Patenting Abroad: Evidence from OECD Countries[1]

Nikos C. Varsakelis[a]

and

Fragiskos Archontakis [b,c]

Keywords: International Patenting; Gravity Equation; OECD Countries
JEL classification: O340; O330

(a) Department of Economics, Aristotle University of Thessaloniki, P.O. Box 184, 54124, Thessaloniki , Greece. *Email address:* barsak@econ.auth.gr
(b) School of Economics & Business Administration, International Hellenic University. 14th km Thessaloniki – Moudania 57001 Thermi, Thessaloniki , Greece. *Email address:* f.archontakis@ihu.edu.gr
(c) Corresponding author.

[1] An earlier version of this work was presented in the STI Conference, Leiden 2010.

Patenting Abroad: Evidence from OECD Countries

Abstract

During the last decades, inventors face more often the dilemma of protecting their invention abroad due to globalization. Consequently, academic and policy makers are increasingly interested in identifying the factors on which this decision might depend. This work relies on an augmented gravity model to explain the international patenting activity of 27 OECD countries for the period 1995-2005. We find that the size of the innovative activity of the target country is the most significant factor explaining the patenting activity abroad. The source country's size of innovative activity gives mixed results. Distance is significant with the correct negative sign, as the gravity theory implies.

Keywords: International Patenting; Gravity Equation; OECD Countries

JEL classification: O340; O330

1. Introduction

The world experienced an unprecedented internationalization of the economic activity during the last three decades. International trade and foreign direct investment dominated this internationalization assisting, among others, the developing countries to achieve high growth rates. Internationalization, on the other hand, led to the re-allocation of global economic activity with OECD countries becoming gradually knowledge and technology oriented economies. In this internationalized environment, inventors from a country faced the dilemma of expanding the protection of their invention in foreign countries too. Indeed, Paci et al. (1997) note that there is a tendency for firms in developed countries to patent in foreign markets. Research has moved towards identifying the factors on which this decision might depend on.

Eaton and Kortum (1996) considered international patenting activity in a model to explain the impact of world innovation on economic growth. They found that physical distance, human capital and patent protection framework of the destination country affect the patenting abroad decision. McCalman (2001) verified these results in an effort to estimate the impact of the GATT – Uruguay round on the transfer of income and McCalman (2005) estimated the impact of the TRIPs agreement on the short and long run growth. He, additionally, found that the cost of patenting is also a significant factor. McCalman applied his analysis to the Eaton and Kortum's data set (for the year 1988). However, since 1988 major changes have eventuated in the field of patents. First, the changes in the patent framework inside the US that led to the explosion of the R&D and patenting activity in the US, during the 1990s (Jaffe, 2000). Second, the TRIPs agreement under the Uruguay round is moving countries to a more unified protection framework. Third, the significant upsurge of international trade and foreign direct investment and the return of the US in the foreign investment market after the deceleration in 1970's and 1980's.

The gravity model is one of the popular models in the empirical trade literature. It usually relates the bilateral trade between countries to the distance between countries and a gravity variable e.g. GDP (Anderson, 1979; Anderson and Van Wincoop 2003; Bergstrand, 1985; 1989; Bougheas et al., 1999; Smith, 1999; 2001). Even though the application of gravity has a long history in trade literature, its use in other international flows is limited.

Tsujimura and Mizoshita (2005) applied the gravity model to explain the intra-EU and extra-EU financial flows after the introduction of the Euro. Harhoff et al. (2007) assess to what extent validation and renewal fees as well as translation costs affect the validation behaviour of patent applicants. They rely on a gravity model that aims at explaining patent flows between inventor and target countries within the European patent system. The results show that the size of countries, their wealth and the distance between their capital cities are significant determinants of patent flows. Validation fees and renewal fees further affect the validation behaviour of applicants. Translation costs seem to have an impact as well. The important role played by fees suggests that the implementation of cost-reducing policy interventions like the London Protocol would induce a significant increase in the number of patents validated in each European country.

More recently, Picci (2010) adopted a gravity model to study the determinants of the intensity of collaboration between pairs of countries and discussed the extent and the determinants of the internationalization of European inventive activity, between 1990 and 2005, using information contained in the European Patent Office's Patstat database. The amount of collaboration between actors residing in different countries is assessed by means of a gravity model. The amount of bilateral collaboration is positively affected by the presence of a common language, a common border and by more similar cultural characteristics. International collaboration is negatively affected by distance, with estimated elasticities that are significantly smaller than the ones that characterize international trade. Finally, Archontakis and Varsakelis (2011) adopted the gravity model based on the theoretical foundation of Anderson (1979) to explain the flow of US patents to the OECD countries. The findings support the hypothesis that the mass of patenting activity in the US and the destination country are significant factors in explaining the behavior of the US patenting activity abroad.

This paper relies on the gravity model to explain the international patenting activity of 27 OECD countries and uses data for the period 1995-2005 when most of the major institutional changes regarding intellectual property rights have been implemented. From our findings it is evident that the size of the innovative activity of the target country is the most significant factor explaining the patenting activity abroad. This is a strong indication that the risk of imitation explains in high degree the decision to patent abroad (Eaton and Kortum, 1996). On the other hand, the source country innovative activity gives mixed results even though the sign and the size for the full set of countries is that proposed by the underlying theory. Distance still plays role as the gravity model suggests, even though there is growing skepticism about the significance of the physical distance in intangible flows in our days.

The rest of the paper is organized as follows. Section 2 presents the model, the data and a discussion of the results. Finally, Section 3 offers some concluding remarks.

2. Empirical Analysis

We apply an augmented gravity model in order to make an international comparison of patenting activity between OECD countries, checking at the same time for possible similarities/differences given the size of the source country.

$$P_{j,i,t} = GP_{j,t}^{a} H_{i,t}^{b} D_{j,i}^{c} \qquad (1)$$

Equation (1) explains the patenting activity of country's *j* residents in a destination country *i* at time *t*, where: $P_{j,i,t}$ are the patent flows from the OECD country *j* to country *i* at time *t* and *G* is a generic term which includes other possibly relevant variables. The gravity variables are: the total number of patents the residents of country *j* registered at time *t* (P_{jt}) and the patenting activity in the target country (H_{it}). Finally, $D_{j,i}$ is the physical distance between the source country *j* and the target country *i*. The generalization of the gravity model by introducing powers is common in the literature since objective of the empirical analysis is to investigate the application of the gravity model and moreover to check whether perfect gravity holds, that is whether $a=b=1$ and $c<0$.

Taking logarithms of equation (1) we now define:

$$y_{jit} = \log P_{j,i,t} \text{ and } \mathbf{X}_t = \left(\log P_{jt}, \log H_{it}, \log D_{ji}, BC_{it}, IPR_i\right)' \qquad (2)$$

where y_{jit} is the dependent variable and $\mathbf{X}_t$ is the vector of the explanatory variables. More specifically, $P_{j,i,t}$ is the number of patents from country *j* to country *i* (denoted as *PAT* in our dataset). The vector of explanatory variables includes: P_{jt} is the total number of patents the residents of the source country *j* registered in the country; the variable $H_{i,t}$ is the number of patents registered in target country *i* by nationals and foreigners[2] (denoted as *HOST*); D_{ji} is the physical distance between the source country *j* and the target country *i* (denoted as *DIST*); the variable BC_{it} is a proxy for the business cycle effect on the decision of the source country patentee to register a patent in target country *i* (denoted as *BUSCYC*); finally, IPR_i is an index which captures the intellectual protection rights framework of the target country.

In order to make our results more robust, we decided to empirically investigate equation (2), via two routes: the full sample for all source countries and a group-based ("large", "medium" and "small" source countries):

i. a "full set" (full sample) with all source countries; maximum 27×27×11=8019 observations with 3959 useful data points.
ii. a group-based, in terms of national innovative activity:
    a. the group of "large" countries consisting of the 6 most innovative countries, with 1230 useful data points;
    b. the group of "medium" countries consisting of 12 countries, with 1907 useful data points; and
    c. the group of "small" countries consisting of 9 least innovative countries, with 822 useful data points.

The groups were formed in the following way: as most representative index of the innovative activity of a country, we selected the sum of patents registered in the source country to its residents during the full sample period. The thresholds were defined as: "Small" <10000 ; 10000 < "Medium" < 100000; and 100000 < "Large".

The data we have in hand consists of 28 OECD countries across 11 years, 1995-2005. Thus, for each individual source country there are a maximum of 27×11=297 observations. Iceland was included only as a recipient country since no patent with origin from Iceland has been registered during the examination period.

Panel data should be used because of several benefits, i.e. help to extract more information, avoid multicollinearity problems and give more efficient results; better identify and measure effects that are not detectable in pure cross-section or pure time-series data. See Baltagi (2001), Cameron and Trivedi (1998) and Greene (2003) for more examples and technical details. Furthermore see Mátyás (1997) and Egger (2000) for the technical details on the empirical estimations of gravity models.

[2] A patentee, who wishes to protect the invention abroad, should patent in countries with high innovation activity and strong knowledge base. The number of patents in the destination country provides strong representation of innovation since the number of patent applications is proportional to the extent of innovation (Watanabe et al., 2001).

2.1 Data and definition of variables

Amongst a wide variety of new measures of national technological capabilities (see for a review Archibugi and Coco, 2005) patent counts and, more generally, patent-based indicators at country level are frequently used to assess countries' innovation performance (Griliches, 1990; OECD, 2001; Guellec and van Pottelsberghe de la Potterie, 2001; Khan and Dernis, 2006; Léger, 2007; van Pottelsberghe de la Potterie and de Rassenfosse, 2008). We used patent applications rather than patents granted because the former has a smaller time lag than the latter and standards for applications are more uniform than those for granting, see Eto and Lee (1993). It is worth noting that patents granted in different patent offices may have different relative weight. For example, the Japanese patent office requires that separate applications be made for each technical aspect of an invention (Paci et al., 1997). Consequently, van Pottelsberghe de la Potterie and de Rassenfosse (2008) suggest: «Japanese priority filings to be divided by 3, as Japanese patents are on average composed of fewer claims (about 8 in 2003, as opposed to 24 in the patents filed at the USPTO)» [3].

More specifically, for the empirical estimation of equation (1), we use the following variables and the corresponding data.

$logP_{j,i,t}$ = ln(*PAT*), the natural logarithm of the patent flows from the source country *j* to the target country *i;* we used the patents granted to residents in countries of the OECD for the period 1995-2005. Data on patents were from the World International Patents Organization database (WIPO).

$logP_{jt}$ = ln(*OUT*), the natural logarithm of the total number of patents registered in source country *j* to its residents. Data were from the WIPO database.

$logH_{it}$ = ln(HOST), natural logarithm of the patents registered in target country *i* by nationals and foreigners of the rest of the sample countries in the OECD countries. Data were from the WIPO database.

$logD_{ji}$ = ln(DIST), the natural logarithm of the weighted distance between the economic centers of the partner countries as proposed by the *Centre D'Etudes Prospectives et D'Informations Internationales* (CEPII).

BC_i : a variable to capture the business cycle impact in the target country *i*, i.e. the difference between trend (calculated using the Hodrick–Prescott filter) and current

[3] Hence, we divided the reported number of Japanese patents by three.

growth rate. When BC is negative, the target economy slows down, when it is positive the economy grows. Data are from OECD database.

IPR_i : an index which captures the intellectual protection rights framework of the target country *i*: data are from Ginarte and Park (1997). This index is time invariant.

Table 2 presents the descriptive statistics of the explanatory variables. Table 3 presents the descriptive statistics of variables *PAT* and *OUT* by group. Table 4 provides the correlation matrix. The level of correlations indicates that problems of multicollinearity are not likely to be manifest in the regression models.

2.2. Methodology and empirical results

Table 5 presents a summary of the estimation results: the full set of our sample countries, the group of large countries, the medium countries and the small ones. The econometric estimation followed was panel random effects (RE) regression. This was decided on the following grounds:

i. According to Goldhaber and Brewer (1997), see also Rauch (1993), due to the fact that the perfect collinearity of the time invariant variables in the fixed effects (FE) econometric models cause a matrix near-singularity, the inverse matrix cannot be calculated.

ii. The huge number of dummies required for the three-way panel model (see Mátyás (1997) and Egger (2000) for more details) to be estimated (host country, source country and time), as compared to our useful data points, would trigger lack of statistical power for estimating the model's parameters.

iii. As Wooldridge (2002, p. 252) notes, when treating panel data using the unobserved effects model $y_{it} = x_{it}\beta + c_i + error$, "With a large number of random draws from the cross section, it almost always makes sense to treat the unobserved effects, c_i , as random draws from the population, along with y_{it} and x_{it}", which provides another reason in favour of the RE model given the large number of countries in our sample.

The adjusted R^2 suggest a good overall performance of the econometric models. The estimated coefficient of the *lnHOST* gravity variable (equal to 0.651) for the full set of countries is positive and significant. The estimated *lnHOST* gravity coefficients for the groups follow a concrete ordered pattern, that is: Large countries exhibit larger estimated coefficients, Medium countries exhibit medium estimated coefficients and

Small countries exhibit smaller estimated coefficients; for instance, we have 0.929 for the Large group, 0.557 for the Medium and 0.362 for the Small. The positive signs indicate that independently of the country's size, the decision to patent in a foreign country increases with the volume of patenting activity in the target country. The above mentioned ordering indicates that this effect is even stronger, the larger the source country. These results verify previous findings (Eaton and Kortum, 1996; Archontakis and Varsakelis, 2011). Eaton and Kortum (1996) found that the decision to patent abroad depends in a degree on the risk of imitation. The ability to imitate and consequently, the risk, are correlated to the size of the patenting activity in the target country. We, using a different methodological approach, reached the same conclusion. The other gravity variable *lnOUT*, the patenting activity in the source country, has given mixed results: a positive and significant coefficient for the full set of countries and Small group, a non-significant coefficient for the Large group and a negative coefficient for the Medium group.

The distance variable *lnDIST* is negative and significant for the full set and the Medium group (and insignificant for the Large and Small groups) as suggested by the theory. Thus distance still matters, but it's impact is not as strong as the finding by Eaton and Kortum (1996). We attribute this fact to the grouping process, which could resulted in smoothing the effect of the distance variable.

Business cycle (BUSCYC) has similar behavior, with respect to statistical significance i.e. statistical significant for all the full set, Large and Medium group of countries (and non-significant for the Small group). The sign of BUSCYC is positive. As Geroski and Walters (1995) point out, major innovations and patents are pro-cyclical and the causal relations run from variations in demand to variations in patenting. In this paper, we are interested in explaining the cross country-cross time variation of the patenting activity from a source country to the rest countries of the OECD. Our result is similar to Geroski and Walters (1995) since the patenting activity from the source to the target seems to be pro-cyclical and indicates that this patenting activity is rather "demand pulled".

The sign of the IPR, contrary to the common belief, is negative (and significant everywhere but the Small group). Eaton and Kortum (1996) found that countries providing strong protection are more attractive destinations for foreign patents. They used a relative patent index created by Rapp and Rozek based on surveys of business and government officials and an examination of patent laws. However, Bosworth

(1984) finds that his “Patent Law” differences variable is not significant in explaining the patent applications from/into the UK. In this paper, we use an alternative patent index developed by Ginarte and Park (1997) based only on the examination of laws. The negative sign indicates that countries with stronger intellectual property rights framework are less attractive in receiving patents from the rest OECD countries, *ceteris paribus.* This finding may be attributed to two reasons: First, the stronger the IPR framework the higher the cost of patenting and because patenting is costly inventors usually decide to protect their inventions in only a small fraction of countries. Second, Ginarte and Park (1997) and Bosworth (1984) distinguish between *statutory versus actual protection* (or *formal versus informal*), which is whether “laws on the books” are carried out. Especially they note that “if there is any overestimation of patent rights and protection, it should be the OECD’s measures”. Consequently, although our result is rather counter-intuitive, there might be the case for further investigation and construction of better IPR indices.

3. Concluding remarks

Conventional wisdom suggests that inventors-patentees tend to protect themselves against imitation, in the countries where such a risk is high. Imitation risk is higher, the higher the innovative activity of the country. Furthermore, there is the perception that the cost of patenting in another country is lower, the smaller the geographical distance between the host and the origin country. Previous empirical research has used gravity models to investigate the internationalization of innovation and patenting activity.

The present paper has built upon this research and put these issues under further scrutiny. Using data from 27 OECD countries, for the period 1995-2005, to explain the variation of patent flows from the source country j to the target country i (the dependent variable) within the framework of a gravity model.

A major finding of this paper is that the gravity variable (measured as the patents registered in the target country by nationals and foreigners of the rest of the sample countries) is positively correlated to the dependent variable. Hence, it seems that inventors-patentees recognize that the imitation risk increases with innovative activity of the target country and therefore decide to protect their inventions by applying for a patent in the target country. However, the other gravity variable used in the paper (measured as the patents registered in the source country) is giving mixed results: for example, while in the full-set is positively correlated, as suggested by theory, results within groups were not as consistent with the theory. Overall, target country seems to be more important in the patentees' decision to patent abroad.

The third gravity variable, i.e. the physical distance, has the correct negative sign when statistically significant: for the full set of countries and the medium group. This weak statistical significance of the physical distance differentiates our results from the previous findings in the literature (Eaton and Kortum, 1996; McCallman, 2001). Business cycle impact is statistically significant and positive verifying the argument of Geroski and Walters (1995) for the pro-cyclical behavior of the patenting activity. Finally, the counter intuitive sign of the IPR regime in the target country demands further investigation.

References

Anderson, J. E. (1979). A Theoretical Foundation for the Gravity Equation. The *American Economic Review* 69(1): 106-116.

Anderson, J. E. and E. Van Wincoop (2003). "Gravity with Gravitas: A Solution to the Border Puzzle", *American Economic Review* 93(1): 170-192.

Archibugi, D. and A. Coco (2005). "Measuring technological capabilities at the country level: A survey and a menu for choice", *Research Policy* 34(2): 175-194.

Archontakis, F. and N. Varsakelis (2011). "U.S. Patents Abroad: Does Gravity Matter?", *Journal of Technology Transfer* 36(4): 404-416.

Baltagi, B. H. (2001). *Econometric Analysis of Panel Data* (2nd edition). Chichester, UK: John Wiley and Sons.

Bergstrand, J.H. (1985). "The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence", *The Review of Economics and Statistics* 67(3): 474-481.

Bergstrand, J. H. (1989). "The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade", *The Review of Economics and Statistics* 71(1): 143-153.

Boswarth, D. L. (1984). "Foreign patent flows to and from the United Kingdom", *Research Policy* 13(2): 115-124.

Bougheas, S., Demetriades, P. O., Morgenroth, E.L.W. (1999). Infrastructure, Transport Costs and Trade. *Journal of International Economics* 47: 169–189.

Cameron, C. A., & Trivedi, P. (1998). *Regression Analysis of Count Data*. New York: Cambridge University Press.

Eaton, J., & Kortum, S. (1996). "Trade in Ideas: Patenting and Productivity in the OECD", *Journal of International Economics* 40: 251-278.

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

Eto, H. and Lee, H. L. (1993). "Foreign patenting and trade with regard to competitiveness", *Technovation* 13(4): 221-233.

Geroski, P.A., & Walters, C.F. (1995). "Innovative Activity over the Business Cycle", *The Economic Journal* 105: 916-928.

Ginarte, J.C. & Park, W.G. (1997). Determinants of patents rights: a cross- national study, *Research Policy* 26: 283-301.

Goldhaber and Brewer (1997). “Why don’t Schools and Teachers seem to matter? Assessing the Impact of Unobservables on Educational Productivity”, *Journal of Human Resources* 32: 505-523.

Greene, W. (2003). *Econometric Analysis*. 5th edition. NJ: Prentice Hall.

Griliches, Z. (1990). Patent Statistics as Economic Indicators: A Survey. *Journal of Economic Literature* 28: 1661-1707.

Guellec, D. and B. van Pottelsberghe de la Potterie (2001). “The internationalisation of technology analysed with patent data”, *Research Policy* 30: 1253–1266.

Harhoff, Dietmar, Hoisl, Karin, Reichl, Bettina and Van Pottelsberghe de la Potterie, Bruno (2007). “Patent Validation at the Country Level - The Role of Fees and Translation Costs”. CEPR Discussion Paper No. DP6565. Available at SSRN: http://ssrn.com/abstract=1140092

Jaffe, A. (2000) “The U.S. Patent System in Transition: Policy Innovation and the Innovation Process”, *Research Policy* 29: 531-557.

Khan, M. and H. Dernis (2006), “Global Overview of Innovative Activities from the Patent Indicators Perspective”, OECD Science, Technology and Industry Working Papers, 2006/3, OECD Publishing.

Léger, A. (2007). “Intellectual Property Rights and Innovation around the World: Evidence from Panel Data”, Disc. Paper 696, DIW Berlin.

Mátyás, L. (1997). Proper Econometric Specification of the Gravity Model. *The World Economy*, 20(3): 363–368.

McCalman, P. (2001). “Reaping what you saw: An empirical analysis of patent harmonization”, *Journal of International Economics*, 55: 161–186.

McCalman, P. (2005). “Who enjoys TRIPs abroad? An empirical analysis of intellectual property rights in the Uruguay round”, *Canadian Journal of Economics* 38: 574–603.

OECD (2001).“Using patent counts for cross-country comparisons of technology output”, paper drafted by H. Dernis, D. Guellec and B. van Pottelsberghe de la Potterie. The paper is an extract from *STI Review* 27. Online at http://www.oecd.org/dataoecd/26/11/21682515.pdf

Paci, R., Sassu, A., Usai, S. (1997). “International patenting and national technological specialization”, *Technovation*, 17(1): 25-38.

Picci, L. (2010). “The Internationalization of Inventive Activity: A Gravity Model Using Patent Data”. *Research Policy* 39(8): 1070-1081.

Rauch, J.E. (1993). “Productivity Gains from Geographic Concentration of Human Capital: Evidence from the Cities”, *Journal of Urban Economics* 34, 380-400.

Smith, P. J. (1999). “Are Weak Patent Rights a Barrier to US Exports?”, *Journal of International Economics* 48: 151–177.

Smith, P. J. (2001). “How do Foreign Patent Rights affect US Exports, Affiliate Sales, and Licenses?”, *Journal of International Economics* 55: 411–439.

Tsujimura, K., and Mizoshita, M. (2005). KEO Discussion Paper, Keio Economic Observatory, Keio University, Tokyo. Online (as of 24 Nov. 2008) at: http://www.sanken.keio.ac.jp/publication/KEO-dp/94/fulltext.pdf

van Pottelsberghe de la Potterie, B. and G. de Rassenfosse (2008). “Policymakers and the R&D-patent relationship”, *Intereconomics* 43(6): 377-380.

Watanabe, C., Tsuji Y.S. and Griffy-Brown, C. (2001). “Patent statistics: deciphering a ‘real’ versus a ‘pseudo’ proxy of innovation”, *Technovation* 21: 783-790.

Wooldridge (2002). *Econometric Analysis of Cross-Section and Panel Data*. MIT Press.

APPENDIX

Table 1: Three alternative routes of looking at data

	Source Countries	Observations
Large (6 countries)	FRA, GER, JPN, KOR, UK, US	6×27×11=1782
Medium (12 countries)	AUS, AUT, BEL, CAN, DEN, FIN, ITA, NL, NZ, NOR, SWE, SWI	12×27×11=3564
Small (9 countries)	CZE, GRE, HUN, IRE, MEX, POL, POR, SP, TUR	9×27×11=2673
Full Set (27 countries)	All source countries	27×27×11=8019

Note: AUS = Australia and AUT = Austria.

Table 2: Descriptive Statistics of Explanatory Variables

Explanatory Variables	*Obs.*	*Mean*	*Std.Dev.*	*Min.*	*Max.*
ln (HOST)	7602	8.889	1.958	3.401	12.881
ln(OUT)	8019	11.525	0.679	-1.521	11.739
BUSCYC	8019	0.144	1.727	-12.176	4.366
ln(DIST)	8019	8.232	1.193	4.951	9.88
IPR	6589	3.486	0.776	1.63	7.3

Table 3: Descriptive Statistics of Variables OUT and PAT by Group

	OUT			PAT		
	Mean	Std. Dev.	Max	Mean	Std.Dev.	Max
Large	72640.73	53928.66	202776	794.35	3374.25	31946
Medium	2843.83	1910.90	8630	59.62	226.01	3434
Small	537.15	254.73	1096	14.47	49.82	541

Table 4: Correlation Matrix of Explanatory Variables

	ln (HOST)	*ln(OUT)*	*BUSCYC*	*ln(DIST)*	*IPR*
ln (HOST)	1.000				
ln(OUT)	-0.007	1.000			
BUSCYC	-0.038	0.026	1.000		
ln(DIST)	0.245	-0.045	-0.039	1.000	
IPR	0.509	-0.216	-0.001	-0.134	1.000

Table 5: Full Set and Group Panel Estimations

Explanatory Variables	**Full Set (RE)**	**Large Countries (RE)**	**Medium Countries (RE)**	**Small Countries (RE)**
ln (HOST)	0.651*** (25.541)	0.929*** (23.971)	0.557*** (14.655)	0.362*** (7.483)
ln(OUT)	0.631*** (21.199)	0.069 (0.798)	-0.962*** (2.612)	0.608*** (5.389)
BUSCYC	0.026*** (3.693)	0.0368*** (3.181)	0.027** (2.515)	0.0001 (0.006)
ln(DIST)	-0.246*** (4.930)	0.034 (0.394)	-0.189*** (2.699)	-0.114 (1.348)
IPR	-0.395*** (4.865)	-0.365*** (2.907)	-0.334*** (2.906)	-0.107 (0.767)
Intercept	-4.991*** (9.359)	-3.208*** (3.129)	2.308** (2.239)	-4.622*** (3.935)
R^2 - adj	0.53	0.64	0.31	0.21
Nr. Obs.	3959	1230	1907	822