IMPACTS OF INTELLECTUAL PROPERTY RIGHT PROTECTION IN FOREIGN COUNTRIES ON KOREA'S EXPORTS

Nguyen K. Doanh [*]
Yoon Heo [**]
Nguyen T. Gam [***]

Abstract

This paper investigates the impacts of IPR protection in foreign countries on Korea's total exports and exports by commodity. Using the modified gravity equation with fixed effects and random effects models for the panel data, our results are summarized as follows. *First*, reinforced IPR protection in foreign countries has a positive effect on Korea's total exports, indicating the dominance of market expansion effects. *Second*, stronger protection of IPRs induces Korea's exports to all foreign countries regardless of their level of development. The effects are stronger in medium-income and high-income countries, followed by low-income countries where the effect is not clear. *Third*, Korea tends to export more to countries with strong imitative ability when the IPR protection in these countries is strengthened, suggesting the market expansion effects. *Finally*, stronger protection of IPRs in foreign countries with weak imitative ability leads to ambiguous reduction in Korea's exports, demonstrating no market power effects. Efforts to increase the GDP, improve social infrastructure, accelerate domestic reforms (openness to trade) and importantly strengthen IPR protection in foreign countries are suggested as a remedy for obstacles to Korea's exports.

1. Introduction

Over the past decade, the protection of intellectual property rights (IPRs) has become one of the most important issues. Indeed, economists have recognized that the protection of Intellectual Property Rights (IPR) has a significant impact on trade flows (See, e.g., Segerstrom et al., 1990; Grossman and Helpman, 1991; Helpman, 1993). The preliminary conjecture is that weak IPR protection distorts natural trade patterns and the ability of firms to transfer technology abroad. Thus, differences in national norms regarding IPR protection are thought to negatively affect freer flows of international trade. This could be one of the reasons why the regulation of national regimes of intellectual property rights has recently become a contentious issue.

[*] Vice-Director of the International Cooperation Center for Training and Study-Abroad, Thai Nguyen University of Economics and Business Administration, Vietnam. Tel: 0084-977-242-268; Fax: 0084-280-647 684; E-mail: nkdoanh@yahoo.com.
[**] Professor, Graduate School of International Studies, Sogang University, Korea. Tel: 0082-2-705-8948; Fax: 0082-2-705-8755. E-mail: hurry@sogang.ac.kr.
[***] Vice-Director of the Department of Training, Scientific Research and International Relations, Thai Nguyen University of Economics and Business Administration, Vietnam. Tel: 0084-912-805 980; Fax: 0084-280-647 684; E-mail: ntgam@yahoo.com.

The results of the Uruguay Round were, however, extremely controversial for many WTO member countries[1]. From the developed countries' point of view, lack of IPR protection in developing countries constitutes an unfavorable trade environment that could reduce their firms' competitive positions. Thus, they called for multilateral rules and enforcement of IPR. On the other hand, many developing countries tend to argue in favor of weak IPR regime. According to them non-protection of IPRs on their part had a negligible impact on producers in OECD countries, and that adoption of stronger IPRs would increase the profitability of foreign firms at the expense of domestic producers and thus would be detrimental to their welfare and development prospects (See Hoekman & Kostecki, 2001).

Theoretically, economic analysis is unable to predict the direction of the impacts of IPR protection on bilateral trade flows[2]. The existence of such ambiguity is due to the fact that the strengthening of IPRs would simultaneously create two effects working in opposite directions (see, e.g., Schwartz, 1991; Taylor, 1993; Taylor, 1994; Maskus and Penubarti, 1995; Smith, 1999). On the one hand, stronger protection of IPRs in the importing countries grants monopoly power to the exporting countries. Also, the level of IPR protection may affect firms to choose to serve a foreign market by FDI or licensing rather than exporting (Ferrantino, 1993). For that reason, the imports may decrease if exporters exercise their enhanced market power by reducing output and charging higher prices to segments of their foreign markets[3]. On the other hand, greater protection of IPRs in the importing country reduces local firms to imitate foreign technologies. This leads to an increase in the net demand for the protected products. Accordingly, the increase in demand induces the exporting firms to supply more exports in the local market.

Since these two effects are offsetting, no clear prediction can be made regarding the nature and direction of the impacts of IPR protection on trade. This theoretical ambiguity regarding the impact of IPR protection on international trade has led to several empirical attempts. Recently, a growing body of literature on the nature and direction of the effects of IPR protection on international trade flows suggested that the relationship between IPRs and trade cannot be generalized (see Maskus and Penubarti, 1995; Frink and Primo-Braga, 2005; Smith, 1999; Rafiquzzaman, 2002; Smith, 2002; Oh and Won, 2005). Results of these studies show that the impact of stronger protection of IPRs on trade is an empirical issue. This has induced us to concentrate on the empirical analysis of the issue on Korean case.

[1] As explained in Hoekman and Kostecki (2001), an intellectual property system seeks to create a balance between the need for a temporary monopoly to create incentives for innovation and the benefits of free access knowledge.

[2] Maskus (2000) noted that theoretical models do not clearly predict the impacts of variable patent rights on trade volumes. Much depends on local market demand, the efficiency of imitative production, and the structure of trade barriers. Also important are the reactions of imperfectly competitive firms. Thus, a clear picture can emerge only from empirical studies.

2. Research objective

This study aims at promoting the understanding of IPR protection and its impacts on international trade, taking Korea as a case study. Therefore, it is guided by the following specific objectives:

- To analyze the impacts of IPR protection in foreign countries on Korea's total exports and exports by commodity.
- To analyze the impacts of IPR protection in foreign countries grouped by development levels and imitation abilities on Korea's total exports and exports by commodity.
- To derive policy implications based on this study.

The empirical analysis in this paper differs from the previous studies in several aspects. *First*, this study provides new evidence regarding the linkage between IPRs and trade with a focus on Korea. Little evidence has ever been documented on the experiences of Korea and in that sense, this study would provide important insights into Korea and the rest of the world where level of economic development and imitation capacity differs across countries. *Second*, the study is based on the analysis of the most recent panel data which allow the patent regime to change over time[4]. *Third*, the impact of IPR is firstly forced to be uniform across sectors and then is allowed to differ across sectors so that industry-specific evidences can be documented. Since many of the previous studies focus on industries at relatively high levels of aggregation, our industry-level analysis is particularly advantageous because the effects of IPR protection on trade can be washed out at the aggregate level. *Fourth*, in order to analyze the impact of IPR protection on trade, we use a set of models, including the fixed effects model and random effects model. *Finally*, to measure the status of an IPR regime, the IPR index developed by Park and Ginarte is used[5].

3. Literature review

The linkage between IPR protection and trade has been discussed at length in the literature. There is a growing body of literature in which the nature and direction of the effects of stronger protection of IPR on trade (See, e.g., Primo Braga and Frink, 1997; Maskus and Penubarti, 1997). Although it is unambiguous that IPR protection can influence trade flows, the net impact on trade flows of strengthening protection of IPRs remains theoretically ambiguous (See, e.g., Maskus, 2000; Maskus & Penubarti, 1995). Stronger protection of IPRs in importing countries allows the foreign exporters to behave more monopolistically and to choose to serve the exporting market by foreign direct investment or by licensing its intellectual asset to a foreign firm (Ferrantino, 1993; Lee & Mansfield,

[4] Most of the previous studies examine single points in time.

[5] A number of studies have attempted to measure IPR cross-nationally, among them are Rapp and Rozek (1990), Seyoum (1996) and Sherwood (1997). However, the IPR index developed by Park and Ginarte (1997) is the most appropriate in the present context because it has the broadest country coverage. Moreover, it allows for a much more fine-tuned ranking of national IPR system.

1996; Maskus, 1998; Seyoum, 1996), which is known as the *market power effect*. Simultaneously, a stronger level of IPR protection in importing countries encourages the foreign exporters to export more to the foreign market due to the shrinkage of imitative activities in importing countries, which is known as the *market expansion effect*. Naturally, the importance of these effects is likely to depend on specific products and market characteristics. Certainly, some products are easier to imitate than thothers, and some products have closer substitutes than others. In addition, the impacts of IPR protection also depend on the exporters. If the exporter is not an innovator, the imports from this exporter's country are less likely to be new technology-intensive. So the protection of IPR is not important for trade in this case.

The observation that theory indicates the relationship between stronger IPR protection and trade could have either sign, depending on product and market characteristics, has led to attempts to resolve this ambiguity empirically. To date, a number of studies have attempted to estimate the effects of IPR protection on trade flows (e.g., Primo Braga and Frink, 1997; Al-Mawali, 2005 Wen-Hsien & Ya-Chi, 2005). Maskus and Penubarti (1995) provided the first systematic evidence on the linkage between IPRs and trade, and demonstrated that national differences in PRs distort trade flows. They found that a stronger protection of IPRs increases trade flows - that is the market expansion effect tends to dominate the market power effect - when all industries are pooled.

A number of previous studies focused on the imitative abilities, threat of imitation and R&D abilities of the importing countries in analyzing the impacts of IPR protection on exports (See Maskus and Penubarti, 1995; Smith, 1999; Smith, 2002; Lui and Lin, 2005). For example, Ferrantino (1993) studied the effect of IPR regimes on exports. Using the US export data, he found that importing countries' patent regimes do not affect total exports. Smith (1999) qualified these results by showing that the market expansion effect of IPRs depends on whether local firms are capable of imitating the exporter's technology. The importing countries are divided into four groups according to threat of imitation, which is defined as R&D expenditure as a percentage of GNP. The dummies for four groups were then interacted with the IPR variable. The study indicated that US exports are sensitive to patent rights in importing countries, and the direction of the relationship rests with the threat of imitation[6]. Specifically, Smith found that there is a negative relationship between IPR protection and imports of those countries with weakest imitative abilities, and positive relationship between IPR protection and imports of those countries with strongest imitative abilities. Rafiquzzaman (2002) found similar results, indicating that stronger patent rights is seen to increase Korean exports to those countries that pose a strong threat of imitation and to reduce exports to countries that pose weakest threat of imitation. This result is also confirmed by Smith (2002), which showed that stronger foreign patent rights stimulate the market expansion of US drug exports across countries with strong imitative abilities, but enhance the marker power of US drug exporters across countries with weak imitative

[6] The threat of imitation may be viewed as a reflection of an importing country's ability to imitate technologies embodied the imported goods.

abilities. More recently, Frink and Primo Braga (2005) found a positive link between IPRs and trade flows for total non-fuel trade, but a weak link between IPRs and high technology trade[7].

Other studies have emphasized on the level of development in analyzing the impacts of IPR protection on trade. For example, Smith (1999) introduced the interaction terms that are the product of interactions between IPR and four dummy variables based on the per capita income of the importers, including low income, lower middle income, upper middle income and high income. Smith found that US exporters respond positively to the strength of IPR protection in countries classified as low middle-income countries, but negatively to other country groups. Rafiquzzaman (2002) used similar methodology to construct the three development dummy interaction variables. These variables are the products of interaction between IPR and development dummies, which are constructed by classifying the importing countries into three groups by their level of economic development, including high income, middle income and low income. The results showed that, at aggregate manufacturing level, Canadian exports respond positively to the strength of IPRs in countries within all levels of development groups.

A review of the previous literature on the subject leads to the following conclusions. *First*, theoretically, there is a link between IPRs and trade flow. More specifically, IPRs do affect trade. However, the nature and the direction of the impact are ambiguous, depending on the interaction between market expansion (which increases trade) and market power effects (which reduces trade). If market expansion effects dominate, the stronger protection of IPR would enhance trade. In contrast, if the market power effects dominate, stronger protection of IPR would reduce trade. *Second*, empirically, evidence on the linkage was mixed, suggesting that the impact of IPR protection on trade flows is an empirical issue and can only be assessed on a case-by-case basis. *Third*, past empirical evidence showed that industrial countries and importing countries with significant threat of imitation and relatively weak IPR regimes tended to experience an increase in bilateral trade[8]. In contrast, in underdeveloped and developing countries with weak patent rights and weak imitation capacities, the market power effect tended to dominate[9]. *Finally*, the response of trade in R&D intensive products to increased IPR protection may be difficult to predict. The reason is that these products are particularly difficult to imitate anyway, and the producers of these products might choose to serve foreign countries through FDI and licensing. These hypotheses are among those being explored further below.

[7] The authors' possible explanations are that the market power effect of IPRs could very well dominate in high-technology sectors, that stronger IPRs lead to a switch from exporting to FDI, or that technology exports depend on alternative means fro appropriation (such as first-mover advantages or reputation.

[8] Industrial countries have strong imitation abilities. So to a large extent, their markets might be served by imitated goods. Stronger IPR regimes would reduce the level of local infringement, and imitated goods are replaced by foreign patented goods, generating a market expansion effect.

[9] Initially, markets of these countries might already be served by foreign exporting firms. Since the imitation abilities in these countries are often weak, the strengthening of IPR regime in these countries would not create the market expansion effect large enough to outweigh the market power effect.

4. Theoretical framework

4.1. Analytical model

The topic being explored is most suited to a quantitative approach. In seeking to empirically estimate the impacts of increased IPR protection on trade flows, a gravity model is adopted. The gravity model is commonly applied in the international trade literature to analyze trade distortions associated with policy differences across countries. For the estimation purpose, the gravity equation is expressed in log-linear form as follows:

$$\ln E_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} + \beta_5 \ln DIST_{ij} + \beta_6 OPEN_{jt} + \beta_7 LOCK_j + \beta_8 IPR_{jt} + e_{ijt} \quad (1)$$

Where:

- E_{ijt} is the Korea's exports to country j at the time t.
- GDP_{it} is the gross domestic products (GDP) of Korea at the time t.
- GDP_{jt} is the gross domestic products (GDP) of the importing country (country j) at the time t.
- POP_{it} is the population of Korea at the time t.
- POP_{jt} is the population of the importing country (country j) at the time t.
- $DIST_{ij}$ is geographical distance, measured as the crow flies, between the capital city of Korea and the capital city of the importing country (country j).
- $OPEN_{jt}$ is openness to trade of the importing country (country j) at the time t, measured as the dollar value of exports plus imports as a percent of gross domestic product (GDP).
- $LOCK_j$ is a dummy variable that equals 1 if the importing country is landlocked and zero otherwise.
- IPR_j is the IPR index of the importing country at the time t.
- e_{ij} is an error term.

The inclusion of supply factor of the exporting country (GDP_{it}) and demand factor of the importing country (GDP_{jt}) is justified on the ground that higher level of exporting country's GDP indicates higher level of production for exports, while higher level of importing country's GDP suggests higher level of demand for imports. Therefore, it is expected that trade increases with the country size, as measured by GDP, with other factors kept constant (See e.g., Chionis and Liargovas, 2002; Frankel, 1993). In other words, the gravity theory predicts that parameters on GDP are positive.

The theoretical justification for population variables (POP_{it} and POP_{jt}) is somewhat imprecise. On the one hand, large population could promote a division of labor and allow more industries to reach efficient economies of scale. Thus, opportunities for trade with foreign partners in a wide variety of goods will increase, suggesting a positive impact of population on bilateral trade (See Oguledo and

Macphee, 1994). On the other hand, populous countries are assumed to be larger in area and thus endowed with a greater quantity and variety of natural resources. The bigger absorption effect of this domestic market causes less reliance on international trade transactions, indicating a negative impact of population on bilateral trade (See Endoh, 1999; Endoh, 2000; Martinez-Zarzoso and Nowak-Lehmann, 2003). Therefore, the coefficients for population could be positive or negative, depending on which effect, absorption effect or economies of scale effect, is dominant.

Distance between trading partners ($DIST_{ij}$) is used as a proxy for several distance-related variables such transport cost, cost of time, "psychic distance" or "cultural cost", and access to relevant market information (See Linenman, 1966) [10]. All of these factors reflect the cost of international transactions of goods and services and are expected to affect trade negatively (See, e.g., Al-Mawali, 2005; Clarete *et al.*, 2003; Deardorff, 1995; Geraci and Prewo, 1977; Martinez-Zarzoso, 2003; Sohn, 2005). Therefore, we expect that the sign of the coefficient for $DIST_{ij}$ variable is negative.

Following Smith (2001) we incorporate the OPEN variable into the equation (2) because countries with higher level of openness tend to trade more. Therefore, we expect that the coefficient on $OPEN_{jt}$ is positive (See Smith, 2001; Smith, 2002).

The inclusion of the variable $LOCK_j$ is justified on the ground that being landlocked is generally considered to reduce international trade. The reason is that the number of border-crossings, which implies a transport cost burden, can explain a major part of the extra cost of overland transport in comparison with maritime transport (See Raballand, 2003). Therefore, we expect that the coefficient on LOCK is negative.

In line with the existing literature, IPR has an indeterminate effect on bilateral trade. This is because stronger protection of IPRs simultaneously increase trade through market expansion effects and reduce trade through market power effect. Therefore, the sign of the coefficient of the IPR index could be positive (reflecting the dominance of market expansion effect) or negative (reflecting the dominance of market power effect), indicating that the impact of IPRs on trade is an empirical issue.

In order to capture the sensitivity of Korea's exports to the strength of IPRs in the importing countries grouped by the level of economic development and imitative ability the equation (1) is written as follows [11]:

$$\ln E_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} + \beta_5 \ln DIST_{ij} + \beta_6 OPEN_{jt} + \beta_7 LOCK_j + \beta_8 IPR_{jt} * D_1 + \beta_9 IPR_{jt} * D_2 + \beta_{10} IPR_{jt} * D_3 + e_{ijt\ 32} \qquad (2)$$

D_1, D_2, and D_3 in the equation (2) are dummy variables.

[10] Psychic distance indicates the lack of familiarity with another country's laws, institutions, and habits.
[11] We adopt Rafiquzzaman (2002) and Smith (2002) for the empirical specification.

First, to analyze the sensitivity of Korea's exports to the strength of national IPRs, in countries grouped by level of development we let the development dummy variables interact with IPR. The development dummy variables are constructed based on classifying the importing countries in our sample into three groups by their level of economic development: high income (HD_{jt}), middle income (MD_{jt}), and low income (LD_{jt})[12]. For the estimation purpose, the equation (2) is re-written as follows:

$$\ln E_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} + \beta_5 \ln DIST_{ij} + \beta_6 OPEN_{jt} + \beta_7 LOCK_j + \beta_8 IPR_{jt} * LD_{jt} + \beta_9 IPR_{jt} * MD_{jt} + \beta_{10} IPR_{jt} * HD_{jt} + e_{ijt\ 32} \quad (3)$$

A positive value of an interaction variable indicates that, within a given level of development, stronger protection of IPRs increase Korean exports to these countries through the market expansion effects. In contrast, a negative value indicates that, within a given level of development, strong IPR protection tends to reduce Korea's exports to these countries via the market power effect.

Second, to capture the effect of imitative ability, we let imitative ability dummy variables interact with IPR variable. The imitative ability dummy variables are constructed by classifying the importing countries in our sample into two groups by their level of imitative abilities: Weak imitative ability (WI_{jt}) and strong imitative ability (SI_{jt}). Drawing on Smith (2002), we use four alternative measures of national imitative ability in order measure a country's ability to imitate technology: (i) R&D expenditure as the percentage of GNP; (ii) R&D scientists and engineers per million population, (iii) R&D technicians per million population, and (iv) educational attainment. For the estimation purpose, the equation (2) is re-written as follows:

$$\ln E_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} + \beta_5 \ln DIST_{ij} + \beta_6 OPEN_{jt} + \beta_7 LOCK_j + \beta_8 IPR_{jt} * WI_{jt} + \beta_9 IPR_{jt} * SI_{jt} + e_{ijt\ 32} \quad (4)$$

A positive value of the coefficient of these interaction terms indicates that, within a given level of imitative ability, stronger IPR protection tends to increase Korea's exports to these countries through market expansion effect. A negative value indicates that, within a given level of imitative ability, stronger protection of IPRs tends to reduce Korea's exports to these countries via market power effect.

4.2. Model specification

First, the regression equation with respect to Korea's total exports to the Rest of the World (ROW) is estimated. This means that, by pooling the panel data on exports, we force the impact of IPRs on Korea's exports to be uniform. Second, the regression model with respect to Korea's *exports* to ROW (classified by Korea's exports by commodity) is estimated. It means that we allow the impacts of IPR protection to differ across the industries.

[12] Our classifications are based on the World Bank categorization.

The rationale for setting up different specifications is as follows. First, using the data of total exports allows us to see the overall impact of IPRs on exports regardless of industries. Second, using the same gravity equation for different sectors allows us to capture the distinctive features of each sector in terms of IPR-sensitivity.

In this study, two techniques are employed, including the fixed effects model and random effects model. The fixed effects model allows for country-pair heterogeneity and gives each country-pair its own intercept. The equations for fixed effects model is expressed in the following form:

$$\ln E_{ijt} = \beta_{0ij} + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} + \beta_5 \ln DIST_{ij} + \beta_6 OPEN_{jt} + \beta_7 LOCK_j + \beta_8 IPR_{jt} * LD_{jt} + \beta_9 IPR_{jt} * MD_{jt} + \beta_{10} IPR_{jt} * HD_{jt} + e_{ijt} \quad (5)$$

$$\ln E_{ijt} = \beta_{0ij} + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} + \beta_5 \ln DIST_{ij} + \beta_6 OPEN_{jt} + \beta_7 LOCK_j + \beta_8 IPR_{jt} * WI_{jt} + \beta_9 IPR_{jt} * SI_{jt} + e_{ijt} \quad (6)$$

Where:

- β_{0ij} indicates that each country-pair has its own intercept.

The fixed effects estimates can help us reduce potential specification errors from omitting important variables. One shortcoming of this model, however, is that it does not allow for time-invariant variables[13] to be included. Therefore, we include the random effects model in order to incorporate differences between cross-sectional entities by allowing the intercept to change, as in the fixed effects model, but the amount of change is random. The random effects model is expressed as follows:

$$\ln E_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} + \beta_5 \ln DIST_{ij} + \beta_6 \ln OPEN_{jt} + \beta_7 LOCK_j + \beta_8 IPR_{jt} * LD_{jt} + \beta_9 IPR_{jt} * MD_{jt} + \beta_{10} IPR_{jt} * HD_{jt} + w_{ijt} \quad (7)$$

$$\ln E_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} + \beta_5 \ln DIST_{ij} + \beta_6 \ln OPEN_{jt} + \beta_7 LOCK_j + \beta_8 IPR_{jt} * WI_{jt} + \beta_9 IPR_{jt} * SI_{jt} + w_{ijt} \quad (8)$$

Where:

- β_0 is the mean intercept, and w_{ijt} is composite error term ($w_{ijt} = \mu_{ij} + u_{ijt}$). μ_{ij} is a random unobserved bilateral effect (which is cross-section or country-pair error component), and u_{ijt} is the remaining error (which is the combined time series and cross-section error component).

[13] Examples of time-invariant variables include distance, ex-colonial relationship, etc.

The random effects model requires that $\mu_{ij} \sim (0, \sigma_{\mu}^2)$, $u_{ijt} \sim (0, \sigma_u^2)$, the μ_{ij} is independent of the u_{ijt}, and the explanatory variables have to be independent of the μ_{ij} and the u_{ijt} for all cross-sections (*ij*) and time periods (*t*). The advantage of random effects model is that both time-series and cross-sectional variations are used.

4.3. Data sources

The purpose of this section is to summarize the data to be used in the estimation of the regression equations. While a large number of studies using the gravity equation to predict trade flows employ cross-section data, the use of panel data allows us to capture the relationship between IRPs and trade over a longer period of time; to account for changing IPR regimes and imitative ability; to control for overall business cycle and disentangle the time invariant country-specific effects (Egger, 2000); and to control for unmeasured country and time-specific heterogeneity (Co, 2004). The basic unit of analysis is the industry. In this study, we use the 1990, 1995, 2000 and 2005 data on Korea's exports (total exports and exports by commodity classified into 2-digit SITC[14]). 95 importing countries are included in our sample, leading to 380 observations.

- *Export data (E_{ijt}):* The data on Korea's exports, as measured in millions US$, come from Korea International Trade Association (KITA), UN Comtrade, and the IMF Direction of Trade Statistics (CD-ROM).
- *GDP data (GDP_{it} and GDP_{jt}),* as reported in US$ millions are extracted from the IMF World Economic Outlook Database and the Economist Intelligence Unit.
- *Population data (POP_{it} and POP_{jt}),* as reported in million people, are extracted from the IMF World Economic Outlook Database and the Economist Intelligence Unit.
- *Distance data ($DIST_{ij}$),* as measured in kilometer, are collected from Indo.com (http://www.indo.com/distance/).
- *Land-lock data ($LOCK_j$)* comes from the Economist Intelligence Unit.
- *Openness data ($OPEN_{jt}$):* The openness index is measured as the dollar value of exports plus imports as a percent of gross domestic product (GDP). The data on exports plus imports are extracted from IMF-Direction of Trade Statistics (sum of exports and imports). The data on GDP come from IMF-World Economic Outlook Database (GDP).
- *Level of development:* The classification of economies according to the level of income is obtained from the World Bank's Classification.
- *Imitative ability:* Data on R&D expenditure as the percentage of GNP; R&D scientists and engineers per million population, R&D technicians per million population are obtained from

[14] The data on IPR index is up to the year 2005.