**	0.179 (0.065)***	-0.336 (0.083)***	0.819 (0.186)***
Non High-tech	0.055 (0.124)	0.216 (0.042)***	-0.196 (0.035)***	0.672 (0.127)***
Classification 2				
Total	7.611 (6.177)	0.303 (0.042)***	-0.496 (0.099)***	0.053 (0.106)
High-tech	10.004 (8.042)	0.313 (0.056)***	-0.530 (0.093)***	-0.063 (0.064)
Non High-tech	6.460 (5.051)	0.177 (0.034)***	-0.464 (0.063)***	0.204 (0.088)**
Classification 3				
Total	0.387 (0.074)***	0.175 (0.055)***	-0.384 (0.069)***	no sample
High-tech	0.547 (0.102)***	0.135 (0.065)**	-0.439 (0.069)***	no sample
Non High-tech	0.277 (0.085)***	0.137 (0.045)***	-0.328 (0.057)***	no sample
Classification 4				
Total	0.330 (0.355)	0.220 (0.029)**	-0.255 (0.106)***	-0.457(0.182)**
High-tech	0.469 (0.396)	0.235 (0.038)***	-0.292 (0.105)***	-0.610 (0.177)***
Non High-tech	0.395 (0.319)	0.175 (0.027)***	-0.212 (0.076)***	-0.727 (0.222)***
Classification 5				
Total	0.460 (0.164)***	0.246 (0.067)***	-0.305 (0.068)***	-1.081 (0.384)***
High-tech	0.498 (0.196)**	0.209 (0.086)**	-0.306 (0.067)***	-0.809 (0.539)
Non High-tech	0.472 (0.146)***	0.188 (0.062)***	-0.327 (0.049)***	-0.930 (0.139)***

Table 7 Threat-of-Imitation and Taiwan's Exports (GMM for Dynamic Panel Data Model), Continuous

	Group 1 Weak Imitative Abilities, Strong IPRs	Group 2 Weak Imitative Abilities, Weak IPRs	Group 3 Strong Imitative Abilities, Strong IPRs	Group 4 Strong Imitative Abilities, Weak IPRs
Classification 6				
Total	0.593 (0.265)**	0.271 (0.048)***	-0.503 (0.105)***	-0.225 (0.075)***
High-tech	0.671 (0.271)**	0.208 (0.066)***	-0.520 (0.096)***	-0.142 (0.096)
Non High-tech	0.275 (0.140)**	0.212 (0.058)***	-0.276 (0.054)***	-0.328 (0.069)***
Classification 7				
Total	0.233 (0.043)***	0.188 (0.036)***	-0.592 (0.124)***	0.066 (0.019)***
High-tech	0.278 (0.052)***	0.145 (0.037)***	-0.597 (0.115)***	0.048 (0.020)**
Non High-tech	0.197 (0.048)***	0.162 (0.043)***	-0.512 (0.114)***	0.054 (0.025)**
Classification 8				
Total	-0.006 (0.077)	0.239 (0.026)***	-0.890 (0.194)***	-0.582 (0.183)***
High-tech	0.033 (0.072)	0.238 (0.033)***	-0.811 (0.180)***	-0.778 (0.207)***
Non High-tech	0.102 (0.056)*	0.152 (0.021)	-0.674 (0.150)***	-0.508 (0.135)***

Note: Figures in parentheses are standard errors. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Classification 1: strong imitative abilities: per capita GDP > 8356; strong IPRs: IPRs index > 4

Classification 2: strong imitative abilities: per capita GDP > 8356; strong IPRs: IPRs index > mean (4.652)

Classification 3: strong imitative abilities: per capita GDP > Taiwan(13150); strong IPRs: IPRs index > 4

Classification 4: strong imitative abilities: per capita GDP > Taiwan(13150); strong IPRs: IPRs index > mean (4.652)

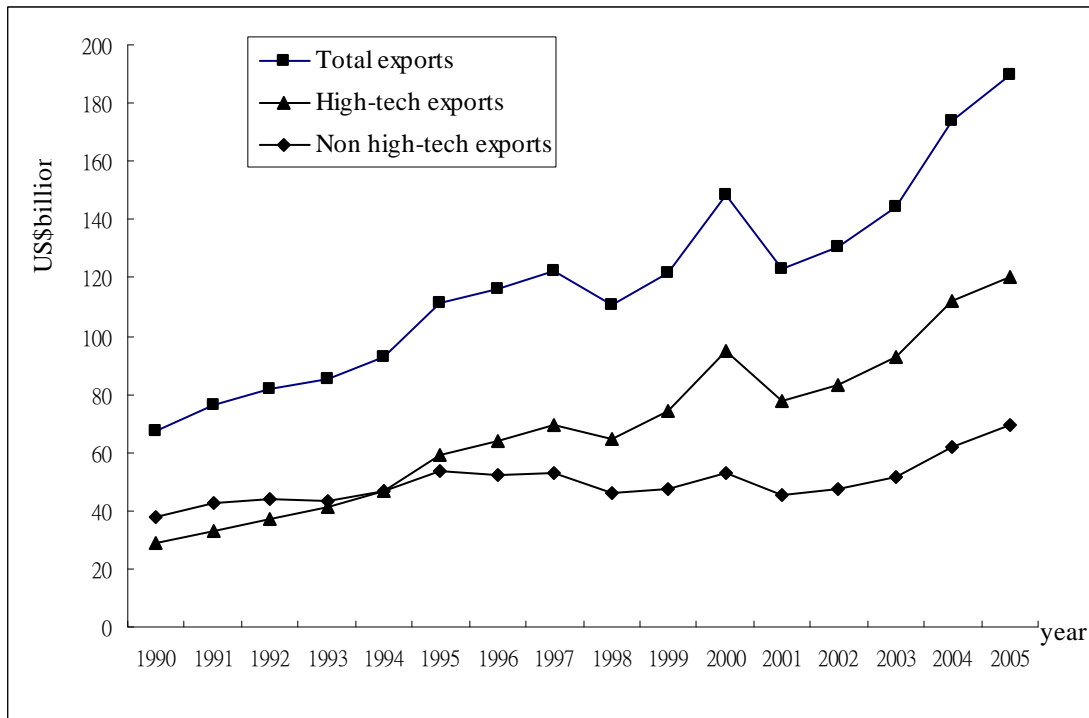
Classification 5: strong imitative abilities: RD/GDP > 0.5%; strong IPRs: IPRs index > 4

Classification 6: strong imitative abilities: RD/GDP > 0.5%; strong IPRs: IPRs index > mean (4.652)

Classification 7: strong imitative abilities: RD/ GDP > Taiwan(1.92); strong IPRs: IPRs index > 4

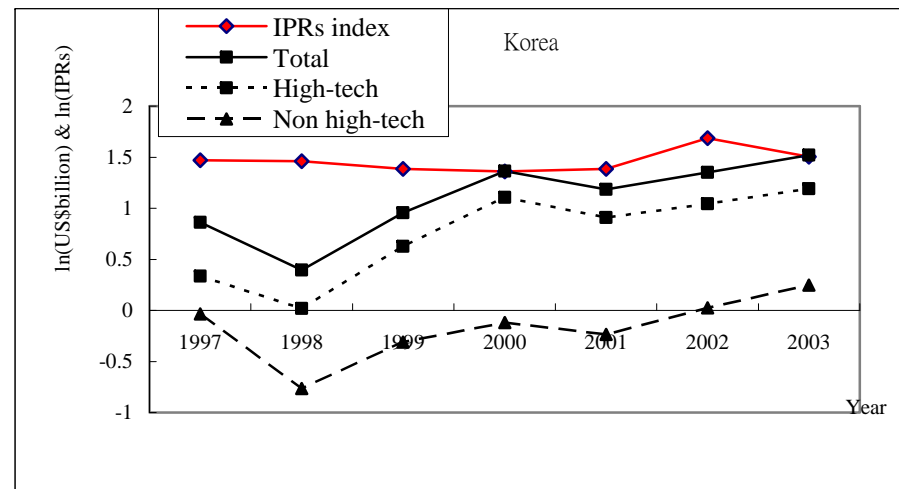
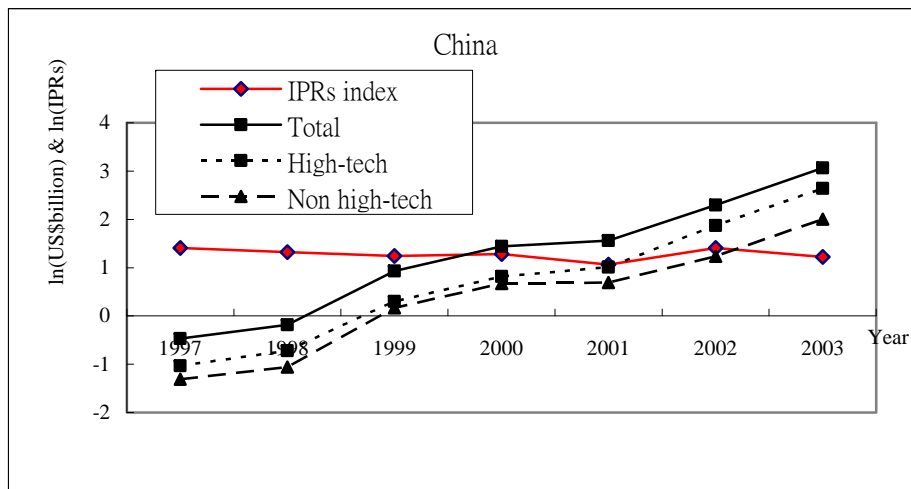
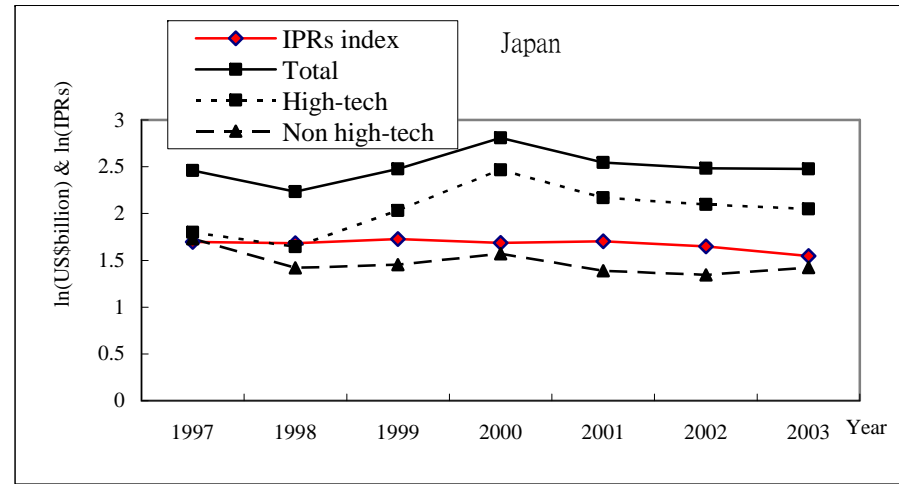
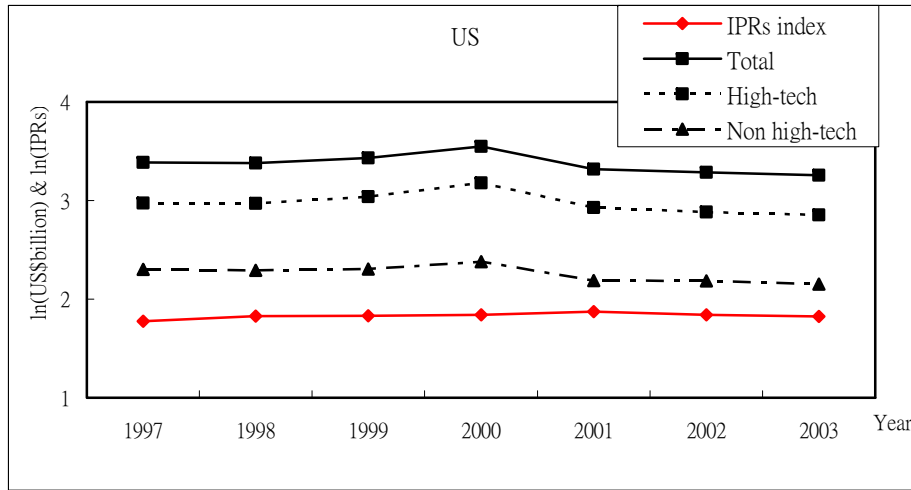
Classification 8: strong imitative abilities: RD/ GDP > Taiwan(1.92); strong IPRs: IPRs index > mean (4.652)

Figure 1 Taiwan's Exports and Its Composition, 1990-2005



Data Source: The data for total exports are obtained from Ministry of Economic Affairs, Taiwan. The values of high-tech and non high-tech exports are calculated by the authors.

Figure 2 Destination Countries' IPRs Strength and Imports Trend



Appendix Countries and Threat-of-Imitation Data

Case	Country	Classification 1	Classification 2	Classification 3	Classification 4	Classification 5	Classification 6	Classification 7	Classification 8
1	Argentina	G4	G4	G2	G2	G2	G2	G2	G2
2	Australia	G3	G3	G3	G3	G3	G3	G1	G1
3	Austria	G3	G3	G3	G3	G3	G3	G1	G1
4	Belgium	G3	G3	G3	G3	G3	G3	G1	G1
5	Brazil	G1	G2	G1	G2	G3	G4	G2	G2
6	Canada	G3	G3	G3	G3	G3	G3	G1	G1
7	Chile	G3	G4	G1	G2	G3	G4	G2	G2
8	China, PR	G2	G2	G2	G2	G4	G4	G2	G2
9	Colombia	G2	G2	G2	G2	G2	G2	G2	G2
10	Czech	G3	G4	G1	G2	G3	G4	G2	G2
11	Denmark	G3	G3	G3	G3	G3	G3	G3	G3
12	Egypt	G2	G2	G2	G2	G2	G2	G2	G2
13	Finland	G3	G3	G3	G3	G3	G3	G3	G3
14	France	G3	G3	G3	G3	G3	G3	G3	G3
15	Germany	G3	G3	G3	G3	G3	G3	G3	G3
16	Greece	G3	G4	G1	G2	G3	G4	G2	G2
17	Hong Kong	G3	G3	G3	G3	G1	G1	G1	G1
18	Hungary	G1	G2	G1	G2	G3	G4	G2	G2
19	Iceland	G3	G4	G3	G4	G3	G4	G4	G4
20	India	G2	G2	G2	G2	G2	G2	G2	G2
21	Indonesia	G2	G2	G2	G2	G2	G2	G2	G2
22	Ireland	G3	G3	G3	G3	G3	G3	G1	G1
23	Israel	G3	G3	G3	G3	G3	G3	G3	G3
24	Italy	G3	G3	G3	G3	G3	G3	G1	G1
25	Japan	G3	G3	G3	G3	G3	G3	G3	G3

26	Jordan	G2	G2	G2	G2	G2	G2	G2	G2
27	Korea, RP	G3	G4	G3	G4	G3	G4	G4	G4
28	Malaysia	G3	G3	G1	G1	G1	G1	G1	G1
29	Mexico	G3	G4	G1	G2	G1	G2	G2	G2
30	Netherlands	G3	G3	G3	G3	G3	G3	G3	G3
31	New Zealand	G3	G3	G3	G3	G3	G3	G1	G1
32	Norway	G3	G3	G3	G3	G3	G3	G1	G1
33	Peru	G2	G2	G2	G2	G2	G2	G2	G2
34	Philippines	G2	G2	G2	G2	G2	G2	G2	G2
35	Porland	G1	G2	G1	G2	G3	G4	G2	G2
36	Portugal	G3	G4	G3	G4	G3	G4	G2	G2
37	Russia	G2	G2	G2	G2	G2	G2	G2	G2
38	Singapore	G3	G3	G3	G3	G3	G3	G1	G1
39	Slovak	G4	G4	G2	G2	G4	G4	G2	G2
40	South Africa	G1	G1	G1	G1	G1	G1	G1	G1
41	Spain	G3	G3	G3	G3	G3	G3	G1	G1
42	Sweden	G3	G3	G3	G3	G3	G3	G3	G3
43	Switzerland	G3	G3	G3	G3	G3	G3	G3	G3
44	Thailand	G1	G2	G1	G2	G1	G2	G2	G2
45	Turkey	G1	G2	G1	G2	G1	G2	G2	G2
46	Ukraine	G2	G2	G2	G2	G2	G2	G2	G2
47	U.K.	G3	G3	G3	G3	G3	G3	G3	G3
48	U.S.	G3	G3	G3	G3	G3	G3	G3	G3
49	Venezuela	G4	G4	G2	G2	G2	G2	G2	G2
50	Vietnam	G2	G2	G2	G2	G2	G2	G2	G2
51	Zimbabwe	G2	G2	G2	G2	G2	G2	G2	G2

G1: weak imitative ability and strong IPRs protection; G2: weak imitative ability and weak IPRs protection;
G3: strong imitative ability and strong IPRs protection; G4: strong imitative ability and weak IPRs protection.