Bilateral trade model specification

Economics, Trade

In this paper, I base this model on the gravity model of international trade as Smith (1999, 2000, and 2002) and Rafiquzzaman (2002). The gravity trade model states that the amount of trade between two countries can be evaluated on their country-level characteristics (Anderson, J. E. , 1979). The basic gravity model can be derived as below: Xijk = ? 0i (Qj/Nj) ? 1i (Nj) ? 2i (Qk/Nk) ? 3i (Nk) ? 4i (Djk) ? 5i (Aijk) ? 6i? ijk (1)

Where Xijk is the volume of export from industry i, country j to importing country k; (Qj/Nj) and (Qk/Nk) represent the income per capita in exporting country j and importing country k. Nj and Nk are defined as total population in exporting country j and importing country k as well, respectively. Djk means the distance between country j and k. Aijk is a number measuring other factors. Finally, ? ijk is random error distribution. Thus, we expect Covariance (? ijk, Xijk) = 0 the error terms are independent of the value X. E (?

) = 0 the average error will be zero because positive and negative error will offset. For further analysis, equation 1 can be modified to the form of a natural logarithm function. Equation 2 is given by: ln (Xijk) =? 0i +? 1i ln (Qj/ Nj) +? 2i ln (Nj) +? 3i ln (Qk/Nk) +? 4i ln (Nk) +? 5i ln (Djk) +? 6i ln (Aijk) + ejk (2) In fact, in our analysis, we widely infer to all industry and only focus on one exporting country – the United States. Therefore, the value of ? 0i +? 1i ln (Qj/ Nj) +? 2i ln (Nj) is constant.

In other words, after taking natural logs, we can ignore the gross national income and population of exporting country j (in this paper is US). Besides, I replace Aijk with patent rights PRk, openness to trade OPENk and tariff rate

TARk. Thus far, the explanatory variables in this paper are population, gross national income per capita, patent right, openness, tariff rate and distance. Next, I denote ? 0 = ? 0i +? 1i ln (Qj/Nj) +? 2i ln (Nj) and rewrite the equation 2. The statistical specification is as below: ln (Xjk) = ? 0 +?

1 ln (GNIk) +? 2 ln (POPk) +? 3 ln (DISTjk) +? 4 ln (OPENk) +? 5 ln (TARk) + ? 6 ln (PRk) + ejk (3) Where Xjk is the volume of export from country j (US) to import country k; GNIk is defined as the gross national income (GNI) per capita measured at purchasing-power-parity (PPP); POPk and OPENk mean the population size and openness to trade - economy freedom of country k; DISTjk represents the direct-line distance between two countries; PRk and TARk is patent rights protection and tariff rate of country k.

In hypothesis 1 test, I group nations into three categories based on the World Bank income classification in 2005. In fact, the World Bank Income Classification has four groups by gross national income per capita: high, upper middle, lower middle and low income countries, as mentioned above. However, the selected countries in this paper do not belong into the group of low income countries. Thus, we use three dummy variables to represent three levels of the country’s development - H, UM, LM groups.

Equation 4 can be modified from equation 3 by replacing three dummy variables – Dh, Dum and Dlm. Through adopting three dummy variables, which there is only one is effective; and other two values are zero, the interrelationship between exports and patent rights with relation to levels of country’s development can be expressed in the equation. Therefore, I conclude the following: ln (Xjk) = ? 0 +? 1 ln (GNIk) +? 2 ln (POPk) +? 3 ln

(DISTjk) +? 4 ln (OPENk) +? 5 ln (TARk) +? 6 Dh ln (PRk) +? 7 Dum ln (PRk) +?

8 Dlm ln (PRk) + ejk (4) In hypothesis test 2, three dummy variables, Sk, Mk and Lk, which represent country’s degree of abilities to imitation as strong, moderate and weak, respectively, are using to segment the selected importing countries into three groups. Similarly, only one dummy variable is effective and other twos are invalid as well. However, the relationship between exports and other independent variables and patent rights with relation to R&D abilities can be expressed in the equation 5.

ln (Xjk) = ? 0 +? 1 ln (GNIk) +? 2 ln (POPk) +? 3 ln (DISTjk) +? 4 ln (OPENk) +? 5 ln (TARk) +? 6 Sk ln (PRk) +? 7 Mk ln (PRk) +? 8 Lk ln (PRk) + ejk (5) In hypothesis test 3, T1, T2, T3, and T4 represent four levels of threat of imitation which consider the existing patent protection and imitative abilities in importing countries k. Therefore, I conclude the following: ln (Xjk) = ? 0 +? 1 ln (GNIk) +? 2 ln (POPk) +? 3 ln (DISTjk) +? 4 ln (OPENk) +? 5 ln (TARk) +? 6 T1 ln (PRk) +? 7 T2 ln (PRk) +?

8 T3 ln (PRk) +? 9 T4 ln (PRk) + ejk (6) In equations 4 to 6 above, the gross national income (GNI) measured at purchasing-power-parity means the whole value (income) of productive activities – goods and service no matter in this country and foreign country when considering price differences among countries. For example, an US-owned subsidiary which operates in other country might decide to send earnings back to parent company in US. GNI includes this kind income.

This index can be applied to compare economic conditions, size of economies across countries (The World Bank, 2008) owing to increases in income on the basis of increases in disposable income as well as increases in consumption expenditure (Gwartney et al. , 1996). Second, population size is associated with market size. A larger economic size and population are regard as a large potential labour supply, a strong potential market demand and a loose market. Third, openness to trade is a measure of the attitude and policies of governments that affect international trade. Greater trade openness implies low trade barriers and trade costs.

Thus, it might stimulate international trade and economic growth associated with satisfactory trade policy. Based on above explanations, these equations suggests positive links between export and three explanatory variables, GNI per capita, population and openness to trade, respectively. Next, long distance implies higher transportation cost. Conversely, higher tariff rate rises on higher cost. The competitive advantage of exporting countries, such as cost advantage, would be weakened owing to higher transportation costs. Thus, distance and tariff rate are inversely related to the international trade volumes.

Finally, a few numbers of dummy variables are employed in this study in order to effectively segment data for analyzing the impact of patent right protection. However the effect might be positive, negative or even be ambiguous, as mentioned above, because the market power effect and market expansion effect might occur at the same time. When the level of patent right protection is improved, the market power reduces exports as a

result of the more concentrated market power exporters gained; while the market expansion effect increase exports because of the increase of demand.

Exporters might not be willing to produce sufficient products to satisfy the whole society because a thing is valued if it is rare. Therefore, the effect depends on the relative dominance of market expansion effect or market power effect. Table 2 above summarizes the relationship between each independent variables and exports. 4. 2 Method and data In this paper, the bilateral export data includes U. S. all export commodities. The cross-sections year is 2005. Export data compiled from the U. S. Department of Commerce and the U. S. International Trade Commission (USITC). I choose aggregate U. S.

export data instead of industry level data because the trade information by Standard Industrial Classification (SIC) codes are only available through 2001 on the USITC website. For further perspective, to verify all export transaction can help us to have a brief overall picture of the subject. Hence, I decide that the exporter (abbreviation j) is the United State and importers (abbreviation k) are the top forty-nine countries partners. From the original detailed data, I observe that US exports concentrate on the top five countries, naming Canada, Mexico, Japan, China and United Kingdom in order.

Over 50% of imports are traded to the top five trading partners. Data on GNI per capita indicator come from the World Development Indicator Database of the World Bank. I further sort GNI per capita into four groups according to the Income Classification of World Bank – high (GNI per capita of $10, 726 or

more), upper middle (GNI per capita is more than $3, 466 but less than $ 10, 725), lower middle (GNI per capita is more than $876 but less than $3, 465), and low (GNI per capita of $875 or less) in 2005. However, from the selected countries, no countries are grouped into low income group.

Dh, Dum, and Dlm represent three dummy variables for the level of development. The value of dummy variables is 0 or 1. In a regression analysis, dummy variables can be used to group data. If data satisfy a specific condition, its value is 1; if not, its value is 0. Hence, the interaction between patent rights protection and the levels of development can be expressed as PRkDh, PRkDum, and PRkDlm. Through this graded income data, I can estimate the influence of patent rights on the international trade across countries with different economic development levels.

Table 3 below summarizes that the distribution of income and patent rights development from 49 US selected importing countries in 2005 seems to concentrate on those countries with high income and strong patent rights protection without regard to export value. Half of importing countries, precisely twenty-eight, are grouping into high income group; twenty-seven countries are sorting into the highest patent rights protection group (index of patent rights is from 4 to 5). Next, the population statistics derive from the United Nations, DESA, and World Population Prospects: The 2007 Revision Population Database of United Nation.

As pointed out earlier, the size of population in a country can be used to estimate the market size. We attempt briefly analyze these raw data in order to further understand this issue. Thus, Figure 5 below shows the distribution

of population size of the selected countries in 2005. It is noteworthy that US tent to export to countries with larger domestic market, in particular countries which the population size is between 20 to 50 million. Furthermore, the economic freedom index is obtainable online from the website of the Heritage Foundation.

This index is evaluated on ten component variables as business freedom, trade freedom, and monetary freedom, freedom from government, fiscal freedom, property rights, investment freedom, financial freedom and labour freedom. Besides, the Heritage Foundation also provides a list of tariff rates in all countries. Figure 6 below shows that the economic freedom index of US top forty-nine trade partners. The geographic distance from capital cities of the fifty countries to Washington DC – the capital of the United States is available from a book (Fitzpatrick, G.

L. , 1986): Direct-line distances: international edition. Figure 7 below illustrates the US top 49 trade partners are mainly concentrated on countries with a geographic range of 5, 000 to 8, 000 km. In particular, this group accounts for over 35 percent. For further understanding the geographic information, I sort out three groups of countries with distance between 3, 000 to 10, 000 kilometres. There are 30 countries filling the bill. Figure 8 below shows the geographic regions of those 30 countries.

It is worth noting that European countries are the major US importers with a geographic distance of 3, 000 to 10, 000 from Washington DC. The next group is countries in America, especially in Middle and South America. Next, as discussed, this paper adopts the Ginarte-park index to be the index of

patent rights. Park, W. G. (2008) has updated the Ginarte-park index of patent rights till 2005. The index is published by the journal of Research Policy. Besides, in order to estimate countries by country's imitative ability, this paper adopts the Number of Utility Patent Applications Filed in the United States from 1995 to 2005.

The data is available online from US Patent and Trademark Office (USPTO). Although, there are many patent offices in the world, the patent office of United States of America is the top two largest in 2005, keeping race with Japan (World Intellectual Property Organization, 2007). Thus, this paper adopts data from USPTO to represent country's abilities to imitation. OECD (2001) points out that there are three main measurements of R&D productivity – input, process and output indicator, respectively.

According to Smith (1999, 2001 and 2002), country's abilities of imitation are evaluated on four factors, 1) the gross domestic product (GDP) share of R&D expenditure, 2) technician engaged in R&D per million population, 3) R&D scientists and engineers per million population, and 4) educational obtainment. It is obvious that Smith calculated country's abilities of imitation based on the total input of R&D investment such as human resources, spending. However, the R&D input and output is not certain linear relationship because R&D performances vary significantly by country.

More input in R&D activities cannot imply more patent outcome and higher technical and innovation skill a country has. After all, the GDP share of R&D expenditure in a single year is not suitable to stand for a country's technological abilities and expenditure might include large sunk costs and

losses. The innovation is not achieved easy and immediately without experience accumulation. This paper estimates a country’s technical skill by its number of patent application. It can be defined as one kind of output indicator. Although, it is true that not all invention would be applied for patents, but a patent must be granted to an invention.

Moreover, I collect data over 11 years from 1995 to 2005; it can reflect the effect of experience accumulation. Based on the explanation, I assume that the degrees of country’s imitative abilities are represented by three dummy variables. Sk, Mk, and Lk represent the degrees of strong, moderate and weak imitative abilities, respectively. Therefore, to remind of the hypothesis framework, nations with weak imitative abilities (Lk) are the number of utility patent application in US over these ten years less than 1, 000 (N? 1, 000).

There are 18 countries that are valid in this position. Secondly, moderate imitative abilities (Mk) is the utility patent application number in US over these ten year more than 1, 000 but less than 50, 000(1, 000

Figure 9 illustrates the total number of patent rights application filed in the United States. Around one-third of countries apply for patents less than 1, 000 items over 11 years, most of them are located in Middle and South America. The top three countries with the strongest imitative abilities are Japan (around 590, 000 items), Germany (around 185, 000 items) and Taiwan (about 110, 000) among the selected trading partners from 1995 to 2005. Besides, this matrix of threat of imitation is structured with four groups: T1, T2, T3, and T4 which utilize dummy variables as well.

This matrix describes the interaction between two explanatory variables – the degree of patent rights and imitative abilities in importing countries. In this study, I define that if a country’s index of patent rights is less than 4, the country has weak patent protection, vice versa; a country has strong patent laws when its patent rights index is more than 4. Furthermore, a country with strong imitative abilities is defined that its utility patent applications filed in US from 1995 to 2005 is accumulated more than 1, 000 items.

In accordance with these two conditions, a matrix between these two independent variables is created. The hypothesis 3 is to investigate the matrix based on Smith’s research (1999). For instance, in group 1, exporting countries are under a little pressure for imitation owing to the importing countries have a low level of technical skill and strong patent rights laws to protect exporting firms. An opposite situation occurs in group 4, a powerless patent protection system but high level of technical skill and capacities in countries cause exporting countries under high pressure for imitation.

Similarly, after grouping data, I further examine the reciprocal effect between the degree of patent rights and these four dummy variables - T1PRk, T2PRk, T3PRk, and T4PRk. For further analysis, seven countries with high income are grouping into strong imitative abilities group, naming Canada, France, Germany, Japan, Taiwan, Korea and United Kingdom. In these seven countries, only Taiwan with high threat of imitation is arranged into Group 4; the others are classified into Group 3 which has moderate risks to imitation. Secondly, there are twenty-four countries in the middle level of imitative abilities.

It is worth mentioning that only India is low-middle income and other five countries are upper-middle income; the remaining eighteen nations are high income. Besides, in moderate imitative abilities group, most countries pose a moderate threat of imitation in Group 3; only Austria poses a weak threat of imitation in Group 1 and the other seven countries pose a strong imitative risk in Group 4. Furthermore, eighteen countries with weak imitative abilities are most grouping into upper-middle income group, only Chile, Poland and Saudi Arabia are high income and Honduras and Nigeria are lower-middle income.

With regard to threat of imitation, there are four countries with weak imitative abilities pose a weak threat of imitation in Group 1 as well, while the remaining fourteen countries pose a moderate imitative risk in Group 2. For further analysis, a table of descriptive statistics and a correlation matrix for these variables without taking natural log is illustrated in Table 4. In the part of summary statistics, it is useful to observe the gap between maximum and minimum to understand how dispersed the distribution is.

For example, forty times gap between the maximum and minimum GNI per capita. Norway is the country with the highest GNI per capita ($ 40, 420) among the selected countries; conversely, Nigeria is the country with the lowest GNI per capital ($ 1, 040). Moreover, correlation provides a measure about the degree of relationship, positive or negative, between two variables. There is a strong and positive association (r= 0. 73) between GNI per capita and openness to trade. Besides, GNI per capita has a strong positive correlation (r= 0.

75) with patent right protection as well. By comparison, higher tariff rate will reduce GNI per capita. Thus, there is a strong and negative relationship (r=-0. 68) between GNI per capita and tariff rate. Furthermore, the larger size of population might decrease a country’s economic development in income or freedom aspects when population growth is faster than income growth. As we would expect, the score of economic freedom is strongly and negatively correlation with tariff rate (r=-0. 64) because higher tariff rate will arise trade barriers.

In addition, from correlation matrix we can see distance is less related even no relationship with other variables. 5. Empirical Results In this section, I estimate Hypothesis 1 to 3 for US aggregate exports in 2005. Equation (4), (5), and (6) which are derived from the gravity model will be used to examine the relationship between US aggregate exports and each independent variable. In fact, all equation we mentioned are defined the population regression equation. Although, there are just forty-nine observations in this paper, which are very few; however, the analysis is interesting so far.

This is because the entire population of observations on each independent variables and the dependent variables is US main trade partners. 5. 1 The estimation result for hypothesis 1 Firstly, Table 5 below indicates the interaction between country’s patent rights and level of development under hypothesis 1. Excluding the product of patent rights index and the country’s income development levels, impacts of other explanatory variables, namely GNI per capita, size of population, scores of economic freedom, the distance

between two countries and tariff rate of importing countries, are as expected.

US exports is positive link with GNI per capita, population and the scores of economic freedom, respectively. For instance, increasing GNI per capital by $1 tends to increase US exports by $0. 84 million, ceteris paribus; increasing the number of population in importing countries by one million people tends to increase US exports by $ 0. 70 million, holding the other explanatory variables constant. Similarly, one unit of improvement in economic freedom index might lead to a steep rise of US exports by $3. 84 million, ceteris paribus.

On the contrary, distance between two countries is likely to be strongly and negatively correlated with US exports. Secondly, I further examine three dummy variables which represent three levels of economic development based on The World Bank Income Classification. According to the test results, three groups all present negative relationship with US exports; the market power effect occurs in all Groups - PRkDh, PRkDum and PRkDlm, in the meanwhile. To be clear, the number of US exports declined while those importing countries proceed to reform their patent systems.

This situation seems be likely to happen in all groups in the test result, no matter whatever the importing countries’ level of development. However, as discussed above in Hypothesis 1, we expect an improvement of patent rights is expected to reduce the international trade if a country is grouped into either high income or upper-middle income groups. And then, a positive link between patent reform and exports might exist in the low-income countries.

There seems to be a contradiction between Hypothesis 1 and the empirical result in the lower-middle income countries group – PRkDlm.

This outcome might be interpreted with caution for the follow reasons. First, the United States accounts for most of patent filing in the world. It can say that US has an uppermostleadershipposition in world invention and innovation. Thereby, all importing countries among the selected list are relatively weak imitative abilities excluding Japan based on their number of patent applications. According to World Intellectual Property Organization (WIPO, 2008), from 1995 to 2005, the total world patent application is around 8. 3 millions items.

Japan accounts for about 45 percent (3. 78 million items) and the United States contributes over 1. 65 million items, around 20 percent over these 11 years. For the reason, it implies that US exports have larger competitive advantages worldwide. In other words, the US has possessed some degree of market power. Hence, market power of US firms would be enhanced when importing countries proceed with patent reforms. As mentioned above, monopolistic corporations will reduce their supply but raise sales prices in order to maximum profit.

Secondly, according to Deardorff (1991), an improvement of patent rights will lead patent holders to earn monopoly profit and distort consumer choice at the same time. To be clear, patents would not only enhance patent holders’ market power but also would split the market into pieces. More granted patents in the world more market segments exist because less patent coverage for its inventors and its inferring market becomes smaller.

As a matter of fact, no matter whatever effects patent protection occurs, market power or market expansion effect, the inferring market would be likely to shrink.

Note: Dependent Variable is US export – ln (Xjk). All variables are in log type. Sample size is 49 countries. R square is 66%. Dh = 1 if GNI per capita > $10, 726, and Dh= 0 otherwise. Dum= 1 if GNI per capita less than $10, 725 but more than $3, 466, and Dum = 0 otherwise. Dlm= 1 if GNI per capita less than $3, 465 but more than $876, and Dlm= 0 otherwise. 1. 2 The estimation result for hypothesis 2 In this section, the interaction between country's patent rights and level of technical skill are examined. Table 6 below illustrates this interaction under hypothesis 2.

Similarly, product of patent rights index and the country's level of technical skill – imitative abilities are excluded firstly. The effects of other explanatory variables are as expected as well. Population size and economic freedom index are positive correlated with US exports. It is worth mentioning that country income level is likely to be nearly no significant with the dependent variable – US exports (r= 0. 06). The effect of other each variable might increase or decrease somewhat, however, the results are similar as the last part – the estimation result for hypothesis 1.

In terms of three groups by country's level of imitative abilities, as described in hypothesis 2, this paper assumes a positive link between patent and export should happen in countries with strong imitative abilities, vice versa, a negative relationship should occur in countries with weak imitative abilities. In addition, an ambiguous effect occurs in countries with middle-

level imitative techniques. In our hypothetical assumptions, market expansion effect occurs in shipping goods to countries with high level of technical skill in a competitive market when importing countries enhance the strength of patent protection.

On the other hand, market power effect occurs if patent holders have possessed a substantial degree of market power. However, the regression results show that US exports have a reverse correlation in all groups, no matter whatever the importing countries' degree of imitative abilities. For instance, one unit of increase in the patent rights index would lead to a steep rise of US exports, and the increase range is depending on the level of country technical skill, ceteris paribus. By collocating with three dummy variables, we know that increasing an additional score of patent rights index is associated with a $1.

94 (or $1. 38 or $0. 81) million decline in US exports in countries with powerless (or moderate or strong) imitative capacities which there is only one group meaningful because only one dummy variable will equal to 1, the other two dummy variables will equal 0 otherwise. A contradiction exists between Hypothesis 2 and the empirical result in SkPRk group which countries with vigorous imitative capacities. A probable inference with caution is as below. In practice, the duration of an invention patent is twenty years.

It is highly probable to cause a situation - the big firms would maintain their dominance all the time owing to the grant of the patent rights by laws, for example US. All selected importing countries have relatively weaker

techniques capacities than the United States as mentioned above in the section 5. 1. From the perspective, the reason can be used to interpret the relative dominance of market power effect in our study, no matter whatever the degree of imitative abilities. Besides, if we consider groups that vary in level of imitative capacities and their influence, the lower abilities to imitation group has the greatest negative link (?

8= -1. 94) with US exports; the second one is in moderate abilities group (? 7= -1. 38); and a relatively slight negative relationship is in strong imitative abilities group (? 6= -0. 81). Based on above analysis, we can observe that the influence results seem to indirectly support the extent of market power effect in hypothesis 2 withrespectto the absolute value. Note: Dependent Variables are US export - ln (Xjk). All variables are in log type. Sample size is 49 countries. R square is 0. 71. Sk = 1 if the number of utility patent applications filed in US from 1995 to 2005 (N) > 50, 000 items, and Sk = 0 otherwise.

Mk = 1 if N less than 50, 000 but more than 1, 000 items, and Mk = 0 otherwise. Lk= 1 if N less than 1, 000 items, and Lk= 0 otherwise. 1. 3 The estimation result for hypothesis 3 This section mainly discusses how country’s patent rights with relation to threat to imitation impact on US exports. Based on the hypothesis 3, we group those selected countries into four groups by their existing patent rights index and technical skill. Table 7 below illustrates the regression results of equation 6 under hypothesis 3.

In relation to the effects of other explanatory variables, the estimated results are similar as the estimation result for hypothesis 1. GNI per capita,

population size and the index of economic freedom are positively correlated with exports, while distance and tariff rate are negatively correlated with exports. On the other hands, we examine the product between patent rights index and four types of risk to imitation. Summarizing results across multiple different groups, indeed, market power effect occurs in Group 1 in countries with strong patent protection but weak imitative capacities.

One index value increase in patent rights in countries with strong patent law but weak technical capacities (Group 1) has likely been a 0. 68 million decline in the amount of US exports. Similarly, the effect of market power also exists in both Group 2 and Group 3, but the influence is slight. On the contrary, market expansion effect does exist in US export to the importing countries with powerless patent rights protection but strong technical skill to imitation (Group 4).

Although the effect-size is not significant, the result displays that one unit of index value increase in patent rights in Group 4 will lead to a 0. 19 million increase in the volume of US export. Note: statistical significance at 5 percent level. Dependent Variables are US export - ln (Xjk). All variables are in log type. Sample size is 49 countries. R square is 0. 70. T1 = 1 if strong patent protection (IPR) bigger than 4 and weak imitative abilities (the number of utility patent applications filed in US from 1995 to 2005: N) more than 10, 000, and T1= 0 otherwise.

T2= 1 if IPR less than 4 and N less than 10, 000, and T2 = 0 otherwise. T3= 1 if IPR more than 4 and N more than 10, 000, and T3= 0 otherwise. Finally, T4= 1 if IPR less than 4 and N less than 10, 000, and T4= 0 otherwise. 6.

Conclusion In recent years, issues of patent rights strength are widely discussed. However, there seems be no a final conclusion surrounding impacts of patent rights on economic development, innovation and invention, international trade, and foreign investment.

In empirical research, there are two mainly effects of patent rights – market power and market expansion. The former effect implies that an exporter will decrease in its import supply to respond to a patent reform in an importing country; the latter effect points out exports will increase in relation to a patent reform. This paper extends Maskus and Penubarti's research (1995) and Smith's paper (1999, 2001, and 2002) to confer the interrelationship between US exports with country's strength of patent rights.

Three framework hypotheses are adopted to group the selected countries in three different methods in this paper. Firstly, countries are categorized by levels of economic development in order to examine what extent US exports are sensitive to various patent systems across countries with different levels of income and economic development. Secondly, countries are categorized by levels of imitative abilities in order to estimate the effect of patent systems across countries with different levels of imitative abilities.

Finally, we examine what extent US exports are sensitive to various patent systems across countries with different imitative risk by grouping the selected countries by levels of threat of imitation. According to the test results, we can observe that US exports are highly projected to decrease to respond to an improvement of patent right in importing countries, no matter

which hypothesis it is and no matter what group it is excluding countries with weak threat of imitation.