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Do Foreign Patent-Protection Rights Promote Domestic R&D Spending? Evidence from Canadian Firms

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Contents

Abstract

This paper examines the evolving role of intellectual property rights (IPR) in the context of globalization, where research and development incentives of Canadian firms are framed not only by Canadian IPR, but also by the IPR of Canada's export market. Using a unique Canadian export firm, product-level dataset, the empirical approach employed in this study explores the differentiated products in industries from firms that can impact business enterprise R&D intensity over a period of nine years. These results are empirically tested by constructing an export-weighted index of trade-partner IPR at the firm-product level. Controlling for year, industry and firm-level fixed effects, the results suggest that Canadian innovation is positively associated with export-partner IPR. These results seem to suggest that policy-makers should explore alternative avenues to design an optimal national property rights regime. The results would further justify the need for multilateral IPR agreements or, more generally, a global IPR framework. The results also support inclusion of the Agreement on Trade-Related Aspects of Intellectual Property Rights into the World Trade Organization's mandate.

1. Introduction

Intellectual property rights (IPR) are a key influence on private innovative activity. The rise of the knowledge economy and the globalization of markets have put IPR at the centre of discussion. With increased globalization of trade and the pace of technological change, there has been a growing demand for IPR protection to be extended globally. Moreover, as commercialization of innovative goods plays a crucial role in the ability of small Canadian firms to remain globally competitive, the aim of this paper is to understand how changes to global IPR standards affect incentives for small Canadian firms to innovate.

The first proactive step toward global IPR protection was inclusion of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) into the trading system. For members of the World Trade Organization (WTO), the TRIPS agreement set a minimum standard of intellectual property (IP) protection and enforcement guidelines, while providing mechanisms for dispute settlements in regard to TRIPS obligations. Harmonization of IP law through the TRIPS agreement is an attempt to unify WTO members in trading innovative goods and services without fear of imitation. Furthermore, it allows more technically advanced goods to flow to developing countries.[1]

Canada's strong IPR system has resulted in diffusion of knowledge by encouraging firms to innovate. Enforcement mechanisms in Canadian IP law support a healthy competitive business environment for innovators. In addition, by providing substantial funding for technological innovation through tax incentives and program support, the system has allowed Canadian firms to continue to grow.

As technological innovation is arguably a precursor to job creation, export growth and economic activity, this paper provides evidence of alternative channels that would continue to enhance Canadian research and development (R&D) activity. This research is especially important as global competitors, such as the European Union (EU), have adopted more direct initiatives to promote economic growth through technological innovation.

For instance, IPR initiatives have recently been lauded as the engine of economic growth in the EU. The 2013 annual report produced by the European Patent Office and the Office for Harmonization in the Internal Market confirms that from 2008 to 2010, R&D-intensive industries accounted for 89 percent of the EU's total trade, but only 72 percent of the trade deficit, indicating a positive contribution to the trade balance. Furthermore, IPR-intensive industries in the EU have generated 26 percent of all jobs, while contributing 39 percent to gross domestic product (GDP). The value added per employee in IPR-intensive industries

1. Developing countries argue that an increase in global IPR would likely create larger technological transfers from developed to developing economies, which would then foster economic growth. However, Lanjouw and Schankerman (1997) and McCalman (2001) argue that transitioning towards a stronger global IPR platform transfers rent from developing countries to multinationals located in high-income countries. These IPR reforms would raise the imitation costs, while placing firms in developing countries at a comparative disadvantage.

is also much greater than in other sectors of the economy. This is reflected by the 41 percent wage premium IPR-industry workers receive relative to other non-R&D-intensive sectors.[2]

However, IPR initiatives undertaken by the EU to strengthen IPR have been a contested debate. While standard theory suggests that IPR, consisting of patents, trademarks and copyrights, encourage innovation by providing firms with dynamic gains (at the expense of market power), empirical evidence of such efficacy is not conclusive. Both the theoretical and the empirical literature provide mixed evidence. With extensive changes to global IPR protection, there has been a growing literature measuring the effect of IPR on innovation across countries and over time. Even so, this paper contributes to the growing literature by examining the effect of foreign IPR on domestic innovation.

In theory, strengthening a foreign country's IPR protection should stimulate domestic innovation as it allows domestic innovators to secure additional profits from foreign markets. As firms now have increased accessibility to global markets, results of this study suggest that innovation in small Canadian firms responds positively to the IPR of export partners.[3] Using a unique Canadian export firm, product-level dataset, the empirical approach employed in this study explores the differentiated products in industries from firms that can impact business enterprise R&D intensity over a period of nine years. These results are empirically tested by constructing an export-weighted index of trade-partner IPR at the firm-product level. These results are robust after controlling for year, industry and firm-level fixed effects.

The remainder of this paper is organized as follows: Section 2 provides a brief current literature review, findings and the motivation for this paper; Section 3 provides information on the Canadian firm-level dataset; Section 4 presents empirical results; and Section 5 presents conclusions.

2. Literature Review

2.1 IPR and Innovation

The case for patent protection begins with understanding that innovation and knowledge are unlike other goods. The knowledge underlying an innovation is non-rival and only partially excludable. To the extent that an innovation is a public good, innovation will be underprovided by the market due to a positive information externality.

2. The positive outcome of IPR reforms on innovation and growth has also been documented in prior studies. For example, a 2012 report by the Economics and Statistics Administration (United States Department of Commerce) and the United States Patent and Trademark Office reveals that in 2010, IPR-intensive industries in the United States generated almost one fifth of all jobs, while contributing 35 percent to GDP. This has also created a wage premium of 42 percent relative to non-R&D-intensive industries.

3. Larger Canadian firms do not seem to be affected by the IPR of export partners. It is hypothesized that even if enforcement of IPR is very low in a target country, a larger firm can still maintain its innovative strategies through foreign direct investment or technology transfers to affiliates. Therefore, it could be reasonably expected that low IPR may have no effect on domestic innovation for these large firms.

Patent protection seeks to address this problem by allowing inventors to exclude others from using their innovation for a period of time. Theoretically, this should provide sufficient incentive for firms to innovate. Yet, extensive empirical evidence related to IPR and innovation remains mixed at best. For instance, earlier work by Kanwar and Evenson (2003) looked at the determinants of innovation in a sample of 29 developed and developing countries from 1981 to 1990. At the country level, they measured R&D intensity as total R&D investment as a proportion of gross national product (GNP). While accounting for several control variables, they concluded that the strength of intellectual property protection is positively and significantly associated with R&D.

Similarly, Schneider (2005) constructed a panel dataset of 47 countries from 1970 to 1990. As a proxy for innovation, Schneider (2005) used the number of successful patent applications in the United States and found that stronger IPR positively affected the rate of innovation for developed countries, while the relationship between IPR and innovation was weakly and inversely related in developing countries. Whereas Allred and Park (2007) found that patent strength is negatively associated with innovative activity in developing countries, they provide further evidence that, while patent strength positively affects R&D activity in developed countries, it also negatively affects patent filings after some critical level of patent protection is reached. However, results from Jaumotte and Pain (2005) suggest that IPR have little impact on business sector R&D spending.

As other papers provide similar empirical results (see Léger (2006) and Glass and Wu (2007)), there may be an endogeneity bias when measuring the relationship between domestic innovation and IPR. For instance, the level of IPR may be highly correlated with the level of development of a country,[4] which in turn impacts R&D activity. Furthermore, correlation between innovation and IPR may also arise because as firms increase their R&D activity, they begin to lobby government for increased IPR.

This paper addresses this endogeneity issue by exploring the IPR regime of Canada's export partners as an exogenous source of variation. By constructing an export-weighted foreign IPR measure, it is argued that a firm considering whether to pursue development of a new product compares the costs of R&D with the profit stream that the product is expected to earn, not just domestically but also in foreign markets. To the extent that the Canadian firm will enjoy stronger patent protection in its export markets, the firm now has a greater expected foreign income stream associated with the innovation and will, therefore, have a stronger incentive to perform R&D. Thus, this paper also contributes to the growing literature on the effect of foreign IPR on domestic innovation.

4. Evidence of this can be seen in Appendix Table A1.

2.2 Foreign IPR and Domestic Innovation

There is a growing literature related to both the theoretical and the empirical work currently examining the relationship between foreign IPR and domestic innovation. For instance, the theoretical framework of Branstetter and Saggi (2011) provides a North–South model that shows the positive impact of strengthening the South's IPR on Northern innovation, whereas the theoretical model of Dinopoulus and Segerstrom (2010) suggests that strengthening the target country's IPR causes temporary increases in domestic innovation. Results presented by Dinopoulus and Segerstrom (2010) are consistent with the empirical evidence of Branstetter (2006) indicating that patent reforms are associated with increased royalty payments from foreign affiliates to their parent firms. Branstetter's (2006) results empirically show that there is an associated increase in R&D spending by these foreign affiliates in the presence of stronger foreign IPR. In other words, improvements in IPR protection result in significant increases in technology transfer from U.S.-based multinationals to their affiliates in IPR reforming countries.

However, there are very few empirical papers that have attempted to examine the impact of foreign IPR on domestic innovation. In perhaps the first empirical paper that examines the link between foreign IPR and domestic innovation, Qiu and Yu (2010) examine the impact of foreign IPR on successful patent applications in the United States. They find that the TRIPS agreement has had a significant impact on U.S. innovation, but that strengthening patent protection in individual countries does not have a statistically significant effect on U.S. innovation. The empirical study looked at successful patent applications in the United States over a 33-year period and major IPR reforms in 21 countries. The empirical design of this paper relies on measuring changes in IPR in individual countries (and the TRIPS agreement) using binary dummy variables. By implementing dummy variables as its main methodology for capturing changes in foreign IPR, there is a high likelihood that other factors may also be captured in the variables, which may explain why country IPR reforms are not seen as a main influence on fostering U.S. innovation.

The closest paper related to this current study is that of Park (2012), who studied the effect of foreign IPR on U.S. innovation using a comprehensive micro database of U.S. multinational firms and their foreign affiliates in developed countries. Using the IPR index created in Park (2008), Park (2012) defines a weighted sum of patent-protection levels based on national exports and foreign direct investment (FDI) outflows. This weighted sum was created for both developed and developing countries. Park (2012) finds that the patent regime of foreign developed countries positively affects firm-level R&D intensity, whereas the patent regime of developing countries does not.

The main limitation of Park's (2012) paper is that the micro database does not provide information on the export destination of each firm, only the region of export (e.g., Europe, Latin America, etc.). Therefore, Park (2012) opted to use national exports and FDI outflows to construct the weighted sum of patent-protection levels. In doing so, Park (2012) could not explore differences in export patterns of firms by industry.

Furthermore, due to the dynamic nature of trade flows, Park (2012) recognized that the weighted sum of patent-protection levels may be endogenous to other factors. To account for this, Park (2012) chose to lag export shares by five years in constructing the weighted sum. However, there would still be a time varying component captured using this methodology.

To avoid this bias, this paper proposes to fix export shares one period before the sample, which ensures that the only component in the export-weighted index that is changing over time is the patent-protection level, not the trade flows themselves. Furthermore, by merging small firm financial data with export data for 233 firms, across 169 industry sectors, that export to 117 countries for the years 2000, 2005 and 2008, this paper will be the first to capture the relationship between business enterprise R&D and export-partner IPR disaggregated at the firm level.

3. Dataset

To examine the impact of export-partner IPR on Canadian innovation, the T2-LEAP-Export and Import Registry Database will be used linked to the Research and Development in Canadian Industry (RDCI) survey. The merged dataset compiles all incorporated export-oriented business enterprises in Canada that have also pursued R&D investments. The database covers the years between 2000 and 2008. The T2-LEAP-Export and Import Registry Database covers all financial information related to incorporated businesses, the eight-digit Harmonized System (HS) industry code of the export, the exporting country and the value of the export. The RDCI survey provides information on firms' total R&D expenditures. To focus on the global competitiveness of small Canadian firms, sample firms were restricted to those with fewer than 100 employees on average.[5]

The measure of IPR used is the patent-protection (PP) index developed by Park and Ginarte (1997) and updated in Park (2008). The PP index provides scores for 122 countries between 1960 and 2010. It measures the strength of national patent rights. The value of the PP index is obtained by aggregating the score of five factors:

1. Coverage
2. Membership in international treaties
3. Duration
4. Enforcement mechanisms
5. Restrictions on patent rights

5. The focus of this paper is to capture the incentives for small Canadian firms to conduct R&D in the presence of a globalized economy. Results can easily be extended to medium-sized and large enterprises. However, the dynamics of large, or multinational, firms change extensively in the presence of globalization.

Each factor has a value ranging between 0 and 1, for an aggregate score ranging between 0 (weakest) and 5 (strongest). As PP index scores change slowly over time, Park (2008) evaluated PP rights for each country at five-year intervals. For a more extensive review of the development of this index, please refer to the Appendix.

The export-weighted IPR (EIPR) index is constructed as the weighted average of the export-partner IPR using the proportion of exports for each firm, for products in each industry, country and time period, as weights. More formally, if X_{ijkt} is defined as the value of exports of firm i at time t, exporting goods classified in industry k to country j, where $j = 1 \ldots J$, we have:

$$EIPR_{ikt} = \sum_{j \neq i}^{J} \frac{X_{ijkt} * IPR_{jt}}{\sum_{j \neq i} X_{ijkt}}$$

As $\sum_{j \neq i}^{J} \frac{X_{jkt}}{\sum X_{ijkt}} = 1$, this is simply a weighted average using the proportion of exports as weights.

As is the case in Park (2012), the index may be endogenous as exports may be flowing to countries with characteristics that are highly correlated with patent-protection levels (i.e., economic development). For example, this can be seen in Appendix Table A1, where the average IPR score is correlated with each country's income classification level.

As Canada's top trading partners are considered "high-income" countries, using this measure would bias the results upwards. To avoid this endogeneity issue, an export-weighted IPR index is created using fixed trade proportions one year before the sample begins. This simple method avoids any issues of endogeneity in the variable of interest as any changes to the export-weighted index will now be due to changes in partner IPR, not changes in trade flows. More formally, the fixed EIPR (FEIPR) is defined as:

$$FEIPR_{ik99} = \sum_{j \neq i}^{J} \frac{X_{ijk99} * IPR_{jt}}{\sum_{j \neq i} X_{ijk99}}$$

where the export trade flows for each firm i, exporting goods classified in industry k to country j, where $j = 1 \ldots J$, are from 1999. As IPR change slowly over time, five-year intervals are used for the dataset; specifically, 2000, 2005 and 2008.

It may also be reasonable to assume that domestic R&D intensity (measured as the ratio of R&D expenditures to sales) does not respond immediately to changes in export-partner IPR. To account for any lags, the forward average of R&D intensity was calculated. For instance, the R&D intensity for firm i for the year 2000 would represent the average R&D intensity for the years between 2000 and 2004 inclusive.[6]

6. Due to data limitations for 2008, the average R&D intensity for the years between 2008 and 2010, inclusive, was used.

The final dataset is comprised of 233 firms, across 169 industry sectors, which export to 117 countries for the years 2000, 2005 and 2008. The dataset has a total of 920 observations.

3.1 Limitations

Due to limitations of the dataset, only the impact of Canadian firm-level innovation on changes in export-partner IPR after the year 2000 can be analyzed. As inclusion of the TRIPS agreement resulted in changes to the IPR system for WTO member economies in 1994, strengthening of patent protection is reflected in the IPR index for 1995 and 2000, whereas few reforms have occurred since. For instance, of the 122 recorded countries in the IPR index, 40 countries have undergone IPR reforms from 2005 to 2008—12 in Latin America, eight in Africa, eight in Europe, four in Asia and eight in Southeast Asia. Of these countries, none has been considered among Canada's top ten export destinations. Therefore, data will vary little over time, with any variation being a result of changes in IPR within these countries.[7]

Another limitation of the dataset is that there may be discrepancies between the year of production of a good and the year it was exported. It may be that a good was produced in one year and exported the following year. Thus, the ratio of the value of exports to sales may not be an accurate measure of a trade-oriented firm.

Lastly, to properly calculate the FEIPR, the dataset only reports business enterprises that have been exporting to the same countries since 1999. The data do not account for new international markets business enterprises have been exporting to after 1999. Therefore, the dynamic EIPR variable would account for these new export destinations. While biased, the results still provide insight into the effect of export-partner IPR on Canadian innovation.

3.2 Descriptive Statistics

Table 1 presents a brief overview of the various industry sectors in the sample aggregated by two-digit HS codes. Tables 2 and 3 provide descriptive statistics of the variables of interest and the correlation between both measures of export-partner IPR respectively.

Table 1: Industry Sectors

HS Code	Sector
30–37	Chemicals & Allied Industries
40	Plastics/Rubbers
54–62	Textiles
64	Footwear/Headgear
84	Machinery/Electrical
90–96	Miscellaneous

7. Firms that export exclusively to the United States were also dropped as there have been no major U.S. IPR reforms since 2000.

Table 1 summarizes the 169 HS five-digit sectors into six general industries. "Miscellaneous" goods that fall under HS codes 90 through 96 refer to exports ranging from medical instruments, clocks and watches to furniture, toys, games and sports requisites. Small Canadian R&D-intensive firms tend to be concentrated in these broadly defined sectors.

Tables 2 and 3 confirm previous concerns regarding the EIPR measure being biased. Specifically, accounting for dynamic changes in firm-level exports, there is a larger deviation in the variable. These changes may not necessarily be due to the exporting country's IPR, but other factors (possibly unobservable) that are driving the results. For example, changes in foreign market preferences or technical inefficiencies within the firm may cause shifts in trade flows each year. While foreign market preferences can bias results, the firm-level fixed-effect model employed in this study can control technical inefficiencies.

Table 2: Descriptive Statistics

Variable	Observations	Mean	SD
Log(R&D Intensity)	920	-10.48	1.256
EIPR	920	3.79	1.257
FEIPR	920	4.68	0.383

Table 3: Correlation

	EIPR	FEIPR
EIPR	1.000	—
FEIPR	0.3026	1.000

4. Empirical Design and Estimation Method

To examine the relationship between export-partner IPR and Canadian innovation, the econometric model will take the following form:[8]

$$\text{Log(R\&D/Output)}_{ikt} = \beta_0 + \beta_1 \text{EIPR}_{ikt} + \iota_i + \upsilon_k + \eta_t + \varepsilon_{ikt}$$

where β_1 represents the degree of responsiveness of innovation to export-partner IPR, η_t is the year dummy variables pick up unobservable changes that directly affect R&D intensity over time, υ_k accounts for industry-specific unobservable characteristics that directly affect R&D intensity, and ι_i represents time-invariant firm-specific fixed effects. By adding these time, industry and firm dimensions to the model, it allows the model to control for unobservable factors and establish the relationship between export-partner IPR and R&D intensity.

For simpler interpretation, a logarithmic transformation to export-partner IPR is applied to the above equation. Table 4 presents results from the model using both measures of export-partner IPR (i.e., EIPR and FEIPR) separately.

8. Typically, the IPR index of Canada would be used as a control variable in this model. However, according to the five factors upon which the IPR index was constructed, there have been no major reforms to Canadian IPR. Therefore, the effect of Canadian IPR on Canadian innovation would be absorbed by the constant β_0 in the model.

Table 4: Econometric Results

Dependent Variable: Log(R&D Intensity)				
	(1)	(2)	(3)	(4)
Panel A				
Log(EIPR)	1.136***	1.319***	0.824	0.837**
	(0.503)	(0.504)	(0.738)	(0.395)
Panel B				
Log(FEIPR)	0.197***	0.197***	0.160***	0.0960**
	(0.058)	(0.058)	(0.058)	(0.046)
Observations	920	920	920	920
Year Effects	No	Yes	Yes	Yes
Industry Effects	No	No	Yes	Yes
Firm Effects	No	No	No	Yes

Note: Robust standard errors clustered by firm. Sample consists of 233 firms, across 169 industry sectors, for the years 2000, 2005 and 2008.
*p<0.10, **p<0.05, ***p<0.01.

Column (1) represents the regression with export-partner IPR only. Column (2) controls for year fixed effects and column (3) controls for year and industry fixed effects. Column (4) is the fully specified model, controlling for year, industry and firm fixed effects.

After controlling for year, industry and country fixed effects, export-partner IPR have a large and significant effect on Canadian innovation. Specifically, using the EIPR measure, a 10-percent increase in export-partner IPR is associated with an increase of about 8.37 percent in domestic innovation. This result is robust across different specification models and significant at the 5-percent level. As the EIPR measure is upward biased, this can be viewed as the upper impact of EIPR on Canadian innovation.

Similarly, using the FEIPR measure, in the fully specified model, the relationship between export-partner IPR and domestic innovation is significant at the 5-percent level. Specifically, a 10-percent increase in export-partner IPR is associated with a 1-percent increase in Canadian innovation.[9]

Results presented here are in line with the initial hypothesis that innovation is positively associated with export-partner IPR. For instance, suppose a small Canadian firm exports 90 percent of its production to the United Kingdom. It is likely that small Canadian firms may be influenced by changes in the U.K.'s IPR and, as small Canadian firms are unlikely to exert any influence on U.K. government policy, changes in the U.K.'s IPR represent a quasi-natural experiment. Hence, this strong relationship between the U.K.'s IPR and Canadian R&D can be readily interpreted as causal. Therefore, results presented here provide

9. The possibility that export-partner IPR and innovation may have a non-linear relationship was also explored. The reasoning is that with further strengthening of patents, firms that choose to innovate may now require licences for multiple patents from multiple sources in the exporting country, which creates delays while also increasing firm costs. While a positive and statistically significant relationship between export-partner IPR and Canadian innovation was observed, an inverse-U relationship between the two was not.

unique evidence of specific global factors that impact Canadian innovation. These results provide an alternative for policy-makers to explore to ensure the success of small Canadian firms on a global scale, as export-oriented, R&D-intensive small firms have numerous obstacles to overcome, in particular, foreign patent protection.

For instance, in an increasingly globalized business environment, small firms require the capacity, resources and management expertise to successfully deliver a marketable product abroad. More importantly, it is crucial for R&D-intensive firms to research local rules, laws and regulations governing IP to adequately protect their own IP assets. Costs associated with legal disputes, either from IP infringement or infringing upon the IPR of others, may threaten the long-term success of small Canadian firms. Furthermore, understanding laws and procedures for protecting IPR in both domestic and target market settings will allow small Canadian firms to create a more successful export strategy.

Therefore, if small Canadian firms are motivated and encouraged to take such precautions to ensure their success, it is reasonable to assume that export-oriented, R&D-intensive small Canadian firms should positively respond to export-partner IPR. Thus, the results of this section not only will have strong policy implications related to Canada's involvement in trade agreements or WTO mandates, such as the TRIPS agreement, but will also identify indirect global channels that can impact Canadian economic growth.

4.1 What Factors are Driving These Results?

While strong patent-protection levels for Canadian export partners positively impact innovation in small Canadian firms, it is still important to understand specifically what factors are driving these results. For instance, of the five factors used to create the weighted patent-protection index, is there a subset of factors that Canadian firms tend to respond to more? To test this idea, an export-weighted index was created for each factor used to develop the patent-protection index. R&D intensity was then regressed on each of these factors separately. Mathematically, this can be expressed as follows:

$$\text{Log(R\&D/Output)}_{ikt} = \beta_0 + \beta_1 \text{Log(IPR}_{ikt}) + \iota_i + \upsilon_k + \eta_t + \varepsilon_{ikt}$$

where IPR_{ikt} represents the export-weighted index of one of the following five factors in the IPR index: loss of rights, enforcement, membership, coverage and duration. Results are presented in Table 5.[10]

10. For brevity, results presented in Table 5 reflect the export-weighted index constructed using fixed trade flows from 1999. Results are similar when using dynamic trade flows as weights.

Table 5: Patent-Protection Factors

Dependent Variable: Log(R&D Intensity)				
	(1)	(2)	(3)	(4)
Panel A				
Loss of Rights	0.158***	0.157***	0.117***	0.078*
	(0.5055)	(0.0544)	(0.0552)	(0.0455)
Panel B				
Enforcement	0.196***	0.196***	0.145**	0.100**
	(0.0580)	(0.0581)	(0.0587)	(0.0449)
Panel C				
Membership	0.344***	0.344***	0.280**	2.28e-17
	(0.0934)	(0.0935)	(0.109)	(0.197)
Panel D				
Coverage	0.221***	0.221***	0.181***	0.0962**
	(0.0590)	(0.0591)	(0.0595)	(0.0453)
Panel E				
Duration	0.181***	0.181***	0.155***	0.0883**
	(0.0583)	(0.0583)	(0.0571)	(0.0447)
Observations	920	920	920	920
Year Effects	No	Yes	Yes	Yes
Industry Effects	No	No	Yes	Yes
Firm Effects	No	No	No	Yes

Note: Robust standard errors clustered by firm. Sample consists of 233 firms, across 169 industry sectors, for the years 2000, 2005 and 2008.
*p<0.10, **p<0.05, ***p<0.01.

Column (1) represents the regression with export-partner IPR factors only. Column (2) controls for year fixed effects and column (3) controls for year and industry fixed effects. Column (4) is the fully specified model, controlling for year, industry and firm fixed effects.

Results suggest that the enforcement mechanisms of the exporting country's legal institution related to intellectual property and the vast coverage of industries protected by patents are strong determinants of innovation in small Canadian firms. Specifically, a 10-percent increase in industry coverage and protection of patents is associated with increases of 0.9 percent and 1 percent, respectively, in innovation in small Canadian firms.

While duration of patents plays an important role, results suggest that membership in international treaty agreements on the part of the target country may not directly encourage small Canadian firms to innovate. Small Canadian firms perhaps respond more to factors related to legal institutions, or factors that directly impact their business. For instance, a small Canadian firm may be reluctant to export a technologically advanced good to countries where legal repercussions associated with IP infringement may be absent. Similarly, small Canadian firms may not necessarily be motivated to innovate and export goods abroad if the target country has entered into a new treaty agreement.

Furthermore, as costs associated with patenting goods or processes are typically relatively significant for small Canadian firms, it seems reasonable that small firms would be increasingly sensitive to changes in these factors. Investments by small Canadian firms to patent their export products in target countries may enhance profits, but only if the target country can legally, and credibly, commit to prosecuting innovators who infringe upon their intellectual property. This explains the positive, and statistically significant, relationship presented in Table 5.

5. Conclusions

In an increasingly globalized marketplace, results of this study provide new insight into the incentives encouraging small Canadian businesses to conduct R&D. This paper finds that Canadian firms innovate in response to changes in IPR of the export market.

Results presented in this paper could further assist policy-makers in designing an optimal national property rights regime. Specifically, the results provide policy-makers with alternatives to spur Canadian innovation. For instance, rather than direct IPR initiatives to protect patent holders as a means of encouraging innovation, policy-makers could concentrate on ensuring that Canada negotiates multilateral trade agreements with countries that have strong IPR. Results indicate that if the potential trade partner has strong IPR, export-oriented, R&D-intensive small firms are more likely to innovate to service this new market. The potential trade partner would then receive a technologically advanced good, while Canadians would benefit from increased innovation, leading to an increase in firm productivity, job creation and, ultimately, economic activity.

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Appendix

Table A1: Patent-Protection Index

High Income	IPR	Upper-Middle Income	IPR	Lower-Middle Income	IPR	Low Income	IPR
Australia	4.33	Algeria	2.78	Angola	1.20	Bangladesh	1.68
Austria	4.33	Argentina	3.56	Bolivia	2.95	Benin	2.54
Belgium	4.67	Botswana	3.28	Cameroon	2.67	Burkina Faso	2.54
Canada	4.54	Brazil	3.43	Côte d'Ivoire	2.71	Burma (Myanmar)	0.20
Cyprus	3.41	Bulgaria	3.83	Egypt	2.55	Burundi	1.98
Czech Republic	3.96	Chile	4.52	El Salvador	3.40	Central African Republic	2.54
Denmark	4.67	China	3.78	Ghana	3.28	Chad	2.54
Finland	4.63	Colombia	3.38	Guatemala	2.61	Ethiopia	2.08
France	4.67	Costa Rica	2.93	Guyana	1.55	Haiti	2.90
Germany	4.67	Dominican Republic	2.44	Honduras	2.82	Kenya	3.11
Greece	4.36	Ecuador	3.60	India	3.26	Liberia	2.36
Hungary	4.18	Gabon	2.67	Indonesia	2.67	Madagascar	2.18
Iceland	3.67	Iran	2.00	Iraq	2.01	Malawi	2.08
Ireland	4.67	Jamaica	3.26	Mauritania	2.88	Mali	2.54
Israel	3.96	Jordan	3.01	Morocco	3.24	Mozambique	2.13
Italy	4.67	Lithuania	3.70	Nicaragua	2.52	Nepal	2.05
Japan	4.67	Malaysia	3.37	Nigeria	2.83	Niger	2.54
Korea	4.27	Mauritius	2.36	Pakistan	2.01	Rwanda	2.18
Luxembourg	4.14	Mexico	3.42	Paraguay	2.73	Sierra Leone	3.00
Malta	3.42	Papua New Guinea	2.70	Philippines	3.82	Somalia	1.46
Netherlands	4.67	Panama	3.35	Republic of Congo	2.67	Togo	2.54
New Zealand	3.68	Peru	3.11	Senegal	2.54	Tanzania	2.73
Norway	4.21	Romania	3.85	Sri Lanka	3.13	Uganda	3.10
Poland	3.86	Russia	3.68	Sudan	2.32	Zimbabwe	2.56
Portugal	4.21	South Africa	3.78	Syria	2.00		
Saudi Arabia	2.28	Thailand	2.60	Ukraine	3.72		
Singapore	4.14	Tunisia	2.94	Vietnam	2.86		
Slovakia	3.82	Turkey	3.98	Zambia	1.90		
Spain	4.33	Uruguay	3.14				
Sweden	4.54	Venezuela	3.08				
Switzerland	4.21						
Taiwan	3.59						
Trinidad and Tobago	3.71						
United Kingdom	4.54						
United States	4.88						
Average	**4.19**		**3.25**		**2.67**		**2.32**

Note: Average patent index for 2000, 2005 and 2008. Organized from high income to low income as classified by the United Nations (2012).

Park's (2008) patent-protection index is a function of five equally weighted factors. Each component within each factor is also equally weighted. The five factors making up the index are listed below:

1) **Coverage** of the following industries that can patent goods or processes:
   a) Pharmaceuticals
   b) Chemicals
   c) Food
   d) Surgical products
   e) Microorganisms
   f) Utility models
   g) Software
   h) Plant and animal varieties

2) **Membership** in five international treaties:
   a) Paris Convention for the Protection of Industrial Property
   b) Patent Cooperation Treaty
   c) International Union for the Protection of New Varieties of Plants
   d) Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure
   e) Agreement on Trade-Related Aspects of Intellectual Property Rights

3) **Duration** of protection:
   a) Value of one if 20 years; otherwise, the duration of the patent (normalized as a fraction of 20 years)

4) **Enforcement Mechanisms** measured as follows:
   a) Preliminary (pretrial) injunctions
   b) Contributory infringement
   c) Burden of proof reversal

5) **Restrictions on Patent Rights**:
   a) Working requirements
   b) Compulsory licensing
   c) Revocation of patents