The University of Nottingham

research paper series

Globalisation, Productivity and Technology

Research Paper 2006/25

Trade, Imitative Ability and Intellectual Property Rights

by

Rod Falvey, Neil Foster and David Greenaway

The Centre acknowledges financial support from The Leverhulme Trust
under Programme Grant F114/BF

Leverhulme Centre
for Research on Globalisation and Economic Policy

The Authors

Rod Falvey is a Professor of International Economics and an Internal Fellow of the Leverhulme Centre for Research on Globalisation and Economic Policy (GEP), University of Nottingham. Neil Foster is a Lecturer at the University of Vienna. David Greenaway is a Professor of Economics and Director of GEP, University of Nottingham.

Acknowledgements

Financial support from the Leverhulme Trust under Programme Grant F114/BE is gratefully acknowledged

Trade, Imitative Ability and Intellectual Property Rights

by

Rod Falvey, Neil Foster and David Greenaway

Abstract

Economic theory suggests some ambiguity concerning the effects of strengthening intellectual property rights (IPRs) on international trade. Here we extend the empirical literature that attempts to resolve this ambiguity. We use panel data to estimate a gravity equation for manufacturing exports, in aggregate and by industry, from five advanced countries to 69 developed and developing countries over the period 1970-99. In particular, we use threshold regression techniques to determine whether the impact of IPR protection on trade depends upon the level of development, imitative ability and market size of the importing country. We confirm the importance of the importers' imitative ability, and also find some evidence of a role for market size in this relationship. The individual industries present different patterns of thresholds and coefficients, with total manufacturing closely reflecting that of fabricated metal products.

JEL Classifications: F10, F13, O34

Keywords: Intellectual Property Rights, International Trade, Gravity Equation, Imitative Ability

Outline

Non-Technical Summary

There is considerable empirical support for the role of trade in international technology diffusion. Since innovations are intellectual property, the strength of an importer's Intellectual Property Rights (IPR) can be expected to affect its trade in goods embodying innovations. Two opposing effects of stronger IPRs on a country's imports have been identified in the literature. Imports may expand because stronger IPRs curtail domestic imitation. But they may contract if exporters choose to exercise their increased market power by reducing sales and raising prices. This theoretical ambiguity concerning the effects of strengthening IPRs on imports has led to several attempts at its empirical resolution. The evidence suggests that imitative ability and market size are important in this relationship, with market expansion effects in countries with high imitative ability and larger markets, and market power effects in countries with low imitative ability and small markets. But this evidence often relies on classifying countries into imitative ability or market size cohorts on a subjective basis, without being able to determine the sensitivity of the outcomes to the classification.

Here we examine manufacturing exports from the main innovating countries to a sample of 69 developed and developing countries. We estimate a gravity equation using panel data grouped into six five-year averages over the period 1970-99. Results are reported for both total manufacturing trade and nine two-digit ISIC industries. Our approach differs from most previous examinations in several respects. The use of: panel data; a wider range of advanced exporters; an alternative measure of imitative ability (schooling); explicit consideration of the interactions between imitative ability and market size; and, most significantly, the use of threshold regression techniques to split our observations into different regimes.

We begin with thresholds on the importer's level of development. This is of interest because of WTO membership typically involves significant strengthening of IPR regimes in developing countries. Our results indicate significant market expansion effects at relatively higher levels of development, but little effect either way for the least developed countries. Market power effects appear rare. We then estimate thresholds for imitative ability and market size separately. There is clear evidence of market expansion effects, but no evidence of market power effects related to imitative ability. The market size results indicate market power effects in only a single industry, and broad evidence of market expansion effects which tend to be stronger in larger markets.

Combined thresholds on imitative ability and market size yield widespread evidence of market expansion effects, increasing in market size, and no evidence of market power effects in countries with high imitative ability. Countries with limited imitative ability also show market expansion effects, largely unrelated to market size; and little evidence of market power effects. The influence of market size appears somewhat secondary to that of imitative ability.

The examination of combined thresholds on imitative ability and the level of IPRs brought the patterns previously identified in the literature into sharper focus. For countries with low imitative abilities, strengthening low IPRs led to a mixture of market expansion and market power effects. But there are industry-specific ceilings beyond which strengthening IPRs will have no significant effect on trade flows. For countries with high imitative abilities we found a clear separation of industries, into those with no significant effects and those with market expansion effects. These outcomes make clear that stronger IPRs will change not only the volume but also the composition of imports from these advanced countries.

If, as the literature suggests, increased manufacturing trade with advanced countries brings technology diffusion, then most developing countries can anticipate increased technology flows as their IPRs are strengthened. The smallest and least developed may see little such benefits, however. For them technology diffusion may have to depend on other channels.

1. Introduction

The TRIPS Agreement, a product of the Uruguay Round (1986-94) of trade negotiations, reflects a growing trend of linking trade policy and Intellectual Property Rights (IPR) regimes. The stated aims of TRIPS, which sets minimum standards of IPR protection to be provided by each World Trade Organisation (WTO) member, include encouraging both innovation and international technology diffusion. The argument relating IPR protection to innovation is clear. IPR protection provides innovators with the legally enforceable power to prevent others from using an intellectual creation or to set the terms on which it can be used. In the absence of such protection new technology or knowledge is likely to be copied or imitated, thus lowering the potential profits of the innovator and reducing the incentive for individuals to undertake innovative activities. To the extent that innovation encourages economic growth, as suggested by many endogenous growth models, we would also expect stronger IPR protection to impact positively upon economic growth. Empirical evidence supporting a relationship between IPRs and innovation has been found by Kanwar and Evenson (2004); other evidence supports the existence of a positive relationship between IPRs and economic growth (Gould and Gruben, 1996; Falvey, Foster and Greenaway, 2006).

The relationship between IPR protection and international technology diffusion on the other hand is less straightforward. Technology may be diffused across borders through a variety of formal and informal channels, including international patenting, trade in goods, foreign direct investment (FDI), technology licensing, the (temporary and permanent) migration of skilled workers and product imitation. In addition to stronger IPR protection possibly affecting these potential channels in opposing ways, often the relationship between IPR protection and a single channel is not unambiguous, depending upon the level of development of the receiving country and whether it is able to carry out significant technical innovation or imitate existing technology. Several empirical studies have considered the relationship between IPR protection and a particular channel of diffusion. Maskus and Penubarti (1995) and Smith (1999) for example consider the relationship between IPRs and trade, while Smarzynska (2004) and Eaton and Kortum (1996) consider the importance of IPR protection for FDI and patenting respectively. Others (for example, Maskus, 1998; Smith, 2001) consider the impact of IPR protection on multiple channels of diffusion simultaneously. The outcomes of these studies are mixed, though stronger evidence is found for the importance of IPR protection for trade and patenting than for FDI[1].

A now large empirical literature supports the role of international trade in transferring technology both among developed countries (for example, Coe and Helpman, 1995) and from developed to developing countries (for example, Coe, Helpman and Hoffmaister, 1997). While issues remain to be resolved (Keller, 2004) the evidence concerning trade as a channel of technology diffusion is perhaps the most consistent of all of the potential channels. In this paper we concentrate on the importance of IPR protection for international trade. Specifically, we examine the importance of IPR protection for manufacturing exports from the G5 countries, in which the bulk of world innovative activity (as measured by R&D expenditure) is conducted, to a sample of 69 developed and developing countries. To do this we estimate a gravity equation using panel data grouped into six five-year averages over the period 1970-99. Results are reported for both total manufacturing trade and nine two-digit ISIC industries. In addition to estimating a linear relationship between IPR protection and trade, we examine whether this relationship depends upon the level of development, imitative ability and market size of the importing country using threshold regression techniques which allow us to estimate both the number of regimes and their position.

Two opposing effects of stronger IPRs on a country's imports have been identified in the literature. Imports may expand with the curtailment of domestic imitation, but may contract if exporters choose to exercise their increased market power. The empirical literature to date has found evidence of both effects, depending on the imitative ability of the importing country. Our results confirm the prevalence of market expansion effects. We also find some evidence of market power effects, but these are scattered and much less prevalent than previously thought. Our investigation also highlights the importance of one industry (Fabricated Metal Products) in determining the link between strengthened IPRs and aggregate imports from these countries. The other industries behave in different ways, implying that stronger IPRs will affect both the volume and composition of these imports, although no clear link with industry R&D intensity is evident.

[1] Even where the evidence indicates a relationship between IPR protection and a specific channel of diffusion, it is often the case that there is little evidence of effective technology transfer. This is particularly the case for FDI. See Falvey, Foster and Memedovic (2006) for a review of the impact of IPRs on the channels of diffusion.

The remainder of the paper is as follows. Section 2 summarises the theory and evidence linking IPR protection to international trade. Section 3 describes our empirical approach, while Section 4 discusses the data. Section 5 describes the results and Section 6 summarises our results and offers some conclusions.

2. Background

Increased IPR protection in a country can directly impact on its imports in two alternative ways. On the one hand, firms should be encouraged to export their goods into foreign markets with strong IPR protection, since such protection reduces the risk of piracy that can diminish the profitability of the firm's activity in that country. In this respect, stronger IPR protection would be expected to raise imports. On the other hand, because stronger IPR protection reduces the ability of domestic firms to imitate, it increases the market power of the exporter, which may encourage the latter to act in a monopolistic manner by reducing sales. Maskus and Penubarti (1995) thus argue that there is a "trade-off between the enhanced market power for the firm created by stronger patents and the larger effective market size generated by reduced abilities of local firms to imitate the product." (p. 229). The 'market power' effect would induce the foreign firm to export less to the domestic market, while the 'market expansion' effect would shift the demand curve facing the firm and encourage larger sales. Taylor (1993) also suggests that a third factor may be important for larger markets with significant imitative abilities, with stronger IPR protection encouraging imports by reducing the need for firms to modify their products to try to deter local imitation, thus reducing costs for exporting firms.

Maskus and Penubarti argue that the 'market expansion' effect is likely to dominate in larger countries with strong imitative abilities, while the 'market power' effect would dominate in smaller countries with weak imitative abilities. Naturally the relative importance of these effects is also likely to depend on product and market characteristics. Some products are easier to imitate than others, and some products have closer substitutes than others. An insignificant effect of stronger IPR protection on aggregated trade volumes could mask significant effects for some individual industries. Hence our interest in also considering disaggregated trade flows below. The impact of IPR protection on trade will also depend on the exporter. If the latter is not an innovator, then imports from this country are less likely to embody new technology and IPR protection should be relatively unimportant for trade, hence our decision to concentrate on exports from those countries that are important producers of new knowledge.

A further complication concerns a firm's decision on its mode of serving a foreign market. In general it faces three possibilities: it may export the good, undertake FDI or license its intellectual asset to a foreign firm. The level of IPR protection may affect the firm's choice, and thus strong IPR protection might diminish trade if it induces firms to choose to serve a foreign market by FDI or licensing rather than exporting (Ferrantino, 1993). But in the absence of reliable panel data on FDI and licensing at a sufficiently disaggregated level for a large enough group of countries we can do little about this.

The observation that theory indicates the relationship between stronger IPR protection and trade could have either sign, depending on product and market characteristics, has lead to attempts to resolve this ambiguity empirically. In one of the earliest explorations, Maskus and Penubarti (1995) use an augmented version of the Helpman-Krugman model of monopolistic competition to estimate the effects of patent protection on exports from 22 OECD countries to a sample of 71 countries in 1984. Their explanatory variables include the importers' per capita GNP, a measure of patent protection developed by Rapp and Rozek (1990), and the interaction between this IPR index and dummies indicating whether the importing developing country has a small or a large market, the latter accounting for market size effects and technological capacity. Their results indicate that higher levels of IPR protection have a positive impact on bilateral manufacturing imports into both small and large developing economies, though the effects were statistically weaker in the smaller economies. Whilst suggestive of the importance of technological capacity or imitative ability for the relationship between IPR protection and trade, their results find little support for a positive impact of IPR protection in the most patent sensitive industries.

This approach is extended by Fink and Primo-Braga (2005) who estimate gravity equations with either total non-fuel trade or "high-tech" trade (a classification based on Primo-Braga and Yeats, 1992) as the dependent variable for a cross-section of 89×88 countries in 1989. High-tech trade is isolated in the expectation that the effects of IPR protection should be stronger for knowledge-intensive trade. The explanatory variables include standard gravity factors (the GDP and populations of both trade partners, distance between trade partners and dummies for common border, common language and membership of preferential trading arrangements) plus a measure of IPR protection for the destination country developed by Ginarte and Park (1997). They deal with the problem of zero trade flows by estimating two equations, one for the probability of zero observations and the other for the magnitude of positive trade flows. They find that stronger IPR protection has a small but significantly positive impact on the probability that countries trade with each other and a significantly positive impact on bilateral trade flows for both total non-fuel imports and exports. But, contrary to expectations, stronger IPR protection is found to have a significantly negative impact on the probability that two countries trade in high-tech goods and no significant impact on bilateral high-tech trade flows. This suggests the presence of a combination of strong market power effects and a tendency for stronger IPR protection to induce producers of high-tech goods to serve foreign markets by licensing or FDI rather than exports.

Considering exports from a large sample of innovating countries has the advantage of allowing for the inclusion of exporter fixed effects. Concentrating on exports from a single country, however, means that we need not be concerned that the distribution of exports will also depend upon the trade stance of the exporting country (Maskus, 2000). Smith (1999) takes advantage of this feature by estimating a gravity equation of exports in 1992 from each of the 50 US states plus the District of Colombia to 96 countries for which the necessary data are available. Both the Rapp and Rozek and Ginarte and Park indices of IPR protection are employed and yield similar results. Smith begins by including interactions between the IPR measure and four dummies based on the per capita income of the importer (high, upper-middle, lower-middle, low). The results show that US exporters respond positively to the strength of IPR protection in countries with lower-middle incomes, but negatively to the strength of IPR protection in other countries. These results suggest that market power effects dominate across countries where IPR protection approximates US standards (high and upper-middle incomes) and across countries with weak imitative abilities (low income countries). In contrast, strengthened IPR protection in countries with weak IPR protection and strong imitative abilities (lower-middle income countries) result in increased imports from the US.

The importing countries are then divided into four groups depending on the threat of imitation (defined according to the level of patent rights and R&D spending as a percentage of GNP). Dummies for these four groups were then interacted with the IPR variable. Smith finds a negative relationship between IPR protection and imports from the US for those countries with the weakest threat of imitation, and a positive relationship for those with the strongest threat of imitation. Overall, she concludes that US exports depend upon IPR protection in importing countries, but that the direction of the relationship depends on the threat of imitation. Weak IPRs are a barrier to US exports, but only for countries that pose a strong threat of imitation.

Rafiquzzaman (2002) carries out a similar analysis on Canadian manufactured exports. Market expansion effects are found for countries with the strongest threat of imitation, and some evidence of market power effects is found where the threat of imitation is weakest. While the outcomes are broadly similar to those that Smith found for the US, the indications of market power effects are generally weaker for Canadian exports.

Recently Co (2004) has extended this approach to a panel framework for a sample of 71 countries over the period 1970-92. Panel data allows one to take account of changes in patent regimes and imitative ability over time, and better controls for unmeasured heterogeneity. Once again the ratio of R&D to GNP is used as a measure of imitative ability, here being interacted with the Ginarte and Park IPR variable. She finds that IPR protection has a negative and significant impact on US exports of non-R&D intensive goods, suggesting that market power effects dominate for this trade, but no significant impact on R&D intensive goods, an outcome similar to that found by Fink and Primo-Braga (2005) for high-tech trade. The coefficients on the interaction between IPR protection and imitative ability are found to be positive and significant for both types of goods, suggesting that the impact of IPR protection depends upon the level of imitative ability, with increased IPR protection having a positive impact on trade in all goods above a certain level of imitative ability[2].

In summary, the evidence from this small empirical literature supports the following hypotheses (see also Fink and Maskus, 2005). First, the level of IPR protection does matter for at least some trade flows in manufactured goods. Second, strengthening IPRS can lead to market power effects for some trade flows, particularly for importing markets where the

[2] Liu and Lin (2005) consider exports by Taiwan in three knowledge-intensive industries (semi-conductor, information and communications equipment). For importing countries with a lower imitative (R&D) ability than Taiwan, the results are analogous to those in the literature (i.e. market power effects in countries with relatively low imitative ability and market expansion effects in the others). For importing countries whose imitative ability exceeds Taiwan's, there are market expansion effects but no market power effects.

threat of imitation is small (due to a small market, limited capacity for imitation or an existing high level of IPRs). Third, strengthening IPRs can lead to market expansion effects for other trade flows, particularly in importing markets with a significant threat of imitation. Finally, the responsiveness of trade in R&D intensive products to increased IPR protection may be difficult to predict, given that these products may be particularly hard to imitate anyway, and that their producers can choose to serve foreign markets through FDI and licensing. These hypotheses are among those explored further below. Our particular point of departure is the observation that to date the tests of hypotheses concerning the levels of IPR protection, market size and imitative ability have relied on the division of the sample into groups based on exogenous criteria with respect to both the number of groups and the location of the thresholds that divide them. Recently developed threshold regression techniques allow both the number and location of these thresholds to be determined from the data rather than imposed. They also allow the number and location of the thresholds to differ across industries.

3. Empirical Analysis

We follow the literature in estimating a gravity equation to determine the impact of IPR protection on the manufacturing imports of our sample of countries. While the exact specification of the gravity equation can vary, our equation includes the GDPs and populations of the importer and exporter, the distance between them and other variables that may enhance or restrict trade. The starting point for our analysis is the following equation;

$$\ln TRADE_{ijt} = \beta_1 \ln DIST_{ij} + \beta_2 \ln GDPM_{it} + \beta_3 \ln GDPX_{jt} + \beta_4 \ln POPM_{it} + \beta_5 \ln POPX_{jt}$$
$$+ \beta_7 COMLAN_{ij} + \beta_8 COMBOR_{ij} + \beta_9 LOCK_i + \delta IPR_{it} + \mu_i + \theta_j + \nu_t + \varepsilon_{ijt}$$

[1]

where *i* and *j* denote the importing and exporting country respectively, and *t* denotes the time period, *TRADE* is exports from *j* to *i* in a particular category; *DIST* is the great circle distance between the capitals; *GDPM* and *POPM* are the GDP and population of the importing country; *GDPX* and *POPX* are the GDP and population of the exporting country; *COMLAN* takes the value one if trading partners share a common language; *COMBOR* takes the value one if the trading partners share a common border; *LOCK* takes the value one if the importing country is landlocked; *IPR* is our index of IPR protection in the importing country; $_i$, $_j$ and $_t$ are importer, exporter and time fixed effects; and $_{ijt}$ is a normally distributed error term.

We expect that, in line with existing literature, distance will have a negative impact on trade flows by increasing transport costs. The GDP's of the importing and exporting country are expected to have a positive impact on trade flows. In the former this is due to a higher GDP indicating a larger market size, which should increase imports, while in the latter higher levels of GDP represent higher productive capacity. There is some ambiguity over the expected sign of the coefficients on population. In general, a larger population is usually associated with a larger country size, which is likely to lead to more diversified production and higher levels of self-sufficiency, and should lower trade flows and imports in particular. A larger population also allows a country to take fuller advantage of economies of scale leading to increased intra-industry trade (Prewo, 1978). For an exporting country therefore, a larger population by encouraging economies of scale would seem to imply larger manufacturing exports. A common language should facilitate communication between trade partners and reduce the search costs of international trade. A common language may reflect former colonial ties, which for historical reasons may also lead to greater trade flows. A common border facilitates trade, but being landlocked is generally considered to reduce international trade due to the relatively high cost of overland transportation. Finally, while these are the expected coefficients for data on total trade we may expect deviations from this when we consider industry data.

While the majority 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 IPRs and trade over a longer period of time; to account for changing IPR regimes and imitative ability; to control for the overall business cycle and to disentangle the time invariant country-specific effects (Egger, 2000); and to control for unmeasured country and time-specific heterogeneity (Co, 2004). When using panel data we need to make a choice between the fixed and the random effects estimator. Co (2004) largely relies on a random effects model since with only one exporter a fixed effects model would preclude the inclusion of time-invariant variables such as distance and the common border dummy. Mátyás (1997) and Egger (2000) argue that where possible a three way fixed effects model (including importer, exporter and time specific fixed effects) should be estimated. Egger for example argues that since the effects we seek to capture are trade policy and other export driving and impeding 'environmental' factors, including historical and geographical determinants which tend not to be random, a fixed effects estimator is more appropriate. These fixed effects are represented by $_{i}$, $_{j}$ and $_{t}$ in the above equation[3].

The estimate of coefficient in [1] gives us a simple linear estimate of the impact that IPR protection has on a country's imports from our five developed countries. But, as discussed above, there are reasons to believe that the relationship between IPR protection and trade is non-linear, and in particular that it may depend upon the level of development, imitative ability and the market size of the importing country. To test these hypotheses we employ the threshold techniques of Hansen (1996, 1999 and 2000)[4], which allow us to estimate rather than impose both the number of regimes and the positioning of the splits. The method is based on a threshold regression where observations fall into regimes that depend on an estimated value of an observed variable (e.g. a measure of imitative ability). In the two-regime model, for example, we have

$$\delta IPR(TH_{it}) = \delta_1 IPR_{it} I(TH_{it} \leq \lambda) + \delta_2 IPR_{it} I(TH_{it} > \lambda)$$

where is the estimated breakpoint or threshold. Here the observations are separated into two regimes depending on whether the threshold variable, TH_{it}, is smaller or larger than the value . The impact of IPR protection on trade will be given by $_{1}$ for countries in the low-regime (i.e. $TH_{it} \leq \lambda$) and by $_{2}$ for countries in the high-regime (i.e. $TH_{it} > \lambda$). We estimate the threshold (as the value that minimises the concentrated sum of squared errors from the least squares regression. In practice this involves searching over distinct values of the threshold variable (TH_{it}) for the value of that minimises the sum of squared errors. After obtaining a value of , we can estimate the parameters of our gravity equation. Having found the threshold we identify whether it is statistically significant by testing the null hypothesis that $\delta_1 = \delta_2$. Rejecting the null hypothesis allows us to conclude that a threshold exists in the IPR-Trade relationship. One complication is that the threshold is not identified under the null hypothesis, implying that classical tests do not have standard distributions and critical values cannot be read off standard distribution tables. We follow Hansen (1996) and bootstrap to obtain the p-value for the test of a significant threshold[5].

---

[3] A further issue is how to deal with zero trade flows. Using five-year averages did alleviate this problem somewhat, but there were still a few cases where zero trade flows were reported. Several options are available (Frankel, 1997, chapter 6), but given that the threshold techniques that we employ below have been developed for OLS we adopt the most straightforward "solution" of adding a small number to the zero observations (equal to \$100), which allows us to estimate the log-linear model.

[4] Hansen (1999) in particular describes the threshold regression technique for panel data with fixed effects.

[5] The bootstrap distribution of the test statistic was computed using 1000 replications of the procedure proposed in Hansen (1996).

This technique can be extended to consider the possibility of more than one threshold (i.e. more than two regimes). We decide upon the optimal number of thresholds by first estimating a single threshold. If this is found to be significant, we search for a second threshold using sequential estimation[6]. If this second estimated threshold is significant we search for a third threshold and so on. As is common in the literature, we impose the restriction that at least 20 percent of observations must lie in each regime to maintain a reasonable sample size in each. This implies that the maximum number of regimes we can consider is five.

The data that we use and its sources are described in the Appendix. We examine manufacturing exports from the five largest developed countries to a sample of 69 other developed and developing countries[7]. World R&D is concentrated in the OECD countries[8], and within the OECD heavily concentrated in these five countries[9]. Table 1 (Column 2) shows that in all industries the leading five countries make up over 80% of total R&D spending by the 15 OECD countries for which we have data. Also reported in Table 1 are the average industry shares in total manufacturing R&D for the G5 countries over the period 1973-1998. It is clear from these figures that R&D is heavily concentrated in two of the two-digit industries, Chemicals and, particularly, Fabricated Metal. The third column of Table 1 reports the ratio of industry R&D to industry production in our five exporting countries, with data averaged over the period 1978-1996, to give an indication of their relative R&D intensities. Once again Chemicals and Fabricated Metal tend to be the most R&D intensive, with much smaller intensities found in the other industries. The final column gives the share of each industry's exports in total manufacturing exports. Not

[6] While it is straightforward to search for more than one threshold simultaneously, this can be expensive in terms of computation time. Fortunately Chong (1994), Bai (1997) and Bai and Perron (1998) have shown that sequential estimation is consistent, thus avoiding this computation problem. In the two threshold case, the method involves fixing the first threshold at its estimated value and searching for a second threshold assuming that the first threshold is fixed. This method can then be extended to any number of thresholds. To test for the significance of the second threshold the bootstrap procedure is once again followed, with the test discriminating between one and two thresholds.

[7] The five exporting countries are France, Germany, Japan, UK and USA. The importing countries are Algeria, Argentina, Australia, Austria, Bangladesh, Belgium-Luxemburg, Bolivia, Brazil, Cameroon, Canada, Central African Republic, Chile, Colombia, Costa Rica, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Finland, Ghana, Greece, Guatemala, Guyana, Haiti, Honduras, Iceland, India, Indonesia, Ireland, Israel, Italy, Jamaica, Kenya, Korea (Republic of), Malawi, Malaysia, Mexico, Netherlands, New Zealand, Nicaragua, Niger, Norway, Pakistan, Paraguay, Peru, Philippines, Portugal, Senegal, Sierra Leone, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syria, Tanzania, Thailand, Togo, Trinidad and Tobago, Turkey, Uganda, Uruguay, Venezuela, Zaire, Zambia, Zimbabwe.

[8] UNIDO (2002) notes that the share of R&D financed by enterprises in advanced countries was 98% in the 1980s and 94% in the 1990s.

[9] The ANBERD database reports total manufacturing R&D expenditure for 15 OECD countries for 1973-1998, and the average share of R&D expenditure by these five economies over that period was 91.4%. There has been a slight decline in this share over the sample period from 92.8% in 1973 to 89.4% in 1998.

unexpectedly given the figures in the previous columns, exports from the G5 to our sample of importing countries are concentrated in Fabricated Metals and, to a lesser extent, Chemicals. The predominance of the former is reflected in the results that follow.

Finally, we explain our choices for threshold variables. As discussed above, the literature points to the relationship between IPR protection and trade depending upon an importer's level of development, imitative ability and market size. We measure an importer's level of

Table 1: Descriptive Data on the Significance of R&D

	Share of G5 in total OECD R&D Expenditure (1973-1998)[1]	Share of industry R&D in Total Manufacturing R&D for G5 (1973-1998)[2]	Ratio of Industry R&D to Production in G5 (1978-1996)[3]	Industry Share of Manufacturing Exports (%)[4]
3 - Total MANUFACTURING	91.4	100	2.23	100
31 - Food, Beverages and Tobacco [FOOD]	84.6	1.76	0.29	5.99
32 - Textiles, Apparel and Leather [TEXTILES]	90.1	0.55	0.24	5.10
33 - Wood Products and Furniture [WOOD]	89.4	0.29	0.19	1.17
34 - Paper, Paper Products and Printing [PAPER]	83.9	0.94	0.28	2.85
35 - Chemical Products [CHEMICALS]	89.5	20.04	2.53	17.97
36 - Non-Metallic Mineral Products [NON-METALLIC]	93.1	1.25	0.98	1.58
37 - Basic Metal Industries	86.9	2.22	0.63	6.33

[BASIC]				
38 - Fabricated Metal Products [FABRICATED]	92.3	72.30	4.07	57.08
39 - Other Manufacturing [OTHER]	88.9	0.63	0.65	1.84

Notes: [1] The figures in this column report the percentage of R&D expenditure in each industry carried out by the leading five economies. Data is available over the period 1973-1998 for 15 OECD countries. [2] The figures in this column report the share of total manufacturing R&D expenditure that is spent in each of the industries. The shares reported are the average shares over the period 1973-1998. [3] This column reports the ratio of industry R&D expenditure to industry production. The figures are averages over the period 1978-1996 for the G5 countries. R&D data are expressed in current PPP US dollars. Production data is expressed in current prices and in national currency. The production data was converted to US dollars, using the PPP exchange rates provided in the STAN database. These PPP's are based on a comparison of consumer goods prices, and are neither industry-specific nor do they reflect relative producer prices. The conversion of these industry-level production data to a common currency should be interpreted with caution therefore. [4] The figures in this column refer to the average shares of exports from the G5 in each industry out of total exports to our sample of importing countries over the period 1970-1999.

development by its GDP per capita. Imitative ability refers to a country's capacity to copy and produce technology and goods produced elsewhere, and is likely to depend upon a range of factors. Smith (1999) employs data on R&D expenditures as a percentage of GNP and the level of IPR protection to split her sample into four groups. But the unavailability of R&D data is limiting in a panel context, and the reliability of the data that is available for developing countries has been questioned[10]. Therefore we measure imitative ability using the average years of secondary schooling in the population over 15 (SYR)[11]. Using

[10] Maskus (2000) observes that "in the developing economies R&D data are highly suspect and not comparable to those in developed countries" (p. 118). He also notes that Smith's designations of countries into the four groups based on R&D data led to a number of anomalies.

[11] We also considered the average years of higher education in the population over 15, but given the similarity of these results with those for secondary schooling we choose to omit them from the paper. They are available upon request, however.

education data, which was also suggested by Smith, gives us another check on the robustness of her results. The final threshold variable that we consider is the level of GDP, as a measure of market size. We expect that the incentive to imitate will be greater in larger markets, other things equal, but that firms in advanced countries may take advantage of market power in smaller markets.

4. Results

4.1. A Linear Relationship

The results of estimating each regression separately using OLS with the IPR variable included linearly are reported in Table 2[12]. All variables are expressed in natural logarithms (except for the dummies and the IPR variable). To ease interpretation we report the results for the two-digit industries listed in descending order of their R&D intensity. The results for the "core" gravity variables are broadly as anticipated, taking into account our small number of exporters and that trade flows are more heavily influenced by the comparative advantage factors picked up by the (unreported) country dummies as we consider narrower industry definitions. We find a negative and significant coefficient on distance. The coefficient on importer GDP is consistently positive and significant, while the coefficient on the population of the importer is negative and significant. Rather unexpectedly the exporter's GDP often has a negative coefficient when it is significant, but this seems to be largely a consequence of the inclusion of fixed effects[13]. The exporter's population usually has a positive coefficient when it is significant. While a common language appears to consistently raise the level of imports across industries, the coefficient on the common border dummy is found to vary in both sign and significance. Again this seems to be a consequence of the inclusion of fixed effects[14]. The coefficient on landlocked sometimes shows "perverse" signs for the same reason.

Turning to the IPR variable, we have significant positive coefficients for all industries, with the exception of Textiles for which an insignificant positive coefficient is found. While we

[12] We also estimated these equations as a system using seemingly unrelated regression (SURE) methods. The SURE results are very similar to the OLS results and are available upon request, but for consistency with the threshold results that we report later which rely on OLS estimates, we report the OLS estimates in the text.

[13] If we re-estimate excluding importer, exporter and time dummies, the size of the negative coefficients on exporter GDP tends to fall significantly, and in many cases becomes significant and positive.

[14] When fixed effects are excluded, the common border is more likely to be positive and significant for the industries, but still negative for the most R&D intensive products. It should be remembered that while we expect a common border to lead to greater trade flows in aggregate, this will not necessarily be the case for each individual product. The negative coefficients may be an idiosyncrasy of the sample since the number of common borders is limited and, with the exception of the US-Mexico border, involve trade between advanced countries.

do not wish to make too much of these results, since this is not our preferred specification, we note that there is no obvious relationship between the size of the coefficient on IPRs and R&D intensity at the industry level, with the largest coefficient on IPRs being found in Food. This illustrates an important point. Our IPR index is that constructed by Ginarte and Park (1997) and is specifically based on the strength of patent protection in the country concerned (see the Appendix for details). While patent protection is particularly significant for R&D intensive industries, a country with a strong patent regime is very likely to provide strong protection for all forms of intellectual property. Certainly TRIPs defines rights across a wide spectrum[15]. As a result we interpret the Ginarte and Park index as a general IPR index, and expect that it may prove significant in industries where IPRs other than patents are important.

Were our investigations to cease at this point, we would conclude that strengthening IPRs would raise exports to all countries, for all manufacturing industries (except one) and would reduce exports in none. But our discussion of the relevant theory and empirical literature indicated that the relationship between IPRs and trade was very likely non-linear in form, with the impact of strengthening IPRs likely to depend on product and importing country characteristics. The coefficients estimated in the linear equation would then represent an "average" effect, whose literal interpretation could be quite misleading. Our threshold regression analysis will demonstrate this.

4.2. Single Variable Thresholds

Our initial approach to examining the importance of third variables in the relationship between IPR protection and trade is to estimate the optimal number of thresholds for each of our three threshold variables in turn. For each threshold variable we report the location of the significant thresholds (both the value and its percentile location) and the coefficient and t-value on IPR protection for each of the corresponding regimes, for each industry[16].

4.2.1 Thresholds on the Level of Development

[15] TRIPs includes agreements on the following forms of intellectual property; copyrights and related rights, trademarks, geographical indications, industrial designs, patents, layout-designs of integrated circuits, and protection of undisclosed secrets.

[16] For brevity and ease of presentation we choose not to report the coefficients on the other gravity variables. These results are available upon request and are broadly in line with those reported in Table 3.

The results reported in Table 3 use the level of development of the importer (specifically the natural log of GDP per capita) as the threshold variable[17]. Our major interest in these results lies in their implications for the impact of strengthened IPR protection on the imports of developing countries. In recent years the latter have shown increased interest in WTO membership as a means of gaining improved access to export markets. At the same time they have expressed concern over the power to advanced country exporters they may concede in their own markets through the accompanying TRIPs obligations. The estimation of thresholds on GDP per capita should indicate the degree to which the existence and strength of market power and market expansion effects are related to importers' levels of development.

The first row in Table 3 shows that there are three significant thresholds for Manufacturing, occurring at the 26th, 47th and 79th percentiles of GDP per capita in the sample. This implies that there are four IPR regimes with similar numbers of observations in each, and with IPR coefficients and t-statistics as shown in the second row[18]. The coefficient on the IPR index is rising as one moves up the regimes, but is only significantly positive in the upper two regimes. As expected the significant coefficient in the linear case is contained within the range of these coefficients, and is larger than the two smaller (and insignificant) coefficients, and smaller than the two larger (and significant) coefficients. These results indicate that it is only in more developed countries that strengthening IPRs will raise manufacturing imports in aggregate. The results for Fabricated are almost an exact reflection of those for Manufacturing, a pattern that we will see repeated below. The only other industry with three significant thresholds is Food, which has a similar pattern of significance of coefficients, though these are all larger. The remaining industries have two significant thresholds. In all cases the IPR coefficient increases as we move to higher income regimes, and the coefficients are always positive and significant in the highest regimes. All industries have a significant threshold at the 26th percentile of GDP per capita (corresponding to the GDP per capita of Senegal in 1975). All bar one (Chemicals) have a negative coefficient in the lowest regime, but only for Textiles is this coefficient significant. Recall that this industry was the only industry for which the coefficient on IPRs was not

---

[17] Note that in this Table there are occasions in which the last estimated threshold was significant. In these cases it was not possible to search for a further threshold whilst maintaining the restriction that 20% of observations must lie in each regime. In these cases we report the results in Table 4 based on the last significant estimated threshold.

[18] The thresholds are marked in italics and are located horizontally in this and the following two tables so as to give a rough indication of their relative location across industries.

significant in the linear regression. Here this is explained as the average of significant market power effects in countries with the lowest levels of development and significant market expansion effects in countries with the highest levels of development.

Smith (1999) and Rafiquzzaman (2002) also examine the links between the impact of a stronger IPR regime and the importer's level of development. They do this by dividing the importing countries into groups based on income per capita and including dummy variables for each group interacted with the IPR variable. Smith finds market expansion effects for the lower middle income group and market power effects for the other three in Manufacturing. The industries exhibit a similar pattern. Rafiquzzaman finds market expansion effects at all income levels for Manufacturing, but some evidence of market power effects, mainly in the low income group, for some industries. Interestingly, our threshold analysis indicates the same number of regimes (four) as Smith for Manufacturing, though in different locations. But as Table 4 indicates, four is not the appropriate number of regimes for the majority of industries. Once this is taken into account significant market power effects are much less in evidence.

What do our results imply about TRIPs and the imports of developing countries? For the relatively more advanced developing countries, that is those countries above the 47th percentile of income per capita in our sample, strengthening their IPR regimes will increase Total Manufacturing imports from our five advanced exporters. Table 3 shows that similar thresholds exist for the two-digit manufacturing industries. For these countries there is the prospect of increased technology diffusion through commodity trade. But for the least developed countries, specifically those below the 26th percentile, strengthening their intellectual property regimes will not increase imports from advanced countries, and indeed will likely reduce them in Textiles. For these countries the prospect of assuming the full TRIPs obligations would appear unattractive. Fortunately many of them can obtain access for their exports under alternative schemes (e.g. through the GSP).

4.2.2 Thresholds on Imitative Ability

Table 4 performs the same analysis using our measure of imitative ability (SYR) as the threshold variable. In this case we expect to observe market expansion effects for countries with high levels of imitative ability, with the possibility of market power effects for those countries with little ability to imitate advanced technology. Manufacturing has one significant threshold and IPRs have a significant positive coefficient in each regime, but larger in the higher regime. This outcome matches that for Fabricated and Chemicals, though the latter's threshold is at a higher level. The other industries show a variety of outcomes, with one to three thresholds. There is only one negative coefficient, and that is insignificant, so there is no evidence of market power effects associated with imitative ability. With one exception (Basic) all coefficients are increasing, positive if significant and either always significant or significant in the higher regimes. There is thus clear evidence that strengthening IPRs increases trade, at least above some level of imitative ability, and that this effect is stronger at higher levels of imitative ability.

4.2.3. Thresholds on Market Size

Table 5 reports the results for market size (GDP) thresholds. Here our interest is in whether we find a pattern of market power effects in small markets and market expansion effects in large markets. Again this is a case where the results for Manufacturing exports and Fabricated exports are very similar. Both show two thresholds and similar coefficients in the three regimes they generate. The market power effect shown for Manufacturing at small market sizes primarily reflects that for Fabricated. While other industries have negative coefficients over this range they are not significant. Three other industries have two significant thresholds, Food has three and the others one. For Manufacturing and Fabricated all coefficients are significant in all regimes and positive and increasing for the larger market sizes. This pattern of increasing coefficients, significant for the larger market sizes is present in four other industries. For two of the remainder there is a significant positive effect only for larger market sizes. A third is positive and significant throughout, but declining, and the last is positive and significant only for the largest and smallest market sizes.

In summary, the results in Tables 4 and 5 confirm that the strength of importer's IPRs is a significant determinant of its manufacturing imports from our five advanced countries. This is evident in Manufacturing exports, and to a greater or lesser degree in the exports of individual manufacturing industries, though it seems that Fabricated most closely matches the aggregate behavior. We find no significant market power effects associated with imitative ability, and those associated with a small market size at the aggregate level reflect those in Fabricated only. Market expansion effects are pervasive at higher levels of imitative ability, and are also evident when we consider market sizes, tending to be stronger in larger markets in most industries.

4.3. Dual Variable Thresholds

In this section we explore the possibility of interactions between different threshold variables. Specifically we examine whether the relationship between strengthening IPRs and trade depends upon the interaction between imitative ability and both the level of IPR protection and market size. The approach we adopt involves three steps. First we take the highest significant threshold on secondary schooling from Table 4 to distinguish between low and high imitative ability, then we search for a second threshold based on either GDP or the level of IPRs in the high imitative ability regime, and finally we search for a third threshold based on the level of GDP or IPRs in the low imitative ability regime. When estimating the third threshold we include the second threshold if it was found to be significant[19]. The final equation (where all thresholds are significant) is therefore

$$\ln TRADE_{ijt} = \beta_k X_{ikt} + \delta_1 IPR_{it} I(SYR_{it} \le \lambda_1; Z_{it} \le \lambda_2) + \delta_2 IPR_{it} I(SYR \le \lambda_1; Z_{it} > \lambda_2) +$$
$$\delta_3 IPR_{it} I(SYR_{it} > \lambda_1; Z_{it} \le \lambda_2) + \delta_4 IPR_{it} I(SYR_{it} > \lambda_1; Z > \lambda_2) + \mu_i + \theta_j + \nu_t + \varepsilon_{ijt}$$

where Z_{it} is either the level of IPR protection or the natural log of the level of GDP.

4.3.1. Thresholds on Imitative Ability and Market Size

The first cases we consider are interactions between secondary schooling and the level of GDP. IPRs are likely to matter more in countries where imitation is more likely, and both high imitative ability (as measured by an educated workforce) and a large market size (as measured by the level of GDP) make imitation more likely, in the latter case due to a large market making successful imitation more profitable. Is it the case, as Maskus and Penurbati suggest, that market expansion effects dominate in larger countries with stronger imitative abilities, while market power effects dominate in smaller countries with weaker imitative abilities? Table 6 reports our results. In the high imitative ability regime the coefficients are positive and significant for all market sizes (except the small market size for Wood). The coefficients are increasing in market size for Manufacturing exports and for six of the industries, and the coefficients are independent of market size for the other three. There is thus clear evidence of market expansion effects, increasing in market size, in countries with

[19] The estimated thresholds on IPR protection or the level of GDP in the high imitative ability regime are not asymptotically efficient, since the threshold was estimated from a sum of squared errors function that was contaminated by the presence of a neglected regime. To deal with this we follow Bai (1997) and re-estimate the high imitative ability threshold now including the estimated threshold in the low imitative ability regime.

high imitative ability. In contrast, the results in the low imitative ability regime are less clear cut. There are no significant effects for Manufacturing exports. The only evidence of market power effects is in Other in small markets. Elsewhere there is evidence of market expansion effects for both small and large market sizes for one industry (Food), for small markets only for three (Chemicals, Paper and Textiles) and for large markets only for another three (Fabricated, Basic and Wood). The coefficients are greater in larger markets in five industries, and lower in four. Clearly there is little evidence of market power effects, and while market expansion effects are common, they are almost equally split between large and small markets. In general, it seems that market size has an ambiguous impact on the IPR-Trade relationship for countries with low imitative ability, but that for countries with high levels of imitative ability market expansion effects tend to be larger in countries with large markets.

4.3.2. Thresholds on Imitative Ability and IPR Protection.

Here we follow the standard approach in the literature, originating with Smith (1999), of splitting the sample into four groups based on both the level of IPR protection and imitative ability. This reflects the view that, although high imitative ability will make imitation more likely, this can be countered by high levels of IPR protection that reduces the threat of imitation. We re-examine this hypothesis using an alternative measure of imitative ability (schooling rather than R&D spending) and a broader sample of exporting countries, as well as allowing the thresholds on both variables to be determined endogenously and to vary across industries.

We have evidence that stronger IPRs are more important when imitative ability is high from section 4.2.2. We now consider discontinuities in this relationship. Our results are presented in Table 7. Consider first the regimes where imitative ability is low. Here there is clear evidence that strengthening IPRs beyond a threshold (which is industry specific) will not affect imports from these advanced countries. For all industries (except Food) the coefficient on IPRs is not statistically significant in the higher IPR range. This is largely as expected; countries in the high IPR regime have a lower threat of imitation, suggesting that market expansion effects may be limited. Unlike Smith (1999) however, we find little evidence of market power effects for this regime. In the low IPR regime we find the coefficient on IPRs to be significant in all industries (except Other and Basic). For Manufacturing and five industries there is evidence of market expansion effects in this regime. For two industries there is evidence of significant market power effects. We conclude that countries with limited imitative ability will find that strengthening their IPR regimes will initially increase manufacturing imports from these five countries, but that this will be accompanied by a shift in the composition of these imports, away from those industries with significant market power effects towards those with significant market expansion effects. Once the IPR regime becomes sufficiently strong, however, further strengthening will leave imports unaffected (except for Food).

A clear pattern also emerges for countries with high imitative abilities. For those industries exhibiting market power effects when imitative ability is low, strengthening IPRs generally has no significant effect when imitative ability is high. For those industries exhibiting market expansion effects when imitative ability is low, strengthening IPRs also has market expansion effects when imitative ability is high, though this effect is invariably weaker in the higher IPR regime (except for Paper where the effects are the same), reflecting the smaller threat of imitation. In general, countries with high imitative ability will find that strengthening their IPR regime leads to increased Manufacturing imports, with similar shifts in the broad composition of these imports occurring as for countries with low imitative ability, since the same industries expand for both low and high imitative ability.

These outcomes broadly support previous results, except that there is far less evidence of market power effects. There are two other noteworthy aspects of these outcomes. The first is the separation of the two-digit industries into two groups – those exhibiting market power effects and those exhibiting market expansion effects. The second is that this separation bears no obvious relationship to an industry's R&D intensity.

Finally, are these results consistent with the argument that the coefficients on IPRs should decline as we move away from regimes with the greatest threat of imitation? Intuitively, countries with high imitative ability and low IPR protection provide the greatest threat of imitation, and those with low imitative ability and high IPR protection offer the least. Countries with high imitative ability and high IPR protection and countries with low imitative ability and low IPR protection are somewhere in between. Do our estimated IPR coefficients decline in this way? The answer is yes for those industries that exhibit market expansion effects, but there is no consistent pattern for those that exhibit market power effects.

5. Summary and Conclusions

The theoretical ambiguity concerning the effects of strengthening IPRs on imports has been much emphasised in the literature and has led to several attempts at its empirical resolution. The general conclusions that have emerged are that imitative ability and, to a lesser extent, market size are important in this relationship, with strong evidence of market expansion effects in countries with high imitative ability and larger markets, and rather weaker evidence of market power effects in countries with low imitative ability and small markets. But establishing these outcomes has often relied on classifying countries into imitative ability or market size cohorts on a subjective basis, without being able to determine the sensitivity of the outcomes to the classification.

As has become standard, we use a variant of the gravity equation to examine the impact of IPR protection on trade, but otherwise our approach differs from most previous examinations in several respects. Firstly, we employ panel data rather than the more usual cross-section data, thus allowing us to control for unobserved heterogeneity both across countries and time. We also consider a wider range of advanced exporters than is usual in the literature. Secondly, we use an alternative measure of imitative ability (schooling) and explicitly consider the interactions between imitative ability and market size. Finally, and most significantly, rather than splitting our observations into different regimes in a subjective manner or making certain assumptions about the form of such interactions (i.e. a linear interaction term), we use threshold regression techniques to estimate both the number of regimes and their positioning.

While we are inclined to agree with previous authors that an importer's imitative ability and market size are likely to be the key characteristics in determining the impact of stronger IPRs on trade flows, the link with the importer's level of development is of some interest in its own right because of the debate over the potential benefits to developing countries from WTO membership. A major concern for these countries has been the implications of TRIPs standards of IPRs for competition in their domestic markets. Our results indicate the likelihood of significant market expansion effects for those countries at relatively higher levels of development, but (except for one industry) no significant effects either way for the least developed countries. While this does not preclude market power effects for individual products, it does suggest that they are not widespread.

We began our investigation of the links between imitative ability, market size and the strength of IPRs by estimating thresholds for imitative ability and market size separately. This revealed clear evidence of market expansion effects, but no evidence of market power effects related to imitative ability. The market power effects observed for Total Manufacturing exports in small markets appear to reflect the outcome in a single industry (Fabricated Metal Products). Again there was broad evidence of market expansion effects which tended to be stronger in larger markets.

We then considered combined thresholds on imitative ability and market size. We found widespread evidence of market expansion effects, increasing in market size, and no evidence of market power effects in countries with high imitative ability. For countries with limited imitative ability, there is also evidence of market expansion effects in most industries, but no clear pattern with regard to market size; and evidence of market power effects in only one industry. We conclude that while market size is not irrelevant to the impact of strengthened IPRs, its influence is somewhat secondary to that of imitative ability.

The examination of combined thresholds on imitative ability and the level of IPRs was directly comparable to the results based on subjective thresholds in the literature. Allowing thresholds to vary across industries brought the patterns previously identified into sharper focus. For countries with low imitative abilities, strengthening low IPRs will lead to market expansion effects for most industries, but market power effects for some. But for each industry (except Food) there is a ceiling beyond which strengthening IPRs will have no significant effect on trade flows. For countries with high imitative abilities we found a clear separation of industries. Those which exhibit market power effects when imitative ability is low show no significant effects from strengthening IPRs when imitative ability is high. Those which exhibit market expansion effects when imitative ability is low, exhibit market expansion effects when imitative ability is high.

The latter results draw attention to the different behaviour of industries and illustrate why it is useful to look beyond Total Manufacturing exports. Fabricated Metal products form about 60% of manufactured exports from these five countries and it is therefore unsurprising that the aggregate relationship reflects that of this industry so closely. The other two-digit industries present a range of outcomes. Strengthening IPRs is likely to change not only the volume but also the composition of imports from these advanced countries, although not necessarily in favour of the more R&D intensive industries. The broad shifts in the composition are largely independent of the level of imitative ability.

Our results show some evidence of market power effects, though these are not common. While a negative coefficient was found on our IPR index in some regression for all industries, these coefficients were rarely statistically significant, and such cases invariably occurred in the "lowest" regimes. Thus for the single thresholds we had market power effects in Food for the least developed countries, and in Total Manufacturing and Fabricated Metal Products for the smallest markets. For the dual thresholds, significant market power effects were found for Other Manufacturing in small markets with low imitative ability, and for Chemicals, Textiles and Wood Products in countries with weak imitative ability and weak IPRs. These results indicate that market power effects are far from pervasive, but should not be discounted for the least developed, small countries with low imitative ability and weak IPRs.

In contrast market expansion effects are pervasive at the industry level. For the single thresholds we found evidence of statistically significant market expansion effects in each industry for at least one regime for all three threshold variables. These occurred at higher levels of development and at higher levels of imitative ability, but not necessarily at larger market sizes. Some industries (Total Manufacturing, Fabricated Metal, Chemicals and Food for the imitative ability thresholds, and Paper for market size thresholds) showed market expansion effects in all regimes. For the dual thresholds, all industries show market expansion effects in countries with high imitative ability regardless of market size, though the effect is stronger in larger markets. Some industries show market expansion effects in large markets with low imitative ability. The combination of a threshold on imitative ability and IPRs yielded market expansion effects for Fabricated Metal products, Non-metallic Minerals and Paper Products in markets with high imitative ability (regardless of the IPR regime, though the effect tended to be weaker in the high IPR regime) and in markets with low imitative ability but weak IPRs. Only for Food Products do we find market expansion effects across the board for both dual thresholds.

If, as the literature suggests, increased manufacturing trade with advanced countries brings technology diffusion, then our results indicate that most developing countries can anticipate increased technology flows as their IPRs are strengthened. The small and least developed may see little such benefits, however. For them technology diffusion may have to depend on other channels. Consideration of how IPRs affect these other channels and, in particular, how they affect exporting firms' choice of market access is an important element of future research in this area.

Appendix

Our data is averaged over six five-year periods, 1970-74, 1975-79, 1980-84, 1985-89, 1990-94 and 1995-99. Due to missing data for various variables the maximum number of observations is 2021. The data for population, GDP and GDP per capita came from the World Bank's World Development Indicators (2001) database. Data on distance, common language and borders and landlockedness came from a website maintained by Jon Haveman. Trade data came from the OECD's International Trade by Commodity Statistic (Historical Series, 1961-1990) and International Trade by Commodity Statistic (1990-1999). The trade data from 1961 to 1990 was in SITC rev. 2 and was converted to ISIC rev. 2 using a concordance supplied by the OECD. The data for 1990 to 1999 was in SITC rev. 3 and was converted to SITC rev. 2 and then ISIC rev. 2 again using a concordance supplied by the OECD. The education data was taken from the Barro and Lee (2001) database. The index of IPR protection is provided in Ginarte and Park (1997) and is the most commonly used indicator of IPR protection. This index was constructed for 110 countries quinquennially for the period 1960-1990. Five characteristics of patent laws are included: extent of coverage; membership in international patent agreements; provisions for loss of protection; enforcement mechanisms and duration of protection. Each was assigned a value ranging from zero to one and their unweighted sums formed the index, with a higher number signalling stronger IPR protection. This data has been updated to 1995 by Park who kindly supplied us with the full set of data. Table A1 provides summary statistics for all the variables.

Table A1: Summary Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
3 - Total Manufacturing	19.1	2.13	4.61	25.58
31 - Food, Beverages and Tobacco	16.73	2.52	4.61	22.28
32 - Textiles, Apparel and Leather	15.46	2.48	4.61	22.18
33 - Wood Products and Furniture	12.78	3.05	4.61	21.68
34 - Paper, Paper Products and Printing	14.79	2.65	4.61	22.38
35 - Chemical Products	17.2	2.33	4.61	23.64
36 - Non-Metallic Mineral Products	14.5	2.43	4.61	21.28
37 - Basic Metal Industries	15.81	2.56	4.61	22.30
38 - Fabricated Metal Products	18.51	2.18	9.36	25.19
39 - Other Manufacturing	14.21	2.62	4.61	21.57
DIST	8.7	0.86	5.27	9.85
GDPM	23.9	1.9	20.0	27.76
POPM	16.22	1.35	12.25	20.69
GDPX	28.4	0.71	27.28	29.71
POPX	18.35	0.55	17.76	19.42
LOCK	0.16	0.37	0	1
COMLAN	0.16	0.37	0	1
COMBOR	0.03	0.18	0	1
IPR	2.55	0.81	0.33	4.57

GDPPC	7.69	1.60	4.74	11.25
SYR	1.40	1.07	0.039	5.037
GDP	23.89	1.90	20.00	27.76

Note: All variables are in natural logs with the exception of the IPR index, dummy variables (i.e. COMBORD, COMLANG, LOCK) and the education index (SYR). The industry identification numbers refer to ISIC rev. 2 Code.

Table 2: OLS Estimates of the Impact of IPR Protection on Trade

Industry	*DIST*	*GDPM*	*POPM*	*GDPX*	*POPX*	*LOCK*	*COMLAN*	*COMBOR*	*IPR*	F-Stat	R^2
Total Manufacturing	-1.0	1.43	-1.31	0.43	1.28	-20.8	0.67	0.11	0.18	15443.1***	0.99
	(-32.95)***	(16.22)***	(-5.86)***	(0.82)	(1.50)	(-1.66)*	(8.80)***	(1.18)	(2.60)***		
Fabricated Metal Products	-0.88	1.47	-1.47	1.75	0.90	-52.40	0.75	0.17	0.19	15699.0***	0.99
	(-31.42)***	(15.14)***	(-6.05)***	(3.40)***	(1.04)	(-4.07)***	(10.90)***	(1.92)*	(2.56)**		
Chemical products	-1.21	1.37	-0.99	-0.11	1.33	-10.09	0.80	-0.35	0.23	7821.7***	0.99
	(-30.46)***	(11.91)***	(-3.63)***	(-0.17)	(1.31)	(-0.62)	(8.36)***	(-2.89)***	(2.86)***		
Non-metallic minerals	-1.29	1.86	-1.45	-0.40	1.55	-11.96	1.11	-0.14	0.19	5965.4***	0.99
	(-33.43)***	(14.06)***	(-4.86)***	(-0.60)	(1.33)	(-0.71)	(13.05)***	(-1.17)	(2.07)**		
Other Manufacturing	-1.13	2.10	-1.38	-2.49	5.34	-30.94	1.21	-0.71	0.20	3951.5***	0.99
	(-25.24)***	(12.13)***	(-3.95)***	(-3.15)***	(3.85)***	(-1.54)	(12.41)***	(-4.23)***	(1.80)*		
Basic Metal Industries	-1.36	1.43	-0.69	-3.54	2.21	65.99	0.66	0.04	0.28	4958.8***	0.99
	(-34.43)***	(10.08)***	(-1.86)*	(-4.35)***	(1.62)	(3.30)***	(6.55)***	(0.30)	(2.38)**		
Food,	-1.08	1.24	-0.95	-5.38	4.08	91.72	0.37	0.30	0.37	5070.4***	0.99

Beverages, Tobacco	(-23.46)***	(6.78)***	(-2.77)***	(-5.36)***	(2.94)***	(4.51)***	(4.07)***	(1.96)**	(3.58)***		
Paper, Paper products, Printing	-1.35	1.37	-1.18	-4.19	2.57	89.25	1.44	-0.10	0.20	5411.4***	0.99
	(-29.54)***	(8.84)***	(-3.80)***	(-5.65)***	(2.08)**	(4.90)***	(16.12)***	(-0.68)	(2.08)**		
Textiles, Apparel, Leather	-1.62	2.25	-1.80	-7.91	10.25	45.15	0.67	0.08	0.16	4473.5***	0.99
	(-31.54)***	(13.79)***	(-4.91)***	(-9.10)***	(6.97)***	(2.06)**	(7.15)***	(0.51)	(1.33)		
Wood products, Furniture	-1.57	2.33	-1.49	-8.20	10.95	30.02	1.23	0.12	0.29	2400.6***	0.99
	(-29.93)***	(12.74)***	(-3.75)***	(-8.57)***	(6.77)***	(1.39)	(10.73)***	(0.73)	(2.28)**		

All regressions include a full set of importer, exporter and time effects that are not reported for brevity. *, ** and *** indicate significance at the 10, 5, and 1 percent level respectively. t-statistics in brackets are based on White heteroscedasticity consistent standard errors.

Table 3: Development Thresholds (Threshold Variable: GDP per capita)

	Percentile	0		50	100
Total Manufacturing	Thres GDP/cap	*6.41*** (26th)*	*7.36** (47th)*	*9.41*** (79th)*	
	Coeff IPR	-0.12 (-1.18)	0.10 (1.19)	0.20 (2.89)***	0.31 (4.03)***
Fabricated Metal Products	Thres GDP/cap	*6.41*** (26th)*	*7.36** (47th)*	*9.41** (79th)*	
	Coeff IPR	-0.13 (-1.13)	0.12 (1.30)	0.21 (2.83)***	0.33 (3.90)***
Chemical products	Thres GDP/cap	*6.41*** (26th)*		*9.41** (79th)*	
	Coeff IPR	0.03 (0.31)	0.23 (2.81)***		0.36 (4.08)***
Non-metallic	Thres	*6.41****	*7.96***		

minerals	GDP/cap	*(26th)*	*(60th)*		
	Coeff IPR	-0.1 (-0.77)	0.15 (1.57)	0.29 (2.93)***	
Other Manufacturing	Thres GDP/cap	*6.41*** (26th)*	*8.57* (71st)*		
	Coeff IPR	-0.17 (-1.09)	0.16 (1.34)	0.32 (2.60)***	
Basic Metal Industries	Thres GDP/cap	*6.41*** (26th)*	*7.92*** (58th)*		
	Coeff IPR	-0.26 (-1.63)	0.22 (1.80)*	0.42 (3.50)***	
Food, Beverages, Tobacco	Thres GDP/cap	*6.41*** (26th)*	*7.44* (48th)*	*8.56*** (71st)*	
	Coeff IPR	-0.07 (-0.47)	0.18 (1.41)	0.30 (2.73)***	0.58 (4.85)***
Paper, Paper products,	Thres GDP/ca	*6.41*** (26th)*	*7.96** (60th)*		

Printing	p			
	Coeff IPR	-0.06 (-0.47)	0.16 (1.56)	0.30 (2.99)***
Textiles, Apparel, Leather	Thres GDP/cap	*6.41*** (26th)*	*7.68** (53rd)*	
	Coeff IPR	-0.43 (-2.40)**	0.06 (0.42)	0.25 (2.17)**
Wood products, Furniture	Thres GDP/cap	*6.41*** (26th)*	*7.73*** (54th)*	
	Coeff IPR	-0.15 (-0.80)	0.12 (0.81)	0.37 (2.94)***

Notes: For each industry group, this table reports the position of the estimated thresholds and their significance (first row) and the estimated coefficient on the IPR variable for each regime and its significance (second row). The coefficients on the remaining variables from the gravity model (including importer, exporter and time effects) are not reported for brevity. *, ** and *** indicate significance at the 10, 5, and 1 percent level respectively. t-statistics in brackets are based on White heteroscedasticity consistent standard errors. The significance of the estimated thresholds is found using the bootstrap procedure of Hansen (1996) with 1000 replications.

Table 4: Imitative Ability Thresholds (Threshold Variable: Average Years of Secondary Schooling)

<table>
<tr><td colspan="2">Percentile</td><td colspan="4">0 50 100</td></tr>
<tr><td rowspan="2">Total Manufacturing</td><td>Thres SYR</td><td colspan="2">1.56**
(65th)</td><td colspan="2"></td></tr>
<tr><td>Coeff IPR</td><td colspan="2">0.13
(1.98)**</td><td colspan="2">0.20
(2.89)***</td></tr>
<tr><td rowspan="2">Fabricated Metal Products</td><td>Thres SYR</td><td colspan="2">1.56***
(65th)</td><td colspan="2"></td></tr>
<tr><td>Coeff IPR</td><td colspan="2">0.14
(1.85)*</td><td colspan="2">0.23
(2.92)***</td></tr>
<tr><td rowspan="2">Chemical products</td><td>Thres SYR</td><td colspan="3">1.96*
(75th)</td><td></td></tr>
<tr><td>Coeff IPR</td><td colspan="3">0.20
(2.47)**</td><td>0.27
(3.32)***</td></tr>
<tr><td rowspan="2">Non-metallic minerals</td><td>Thres SYR</td><td>0.56*
(26th)</td><td>1.56***
(65th)</td><td colspan="2"></td></tr>
<tr><td>Coeff IPR</td><td>0.08
(0.83)</td><td>0.14
(1.53)</td><td colspan="2">0.26
(2.69)***</td></tr>
<tr><td rowspan="2">Other Manufacturing</td><td>Thres SYR</td><td colspan="2">1.56***
(65th)</td><td colspan="2"></td></tr>
<tr><td>Coeff</td><td colspan="2">0.11</td><td colspan="2">0.26</td></tr>
</table>

	IPR	(0.97)	(2.26)**		
Basic Metal Industries	Thres SYR	*0.5*** *(21st)*	*0.97** *(44th)*	*1.56** *(65th)*	
	Coeff IPR	0.13 (1.07)	0.27 (2.30)**	0.20 (1.60)	0.29 (2.37)**
Food, Beverages, Tobacco	Thres SYR	*0.59*** *(28th)*	*1.2** *(52nd)*	*1.95** *(75th)*	
	Coeff IPR	0.26 (2.27)**	0.35 (3.33)***	0.42 (3.87)***	0.49 (4.55)***
Paper, Paper products, Printing	Thres SYR	*0.7*** *(34th)*	*1.56*** *(65th)*		
	Coeff IPR	0.11 (1.09)	0.19 (1.96)*	0.28 (2.84)***	
Textiles, Apparel, Leather	Thres SYR	*0.5** *(25th)*	*1.21**** *(52nd)*	*1.95** *(75th)*	
	Coeff IPR	-0.01 (-0.08)	0.09 (0.70)	0.26 (2.09)**	0.35 (2.77)***
Wood products, Furniture	Thres SYR	*1.56*** *(65th)*			
	Coeff	0.13	0.39		

	IPR	(1.04)	(3.05)***

Notes: See Table 3.

Table 5: Market Size Thresholds (Threshold Variable: GDP)

Percentile		*0*	*50*	*100*
Total Manufacturing	Thres GDP	*22.18**** *(21^{st})*	*24.91*** *(65^{th})*	
	Coeff IPR	-0.17 (-3.02)***	0.14 (1.93)*	0.22 (3.20)***
Fabricated Metal Products	Thres GDP	*22.18**** *(21^{st})*	*24.91*** *(65^{th})*	
	Coeff IPR	-0.22 (-3.48)***	0.15 (1.91)*	0.24 (3.20)***
Chemical products	Thres GDP	*22.82*** *(38^{th})*		
	Coeff IPR	0.36 (3.64)***	0.22 (2.76)	
Non-metallic minerals	Thres GDP	*22.18**** *(21^{st})*	*25.79*** *(79^{th})*	
	Coeff IPR	-0.12 (-1.11)	0.14 (1.49)	0.25 (2.73)***
Other	Thres	*24.37****		

Manufacturing	Thres GDP	*(53rd)*			
	Coeff IPR	0.31 (2.52)**	0.12 (1.06)		
Basic Metal Industries	Thres GDP	22.15*** (20th)	25.81** (79th)		
	Coeff IPR	-0.05 (-0.36)	0.21 (1.81)*	0.37 (3.22)***	
Food, Beverages, Tobacco	Thres GDP	*22.15*** (20th)*	*23.44* (46th)*	*25.37*** (72nd)*	
	Coeff IPR	-0.19 (-1.16)	-0.03 (-0.21)	0.35 (3.13)***	0.54 (5.15)***
Paper, Paper products, Printing	Thres GDP	*22.48* (29th)*			
	Coeff IPR	0.27 (2.53)**	0.19 (1.98)**		
Textiles, Apparel, Leather	Thres GDP	*23.02*** (41st)*			
	Coeff IPR	-0.01 (-0.06)	0.23 (1.96)*		
Wood products,	Thres GDP	*22.8*** (38th)*	*25.11** (66th)*		

Furniture	Coeff IPR	0.43 (2.78)***	0.19 (1.45)	0.36 (2.71)***

Notes: See Table 3.

Table 6: Imitative Ability and Market Size

		Low Imitative Ability		High Imitative Ability	
		Small Market	Large Market	Small Market	Large Market
		1	2	3	4
Total Manufacturing	Thres	$SYR \leq 1.56$ $GDP \leq 22.11$	$SYR \leq 1.56$ $GDP > 22.11$	$SYR > 1.56$ $GDP \leq 26.25$	$SYR > 1.56$ $GDP > 26.25$
	Coeff IPR	-0.05 (-0.63)	0.11 (1.52)	0.15 (2.00)**	0.26 (3.52)***
Fabricated Metal Products	Thres	$SYR \leq 1.56$ $GDP \leq 22.11$	$SYR \leq 1.56$ $GDP > 22.11$	$SYR > 1.56$ $GDP \leq 26.3$	$SYR > 1.56$ $GDP > 26.3$
	Coeff IPR	-0.07 (-0.77)	0.14 (1.84)*	0.20 (2.69)***	0.25 (3.24)***
Chemical Products	Thres	$SYR \leq 1.96$ $GDP \leq 22.82$	$SYR \leq 1.96$ $GDP > 22.82$	$SYR > 1.96$ $GDP \leq 26.42$	$SYR > 1.96$ $GDP > 26.42$
	Coeff IPR	0.27 (2.90)***	0.12 (1.51)	0.18 (2.24)**	0.33 (3.72)***
Non-metallic minerals	Thres	$SYR \leq 1.56$ $GDP \leq 22.17$	$SYR \leq 1.56$ $GDP > 22.17$	$SYR > 1.56$ $GDP \leq 25.88$	$SYR > 1.56$ $GDP > 25.88$
	Coeff IPR	-0.12 (-1.15)	0.10 (1.09)	0.17 (1.85)*	0.29 (3.04)***
Other Manufacturing	Thres	$SYR \leq 1.56$ $GDP \leq 21.20$	$SYR \leq 1.56$ $GDP > 21.20$	$SYR > 1.56$ $GDP \leq 25.82$	$SYR > 1.56$ $GDP > 25.82$
	Coeff IPR	-0.59 (-1.66)*	0.12 (1.07)	0.27 (2.33)**	
Basic Metal Industries	Thres	$SYR \leq 1.56$ $GDP \leq 22.11$	$SYR \leq 1.56$ $GDP > 22.11$	$SYR > 1.56$ $GDP \leq 26.20$	$SYR > 1.56$ $GDP > 26.20$
	Coeff IPR	-0.08 (-0.64)	0.20 (1.74)*	0.24 (2.06)**	0.34 (2.91)***
Food, Beverages, Tobacco	Thres	$SYR \leq 1.95$ $GDP \leq 21.14$	$SYR \leq 1.95$ $GDP > 21.14$	$SYR > 1.95$ $GDP \leq 24.69$	$SYR > 1.95$ $GDP > 24.69$
	Coeff IPR	1.01 (2.81)***	0.27 (2.54)***	0.21 (1.84)***	0.39 (3.73)***

Paper, Paper products, Printing	Thres	$SYR \le 1.56$ $GDP \le 22.48$	$SYR \le 1.56$ $GDP > 22.48$	$SYR > 1.56$ $GDP \le 24.29$	$SYR > 1.56$ $GDP > 24.29$
	Coeff IPR	0.22 (2.09)**	0.10 (0.98)	0.22 (2.21)**	
Textiles, Apparel, Leather	Thres	$SYR \le 1.56$ $GDP \le 22.00$	$SYR \le 1.56$ $GDP > 22.00$	$SYR > 1.56$ $GDP \le 25.88$	$SYR > 1.56$ $GDP > 25.88$
	Coeff IPR	0.27 (1.89)*	0.03 (0.26)	0.22 (1.81)*	
Wood products, Furniture	Thres	$SYR \le 1.56$ $GDP \le 25.74$	$SYR \le 1.56$ $GDP > 25.74$	$SYR > 1.56$ $GDP \le 23.53$	$SYR > 1.56$ $GDP > 23.53$
	Coeff IPR	0.02 (0.12)	0.32 (2.21)**	0.21 (1.28)	0.44 (3.42)***

Notes: The results in this table are for the interactions between two threshold variables. Observations are split into a low and high imitative ability regime based on the highest SYR threshold from Table 5. Thresholds are then calculated based on the level of GDP in both the low and the high imitative ability regimes, giving a possible number of four regimes. In some cases no significant threshold on GDP is found for the high imitative ability regime, with the coefficient reported being that from assuming no threshold in the high imitative ability regime. The first row for each industry reports the estimated thresholds on both SYR and GDP, while the second reports the estimated coefficients on the IPR variable and their significance. The coefficients on the remaining variables from the gravity model (including importer, exporter and time effects) are not reported for brevity. *, ** and *** indicate significance at the 10, 5, and 1 percent level respectively. t-statistics in brackets are based on White heteroscedasticity consistent standard errors. The significance of the estimated thresholds is found using the bootstrap procedure of Hansen (1996) with 1000 replications.

Table 7: Imitative Ability and Intellectual Property Rights

		Low Imitative Ability		High Imitative Ability	
		Low IPRs	High IPRs	Low IPRs	High IPRs
		1	2	3	4
Total Manufacturing	Thres	$SYR \le 1.56$ $IPR \le 3.27$	$SYR \le 1.56$ $IPR > 3.27$	$SYR > 1.56$ $IPR \le 2.95$	$SYR > 1.56$ $IPR > 2.95$
	Coeff IPR	0.30 (3.70)***	0.09 (1.18)	0.37 (4.25)***	0.23 (3.20)***
Fabricated Metal Products	Thres	$SYR \le 1.56$ $IPR \le 3.27$	$SYR \le 1.56$ $IPR > 3.27$	$SYR > 1.56$ $IPR \le 2.95$	$SYR > 1.56$ $IPR > 2.95$
	Coeff IPR	0.28 (3.12)***	0.09 (1.08)	0.36 (3.87)***	0.25 (3.12)***
Chemical Products	Thres	$SYR \le 1.96$ $IPR \le 2.41$	$SYR \le 1.96$ $IPR > 2.41$	$SYR > 1.96$ $IPR \le 3.31$	$SYR > 1.96$ $IPR > 3.31$
	Coeff IPR	-0.29 (-2.25)**	-0.07 (-0.78)	-0.06 (-0.59)	0.08 (0.95)
Non-metallic minerals	Thres	$SYR \le 1.56$ $IPR \le 3.18$	$SYR \le 1.56$ $IPR > 3.18$	$SYR > 1.56$ $IPR \le 2.95$	$SYR > 1.56$ $IPR > 2.95$
	Coeff IPR	0.29 (2.74)***	0.07 (0.63)	0.39 (3.52)***	0.28 (2.91)***
Other Manufacturing	Thres	$SYR \le 1.56$ $IPR \le 2.67$	$SYR \le 1.56$ $IPR > 2.67$	$SYR > 1.56$ $IPR \le 2.56$	$SYR > 1.56$ $IPR > 2.56$
	Coeff IPR	-0.06 (-0.49)	0.08 (0.74)	0.18 (1.52)	
Basic Metal Industries	Thres	$SYR \le 1.56$ $IPR \le 2.41$	$SYR \le 1.56$ $IPR > 2.41$	$SYR > 1.56$ $IPR \le 3.35$	$SYR > 1.56$ $IPR > 3.35$
	Coeff IPR	-0.17 (-1.22)	0.03 (0.24)	0.05 (0.46)	0.16 (1.43)
Food, Beverages, Tobacco	Thres	$SYR \le 1.95$ $IPR \le 3.24$	$SYR \le 1.95$ $IPR > 3.24$	$SYR > 1.95$ $IPR \le 2.89$	$SYR > 1.95$ $IPR > 2.89$
	Coeff IPR	0.53 (4.66)***	0.29 (2.64)***	0.68 (5.50)***	0.45 (4.24)***

Paper, Paper products, Printing	Thres	$SYR \leq 1.56$ $IPR \leq 3.36$	$SYR \leq 1.56$ $IPR > 3.36$	$SYR > 1.56$ $IPR \leq 2.91$	$SYR > 1.56$ $IPR > 2.91$
	Coeff IPR	0.19 (1.98)**	-0.07 (-0.53)	0.26 (2.73)***	
Textiles, Apparel, Leather	Thres	$SYR \leq 1.56$ $IPR \leq 3.36$	$SYR \leq 1.56$ $IPR > 3.36$	$SYR > 1.56$ $IPR \leq 2.93$	$SYR > 1.56$ $IPR > 2.93$
	Coeff IPR	0.24 (1.90)*	-0.12 (-0.77)	0.44 (3.24)***	0.27 (2.26)**
Wood products, Furniture	Thres	$SYR \leq 1.56$ $IPR \leq 2.70$	$SYR \leq 1.56$ $IPR > 2.70$	$SYR > 1.56$ $IPR \leq 2.54$	$SYR > 1.56$ $IPR > 2.54$
	Coeff IPR	-0.43 (-2.64)***	-0.06 (-0.48)	-0.21 (-1.15)	0.09 (0.66)

Notes: The results in this table are for the interactions between two threshold variables. Observations are split into a low and high imitative ability regime based on the highest SYR threshold from Table 5. Thresholds are then calculated based on the level of IPRs in both the low and the high imitative ability regimes, giving a possible number of four regimes. In some cases no significant threshold on IPRs is found for the high imitative ability regime, with the coefficient reported being that from assuming no threshold in the high imitative ability regime. The first row for each industry reports the estimated thresholds on both SYR and IPRs, while the second reports the estimated coefficients on the IPR variable and their significance. The coefficients on the remaining variables from the gravity model (including importer, exporter and time effects) are not reported for brevity. *, ** and *** indicate significance at the 10, 5, and 1 percent level respectively. t-statistics in brackets are based on White heteroscedasticity consistent standard errors. The significance of the estimated thresholds is found using the bootstrap procedure of Hansen (1996) with 1000 replications.

References

Bai, J., 1997. Estimating multiple breaks one at a time. *Econometric Theory*, 13, 315-352.

Bai, J. and P. Perron, 1998. Estimating and testing linear models with multiple structural changes. *Econometrica*, 66, 47-78.

Barro, R. J. and J-W Lee, 2001. International data on educational attainment: Updates and implications. *Oxford Economic Papers*, 53, 541-563.

Chong, T., 1994. Consistency of change-point estimators when the number of change-points in structural change models is underspecified. *Working Paper*, Chinese University of Hong Kong.

Co, C. C., 2004. Do patent rights regimes matter? *Review of International Economics*, 12, 359-373.

Coe, D. T. and E. Helpman, 1995. International R&D spillovers. *European Economic Review*, 39, 859-887.

Coe, D. T., Helpman, E. and A. W. Hoffmaister, 1997. North-South R&D spillovers. *Economic Journal*, 107, 134-150.

Eaton, J. and S. Kortum, 1996. Trade in ideas: Patenting and productivity in the OECD. *Journal of International Economics*, 40, 79-90.

Egger, P., 2000. A note on the proper econometric specification of the gravity equation. *Economics Letters*, 66(1), 25-31.

Falvey, R. E., Foster, N. and D. Greenaway, 2006. Intellectual property rights and economic growth. *Review of Development Economics* (forthcoming).

Falvey, R. E., Foster, N. and O. Memedovic, 2006. The role of intellectual property rights in technology transfer and economic growth. UNIDO Working Paper, UNIDO, Vienna.

Ferrantino, M. J., 1993. The effect of intellectual property rights on international trade and investment. *Weltwirtschaftliches Archiv*, 129, 300-331.

Fink, C. and K. E. Maskus, 2005. Why we study intellectual property rights and what we have learned. In Fink, C. and K. E. Maskus (eds.), *Intellectual Property and Development: Lessons from Recent Economic Research*, The World Bank, Washington, DC.

Fink, C. and C. A. Primo-Braga, 2005. How stronger protection of intellectual property rights affects international trade flows. In Fink, C. and K. E. Maskus (eds.), *Intellectual Property and Development: Lessons from Recent Economic Research*, The World Bank, Washington, DC.

Frankel, J., 1997. *Regional Trading Blocs in the World Economic System*. Institute for International Economics, Washington, DC.

Ginarte, J. C. and W. G. Park, 1997. Determinants of patent rights: A cross-national study. *Research Policy*, 26, 283-301.

Gould, D. M. and W. C. Gruben, 1996. The role of intellectual property rights in economic growth. *Journal of Development Economics*, 48, 323-350.

Hansen, B. E., 1996. Inference when a nuisance parameter is not identified under the null hypothesis. *Econometrica*, 64, 413-430.

Hansen, B. E., 1999. Threshold effects in non-dynamic panels: Estimation, testing and inference. *Journal of Econometrics*, 93, 345-368.

Hansen, B. E., 2000. Sample splitting and threshold estimation. *Econometrica*, 68, 575-603.

Kanwar, S. and R. E. Evenson, 2003. Does intellectual property protection spur technological change? *Oxford Economic Papers*, 55, 235-264.

Keller, W., 2004. International technology diffusion. *Journal of Economic Literature*, 42, 752-782.

Liu, W-H. and Y-C. Lin, 2005. Foreign patent rights and high-tech exports: Evidence from Taiwan. *Applied Economics*, 37, 1543-1555.

Maskus, K. E., 1998. The role of intellectual property rights in encouraging foreign direct investment and technology transfer. *Duke Journal of Comparative and International Law*, 9, 109-161.

Maskus, K. E., 2000. *Intellectual Property Rights in the Global Economy*. Institute for International Economics, Washington, DC.

Maskus, K. E. and M. Penubarti, 1995. How trade-related are intellectual property rights? *Journal of International Economics*, 39, 227-248.

Mátyás, L., 1997. Proper econometric specification of the gravity model. *The World Economy*, 20, 363-368.

Prewo, W., 1978. Determinants of the trade pattern among OECD countries from 1958 to 1974. *Jahrbucher fuer Nationaloekonomie und Statistik*, 193, 341-358.

Primo-Braga, C. A. and A. Yeats, 1992. The simple arithmetic of existing multilateral trading arrangements and implications for a post-Uruguay round world. International Trade Division, World Bank, processed.

Rapp, R. T. and R. P. Rozek, 1990. Benefits and costs of intellectual property protection in developing countries. *Journal of World Trade*, 24, 75-102.

Rafiquzzaman, M., 2002. The impact of patent rights on international trade: Evidence from Canada. *Canadian Journal of Economics*, 35, 307-330.

Smarzynska, B., 2004. The composition of foreign direct investment and protection of intellectual property rights: Evidence from transition economies. *European Economic Review*, 48, 39-62.

Smith, P. J., 1999. Are weak patent rights a barrier to U.S. exports? *Journal of International Economics*, 48, 151-177.

Smith, P. J., 2001. How do foreign patent rights affect U.S. exports, affiliate sales, and licenses? *Journal of International Economics*, 55, 411-440.

Taylor, M. S., 1993. TRIPs, trade and technology transfer. *Canadian Journal of Economics*, 26, 625-637.

UNIDO, 2002. *Industrial Development Report 2002/2003*. United Nations Industrial Development Organization, Vienna.

World Bank, 2001. *World Development Indicators*. World Bank, Washington, DC.