# US Firm Exports and Intellectual Property Rights

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October 28, 2013[1]

*Preliminary, Please Do Not Cite*

**Abstract**

How do intellectual property rights (IPR) policies affect international trade? In this paper we consider two of the central results from the model of Lin (2013) (i) that IPR reforms should expand the range of goods exported to a country through the extensive margin of trade and (ii) firms with more newly developed products should be more sensitive to IPR policies than other innovative firms. Building the first comprehensive matched firm-level data set on destination-specific exports and patents, we begin by documenting a number of facts on the relationship between trade and innovation. Notably, while only 9% of manufacturing firms have a patent, they account for 89% of all manufacturing exports. In preliminary findings, we then document a statistically significant relationship between whether or not a firm has a patent and its sensitivity to IPR policies in terms of its exports. Firms with more newly developed patents show a larger sensitivity than other firms. Future directions for the analysis are then discussed.

JEL Classification Numbers: F13, F14, M21, O31, O3
Keywords: trade, innovation, intellectual property rights, patents.

[1]The authors' e-mail addresses are jenxlin@umich.edu and wlincoln@jhu.edu. We thank Alan Deardorff, Andrei Levchenko, Jim Levinsohn, Andrew McCallum, Jagadeesh Sivadasan, and seminar participants for helpful comments and suggestions. We especially thank Bill Kerr for useful discussions as well as for sharing the Census patent bridge with us. All errors are our own.

# 1 Introduction

In recent years intellectual property rights (IPRs) have become a highly contentious policy issue, particularly with respect to international trade agreements. At the same time, increasing evidence has shown that technology diffusion is a primary determinant of income differences across countries and that international trade can play a role in this diffusion. In this paper we investigate for the first time how IPR policies affect international trade flows through the extensive margin. We consider two of the central predictions of the model of Lin (2013) (i) that a strengthening of IPR policies should expand the range of goods exported to a country and (ii) in a dynamic environment, firms with more recently developed products should be more sensitive to IPR policies than other firms due to a higher present value of profits that remain to be realized. Focusing on the manufacturing sector where such issues are the most important, we begin by documenting a number of new stylized facts that explain why IPRs have become such a contentious issue in international trade negotiations; international trade is disproportionately important to innovative firms and these companies account for the overwhelming majority of aggregate exports. We then consider a specification that analyzes the determinants of where firms export to. The results are strongly consistent with the two predictions of the model, suggesting that IPR policies are closely related to the exporting decisions of firms. We think that our findings should inform policy debates concerning IPRs and should likely only grow in importance as new technologies become increasingly central to economies worldwide.

Until recently, the literature on intellectual property rights and trade has been mostly theoretical in nature. The empirical literature to date has delivered mixed results on how a strengthening of IPRs affects exports. Ferrantino (1993) finds no significant impact, Smith (1999) finds a negative impact, and Maskus and Penubarti (1995) and Ivus (2010) have found positive impacts. The problem facing firms, however, should be different for the extensive margin relative to the intensive margin. In policy debates many of the arguments advanced for why IPR policies should affect international trade are often with respect to the extensive margin of trade of whether or not firms export to a particular country, rather than just the aggregate volume of trade. In this paper our intention is to explore exactly this extensive margin relationship.

As our paper is the first to match comprehensive information on patenting behavior with exporting and production activities at the firm level, we are able to provide the most detailed description of the nexus between innovation and trade to date. Due to data constraints as well as the fact that manufacturing industries account for the vast majority of patents, we focus on this sector for the analysis. We find a powerful relationship between the two activities, with exporters far more likely than other firms to patent as well as to hold a larger number of patents conditional on holding one. Patenting firms are also far more likely to export. Indeed, 82% of firms with patents export to at least one country. Patenting firms also account for 89% of total exports, even though

they only account for 9% of all firms.

We next consider cross sectional evidence on the relationship between trade and intellectual property rights policies. Using a measure of IPR protection across countries, we find that firms with patents are more sensitive to these policies than other firms. We further find that firms with more recently developed patents are more sensitive than firms with older patented technologies. These two findings are strongly consistent with the theory of Lin (2013) and suggest that the mechanisms explored in this model can help explain the trade flows that we observe across countries. These results are robust across a number of different estimation approaches and econometric methods.

Our results speak to a number of issues in policy debates. They are consistent with the claims of developed country trade representatives that a strengthening of IPRs should provide additional incentives for exports from their countries. Given the importance of patenting firms to aggregate trade, they also help explain why this has been a top priority for US trade negotiators. The findings further have significant implications for welfare in developing countries. IPR reforms should expand the range of goods exported to the country, which should in and of itself improve the welfare of consumers through love of variety effects. Fully understanding the trade-off described in the model between these love of variety effects and lower prices due to piracy, however, is beyond the scope of the analysis here. As the rate of patenting and technological progress increases, we expect these issues to become even more important in the future.

Stepping outside of the context of the model, access to an expanded range of intermediate inputs may also benefit firms in countries that pursue reforms (e.g., Rivera-Batiz and Romer, 1991). This may further increase the range of varieties and types of products ultimately available to consumers, generating dynamic welfare gains. A substantial amount of US exports are in intermediate inputs and recent studies have highlighted the importance of access to imported intermediates for firm productivity and innovation (e.g., Goldberg, Khandelwal, Pavcnik, and Topalova, 2010). Thus, while the debate about whether stronger IPR policies encourage or hinder innovation is ongoing (e.g., Williams, 2013), our work highlights an indirect channel through which stronger IPR policies can help spur innovation. This is particularly true with respect to the developing country context. Our results should therefore inform not only discussions in trade negotiations but also policy debates within developing countries themselves.

Finally, our results contribute to an understanding the determinants of cross-country differences in the standard of living. Studies on the experiences of recent years as well as the work of economic historians has highlighted the important role of technology diffusion in determining economic development. International trade has long been thought of as a conduit for such diffusion. Our work suggests a subtle relationship between these two activities. Firms are very much aware of the risks involved in exporting to low IPR countries, highlighting that while these policies may determine how likely a technology is to be imitated in the country given that it is sold there, they also determine the range of products actually sold there in the first place. This fact is likely to have dampened the

effects of trade as a conduit for technology diffusion across countries.

In the next section we describe our data and a number of descriptive analyses on the relationship between trade and innovation. We then discuss the details of our specification and cross sectional estimations in Section 3. We conclude in the last section, discussing future directions for our work that build upon the analyses presented here.

## 2 Data and Descriptive Statistics

Our data come from a number of sources and we begin by describing each of the data sets that we will draw upon. We then undertake a number of descriptive analyses to provide more context for our estimations. The information on firms' exports comes from the Census Bureau's Linked/Longitudinal Firm Trade Transaction Database (LFTTD) that was originally constructed from US Customs Data. It links export shipments reported by US Customs to individual firms and we can follow these transactions from 1992 to 2008. Data are collected for every export transaction with a value greater than $2,500 and we recode the shipment values below $2500 as zero for the sake of consistency. For each shipment, we have information on the destination country as well as whether or not it was between related parties. Related party transactions refer to intra-firm trade between business units in the US and abroad. In order to get basic information on firm characteristics, we merge the LFTTD with the Longitudinal Business Database (LBD), which tracks employment, payroll, and industry measures for every legally operating business establishment in the Unites States. These establishments can then be aggregated to the level of the firm using identifiers developed by the Census. Jarmin and Miranda (2002) provide an extremely thorough description of the construction of the LBD as well as a number of associated descriptive analyses.

In order to obtain more detailed information on firm characteristics, we combine this merged data set with the Census of Manufacturers (CMF). This survey of all manufacturing establishments in the United States is done every five years ending in 2 or 7 (e.g. 1997). We only keep firms with positive employment that appear in both the LBD and CMF, drop those for whom we have not been able to assign an SIC code using the LBD data, and then drop those firms who are not determined to be primarily manufacturing firms from the LBD based on employment counts across sectors. While this has the disadvantage of restricting our analysis to manufacturing firms, it allows us to account for a far greater level of heterogeneity. Balasubramanian and Sivadasan (2011) document that manufacturing firms account for approximately 70% of all patents. Manufacturing exports also account for a substantial portion of US exports, suggesting that these industries are of primary importance for understanding the effects of intellectual property rights on trade.

Our information on patents come from the US Patent and Trademark Office (USPTO) and cover the universe of granted patents in the US. Hall, Jaffe, and Trajtenberg (2001) describe these records in depth and Griliches (1990) discusses the use of patents as indicators of innovation. We have updated these records to cover the period from January 1975 to May 2009, containing over 4 million granted patents. These data were then merged on to the Longitudinal Business Database using a bridge originally developed by Kerr and Fu (2008), Balasubramanian and Sivadasan (2011), and Acemoglu, Akcigit, Bloom, and Kerr (2013). This bridge was developed by using a matching algorithm between firm names and addresses contained in both the Census data and patent records. Extensive work is done to ensure that corporate subsidiaries are correctly linked to their parent firm, although this is one of the primary limitations of the matching algorithms. We further hand matched a number of the patents for the largest exporting and R&D firms using the LFTTD and the Census' Survey of Industrial Research and Development. We only keep patents with an associated assignee and only keep private sector patents for the analysis. Following standard practice in the literature, we consider the date of a patent to be its application year. Based on patent law, a firm's total patent stock is measured by aggregating all of the granted patents that it applied for in the last 20 years.

Our sample of countries is determined by our ability to obtain information on them from outside sources. In order to control for a number of foreign country characteristics, we further used information from several additional sources. First, measures of GDP and population were sourced from the World Bank and were complemented with using information from the CIA World Factbook for a few missing observations. From Centre d'Etudes Prospectives et d'Informations Internationales (CEPII), we obtained measures of (i) whether or not the country shares a border with the US (ii) an indicator for whether the country shares a common language with the US, which equals 1 if a language is spoken by at least 9% of the population in both countries (iii) number of hours in time difference between the US and the country (iv) whether the country shares a colonial relationship with the US (i.e. Britain) and (v) the area of the country in square kilometers. These measures have become standard covariates in the literature on understanding the determinants of trade flows.

Measures of distance from the US are also sourced from CEPII. They are calculated following the great circle formula, which uses the latitudes and longitudes of the most important city in each country in terms of population for the distance from the US. From the data set developed by Helpman, Melitz, and Rubinstein (2008) we use data on the similarity of the religious makeup of the country with the US, whether the country is an island, and whether it is landlocked. The common religion variable is constructed as in the original study: (% Protestants in the US $\cdot$ % Protestants in country j)+(% Catholics in the US $\cdot$% Catholics in country j) + (% Muslims in the US $\cdot$ % Muslims in country j). This measure has been shown to be an important determinant of trade flows, in particular with respect to the extensive margin of trade.

To measure the strength of intellectual property rights protection across

countries, we use an index (hereafter the "GP index") originally developed by Ginarte and Park (1997) and updated by Park (2008). This index was constructed for every five years going back to 1960 and is based on five categories of patent protection (i) the extent of coverage of patent laws, (ii) membership in international patent agreements, (iii) provisions for loss of protection, (iv) enforcement mechanisms, and (v) duration of protection. Each country receives a score between zero and one for each category, with an aggregate possible total score of 5. In Table 3 we list the countries in our sample ranked in terms of their GP index. The ordering makes sense intuitively, with Japan and the countries of Western Europe at the top of the list and countries like Ethiopia and Mozambique towards the bottom.

In Figure 1 we graph a number of tabulations with respect to the frequencies of innovative and exporting activities. While 23% of firms without patents export, 82% of those with patents export, indicating that the vast majority of innovative firms are connected to the global economy. This result mirrors that of Aw, Roberts, and Xu (2011) for the Taiwanese electronics industry. It also suggests that international trade is a central issue for innovative firms, particularly from a policy perspective. In a similar vein, while 16% of firms without patents have related party exports, 45% of firms with patents have them. These firms are thus much more likely to be engaged in vertical foreign direct investment. Finally, looking at this relationship from the perspective of trade, 25% of exporters have a patent while only 2.2% of non-exporters have a patent.

To provide a benchmark for our estimations in Section 3, we find that the unconditional probability of exporting to any one of the 112 countries in our sample is 1.3%. In terms of the average number of countries sold to for exporters, we find a significant difference between firms with patents and those without them. Those without patents export to three countries on average while those with them tend to export to eleven. There is significantly more dispersion, however, in the number of countries exported to for firms with patents. Looking at the relationship between trade and innovation from the other side, amongst firms that have at least on patent, exporting firms have 36 patents on average. Non-exporting firms only have 2.4 on average. Similar to the other calculations above, there is significantly more variation for exporting firms.

Looking at firms with related party exports, firms with patents only ship 21% of their exports to related parties whereas firms without patents ship 27% of the exports to related parties. This provides an interesting juxtaposition with the results shown in Figure 1. While firms with patents are far more likely to engage in related-party exports, they tend to ship a smaller percentage of them to related parties if they do. While a number of explanations are possible here, this fact is consistent with firms that have sensitive intellectual property engaging in vertical foreign direct investment for the purposes of transferring sensitive inputs internationally. More generally, the descriptive results in Figure 1 and Table 1 suggest a powerful relationship between trade and innovative activities.

# 3 Cross Sectional Evidence

In order to get a sense of whether there is a relationship between a firm's holdings of intellectual property and the sensitivity of their export behavior to IPR policies in foreign countries, we consider the linear probability model

$$Export_{ic} = \mu_i + \mu_c + \beta \times Pat_i \times GP_c + \gamma X_{ic} + \varepsilon_{ic} \tag{1}$$

Here $Export_{ic}$ is an indicator for whether firm $i$ exported to country $c$. Fixed effects $\mu_i$ account for a variety of firm characteristics, such as productivity, size, and total number of patents. The fixed effects $\mu_c$ control for country characteristics such as distance to the US, GDP per capita, and whether they share a common language with the US. In order to construct measures of firm heterogeneity, we focus on 1997 for estimation since we can then draw upon the 1997 Census of Manufacturers. This data set contains information on a large number of firm characteristics that is not available from other sources. $X_{ic}$ contains a number of controls that we will discuss briefly. Our main object of interest here is the coefficient $\beta$ on the interaction term between the indicator for whether firm i holds a patent $Pat_i$ and $GP_c$, the GP index for country c normalized to lie between zero and one. If $\beta$ is estimated to be different than zero, this would suggest that there is a relationship between a firm's dependence on the patent system and its decisions of where to export, in terms of the IPR policies of the countries under consideration.

In column (1) of Table 2 we consider a specification with our basic set of controls. All estimations cluster standard errors at the level of the firm. In addition to our main interaction term we include interactions between (i) whether or not a firm had a patent and the GDP per capita of the country (ii) the log employment of the firm and the GP index of the country and (iii) the productivity of the firm and the GP index of the country, where productivity is measured with the Solow residual. The estimate $\hat{\beta}$ suggests that an improvement of the GP index from the lowest to the highest possible value is associated with a 5% increase in the probability that a firm with a patent exports to it relative to a firm without patents, ceteris paribus. Thus if a country improved its level of IPR protection from that in Angola to that of the United Kingdom, for example, this would be associated with a 3.8% increase in the probability. This relationship is very precisely estimated, with a $t$ statistic of 37. In column (2) we consider how this relationship varies across different levels of IPR protection, accounting for the fact that the relationship may be non-linear. We define high IPR protection countries as those with GP scores between 4 and 5 and those with medium IPR protections as those between 3 and 4. We then consider a specification in which we include interactions between these indicators and our patent indicator. Effects are measured relative to countries with scores below 3. We find statistically significant results for each of the categories, with the economically intuitive magnitude differences across the two different interaction terms.

In column (3) we consider including a whole bevy of additional controls into our baseline specification in column (1). In particular, we interact our patent indicator $Pat_i$ with a number of different country characteristics, including (i) distance from the US, measured in kilometers (ii) whether or not the country shares a border with the US (iii) whether or not the country shares a common language with the US, defined as described above (iv) the geographic area of the country in square kilometers (v) number of hours in time difference between the US and the country (vi) whether the country shares a colonial relationship with the US (i.e. Britain). When adding the controls, the coefficient estimate $\hat{\beta}$ declines modestly but remains economically and statically significant. The estimations in columns (1)-(3) are all consistent with the central prediction of the model of Lin (2013), that IPR policies should be related to the range of products exported to a country through the extensive margin of trade.

In the final two columns, we consider one of the other main predictions of the model, from a dynamic perspective, that firms with more newly developed patents should be more sensitive to IPR policies than other firms due to a greater discounted value of expected future profit. To do so, we consider two specifications similar to those found in columns (1) and (3). We additionally include a triple interaction term with (i) whether or not a firm has a patent (ii) the GP index for the country and (iii) the average age of a firm's patents. Consistent with the predictions of the model, the results suggest that firms with less recently developed products tend to be less sensitive to IPR policies with respect to their exports. As the average age of a firm's patents is 7 years, however, these results suggest that the age of a firms patents is not the only factor affecting this relationship.

We have done a number of robustness checks on these results. Getting to the role of market size in the model, the regression results are robust to including a measure of total GDP instead of GDP per capita. Another issue is that considering the binary indicator $Pat_i$ for whether the firm has a patent or not may be too strong of a categorization. Using a measure of the total number of the firm's patents in the interaction terms also yields similar conclusions. Finally, while the results presented here use a linear probability model, we further come to similar conclusions using the conditional fixed effects logit model of Chamberlain (1980).

# 4 Conclusions and Future Directions

In this paper we have tried to better understand the relationship between trade and innovation. We began by documenting a number of new stylized facts that suggest the importance of this relationship. Drawing upon the work of Lin (2013), we then considered two predictions of the model (i) that IPR policies should affect the extensive margin of trade and (ii) firms with more recently

developed patents should be more sensitive to IPR policies than other firms. We find evidence consistent with both of these claims that is robust to a number of different estimation approaches.

While not yet disclosed, we have been working on a number of additional findings. In order to get a sense of how patenting relates to exports, in preliminary findings we are finding significant increases in exports following the years after a firm's first patent. This suggests a close link between patents, innovation, and trade. There are a number of explanations for such a finding and we are currently working on understanding these better. Due to issues surrounding the Census disclosure process, particularly with respect to multiple disclosures on similar samples, we have chosen not to disclose these preliminary findings until the analysis is fully complete.

While our analysis here has looked at the cross sectional relationship between a firm's holdings of patents and its sensitivity to intellectual property rights policies in terms of their exports, we have also begun to undertake an analysis of firms' responses to several IPR policy reforms in foreign countries over time. Longitudinal evidence on the effects of IPR reforms is still quite thin (see, for example, the discussion in Ivus, 2010). We have identified six large IPR reforms that occurred during the time span of our data from 1992 to 2008 in (i) Argentina (ii) Brazil (iii) Colombia (iv) Philippines (v) Turkey and (vi) Venezuela. These reforms have been discussed at length in Branstetter et al (2006) and were identified using changes in the GP index as well as by drawing upon the work of Maskus (2000) and Qian (2004). In preliminary results, using a differences-in-differences specification we are finding significant increases in exporting from patenting firms relative to other firms in response to these reforms, supporting the findings of a cross sectional relationship documented here. These predictions and others of the model will be explored at length in future work.

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**Table 1: Descriptive Statistics for Firm Panel**

| | Mean | Standard Deviation |
|---|---|---|
| Probability that a firm exports to a given country | 0.013 | 0.114 |
| Total exports accounted for by firms with patents (%) | 89% | |
| Related party exports accounted for by firms with patents (%) | 95% | |
| Amongst patenting firms, average number of patents | 30.15 | 368.17 |
| Amongst firms that export | 36.18 | 406.00 |
| Amongst firms that do not export | 2.42 | 6.30 |
| Amongst exporters, average number of countries exported to | 5.09 | 8.44 |
| Amongst Patent Firms | 10.94 | 13.12 |
| Amongst non-Patent Firms | 3.12 | 4.67 |
| exports that are related party | 24.35 | 29.73 |
| Amongst firms with patents | 21.01 | 25.82 |
| Amongst firms without patents | 27.32 | 32.53 |
| Number of Firms | | |

Notes: Table describes a number of tabulations on exporting and innovative activities for manufacturing firms in the US. These are based on the 158,234 firms in the sample described in Section 2 of the paper.

**Table 2: Determinants of Exporting**

| | Dependent Variable is a (0,1) Indicator Variable for Whether the Firm Exports To a Country | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| (0,1) Patent * GP index | 0.0514 | | 0.0363 | 0.0662 | 0.0510 |
| | (0.0015) | | (0.0014) | (0.0037) | (0.0036) |
| (0,1) Patent * GP index * Average Patent Age | | | | -0.0022 | -0.0022 |
| | | | | (0.0005) | (0.0005) |
| (0,1) Patent * (0,1) Medium GP index | | 0.0262 | | | |
| | | (0.0007) | | | |
| (0,1) Patent * (0,1) High GP index | | 0.0706 | | | |
| | | (0.0012) | | | |
| Log(employment) * GP index | 0.0365 | 0.0071 | 0.0365 | 0.0366 | 0.0366 |
| | (0.0004) | (0.0001) | (0.0004) | (0.0004) | (0.0004) |
| Productivity * GP Index | 0.0160 | 0.0031 | 0.0160 | 0.0159 | 0.0159 |
| | (0.0005) | (0.0001) | (0.0005) | (0.0005) | (0.0005) |
| (0,1) Patent * Log(GDP per capita) | 0.0281 | 0.0220 | 0.0304 | 0.0281 | 0.0304 |
| | (0.0004) | (0.0003) | (0.0004) | (0.0004) | (0.0004) |
| (0,1) Patent * Log(Distance) | | | 0.0371 | | 0.0371 |
| | | | (0.0011) | | (0.0011) |
| (0,1) Patent * (0,1) Shares Border | | | 0.2365 | | 0.2365 |
| | | | (0.0028) | | (0.0028) |
| (0,1) Patent * (0,1) Common Language | | | 0.0108 | | 0.0108 |
| | | | (0.0004) | | (0.0004) |
| (0,1) Patent * Area | | | 0.0000 | | 0.0000 |
| | | | (0.0000) | | (0.0000) |
| (0,1) Patent * Time Difference | | | -0.0056 | | -0.0056 |
| | | | (0.0002) | | (0.0002) |
| (0,1) Patent * (0,1) Colonial Relationship | | | 0.0997 | | 0.0997 |
| | | | (0.0016) | | (0.0016) |
| (0,1) Patent * Common Religion | | | -0.0779 | | -0.0779 |
| | | | (0.0014) | | (0.0014) |
| (0,1) Patent * (0,1) Island | | | -0.0176 | | -0.0176 |
| | | | (0.0007) | | (0.0007) |
| (0,1) Patent * (0,1) Landlocked | | | -0.0102 | | -0.0102 |
| | | | (0.0004) | | (0.0004) |
| Firm Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Country Fixed Effects | Yes | Yes | Yes | Yes | Yes |

Notes: Estimations consider the determinants of exporting to a particular country. All specifications include country and firm fixed effects and cluster standard errors at the level of the firm. There are 158,234 firms in the sample and we consider the determinants of their export behavior to a set of 112 countries, for a total number of observations of 17,722,208. These countries are listed in Table3.

**Table 3: Intellectual Property Rights Indices of Countries in Our Sample**

| Rank | Country | GP | Rank | Country | GP | Rank | Country | GP | Rank | Country | GP |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Belgium | 4.54 | 31 | Taiwan | 3.17 | 61 | Tanzania | 2.32 | 91 | Chad | 1.78 |
| 2 | Denmark | 4.54 | 32 | Israel | 3.14 | 62 | Zimbabwe | 2.28 | 92 | Niger | 1.78 |
| 3 | France | 4.54 | 33 | Mexico | 3.14 | 63 | Fiji | 2.20 | 93 | Egypt | 1.73 |
| 4 | Netherlands | 4.54 | 34 | Sri Lanka | 2.98 | 64 | China | 2.12 | 94 | Tunisia | 1.65 |
| 5 | United Kingdom | 4.54 | 35 | Czech Republic | 2.96 | 65 | Iraq | 2.12 | 95 | Zambia | 1.62 |
| 6 | Finland | 4.42 | 36 | Slovak Republic | 2.96 | 66 | Liberia | 2.11 | 96 | Malta | 1.60 |
| 7 | Japan | 4.42 | 37 | Hong Kong | 2.90 | 67 | Cameroon | 2.10 | 97 | Costa Rica | 1.56 |
| 8 | Sweden | 4.42 | 38 | Vietnam | 2.90 | 68 | Gabon | 2.10 | 98 | Indonesia | 1.56 |
| 9 | Canada | 4.34 | 39 | Jamaica | 2.86 | 69 | Uruguay | 2.07 | 99 | Paraguay | 1.53 |
| 10 | Italy | 4.33 | 40 | Nigeria | 2.86 | 70 | Ecuador | 2.04 | 100 | Brazil | 1.48 |
| 11 | Austria | 4.21 | 41 | Uganda | 2.85 | 71 | Malawi | 2.03 | 101 | Panama | 1.46 |
| 12 | Spain | 4.21 | 42 | Ghana | 2.83 | 72 | Somalia | 2.00 | 102 | Pakistan | 1.38 |
| 13 | Switzerland | 4.21 | 43 | Venezuela | 2.82 | 73 | Burkina Faso | 1.98 | 103 | India | 1.23 |
| 14 | Australia | 4.17 | 44 | Cyprus | 2.78 | 74 | C. African Republic | 1.98 | 104 | Guyana | 1.13 |
| 15 | Germany | 4.17 | 45 | Algeria | 2.74 | 75 | Mali | 1.98 | 105 | Nicaragua | 1.12 |
| 16 | Ireland | 4.14 | 46 | Colombia | 2.74 | 76 | Mauritania | 1.98 | 106 | Guatemala | 1.08 |
| 17 | Hungary | 4.04 | 47 | Argentina | 2.73 | 77 | Senegal | 1.98 | 107 | Jordan | 1.08 |
| 18 | New Zealand | 4.01 | 48 | Peru | 2.73 | 78 | Togo | 1.98 | 108 | Angola | 0.88 |
| 19 | Chile | 3.91 | 49 | Malaysia | 2.70 | 79 | Rwanda | 1.95 | 109 | Burma | 0.20 |
| 20 | South Korea | 3.89 | 50 | Lithuania | 2.69 | 80 | Mauritius | 1.93 | 110 | Ethiopia | 0.00 |
| 21 | Norway | 3.88 | 51 | Iceland | 2.68 | 81 | Iran | 1.91 | 111 | Mozambique | 0.00 |
| 22 | Singapore | 3.88 | 52 | Turkey | 2.65 | 82 | Congo | 1.90 | 112 | Papua New Guinea | 0.00 |
| 23 | Ukraine | 3.68 | 53 | Sudan | 2.61 | 83 | Honduras | 1.90 | | | |
| 24 | Russian Federation | 3.48 | 54 | Haiti | 2.58 | 84 | Ivory Coast | 1.90 | | | |
| 25 | Greece | 3.47 | 55 | Philippines | 2.56 | 85 | Bangladesh | 1.87 | | | |
| 26 | Poland | 3.46 | 56 | Sierra Leone | 2.45 | 86 | Syria | 1.87 | | | |
| 27 | South Africa | 3.39 | 57 | Kenya | 2.43 | 87 | Madagascar | 1.85 | | | |
| 28 | Portugal | 3.35 | 58 | Thailand | 2.41 | 88 | Saudi Arabia | 1.83 | | | |
| 29 | Bulgaria | 3.23 | 59 | Bolivia | 2.37 | 89 | Nepal | 1.79 | | | |
| 30 | El Salvador | 3.23 | 60 | Trinidad & Tobago | 2.33 | 90 | Benin | 1.78 | | | |

Notes: Table rank the 112 countries in our sample based on their index of intellectual property rights in 1995 as developed by Ginarte and Park (1997) and updated by Park (2008). This index is constructed based on five categories of patent protection discussed in the text.

**Figure 1: Innovation and Exporting Frequencies**