Centre for Study of Living Standards-Productivity Partnership Conference:
"*Explaining Canada's Post-2000 Productivity Performance*"

Innovation and productivity outputs in Canadian firms and the role of policy incentives

Claudia De Fuentes, Associate Professor, Sobey School of Business, Saint Mary's University
923 Robie St. Halifax, NS, B3H 3C3, Canada
Phone 902 420 5851
e-mail: claudia.defuentes@smu.ca

Abstract

Innovation Surveys have been the key source of information for studying innovation in a fairly systematic and comparative way; several studies have used these surveys to contribute to the literature on innovation studies. This paper seeks to contribute to the literature by analyzing the main determinants of innovation in Canadian firms, differentiating by three types of innovation. In addition, we explore the main factors that contribute to explain innovation impact on firm's performance measured as revenue and access to international markets. We differentiate their effects for manufacturing and service sectors in Canadian firms for the years 2009 and 2012. Our results suggest that active innovation strategies are crucial for innovation output, and also the level of innovation and enforcing unique features in products or services is crucial for high innovation performance. Our results have important managerial implications in terms of the type of innovation output that firms want to emphasize, and also the focus of innovation strategy to contribute to firm performance.

Key words: product innovation, service innovation, process innovation, innovation performance, innovation determinants.

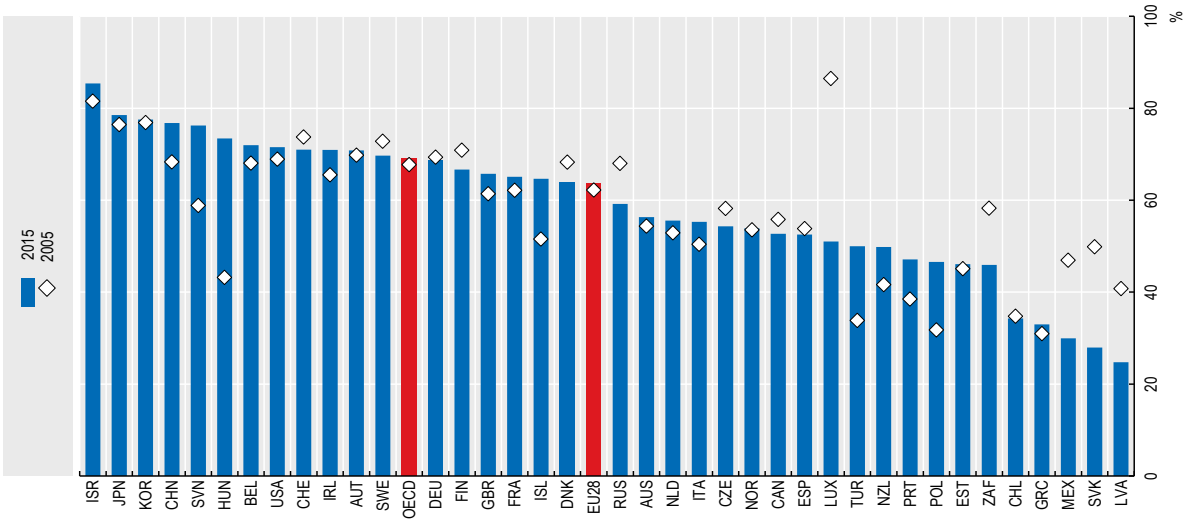
JEL codes: 031, 038, 043, 051.

1. Introduction

Government expenditure in R&D (GERD) in Canada remains above the OECD average, in addition, Canada is within the ten top countries for higher education expenditure on R&D (HERD). However, Canada has a high rate of support relative to countries with similar business R&D-to-GDP ratios, and since early 2000 Canada business R&D has decreased. In 2015, Canada business R&D as a percentage of gross domestic expenditure on R&D was 52%, it slightly decreased from 2005, and it has been below the average of OECD countries (See figure 1.)

Figure 1. Business R&D, 2005 and 2015

As a percentage of gross domestic expenditure on R&D



Source: OECD, Main Science and Technology Indicators Database, http://oe.cd/msti, July 2017. StatLink contains more data.

Business R&D is a highly concentrated activity; within countries a small number of firms are responsible for a large proportion of total business R&D. In Canada, the 50 largest domestic R&D performers account for 39% of BERD (OECD, 2017). This contributes to a low investment in R&D at a country level, and as argued by Crepon, et al. (1998), this can have important implications for innovation output and productivity performance. Several studies have shown an important correlation between firm's innovation intensity --i.e. the expenditure on innovation

activities-- innovation outputs, and firms' productivity (Crépon, Duguet and Mairesse, 1998). For example, Crespi and Zuñiga (2012) evaluate the effects of innovation outputs on productivity in manufacturing firms from different Latin American countries. More recently, such models have incorporated studies of services firms (Polder et al. 2009).

With the publication of the Oslo Manual by the Organisation for Economic Co-operation and Development (OECD) in 1992, which has been revised several times, a new source of data about industrial innovation appeared. A large number of countries now conduct Innovation Surveys, using the same definitions, while not necessarily the same instruments (samples, questionnaires and statistical analysis techniques). The European Union was the first user of the Oslo methodology, with its Community Innovation Surveys (CIS), which were originally conducted every four years from 1993 to 2007 and every two years afterwards. Soon after, Canada, the United States, Latin American countries (Argentina, Brazil, Chile, Colombia, Mexico, Peru, Uruguay, and Venezuela), Asian countries (China, India, Indonesia, Japan, Malaysia, Singapore, South Korea, Taiwan, Thailand, and Vietnam) and several African countries launched their own Innovation Surveys (Hong et al. 2012). Beginning with the first CIS, questions were asked about product and process innovation, and after 2005 questions were added about organizational and marketing innovations as well. Yet the sectors covered and the samples are not the same from one country to the next or over the years within the same country, very small firms are not often included, there is no possibility of panel analysis because the samples vary from one survey to the next, and many responses are qualitative and fairly subjective. A more precise picture started to emerge about the contours of innovation in many countries, a contour that the studies on private-sector R&D based on the Frascati Manual could not provide.

The Innovation Surveys allowed the publication of dozens of empirical studies about firms' innovation. These papers studied the age of the innovators (Børing et al. 2016), re-examined innovation heterogeneity across sectors (Baum et al. 2016), compared technological and non-technological innovation in manufacturing and services (Aboal & Garda 2015, De Fuentes et al. 2015), evaluated the impact of R&D cooperation between universities and public R&D labs and industrial firms (Pippel & Seefeld, 2015), studied innovation barriers (D'Este et al. 2015), investigated the effects of firms' open innovation models on policy incentives (Fu, 2012), and measured the economic impact of innovation on service and manufacturing firms (Mohnen et al. 2013).

The Surveys also allowed researchers to have a second look at some accepted and popular typologies of innovating sectors, such as the Pavitt's taxonomy on sectoral innovation, by adding services and information technologies (Bogliacino and Pianta, 2016), and also reviewing technological paradigms, regimes, and trajectories. This is the case in a new and more up-to-date taxonomy of sectoral patterns of innovation (Castellacci, 2008). These papers also shed some light on innovation in services and added new measurements and concepts (Hipp and Grupp, 2005).

Using the Innovation Surveys, some papers have gone much further in the theoretical discussion. Thus, discovering complementarities in innovation policy, Mohnen and Röller (2005) proposed the concept of super-modularity: they found that innovation policy is more effective when firms use more than one policy incentive in order to innovate. The policy implications of this finding are important: countries should use more than one incentive, and a package of policies is preferable to relying on just one or two of them. The lessons for developing countries are also

important: they must devise not one but a battery of incentives in order to break the innovation inertia of the public and private sectors.

Among the first research papers that used information from innovation surveys in Canada to study innovation and productivity in Canadian firms were those of Baldwin (1996), Mohnen and Rosa (2002), Therrien and Mohnen (2003), and Mohnen and Therrien (2003), Amara and Landry (2005), Amara, Landry and Traoré (2008). These studies found that the most critical government programs to support innovation were tax credits for R&D, both federal and provincial, (almost 51% of innovative firms used them between 2010 and 2012), followed by direct grants such as the Industrial Research Assistance Program (IRAP) funding (17%), hiring programs for recent graduates, and training. They also found that large enterprises conducted innovation more often than medium-sized and small enterprises, but across the board, for all sizes, over the years the percentage of firms conducting innovation declined in Canada. Innovation was more frequent in professional, scientific, and technical services, followed by manufacturing, finance and insurance, and information and cultural industries. Transportation, mining, quarrying, and oil and gas extraction, and wholesale are less innovative. In terms of regions, these studies show that Ontario was the most innovative region, followed by Alberta and Quebec.

This paper seeks to contribute to the literature by analyzing the main drivers for innovation at the firm level differentiating between three types of innovation –product, service and process— and also the effect that these three types of innovation have on firm's performance measured in revenues, and access to different markets. In addition, we differentiate their effects for manufacturing and service sectors for the years 2009 and 2012.

This paper seeks to provide empirical results that contribute to informed innovation policy. This paper contributes to the literature in different ways. First, it seeks to identify the main determinants for innovation differentiating by type of innovation. Second, it explores in more detail the role of innovation output on firm performance.

The remainder of the paper is structured as follows; section 2 presents a brief literature review on innovation determinants and innovation performance. Section 3 presents the sources of data and methodology utilized in the paper. Section 4 discusses the empirical results, and section 5 provides a conclusion.

2. Literature review

This theoretical framework provides a discussion regarding the contribution of Innovation Surveys to understanding innovation, including its main determinants and effect on firm performance.

2.1 Contribution of Innovation Surveys to understanding innovation

The original emphasis of Innovation Surveys was on manufacturing innovation. A fairly large literature review of empirical studies of innovation in the manufacturing sector, published between 1993 and 2003, focused only on product and process innovation in manufacturing. The 108 articles covered in this thorough review (Bekheich et al. 2006) were mostly based on data provided by national or CIS that were conducted using the Oslo Manual methodology. The study found that CIS provide information regarding the determinants of innovation that are internal and external to the firm. The main internal determinants of innovation are associated with the firm's basic characteristics, the firm's global strategies and control activities, the firm's culture, and its

management team. The main external determinants of innovation are industry-related variables, regional variables, networking, use of external knowledge, government and public policies, and contextual culture.

Note that, in this review, the internal characteristics of firms dominate and outnumber their external characteristics. This may be considered a shortcoming of the literature. The collection of data from the firms highlights the knowledge that the respondents to the survey may have. This, in a sense, the data is a synchronic and somewhat biased collection of data. Businessmen tend to attribute to themselves the successes of innovation and blame on government policy the eventual failures of their innovation projects. Using data from Statistics Canada's Growing Small and Medium-Sized Enterprises (GSME) innovation survey, Baldwin (1996) found that managers attributed to themselves the success of fast-growing firms. Yet the statistical analyses showed that R&D spending was the best predictor of the firms' successful growth. Changes in the policy context or environment often go unnoticed by managers, and they are the ones who respond to Innovation Surveys.

Also, since the number of Canadian companies conducting R&D increased from just 300 in 1970 to thousands of them today, due to more numerous and better-designed government policies, it may be said that the institutional environment is a key determinant of innovation activities in private firms (Niosi, 2000). In other late-industrializing countries such as Finland (Dahlman et al. 2005; Halme et al. 2014), Singapore (Wong, 2001), South Korea (Kim, 1997), Taiwan (Dodgson et al. 2008; Wade, 1990) and now China (Fu, 2015), public incentives such as tax credits for R&D, direct subsidies, public R&D laboratories, and government-organized alliances fostered the rise of innovation in private firms. A quick succession of government incentives for innovation is

behind the East Asian miracle. It was only government venture capital that usually had no impact on innovation (Lerner, 2009). The comparative analysis of Innovation Surveys at two different points in time helps to identify and explain the differences in innovation policy and its impact on firms' innovation.

Fortunately, we are not completely without reviews and analyses of the innovation survey data coming from countries outside the European Union and North America. Bogliacino et al. (2009) have retraced the evidence about innovation produced by Innovation Surveys in not less than fourteen developing and emerging countries, namely Russia, Ukraine, Turkey, China, South Korea, Malaysia, Thailand, Taiwan, Singapore, South Africa, Argentina, Brazil, Chile, and Colombia. Almost all of the surveys devoted their efforts to studying innovation in manufacturing and services. In most developing countries, innovation suffered from lack of resources and integration of firms' activities with national systems of innovation. On the other side, in emerging countries such as China, Russia, Taiwan, Singapore, and South Korea, determinants and obstacles were similar to those in the European Union and North America (excluding Mexico). In other words, government policy incentives and public research institutions had already managed to nurture innovative activities in private firms, as well as changing the country's culture towards a more innovative one. Also, while in advanced countries innovation takes place both in large established firms and small firms, in emerging and developing countries most innovation is the realm of large firms. In addition, affiliates and subsidiaries of foreign multinational corporations tend to be more innovative than national firms, which also tend to be smaller. Passive patterns for acquiring technological capabilities also prevail: firms acquire technology through the incorporation of new machinery and licensing, rather than through internal R&D, and other innovative practices. These patterns can also be

found in Canada, where foreign subsidiaries of multinational corporations are larger (but not necessarily more innovative) than domestic firms of similar size and industry.

Since 2005, Innovation Surveys using the Oslo Manual methodology have added organizational innovation. In Canada, the 2014 Innovation survey found that organizational innovation was as frequent as product, process, and marketing innovation (Table 1).

Table 1: Types of innovation in Canadian firms (percentage of firms), 2009 and 2014

Innovation	2007-2009	2010-2012
All innovation	66.8	63.5
Product innovation	34.8	35.1
Process innovation	33.5	29.0
Organizational innovation	34.6	37.9
Marketing innovation	35.4	33.3
Non-innovative	33.2	36.5

Source: Survey of innovation and business strategy

http://www5.statcan.gc.ca/cansim/pick-choisir?lang=eng&p2=33&id=3580221

In addition, as in emerging and developing countries, the off-the-shelf acquisition of advanced technologies was by far the most common method of integration of advanced technologies in the surveyed firms (58.3%), followed by the licensing of advanced technologies (20.9%). Another significant group of 15.8% leased off-the-shelf advanced technologies. A mere 12% of the firms developed new advanced technologies (see Table 2). Another 18.9% of the surveyed firms customized or significantly modified existing advanced technologies.

Table 2: Methods of acquisition of advanced technologies by Canadian firms, 2014

Method	% Surveyed enterprises
Purchasing off-the-shelf advanced technologies	58.3
Licensing advanced technologies	20.9
Customizing or significantly modifying existing advanced technologies	18.9

Method	% Surveyed enterprises
Leasing off-the-shelf advanced technologies	15.8
Developing new advanced technologies	11.9
Other methods	10.7
Signing sharing agreements	5.7
Partnering with the private sector	5.0
Partnering with academic or research organizations	1.9
Merging with or acquiring another enterprise with advanced technologies	1.4

Source: Survey of Advanced Technologies

http://www.statcan.gc.ca/daily-quotidien/160318/t002c-eng.htm

Table 3 indicates the main export markets in 2009 and 2012.

Table 3: Main export markets by Canadian firms. Percentage of sales of highest-selling good or service across selected geographic markets, 2009 and 2012

Geographic markets	2009	2012
Local market (23)	63.4	58.1
Rest of province or territory	17.9	19.9
Rest of Canada	9.5	10.3
United States	6.6	8.6
Europe		1.1
Asia Pacific	0.7	
Rest of the world	0.8	

Source: Survey of innovation and business strategy

http://www.statcan.gc.ca/daily-quotidien/140825/dq140825b-cansim-eng.htm

2.2 Canadian literature on industrial innovation based on surveys

In 1993 Statistics Canada conducted its first Innovation survey which was aimed at the manufacturing sector. In 1996 it conducted another study, this time for innovation in the financial sector. Several other surveys followed the 1999 Survey of Innovation, and then there were those of 2003, 2005, 2009, and 2012, main results of which were published in 2014. Table A.1 in the

appendix summarizes the evolution of the Innovation Surveys produced by Statistics Canada using the Oslo Manual methodology.

Among the first research papers that used this information were those of Baldwin (1997), Mohnen and Rosa (2002), Therrien and Mohnen (2003), and Mohnen and Therrien (2003), Amara and Landry (2005), Amara, Landry and Traoré (2008), and Therrien, Doloreux and Chamberlin (2011) followed. These Statistics Canada Innovation Surveys found that the most critical government programs to support innovation were tax credits for R&D, both federal and provincial, (almost 51% of innovative firms used them between 2010 and 2012), followed by direct grants such as the Industrial Research Assistance Program (IRAP) funding (17%), hiring programs for recent graduates, and training. Large enterprises conducted innovation more often than medium-sized and small enterprises, but across the board, for all sizes, over the years the percentage of firms conducting innovation declined in Canada. Innovation was more frequent in professional, scientific, and technical services, followed by manufacturing, finance and insurance, and information and cultural industries. Transportation, mining, quarrying, and oil and gas extraction, and wholesale are less innovative. Ontario was the most innovative region, followed by Alberta and Quebec.

The sums involved are large: in Canada, the Scientific Research and Experimental Development (SR&ED) federal program has a fiscal cost of C$3.5 billion and some 24,000 firms from all economic sectors make use of this incentive. In addition, in the case of Canada, public direct expenditure on innovation amounts to C$1.5 billion, which includes National Research Council appropriations, IRAP's advisory services, IRAP's direct R&D funding for Small and Medium Enterprises (SMEs), the Strategic Aerospace and Defense Initiative, and other programs. All in

all, the federal government spent almost $5 billion in support for private sector R&D in 2010-11 (Canada, Expert Panel, 2011). With such sums on the expenditures side of the national accounts, a precise and regular assessment of their effect should be mandatory.

In a recent study on the determinants of R&D in Canada's knowledge-intensive business services (KIBS), using a methodology similar to the one proposed by the Oslo Manual but not using Statistics Canada data, Doloreux et al. (2016) found that firms' internal capacity – not external factors such as public policy – was the most important factor explaining innovation. The sample included 1,142 firms based in Québec, a sample that is comparable to a Statistics Canada sample for all of Canada.

2.3 The effect of innovation on exports

A fairly large amount of academic research has been devoted to the links between innovation and exports. Many of these papers address what is often called the neotechnology theory of trade based on the works of Posner (1961) and Vernon (1966), among others (Zhao and Li, 2001). These studies emphasize the fact that innovative firms tend to gain market share in the global economy. Trade of manufacturing products between advanced countries is often the result of technical change producing comparative cost differences.

Some of these studies are based on the Innovation Surveys. The majority of these studies analyzed the impact of innovation on exports both in manufacturing and in science-based industries (Cassiman et al. 2010; Pla-Barber & Alegre, 2007; Sahaym et al. 2012), but a minority went in the other direction and studied the impact of exports on innovation (Crespi & Zuniga, 2012; De Fuentes, Dutrénit, Santiago, & Gras, 2015). A Canadian study (Lileeva and Trefler,

2010) showed that, after the NAFTA agreement passed in the late 1990s and opened export markets to Canadian firms, product and process innovation in Canada accelerated, followed by export growth. In addition, a Korean study showed that innovation increased exports in most industries, while in another the reverse was true: exports increased innovation (Kim et al. 2009). Similarly, a study on Slovenia found that, in most industries, the rise of exports had a positive impact on innovation after the country entered in the European Union (de Loecker, 2007). Other studies confirmed the exports-to-innovation link (Yang and Chen, 2012). Using the CIS for Britain, Harris and Li (2009) found that both size and R&D activities are linked to export activities. Employing the CIS for Slovenia, Damijan et al. (2010) developed the "learning-by-exporting" hypothesis, underlining the reverse causality, from exports to innovation. They insist on the fact that the innovation and exports link may work in both directions, but that few authors have explored the learning effects of exporting, and even fewer have explored the geography of exports on innovation.

Some other studies have used ad hoc surveys to explore the effect of three types of global innovation networks. These networks include exports, international collaboration, and interaction with firms' subsidiaries. These works show in general that firms with more global collaborations also generate more new-to-the world innovation (Harirchi & Chaminade, 2014), and that the decision to engage in global networks is greatly influenced by the technological capabilities of firms from the country of origin, while the selection of the country of destination is based on the contextual characteristics of the host country (Cristina Chaminade, 2011; C. Chaminade & De Fuentes, 2012). These studies emphasize the importance of analyzing in more detail the geography of these networks, as the effort to engage in any type of global networks, and the learning processes associated, vary according the characteristics of the country of destination.

In addition, Szczgielski et al. (2017) found that, for Poland and Turkey, exporting firms are more likely to innovate and receive government grants. Therefore, we argue that there is a sort of multiplier effect of the interaction between exports and innovation.

3. Methodology

3.1 Data

The main aim of this paper is to analyze the main drivers for innovation at the firm level differentiating between three types of innovation –product, service and process— and also the effect that these three types of innovation have on firm's performance measured in revenues, and access to different markets. In addition, we differentiate their effects for manufacturing and service sectors for the years 2009 and 2012. To conduct the analysis, we use information from the Canadian Survey of Innovation and Business Strategy (SIBS) from 2009 and 2012. Both surveys are comparable, as they contain the same questions. The survey is conducted by Statistics Canada with the objective to provide statistical information on the strategic decisions, innovation activities, and operational tactics used by Canadian enterprises. The survey also collects information on the involvement of enterprises in global value chains.

The Canadian Survey of Innovation and Business Strategies (SIBS) has several advantages over the European CIS, as firms answer several questions on their strategies, the markets in which they operate and their competitors. The SIBS questions address the following themes: business strategies and monitoring, enterprise structure, operational activities, relocation of business activities, sales activities, business practices and relationships with suppliers, advanced technology use, technology and non-technology innovation, production performance

management, human resource management, main product and market structure, government support programs, and obstacles to innovation. For this analysis, we will focus on the sections of the survey related to innovation business strategies, enterprise structure, relocation of innovation activities, sales activities, technology and non-technology innovation, and main product and market structure. The SIBS database does not include general information about some firm's characteristics, such as number of workers, revenue, age, etc. This data was completed by using additional survey data from Statistics Canada.

According to Statistics Canada, the target population for the survey was defined so as to meet information needs at different levels of industry detail. The population was limited to enterprises that had at least 20 employees and revenues of at least $250,000 and were within 14 sectors, defined according to the North American Industry Classification System (NAICS, Statistics Canada, 2007).[1] Using NAICS (Statistics Canada, 2007), we classify these firms as high-tech manufacturing, low-tech manufacturing, KIBS, or traditional services. For the observations in 2009, a stratified random sample of 6,233 enterprises was selected from a population of 37,216 enterprises. For the observations in 2012, a stratified random sample of 7,818 enterprises was selected from a target population of 67,807 enterprises of Statistics Canada's Business Register. The target population was stratified by industrial grouping, region, and three size classes based on the number of employees per enterprise.[2]

[1] Agriculture, Forestry, Fishing and Hunting; Mining, Quarrying, and Oil and Gas Extraction; Utilities; Construction; Manufacturing; Wholesale Trade; Retail Trade; Transportation and Warehousing; Information and Cultural Industries; Finance and Insurance; Real Estate and Rental and Leasing; Professional, Scientific and Technical Services; Management of Companies and Enterprises; and Administrative and Support, Waste Management and Remediation Services. For this analysis, we excluded Agriculture, Forestry, Fishing and Hunting; Mining, Quarrying, and Oil and Gas Extraction; Utilities; and Construction, focusing only on services and manufacturing industries.
[2] Small (20 to 99 employees); medium-sized (100 to 249 employees); and large (more than 249 employees).

3.2 Error detection and imputation, outliers

Following Mohnen et al. (2006), we performed an extensive cleaning for outliers and inconsistencies in the data set --e.g., firms with fewer than twenty employees, with missing industry affiliation, with expenditures in innovation in excess of 100% of sales, and with R&D-to-sales ratios in excess of 80%. Our usable sample for 2009 contains 4,024 firms – 2,878 manufacturing firms and 957 services firms – and for 2012 contains 4,285 firms – 2,533 manufacturing firms and 1,412 services firms.

3.3 The model

In order to identify the main drivers for innovation at the firm level and also the effect that these three types of innovation have on firm's performance we built a two-stage model. The first stage of the model is represented by three Probit equations (equations 1.1, 1.2 and 1.3), where the dependent variable is a dummy variable that indicates if the firm introduced product, process or service innovation for the years 2008-2009 and 2010-2012. The second stage is the impact equation and is represented by two Tobit equations (equation 2.1 and 2.2), where the dependent variables represent the revenues and percentage of international markets.

$Prod_i = \Sigma X_i\beta + \varepsilon_i$ (eq. 1.1)

$Serv_i = \Sigma X_i\beta + \varepsilon_i$ (eq. 1.2)

$Proc_i = \Sigma X_i\beta + \varepsilon_i$ (eq. 1.3)

$Rev_i = \Sigma X_i \beta + u_i$ (eq. 2.1)

$Mark_i = \Sigma X_i \beta + u_i$ (eq. 2.2)

The set of independent variables for equations 1.1, 1.2 and 1.3 consists of those factors that have been associated by the literature with innovation determinants. For this paper we included structural factors such as firm size, if the firm is a subsidiary, location of headquarters in the US, Europe or Canada, and type of sector; innovation strategy, such as strategic focus on innovation, close vs. open innovation, outsource of innovation, offshore of production of goods or services; knowledge, such as engaging employees in innovation, and employees with university degree.

For the second stage of the model, the set of independent variables contains those also suggested by previous literature as having an effect on innovation impact. For this paper, we focused on structural factors, such as location of headquarters, and sector; value creation, such as unique features from products or services; non technological innovation such as market and organizational; knowledge, such as employees with university degree; innovation strategy, such as close vs. open innovation, outsource innovation, and level of innovation.

For both equations we controlled for industry dummies. The error term indicates the effect of omitted variables. Estimates of marginal effects are presented, and standard errors are estimated by bootstrapping.

We computed this two-stage model on our complete sample of manufacturing and services firms for the 2009 and 2012 periods. To better capture the behavior of services and manufacturing firms, we computed three different model specifications. Model 1 includes the complete sample. Model 2 is computed for manufacturing firms only, and Model 3 is computed for services firms only.

3.4 Variables

Table 4 indicates the variables used in this model and the stages where we used each of them. We used variables related to firms' characteristics such as firm size, as larger firms tend to spend more on innovation; they are also more prone to capture economies of scale related to production and R&D, and they also benefit from a larger pool of human resources and are more likely to engage in innovation activities (Crespi and Zuniga, 2012). We used firm size in stage 1. We also relied on variables that indicate the type of firm --for example, whether it is headquartered in Canada, Europe, or the U. S., whether it is a subsidiary, or whether the firm has subsidiaries in Europe or the U.S. As Mohnen (2010) and Crespi and Zuniga (2012) argue, firms with headquarters or subsidiaries in developed countries enjoy a strong network for knowledge sharing and support for innovation. We controlled by sector across the two stages of our model. We also used strategy related variables, such as innovation strategy, and strategic focus on innovation, as firms with a deliberate innovation strategy also engage in more innovation activities. Within this set of variable we also include those related to the strategy to access external knowledge for innovation, for example close vs. open innovation, outsource of innovation, and offshore of production of goods or services. Chesborough (2003) for example highlighted the importance of external sources of knowledge for the innovation process. Highly skilled human resources play a crucial role for the success of firms (D'Este et al. 2014), we used variables related to engaging employees in innovation, and employees with university degree to account for the effect that highly skilled human resources have on the innovation process.

Mohnen (2010) and Griffith et al. (2006), among others, argue that firms with export markets tend to innovate more. In particular for the second stage of the equation we used variables related

to the importance of value creation, as these has been recognized as an important factor for firm performance. We used variables such as unique features from products or services; non-technological innovation such as market and organizational; and level of innovation.

Table 4: Descriptive variables

Variables	Code	Description	Stage
Close innovation	close_innov	Dummy=1 if firm generates innovation mainly relying from internal sources of knowledge	1
Open innovation	open_innov	Dummy=1 if firm generates innovation mainly relying from external sources of knowledge	1
Outsource innovation	outsource_innov	Dummy=1 if firm outsource innovation activities	1
Production of goods outside Canada within firm	c0142013	Dummy=1 if firm produces goods outside Canada within firm	1
Provision of services outside Canada within firm	c0142023	Dummy=1 if firm provides services outside Canada within firm	1
Engaging employees in decision making	empl_dm	Dummy=1 if firm engages employees in decision making	
Micro firm	micro_firm	Dummy=1 if firm has less than 49 employees	1
Small firm	small_firm	Dummy=1 if firm has more than 50 and less than 249 employees	1
Medium firm	medium_firm	Dummy=1 if firm has more than 250 and less than 499 employees	1
Subsidiary	c0090000	Dummy=1 if firm is a subsidiary	1
% of employees with university degree	c0630000	Numeric= percentage of employees with university degree	1&2
Focus leader	focus_leader	Dummy=1 if strategic focus is leader in market	1
Strategic focus on developing new products/services	strat_new	Dummy=1 if strategic focus is developing new products/services	1
Strategic focus on new managerial practices	strat_new_man	Dummy=1 if strategic focus is implementing new managerial practices	1
Strategy against competitors	strat_against_comp	Dummy=1 if strategic focus is strategy against competitors	1
Strategy to innovate with customers	strat_customers	Dummy=1 if strategic focus is innovate with customers	1
High tech	htmanuf	Dummy=1 if firm is high-tech manufacturing	1&2
Low tech	ltmanuf	Dummy=1 if firm is low-tech manufacturing	1&2
Traditional services	tradserv	Dummy=1 if firm is traditional services	1&2
Knowledge intensive business services	kibs	Dummy=1 if firm is knowledge intensive business services	1&2
Innovative products/services has unique features	unique_features	Dummy=1 if firm main innovation has unique features	2
Organizational innovation	org_innov		2
Market innovation	market_innov		2
US or Europe headquarter	north_HQ	Dummy=1 if firm is headquartered in US or Europe	2
Canada headquarter	can_HQ	Dummy=1 if firm is headquartered in Canada	2
Subsidiary in US or Europe	north_SD	Dummy=1 if firm has subsidiaries in US or Europe	2
New to market innovation	c0840010	Dummy=1 if main innovations are new to market	2
New to firm innovation	c0840020	Dummy=1 if main innovations are new to firm	2

4. Empirical analysis

We present the results of our analysis in two main stages. In equation 1.1, 1.2 and 1.3 (stage 1), we observe the main determinants for three different types of innovation. In equation 2.1 and 2.2 (stage 2), we observe the main determinants for firm performance, including the predictors from stage 1. Results from these two equations are presented in Table 5 and Table 6.

4.1. Determinants to innovation

Identifying the main determinants for innovation and differentiating by type of innovation is critical, as it contributes to a better understanding of innovative performance across Canadian firms, and also provides valuable information regarding the main factors that contribute to firm performance.

Many of the variables that we tested as determinants of innovation are associated with firm size, type of firm, and innovation strategy. Our results suggest that firm size is an important determinant for innovation, but mainly for the 2012 period, in particular for micro and small firms, for both the manufacturing and the service sectors. However, for medium-size firms results are not significant for 2012. Our results contribute to those by De Fuentes et al. (2015), as we show the effect of firm size for two different periods.

Using an open innovation strategy that is related with the identification and use of external sources of information also does play an important role for innovation output. As argued before by Chesborough (2003), and Laursen and Salter (2011) the use of external sources of information remains a critical component for innovation performance at the firm level, and our results show that indeed, having an open innovation strategy has a positive impact on innovation output.

As well, engaging employees on innovation activities shows to be positive, in particular for service and process related innovation, while highly skilled human resources are positive for all the three types of innovation. This result is linked to previous discussion in innovation studies (D'Este et al 2014) that show the importance of highly skilled human resources for the innovation process at the firm level.

Regarding innovation strategy, the variable that has positive results across all three types of innovation is strategic focus on developing new products/services. While focus on new managerial practices, strategy against competitors and strategy to innovate with customers, are also relevant but mainly for innovation in product and services.

(Table 5 & 6 here)

4.2. Firm performance

Regarding the second stage of the model, innovation impact, we differentiate the analysis between impact on firm's revenue, and percentage of international market. Firm revenue is measured as the logarithm of firm's revenue, and international market as the percentage of sales to international markets, as we argue that firms that innovate more also engage in more international markets (Griffith et al. 2006)

Organizational innovation, the level of innovation and the predictors of service and process innovation are important determinants for firm performance in terms of firm's revenue. While unique features of products or services, having a subsidiary in US or Europe, and the predictors

of process and product innovation are important determinants for the impact of firm performance measured as access to international markets.

As several studies have shown there is an important correlation between firm's innovation and access to international markets. Our results suggest that innovation output, does indeed play an important role in accessing international markets.

(Table 7 & 8 here)

5. Conclusions

The main objective of this paper was to contribute to the discussion on innovation and firm performance of Canadian firms for the period 2009-2012. We analyzed the main determinants of innovation output at the firm level that include structural and strategic factors and differentiate by the type of innovation output, process, service, and product. Our results indicate that strategic factors play a decisive role on innovation output, in particular for product and service innovation. Regarding innovation impact on firm's revenue and access to international markets, our results show that there is also a trade off between the factors that have impact on revenue versus those that have an impact on international markets.

As suggested by Damijan et al. (2010), there is a positive causality effect between exports and innovation. Firms that engage in exports tend to show higher levels of innovation intensity, and also as our results show, firms that innovate more show a positive reach in international markets. There is an abundant literature on the benefits of trade agreements and export growth and product diversification. Yet in Canada less than 4% of companies export, and most of these export only to the U.S. (Currie, 2014). He suggests several methods for increasing and diversifying Canadian

exports. They include the signature of trade agreements with other regions and countries, such as the recent CETA (Canada-European Union Comprehensive Economic and Trade Agreement), signed on October 30, 2016, which will dismantle almost all tariff barriers with the European Union, open EU public markets at all levels, and may provide an incentive to innovation in Canada (Canada, 2016).

Finally, this study has several limitations. First, the data collected from 2009 and 2012 is comparable, but the firms answering the survey might vary across periods. Second, we only tested for some of the variables indicated in the literature, and recognize the complexity of innovation and also the difficulty to capture the effect of all the important determinants for innovation performance.

Appendix

Table A.1: Canada's main Innovation Surveys, 1993-2014

3-year Reference period	Year published	Sector(s) included	Types of innovation included	Conducted by
1991-3	1993	Manufacturing	Product and process innovation and advanced technology	Statistics Canada
1994-6	1996	Communications, financial services, technical business services	Product and process innovation and advanced technology	Statistics Canada
1997-9	1999	Construction	Innovation and advanced technology in the construction industry	Statistics Canada (Survey 4224)
1997-9	1999	Manufacturing and selected natural resource industries	Product and process innovation and advanced technology	Statistics Canada
2003-5	2005	ICT, professional, scientific, and technical service industries	Product and process innovation and advanced technology	Statistics Canada,
2002-4	2006	Manufacturing and logging industries	Survey of product, process, non-technical innovation and business strategy	Statistics Canada, with Industry Canada, ISQ, NRC, & other federal and provincial agencies (Survey 4218)
2007-8	2009	Most sectors, including agriculture, manufacturing, trade, and utilities[3]	Survey of product, process, non-technical innovation and business strategy	Statistics Canada with Industry Canada and Foreign Affairs and International Trade Canada (Survey 5171)

[3] Agriculture, Forestry, Fishing and Hunting; Mining, Quarrying, and Oil and Gas Extraction; Utilities; Construction; Manufacturing; Wholesale Trade; Retail Trade; Transportation and Warehousing; Information and Cultural Industries; Finance and Insurance; Real Estate and Rental and Leasing; Professional, Scientific and Technical Services; Management of Companies and Enterprises; Administrative and Support, Waste Management and Remediation Services

Table 5: Decision to innovate 2009

	All sample			Manufacturing			Services		
Variables	innovation output all sample dummy product	innovation output all sample dummy service	innovation output all sample dummy all process	innovation output manufacturing dummy product	innovation output manufacturing dummy service	innovation output manufacturing dummy all process	innovation output services - dummy product	innovation output services - dummy service	innovation output services - all dummy process
Close innovation	1.845***	1.428***	2.431***	2.074***	1.132***	2.573***	1.237***	2.149***	2.033***
	(0.057)	(0.053)	(0.109)	(0.076)	(0.059)	(0.154)	(0.160)	(0.139)	(0.227)
Open innovation	1.374***	0.974***	2.623***	1.593***	0.760***	2.738***	0.905***	1.764***	2.416***
	(0.079)	(0.055)	(0.117)	(0.090)	(0.061)	(0.178)	(0.157)	(0.170)	(0.244)
Outsource innovation	1.173***	0.760***	2.603***	1.334***	0.599***	2.781***	1.043***	1.186***	2.178***
	(0.100)	(0.074)	(0.141)	(0.088)	(0.075)	(0.149)	(0.154)	(0.198)	(0.293)
Production of goods outside Canada within firm	0.348***	-0.149*	-0.147	0.195*	-0.077	-0.144	1.153***	-0.461*	-0.330
	(0.083)	(0.090)	(0.113)	(0.102)	(0.082)	(0.141)	(0.255)	(0.251)	(0.218)
Provision of services outside Canada within firm	-0.062	0.099	0.082	-0.071	0.032	0.170	-0.121	0.131	-0.066
	(0.101)	(0.072)	(0.105)	(0.111)	(0.109)	(0.131)	(0.140)	(0.186)	(0.166)
Engaging employees in decision making	0.048	0.193***	0.059	0.015	0.200***	0.111	0.071	0.209	-0.047
	(0.060)	(0.059)	(0.053)	(0.066)	(0.063)	(0.075)	(0.116)	(0.137)	(0.146)
Micro firm	0.115	0.057	-0.202*	0.174	0.156	-0.238*	0.187	-0.089	-0.252
	(0.098)	(0.086)	(0.121)	(0.126)	(0.117)	(0.141)	(0.223)	(0.248)	(0.196)
Small firm	0.080	-0.048	-0.131	0.058	0.033	-0.206	0.323	-0.210	-0.061
	(0.102)	(0.089)	(0.110)	(0.111)	(0.105)	(0.142)	(0.267)	(0.241)	(0.219)
Medium firm	0.028	-0.060	-0.028	0.093	-0.057	-0.147	0.132	-0.108	0.196
	(0.111)	(0.099)	(0.141)	(0.124)	(0.123)	(0.170)	(0.304)	(0.281)	(0.297)
Subsidiary	0.005	-0.102	-0.081	0.102	-0.107	-0.019	-0.084	-0.227	-0.232
	(0.065)	(0.088)	(0.078)	(0.108)	(0.085)	(0.098)	(0.146)	(0.142)	(0.146)
% of employees with university degree	0.004**	0.00189*	-0.001	0.008***	0.004**	-0.006***	0.000	0.000	0.003
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Focus leader	0.346***	0.165**	-0.196**	0.328***	0.125	-0.165***	0.286	0.004	-0.066
	(0.081)	(0.076)	(0.091)	(0.081)	(0.087)	(0.063)	(0.243)	(0.185)	(0.228)
Strategic focus on developing new products/services	0.573***	0.199***	-0.080	0.570***	0.150**	-0.156**	0.499***	0.409***	0.139
	(0.066)	(0.049)	(0.056)	(0.074)	(0.065)	(0.068)	(0.090)	(0.135)	(0.133)
Strategic focus on new managerial practices	-0.052	0.145***	0.235***	-0.020	0.173***	0.267***	-0.136	0.036	0.157
	(0.052)	(0.031)	(0.054)	(0.050)	(0.054)	(0.061)	(0.131)	(0.107)	(0.104)
Strategy against competitors	0.167***	0.264***	-0.029	0.220***	0.269***	-0.043	0.143	0.217*	0.055
	(0.055)	(0.053)	(0.063)	(0.070)	(0.070)	(0.059)	(0.117)	(0.116)	(0.126)
Strategy to innovate with customers	-0.030	0.300***	0.275***	-0.026	0.273**	0.281***	-0.147	0.295**	0.325*
	(0.075)	(0.068)	(0.089)	(0.114)	(0.109)	(0.100)	(0.155)	(0.142)	(0.176)
High tech	0.715***	-0.655***	0.397**	0.112*	0.051	0.015			
	(0.220)	(0.180)	(0.200)	(0.065)	(0.068)	(0.084)			
Low tech	0.663***	-0.722***	0.428**						
	(0.227)	(0.191)	(0.210)						

	All sample			Manufacturing			Services		
Variables	innovation output all sample dummy product	innovation output all sample dummy service	innovation output all sample dummy all process	innovation output manufacturing dummy product	innovation output manufacturing dummy service	innovation output manufacturing dummy all process	innovation output services - dummy product	innovation output services - dummy service	innovation output services - all dummy process
Traditional services	-0.070	0.217	-0.224						
	(0.193)	(0.142)	(0.169)						
Knowledge intensive business services	-0.203	0.241	-0.131				0.052	0.020	-0.013
	(0.214)	(0.157)	(0.228)				(0.131)	(0.135)	(0.141)
	-3.605***	-0.770	-2.690***	-0.101	-1.203	-2.152**	-4.626**	-1.039	-1.834**
	(0.902)	(0.940)	(0.809)	(0.952)	(0.859)	(0.958)	(2.100)	(2.037)	(0.783)
Observations	4,222	4,222	4,222	3,002	3,002	3,002	1,026	1,026	1,026

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1Sector Control variables included

Table 6: Innovation output 2012

	All sample			Manufacturing			Services		
Variables	innovation output all sample dummy product	innovation output all sample dummy service	innovation output all sample dummy all process	innovation output manufacturing dummy product	innovation output manufacturing dummy service	innovation output manufacturing dummy all process	innovation output services - dummy product	innovation output-services - dummy service - Missing	innovation output services - all dummy process
Close innovation	1.925***	1.537***	2.360***	2.418***	1.105***	2.677***	1.119***	1.237***	1.968***
	(0.062)	(0.061)	(0.107)	(0.120)	(0.066)	(0.175)	(0.098)	(0.160)	(0.152)
Open innovation	1.347***	1.184***	2.786***	1.791***	0.789***	3.300***	0.843***	0.905***	2.143***
	(0.087)	(0.061)	(0.113)	(0.126)	(0.085)	(0.205)	(0.104)	(0.157)	(0.130)
Outsource innovation	1.254***	0.894***	2.716***	1.354***	0.675***	3.117***	1.095***	1.043***	2.178***
	(0.103)	(0.084)	(0.150)	(0.132)	(0.103)	(0.234)	(0.182)	(0.154)	(0.226)
Production outside Canada within firm	0.370***	-0.024	0.063	0.151	0.018	0.045	0.932***	1.153***	0.147
	(0.095)	(0.103)	(0.097)	(0.114)	(0.101)	(0.131)	(0.159)	(0.255)	(0.268)
Production of goods outside Canada within firm	-0.045	0.073	-0.111	0.073	0.156	-0.116	-0.121	-0.121	-0.200
	(0.097)	(0.070)	(0.089)	(0.128)	(0.105)	(0.119)	(0.150)	(0.140)	(0.145)
Engaging employees in decision making	0.016	0.180***	0.065	-0.095	0.161**	0.145**	0.121	0.071	0.012
	(0.056)	(0.054)	(0.049)	(0.072)	(0.069)	(0.073)	(0.104)	(0.116)	(0.105)
Micro firm	0.332***	0.196**	-0.317***	0.146	0.282*	-0.388**	0.522***	0.187	-0.338*
	(0.116)	(0.087)	(0.122)	(0.158)	(0.146)	(0.180)	(0.183)	(0.223)	(0.198)
Small firm	0.232*	0.104	-0.100	0.038	0.124	-0.112	0.426**	0.323	-0.114
	(0.119)	(0.082)	(0.108)	(0.142)	(0.127)	(0.171)	(0.198)	(0.267)	(0.206)
Medium firm	0.128	-0.137	-0.204	-0.254	-0.017	-0.035	0.625**	0.132	-0.587**
	(0.136)	(0.128)	(0.154)	(0.183)	(0.174)	(0.191)	(0.253)	(0.304)	(0.234)

	All sample			Manufacturing			Services		
Variables	innovation output all sample dummy product	innovation output all sample dummy service	innovation output all sample dummy all process	innovation output manufacturing dummy product	innovation output manufacturing dummy service	innovation output manufacturing dummy all process	innovation output services - dummy product	innovation output-services - dummy service - Missing	innovation output services - all dummy process
Subsidiary	-0.092	-0.160*	-0.095	0.079	-0.318***	-0.158	-0.141	-0.084	-0.065
	(0.084)	(0.083)	(0.082)	(0.108)	(0.101)	(0.123)	(0.146)	(0.146)	(0.131)
% of employees with university degree	0.00557***	0.00450***	-0.00226*	0.0116***	0.00481***	-0.00596***	0.00448***	0.000	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Focus leader	0.126*	0.172*	-0.027	0.237*	0.123	-0.170*	-0.230	0.286	0.329
	(0.073)	(0.094)	(0.087)	(0.127)	(0.112)	(0.100)	(0.195)	(0.243)	(0.252)
Strategic focus on developing new products/services	0.566***	0.163**	-0.137**	0.476***	0.092	-0.098	0.789***	0.499***	-0.199*
	(0.058)	(0.071)	(0.066)	(0.071)	(0.063)	(0.079)	(0.093)	(0.090)	(0.120)
Strategic focus on new managerial practices	0.0952*	0.094	0.156**	0.028	0.121**	0.133	0.062	-0.136	0.192*
	(0.055)	(0.058)	(0.062)	(0.070)	(0.060)	(0.084)	(0.109)	(0.131)	(0.099)
Strategy against competitors	0.200***	0.196***	0.044	0.216**	0.179**	0.055	0.204*	0.143	0.103
	(0.053)	(0.058)	(0.048)	(0.089)	(0.072)	(0.076)	(0.110)	(0.117)	(0.093)
Strategy to innovate with customers	0.043	0.362***	0.216***	-0.003	0.347***	0.299***	0.134	-0.147	0.080
	(0.076)	(0.078)	(0.074)	(0.106)	(0.098)	(0.113)	(0.113)	(0.155)	(0.115)
High tech	0.581***	-0.718***	0.153	0.088	0.058	-0.232**			
	(0.114)	(0.120)	(0.141)	(0.088)	(0.081)	(0.092)			
Low tech	0.490***	-0.757***	0.442***						
	(0.117)	(0.140)	(0.144)						
Traditional services	-0.446***	0.159*	-0.335**						
	(0.113)	(0.090)	(0.136)						
Knowledge intensive business services	-0.296**	0.207	-0.047				0.243**	0.052	0.168
	(0.144)	(0.129)	(0.140)				(0.110)	(0.131)	(0.119)
	-2.706***	-1.102	-3.692***	-1.995**	-0.775	-3.361***	-3.060**	-4.626**	-3.922***
	(0.799)	(0.741)	(0.717)	(0.910)	(0.780)	(0.951)	(1.399)	(2.100)	(1.204)
	4,450	4,450	4,450	2,616	2,616	2,616	1,483	1,483	1,483

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1Sector Control variables included

Table 7: Innovation impact 2009

	All sample		Manufacturing		Services	
Variables	Impact - Revenue	Impact - International Markets	Impact - Revenue	Impact - International market	Impact - Revenue	Impact - International Market
Innovative products/services has unique features	-0.092	6.507***	-0.083	7.701***	0.313	-0.166
	(0.109)	(2.519)	(0.119)	(2.513)	(0.252)	(6.258)

	All sample		Manufacturing		Services	
Variables	Impact - Revenue	Impact - International Markets	Impact - Revenue	Impact - International market	Impact - Revenue	Impact - International Market
Organizational innovation	0.273***	-3.459	0.302***	-0.896	0.205	-13.87**
	(0.093)	(2.500)	(0.109)	(2.964)	(0.231)	(6.651)
Market innovation	0.039	1.369	0.091	-0.955	-0.243	-1.688
	(0.105)	(2.175)	(0.093)	(2.457)	(0.243)	(4.096)
US or Europe headquarter	-0.069	-12.440	-0.005	-13.680	2.017	25.840
	(0.324)	(8.471)	(0.388)	(9.871)	(2.624)	(39.750)
Canada headquarter	-1.001***	-19.43**	-0.699*	-13.290	2.052	7.669
	(0.348)	(8.445)	(0.374)	(9.863)	(2.524)	(37.820)
Subsidiary in US or Europe	0.832***	23.95***	0.741***	19.53***	-0.148	22.58***
	(0.102)	(2.505)	(0.146)	(2.839)	(0.249)	(5.334)
% of employees with university degree	0.0135***	0.279***	0.0301***	0.300***	-0.006	-0.035
	(0.003)	(0.066)	(0.004)	(0.116)	(0.004)	(0.072)
New to market innovation	0.500***	-1.814	0.424***	-2.858	0.409*	2.088
	(0.097)	(1.962)	(0.125)	(2.978)	(0.219)	(6.447)
New to firm innovation	0.356***	-3.070	0.412***	-2.339	0.297	-3.563
	(0.112)	(2.747)	(0.145)	(2.354)	(0.290)	(6.712)
High tech	-0.894**	6.998	0.088	16.93***		
	(0.414)	(11.380)	(0.113)	(2.346)		
Low tech	-1.094***	-11.030				
	(0.389)	(11.220)				
Traditional services	0.468	42.76***				
	(0.381)	(10.210)				
Knowledge intensive business services	-0.040	46.23***			0.204	6.947
	(0.334)	(10.360)			(0.252)	(4.449)
Predictor output product innovation	-0.291	37.18***	1.756**	63.52***	0.352	111.5***
	(0.552)	(14.390)	(0.771)	(17.830)	(0.698)	(18.110)
Predictor output service innovation	-2.272***	-98.11***	-5.274***	-82.69***	-5.822***	-106.8***
	(0.582)	(14.810)	(0.777)	(19.170)	(1.081)	(24.030)
Predictor output process innovation	4.678***	150.7***	3.247**	116.4**	6.555***	120.1**
	(1.638)	(42.110)	(1.582)	(46.580)	(2.168)	(51.530)
Constant	14.42***	5.409	11.05***	-39.90**	13.63***	24.730
	(0.648)	(18.780)	(0.687)	(18.790)	(2.427)	(44.010)
Observations	1,821	2,077	1,394	1,511	388	456

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1Sector Control variables included

Table 8: Innovation impact 2012

	All sample		Manufacturing		Services	
Variables	Impact - Revenue	Impact - International Markets	Impact - Revenue	Impact - International market	Impact - Revenue	Impact - International Market
Innovative products/services has unique features	-0.308**	6.053***	-0.187	8.402***	-0.471**	2.276
	(0.120)	(2.189)	(0.158)	(2.858)	(0.239)	(7.208)
Organizational innovation	0.347***	-1.504	0.402***	-2.729	0.312**	1.303
	(0.083)	(1.963)	(0.086)	(2.088)	(0.122)	(3.953)
Market innovation	0.0980*	-1.693	0.155	-2.127	0.110	0.256
	(0.055)	(2.227)	(0.096)	(2.182)	(0.146)	(4.220)
US or Europe headquarter	0.161	-5.103	0.008	4.328	-0.253	-35.84**
	(0.295)	(6.663)	(0.290)	(8.446)	(0.749)	(17.170)
Canada headquarter	-1.032***	-25.82***	-1.026***	-10.670	-1.139	-48.39***
	(0.260)	(6.596)	(0.283)	(8.033)	(0.742)	(16.820)
Subsidiary in US or Europe	0.921***	32.41***	0.893***	21.97***	0.568**	48.59***
	(0.096)	(2.519)	(0.124)	(2.690)	(0.223)	(4.453)
% of employees with university degree	0.00767***	0.425***	0.0196***	0.687***	0.001	0.340***
	(0.002)	(0.051)	(0.003)	(0.067)	(0.002)	(0.061)
New to market innovation	-1.596***	3.888	-1.474***	2.000	-1.971***	7.958
	(0.084)	(2.384)	(0.125)	(2.549)	(0.213)	(5.028)
New to firm innovation	-2.382***	-4.722*	-2.363***	-3.354	-2.481***	-7.306
	(0.089)	(2.711)	(0.121)	(3.428)	(0.198)	(4.906)
High tech	0.036	61.03***	0.240***	22.29***		
	(0.122)	(5.191)	(0.082)	(1.953)		
Low tech	-0.378***	36.73***				
	(0.110)	(4.911)				
Traditional services	-0.431***	17.89***				
	(0.093)	(4.753)				
Knowledge intensive business services	-0.803***	12.37**			0.090	-1.542
	(0.130)	(5.654)			(0.141)	(4.344)
Predictor output product innovation	-3.482***	-31.71***	-2.315***	-20.770	0.352	111.5***
	(0.448)	(10.660)	(0.463)	(12.710)	(0.698)	(18.110)
Predictor output service innovation	0.165	8.483	-2.718***	-79.73***	-5.822***	-106.8***
	(0.393)	(10.460)	(0.614)	(14.760)	(1.081)	(24.030)
Predictor output process innovation	4.467***	57.81***	-3.499***	-38.85***	6.555***	120.1**
	(0.650)	(15.740)	(0.674)	(14.640)	(2.168)	(51.530)
Constant	19.73***	-30.74***	19.28***	-3.782	19.48***	-3.535
	(0.289)	(8.278)	(0.283)	(8.767)	(0.735)	(16.360)
Observations	4,122	4,450	2,457	2,616	1,355	1,483

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1Sector Control variables included

Acknowledgments

This work was supported by the The David Sobey Centre for Innovation in Retailing and Services from the Sobey School of Business, the Faculty of Graduate Studies and Research at Saint Mary's University, and SSHRC Canada Research Chair.

We thank the CDER at Statistics Canada for providing us with access to the SIBS 2009 and 2012.

Bibliography

Aboal, D., Garda, P., 2015. Technological and non-technological innovation and productivity in services vis-à-vis manufacturing sectors. Economics and Innovation and New technology 25(5), 435-454.

Amara, N., Landry, R., 2005. Sources of information as determinants of novelty of innovation in manufacturing firms: evidence from the 1999 Statistics Canada Innovation Survey. Technovation 25(3), 245-259.

Amara. N., Landry, R., Doloreux, D., 2009. Patterns of innovation in knowledge-intensive business services. Service Industries Journal 29(4), 407-430.

Amsden, A., 1989. Asia's Next Giant: South Korea and Late Industrialization. Oxford University Press, Oxford.

Amsden, A., Chu, W.W., 2003. Beyond Late Development: Taiwan's Upgrading Policies. MIT Press, Cambridge, Mass.

Baldwin, J.R., 1996. Innovation and success in Canada: small and medium-sized enterprises, in: de la Mothe, J., Paquet, G. (Eds), Evolutionary Economics and the New International Political Economy. Pinter, London, pp. 238-256.

Baldwin, J.R., Gray, T., Johnson, J., 1996. Advanced Technology Use and Training in Canadian Manufacturing. Canadian Business Economics 5, 51-70.

Baldwin, J.R., Sabourin, D., 2000. Innovative activity in Canadian food processing establishments: the importance of engineering practices. International Journal of Technology Management 20 (5-8), 511 -527.

Baum, C., Lööf, F., Nabavi, P., Stephan A., 2016. A new approach to estimation of the R&D-innovation-productivity relationship. Economics of Innovation and New Technology doi: 10.1080/10438599.2016.1202515.

Bhaskaran, S., 2006. Incremental Innovation and Business Performance: Small and Medium-Sized Food Enterprises in a concentrated industry. J. Small Bus. Manag 44, 64-80, doi:10.1111/j.1540-627X.2006.00154.x

Bogliacino, F., Perani, G., Pianta, M., Supino, S., 2009. Innovation in developing countries: evidence from innovation surveys, Paper for the FIRB conference: Entrepreneurship in the knowledge-based economy, Bocconi University, Milan, 7-8 September 2009.

Bogliacino, F., Pianta, M., 2016. The Pavitt taxonomy revisited: patterns of innovation in manufacturing and services. Economia Politica 33(2), 153-180.

Børing, P., Fevolden, A. M., Herstad, S., 2016. Eager and able: a study of innovation activity among young, mature and old firms in Norway. Economic Bulletin 36(1), 291-297.

Busom, I., Corchuelo, B., Martinez-Ros, E., 2014. Tax incentives…or subsidies for business R&D? Small Business Economics, 43(3), 571-596.

Canada, 2016. Canada-European Union Comprehensive Economic and Trade Agreement. A Progressive Trade Agreement for a Strong Middle Class, Ottawa.

Canada, Expert Panel on Innovation in Canada, 2011. Innovation Canada: A Call to Action, Ottawa, Industry Canada.

Cassiman, B., Golovko, E., Martínez-Ros E., 2010. Innovation exports and productivity. International Journal of Industrial Organization 28, 372-376.

Castellacci, F., 2008. Technological paradigms, regimes and trajectories: manufacturing and service industries in a new taxonomy of sectoral patterns of innovation. Research Policy 37(6-7), 978-994.

Castellacci, F., Lie, C. M., 2015. Do the effects of R&D tax credits vary across industries? A meta-regression analysis. Research Policy 44, 819-832.

Chaminade, C., 2011. Do regions make a difference? Exploring the role of regional innovation systems and institutions in global innovation networks. Paper presented at the Ingineus internal meeting, Copenhagen.

Chaminade, C., De Fuentes, C., 2012. Competences as drivers and enablers of globalization of innovation: the Swedish ICT industry and emerging economies. Innovation and Development 2(2), 209-229.

Crépon, B., Duguet E., Mairesse, J. (1998). Research, innovation, and productivity: An econometric analysis at the firm level. NBER Working paper series 1-43.

Crespi, G., Zuniga, P., 2012. Innovation and Productivity: Evidence from Six Latin American Countries. World Development *40*(2), 273-290, doi:http://dx.doi.org/10.1016/j.worlddev.2011.07.010

Currie, B., 2014. How to promote smart exporting among Canadian companies. Ottawa, Institute for Research on Public Policies.

Dahlman, C., Routti, J., Ylä-Anttila, P. (Eds), 2005. Finland as a Knowledge Economy, Elements of Success and Lessons Learned, Washington D.C., World Bank Institute.

Damijan, P., Kostevc, C., Polanec, S., 2010. From innovation to exports or vice versa? The World Economy 33(3), 374-398.

De Fuentes, C., Dutrénit, G., Santiago, F., Gras, N., 2015. Determinants of Innovation and Productivity in the Service Sector in Mexico. Emerging Markets Finance and Trade 51(3), 578-592, doi:10.1080/1540496X.2015.1026693

De Loecker, J., 2007. Do exports generate higher productivity? Evidence from Slovenia. Journal of International Economics 73, 69-98.

Dodgson, M., Mathews, J., Kastelle, T., Hu, M. C., 2008. The evolving nature of Taiwan's national innovation system: the case of biotechnology innovation networks. Research Policy 37(3), 430-445.

Doloreux, D., Shearmur, R., Rodriguez, M., 2016. Determinants of R&D in knowledge-intensive business services firms. Economics of Innovation and New Technology 25(4), 391-405, doi: 10.1080/10438599.2015.1067001

Evangelista, R., Vezzani, A., 2010. The economic impact of technological and organizational innovations. Research Policy 39, 1253-1263.

Fu, X., 2012. How does openness affect the importance of incentives for innovation? Research Policy 41(3), 512-523. doi:http://dx.doi.org/10.1016/j.respol.2011.12.011

Fu, X., 2015. China's Path to Innovation, Cambridge University Press.

Griffith, R., Huergo, E., Mairesse, J., Peters, B., 2006. Innovation and productivity across four European countries. Oxford Review of Economic Policy 22(4), 483–498, https://doi.org/10.1093/oxrep/grj028

Guan, J., Ma, N., 2003. Innovative capability and export performance of Chinese firms. Technovation 23, 737-747.

Gunday, G., Ulusoy, G., Kilic, K., Apkian, L., 2011. Effects of innovation types on firm

performance. International Journal of Production Economics 133(2), 662-676.

Hall, B., Van Reenen, J., 2000. How effective are fiscal incentives for R&D? A review of the evidence. Research Policy 29(4-5), 449-469, doi:http://dx.doi.org/10.1016/S0048-7333(99)00085-2

Halme, K., Lindy, I., Piirainen, K. A., Salminen V., White, J., (Eds), Finland as a Knowledge Economy 2.0, Lessons on policies and governance. World Bank Institute, Washington D.C.,

Harirchi, G., Chaminade, C., 2014. Exploring the Relation Between the Degree of Novelty of Innovations and User-Producer Interaction Across Different Income Regions. World Development 57(0), 19-31. doi:http://dx.doi.org/10.1016/j.worlddev.2013.11.013

Harris, R., Li, Q. C., 2009. Exporting, R&D, and absorptive capacity in UK establishments. Oxford Economic Papers 61, 74-013.

Hipp, C., Grupp, H., 2005. Innovation in the service sector: the demand for service-specific innovation measurement concepts and typologies. Research Policy 34(4), 517-535.

Hong, S., Oxley, L., McCann, P., 2012. A survey of innovation surveys. Journal of Economic Surveys 26(3), 420-444.

Kim, L., 1997. Imitation to Innovation, the Dynamics of Korea's Technological Learning. Harvard Business School Press, Boston.

Kim, S-I., Gopinath, M., Kim, H., 2009. High productivity before or after exports? An empirical analysis of Korean manufacturing firms. Journal of Asian Economics 20, 410-418.

Koga, T., 2003. Firm size and R&D tax incentives. Technovation 23(7), 643-648.

Lerner, J., 2009. Boulevard of Broken Dreams, Why Public Efforts to Boost Entrepreneurship and Venture Capital have failed – and what to do abut it. Princeton University Press, Princeton, NJ.

Lilieeva, A., Trefler, D., 2010. Improved access to foreign markets raises plant-level productivity…for some plants. The Quarterly Journal of Economics, 125(3), 1051-1099.

Lundvall, B.-Å., Borrás, S., (Eds), 2004. Science, Technology and Innovation Policy. Oxford University Press, Oxford.

Mohnen, P., Röller, L. H., 2005. Complementarities in innovation policy. European Economic Review 49, 1431-1450.

Mohnen, P., Rosa, J., 2002. Barriers to Innovation in Service Industries in Canada, in: Feldman,

M., Massard, N., (Eds), Institutions and Systems in the Geography of Innovation, Kluwer Academic Publishers, Boston, pp. 231-250.

Mohnen, P., Therrien, P., 2003. Comparing the Innovation Performance of Manufacturing Firms in Canada and in Selected European Countries: an Econometric Analysis, in: Gault, F. (Ed), Understanding Innovation in Canadian Industry. School of Policy Studies, Queen's University, Kingston and Montreal: McGill-Queen's University Press, pp. 313-339.

Monreal-Pérez, J., Aragón Sanchez, A., Sanchez-Marin, G., 2012. A longitudinal study of the relationship between export activity and innovation in the Spanish firm: the moderating role of productivity. International Business Review 21, 862-877.

Nelson, R.R., 2005. Technology, Institutions and Economic Growth. Harvard University Press, Cambridge, Mass.

Niosi, J., 2000. Canada's National System of Innovation. McGill-Queen's University Press, Montreal and Kingston.

OECD, 2010. Business Innovation Policies: selected country comparisons. OECD Directorate for Science, Technology and Industry, Paris.

OECD, 2017. Science, Technology and Innovation Scoreboard 2017. OECD, Paris.

Pippel, G., Seefeld, V., 2015. R&D cooperation with scientific institutions: a difference-in-difference approach. Economics of Innovation and New Technology 25(5), 455-469.

Pla-Barber, J., Alegre, J., 2007. Analysing the link between export intensity, innovation and firm size in a science-based industry. International Business Review 16, 275-293.

Polder, M., Leeuwen, G.V., Mohnen, P., Raymond, W. (2009). Productivity effects of innovation modes. Statistics Netherlands, Discussion paper Discussion paper (09033).

Posner, M., 1961. International Trade and Technical Change. Oxford Economic Papers, New Series 13(3), 323-3411.

Ramstad, E., 2009. Expanding innovation system and policy- an organisational perspective. Policy Studies 30(5), 533-553.

Romero-Jordán, D, Delgado-Rodriguez, M.J., Alvarez-Ayuso, I., de Lucas-Santos, S., 2014. Assessment of the public tools used to promote R&D investment in Spanish SMEs. Small Business Economics 43, 959-976.

Roper, S., Love, J.H., 2002. Innovation and export performance: evidence from the UK and German manufacturing plants. Research Policy 31(7), 1087-1102, doi:http://dx.doi.org/10.1016/S0048-7333(01)00175-5

Sahaym, A., Treviño, L. J., Steensma, K., 2012. The influence of managerial discretion, innovation and uncertainty on export intensity: a real options perspective. International Business Review 21, 1131-1147.

Szczygielski, K., Grabowski, W., Pamukcu, M.T., Tandogan, V.S., 2017. Does government support for private innovation matter? Firm-level evidence from two catching-up countries. Research Policy 46(1), 219-237, doi:http://dx.doi.org/10.1016/j.respol.2016.10.009

Teece, D., 1986. Profiting from technological innovation: implications for integration, collaboration, licensing and public policy. Research Policy 15(5), 285-305.

Thérrien, P., Mohnen, P., 2003. How Innovative are Canadian Firms Compared to Some European Firms? A comparative look at innovation surveys. Technovation 23(4), 359-369.

Vernon, R., 1966. International investment and international trade in the product life cycle. The Quarterly Journal of Economics 80(2), 190-207.

Wade, R., 1990. Governing the Market: Economic Theory and the Role of Government in East Asia's Industrialization. Princeton University Press, Princeton, N.J.

Wong, P.K., 2001. Leveraging multinational corporations, fostering technopreneurship: the changing role of S&T policy in Singapore. International Journal of Technology Management 22(5-6), 537-569.

Yang, C.-H., Huang, C.-H., Hou, T.C.-T. 2012. Tax incentives and R&D activity: Firm-level evidence from Taiwan. Research Policy 41(9), 1578-1588. doi:http://dx.doi.org/10.1016/j.respol.2012.04.006

Zhao, H., Li, H., 2001. R&D and exports: an empirical analysis of Chinese manufacturing firms. The Journal of High-Technology Management Research 8(1), 89-105.