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Exporter Dynamics and Productivity

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Editor

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Part III: Canadian Trade and Investment Dynamics

Foreword

This edition of *Trade Policy Research* takes up the general theme of exporter dynamics and productivity. To explore these issues, the Department of Foreign Affairs and International Trade (DFAIT) organized a conference on Exporter Dynamics and Productivity on March 27, 2009. This volume builds on the discussions at that conference.

Consistent with the recent focus in the international economics literature on firm-level or product-level analysis, many of the papers in this volume explore the microeconomic underpinnings of the linkage between international engagement—through trade or foreign direct investment—and productivity growth. They highlight the importance of international engagement to Canada's prosperity but also the obstacles that firms must surmount in order to successfully enter and sustain their presence in foreign markets, as well as the contribution that public sector program support can make in helping firms find their footing in foreign markets—including the first-ever econometric assessment of the impact on firm-level export performance of the export promotion services provided by DFAIT's Trade Commissioner Service.

This volume continues the practice of sharing with the wider research community and the interested public the results of trade-and investment-related policy research undertaken within, on behalf of, or in collaboration with Foreign Affairs and International Trade Canada. Launched in 2001 as part of the response to the Government of Canada's *Policy Research Initiative*, a government-wide effort to re-create and expand its research capacity, the *Trade Policy Research* series is now in its ninth edition.

Previous volumes have followed developments in trade and investment policy, addressed topical issues in international economics such as services trade liberalization and global value chains, and showcased research and analysis conducted within the Government of Canada on various aspects of trade policy and economic globalization more generally, including a special edition on NAFTA @ 10 in 2005.

Through this volume, Foreign Affairs and International Trade Canada seeks to continue to contribute actively to the development and dissemination of knowledge concerning the role of international trade and investment in Canada's economy and in the global economy more generally, while at the same time stimulating the development of the Department's research capacity, and further developing links with professional and academic researchers in the field of international commerce.

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Exporter Dynamics and Productivity: Editor's Overview

Dan Ciuriak

The linkage between economic growth and openness to international trade and investment has long been subject to controversy.

Traditional trade theory promises efficiency gains to nations that partake in the international division of labour but not necessarily a higher rate of growth. The advent of endogenous growth theory provided theoretical models that do promise higher growth for more open economies (Romer, 1990). In these models, trade stimulates growth-enhancing technological change by increasing returns to innovation and/or by facilitating the absorption of technology developed abroad (e.g., through knowledge spillovers)[1], a particularly important consideration for smaller economies.

A number of studies sought to demonstrate the empirical validity of the connection between openness and growth on the basis of cross-country comparisons, including Sachs and Warner (1995), Edwards (1998), Frankel and Romer (1999), Dollar and Kraay (2002), and Wacziarg and Welch (2003). While influential, the claims made in these papers to have established a general link between greater openness and higher rates of growth were disputed on methodological grounds (Rodriguez and Rodrik, 2001; Easterly, 2005; and Rodriguez, 2007).

A more recent effort by Estevadeordal and Taylor (2008) to settle the controversy by explicitly addressing the various critiques reached the narrower conclusion that liberalizing

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[1] Paul Romer's 1990 "Endogenous Technological Change" paper explicitly linked international integration to higher growth. Rivera-Batiz and Romer (1991) emphasized knowledge spillovers internationally through economic integration as a driving force.

tariffs on imported capital and intermediate goods did lead to faster GDP growth. However, policymakers in most countries did not wait for research to confirm this particular insight; pressure from business had long since led governments to lower tariffs on capital goods and industrial inputs. In Canada, Budget 2010 went the final step and simply eliminated them all.

However, that may not be all there is to this issue. In recent years, understanding of the role of trade and investment in economic growth has been significantly improved by new theoretical and empirical analysis based on explicit recognition of the heterogeneous nature of firms.

The theoretical framework for this body of research is provided by "new new trade theory" (Melitz, 2003). In this literature, firms of widely varying size and level of productivity co-exist in the same industry. Products of varying quality co-exist in the same markets. Firms face sunk costs of introducing their products into foreign markets in terms of obtaining market intelligence, identifying foreign partners, dealing with foreign regulatory requirements, setting up distribution and after-sales service networks and so forth. Entrants also face uncertainty about success in foreign markets. They have less knowledge than established firms about these markets and the local partners or agents they must engage (information asymmetries). International macroeconomic conditions, including business cycles and real exchange rates feature both volatility and protracted disequilibrium conditions that can affect a firm's profitability in foreign markets. Accordingly, not all firms engage in trade and foreign investment and, of those that do, many enter fewer markets than they might optimally serve. Indeed only relatively highly productive firms can absorb the costs of entering export markets and only the most productive of these can absorb the still higher costs of investing abroad while remaining profitable in those markets. As well, the flux of entry into and exit out of various foreign markets—or change at the "extensive margin"—is high. This constitutes an important factor in determining a country's overall trade growth, alongside changes in sales by existing exporters of established products in established markets (which represents change at the "intensive margin").

At the same time, the increased availability of large, firm-level datasets has allowed researchers to shed light on the firm-level dynamics that are reflected in aggregate national trade and investment performance measures, on the quantitative significance of the channels through which trade and investment influence the productive capacity of a national economy, and on the effectiveness of public policies that affect firms' export engagement.

To explore these research developments, the Department of Foreign Affairs and International Trade organized a conference on Exporter Dynamics and Productivity, 27 March 2009. The present edition of *Trade Policy Research* is comprised of research presented at the conference and developed since.

This chapter provides a thematic overview of the findings of these papers. Following the structure of the book, it addresses in turn: exporter dynamics and productivity; the effectiveness of trade promotion programs; and Canadian trade and investment dynamics.

Exporter dynamics and productivity

John Baldwin and Beiling Yan, in their paper "Export Market Dynamics and Plant-level Productivity: Impact of Tariff Reductions and Exchange Rate Cycles," examine how trade liberalization and fluctuations in real exchange rates affect export-market entry/exit and plant-level productivity.

Inspection of the firm-level data quickly reveals that firms that export and those that do not differ markedly in measurable characteristics: exporters tend to be larger, more productive, and more innovative. The perennial question in the literature has been whether this superior performance is a consequence of exporting—i.e., as a result of "learning by exporting", or of access to economies of scale enabled by serving larger markets—or is exporting a consequence of superior performance? That is, do good firms "self-select" into export markets (and conversely do weak firms self-select out)?

In line with the emerging consensus, Baldwin and Yan find that self-selection is an important determinant of export activity at the firm level—that is, more efficient plants are more likely to enter and less likely to exit export markets. However, by tracking the comparative behaviour of firms post-export market entry and exit, they also lend support to the thesis that exporting boosts productivity. In particular, using both multivariate regressions and propensity score matching and the difference-in-differences technique, they are able to show that entrants to export markets improve their productivity performance relative to the population from which they originated by about 4 percentage points while plants that stay in export markets do better than comparable plants that exited by 5.7 percentage points in the multivariate analysis and by 7.1 percentage points in the propensity-score matching analysis.

The research design of their paper also allows Baldwin and Yan to assess whether market access conditions affect the likelihood of export market entry/exit and the extent of gains from exporting. They track the experience of Canadian manufacturing plants over three separate periods that featured different combinations of tariff rate changes and real exchange rate movements. In the first period, from 1984 to 1990, improvements in export profitability generated by tariffs cuts negotiated in the Tokyo Round were more than offset by the appreciation of the Canadian dollar from US$0.77 in 1984 to US$0.86 in 1990. In the second period, from 1990 to 1996, the still greater improvements in export opportunities due to the FTA and NAFTA tariff reductions were compounded by a depreciation of the Canadian dollar to US$0.73. In the third period, from 2000-2006, border costs stopped falling with completion of the tariff reductions under the Canada-U.S. free trade treaties and the creation of new trade costs due to post-9/11 border frictions. At the same time, export profitability was sharply reduced by the steep appreciation of the Canadian dollar from US$0.67 in 2000 to US$0.88 in 2006. These three periods also featured very different degrees of buoyancy in domestic markets, with the late 1980s and 2000s providing much stronger domestic demand conditions for Canadian manufacturers than the early 1990s.

Using these periods as natural experiments, Baldwin and Yan find that a one percentage point decline in the Canadian dollar increases the probability that a non-exporter will start exporting by around one percentage point, while a similar increase in the real exchange rate increases the probability that an active exporter will exit from export markets. A one percentage point own-tariff reduction has the same impact on export market entry as a one percentage point depreciation of the dollar.

Importantly, they also show that the overall productivity advantage of exporters over non-exporters is affected by currency developments. The superior performance of Canadian export-market entrants and continuing exporters was reinforced in the 1990-1996 period when the Canadian dollar depreciated. The advantage, however, was reduced in the 1984-1990 when the Canadian dollar appreciated and almost completely eliminated in the 2000-2006 when the dollar appreciated even more steeply.

The Baldwin-Yan results suggest that that the export market entry/exit dynamic driven by real exchange rate fluctuations is an important factor in the Canadian productivity growth puzzle. As well, these results lend support to the Baldwin and Lyons (1996) argument that large misalignments of exchange rates over extended periods entail welfare costs due to hysteresis effects in trade, with entailed industrial dislocation and scrapping of sunk assets.

Exposure to international trade impacts on a firm's productivity in a variety of ways, including by influencing the scale and scope of its production, which in turn are important considerations in its technology decisions. Alla Lileeva and Johannes Van Biesebroeck, in their paper, "The Impact of Trade and Technology Adoption on Production Flexibility in Canadian Manufacturing," examine scale and scope economies in Canadian manufacturing plants, how these are affected by technology choices and how technology choices are, in turn, influenced by trade.

Manufacturing activity is usually assumed to be subject to positive scale economies, at least over an initial range, since spreading fixed costs over a greater number of units produced reduces per unit costs. However, it is not clear on *a priori* grounds whether manufacturing activity is also subject to economies of scope. If there are joint products or if overhead costs can be spread over multiple product lines, there might be economies of scope; on the other hand, if a firm increases its productivity by specializing in fewer product lines, diseconomies of scope would be indicated. Complicating the story, there could be economies of scope at the *firm* level, notwithstanding diseconomies of scope at the *plant* level, if as Lileeva and Van Biesebroeck note, some of a firm's expenditures such as R&D costs can be spread over multiple plants. Importantly, firms can choose more or less flexible technologies that are optimal for, respectively, more or fewer product lines.

Lileeva and Van Biesebroeck find that Canadian plants generally face economies of scale but diseconomies of scope. While the scale-scope trade-off appears to be a pervasive phenomenon, it varies with the industrial context. In some cases, scale economies and the penalty for variety are large in absolute value; Lileeva and Van Biesebroeck identify these as involving mass production technologies. In other cases, scale economies and the penalty for variety are low; these they identify as involving flexible production systems. Examining cases where firms switch technologies, their results indicate that the "old" production technologies are more flexible and the newly adopted technology involves mass production. Thus, over time mass production technology has gained in importance.

The impact of trade liberalization differs for exporters versus non-exporters. The reduction of U.S. tariffs under the Canada-United States free trade agreements is associated with a decrease in available scale economies. Lileeva and Van Briesebroeck note that this might reflect investment by Canadian plants in the new technology needed to access these potential scale economies or—more plausibly, they suggest—simply an expansion of output, exploiting and exhausting the scale economies that their existing technologies provided. The reduction of Canadian import tariffs, on the other hand, had the reverse effect on import-competing industries. Plants in industries where Canadian tariffs declined significantly saw their available scale economies grow—which could reflect an adjustment to more flexible production technologies to reduce the productivity penalty associated with a large product portfolio, or more plausibly in view of the finding that technology-switching firms typically switch to mass production techniques, a reduced scale of operations or a reduced product palette to bring the range of products produced into a range that the reduced-scale plants could handle.

The Lileeva-Van Biesebroeck results highlight the role of trade in influencing firms' *process* technology choices and re-focus attention on the role of economies of scale in productivity performance and the role of trade in prompting a switch to technology that offers greater scale economies, a somewhat neglected topic in the trade literature in recent years.

Pierre Therrien and Petr Hanel, in their paper "Innovation and Productivity in Canadian Manufacturing Establishments", shed light on the interaction of productivity and trade with both process and product innovation.

This paper is grounded in the literature that seeks to unpack the role of technological change in growth and to understand the determinants of innovation. The research questions that initially drove this literature were posed in the first instance by growth accounting studies that assigned an important contribution to growth in advanced industrial countries to a residual in the growth accounting formula that was associated with disembodied technological change (i.e., technological change that was not embodied in the form of new, more efficient capital equipment). The productivity growth slowdown of the 1970s and 1980s in the United States and other advanced industrial countries focussed rather urgent attention on the innovation process: was the productivity growth slowdown due to a slowdown in the pace of innovation? And, if so, was this due to lagging innovation inputs, such as R&D? The key objectives of the innovation literature thus became to accurately measure the links between innovation and productivity, and between innovation inputs and innovation outputs. In the firm-based studies within this literature, engagement in trade is just one characteristic of firms that must be controlled for in order to obtain good estimates of the above linkages. For trade analysis, of course, the role of engagement in trade is the key feature.

This body or research is concerned with self-selection issues but in this case with self-selection into innovative activities. Therrien and Hanel apply an extension of an OECD model based on an approach developed by Crépon, Duguet and Mairesse (1998). This approach involves a system of three stages with four recursive equations: the first stage models the firm's decision to engage in R&D and, given self-selection into this activity, the resources committed to this activity. The second stage estimates the impact of R&D inputs on innovation, measured as sales of innovative products, and the third stage estimates the impact of innovation on the firm's productivity. The role of trade is captured in the first stage as a factor that influences the decision to innovate and the resources to commit to this activity.

Consistent with other findings in the literature, exporters are found to be more likely to be innovators than non-exporters but, unlike earlier results with the OECD version of this model, Therrien and Hanel find that it is exporting to non-U.S. markets that is associated with a greater likelihood of Canadian firms being innovators. They suggest that this may reflect the more demanding nature of selling to these markets compared to the familiar U.S. market. Moreover, exporting is associated with greater innovation intensity—in this case, regardless of the market to which the firm exports. Therrien and Hanel do not attempt to disentangle the complex relationship between exporting and innovation; they note, however, that causation is likely to run both ways. Exporting is likely to increase innovation by exposing firms to knowledge spillovers in foreign markets, providing added incentives to innovate by extending firms' potential market size, and providing new competitive stimuli. On the other hand, successful innovation may be the foundation for firms' entry into export markets.

Other important results of this study bear on the issue of Canada's record on innovation and productivity. Therrien and

Hanel find that greater resource commitment to innovative activity is associated with larger sales of innovative products and that firms with greater sales of innovative products are more productive. They note that, while a large proportion of Canadian firms describe themselves as innovators, the resource commitment to innovation is often quite small—they observe that a large percentage of firms reporting R&D activity and claiming R&D tax credits spend less than $100,000 per year, which is below the critical mass of human and complementary resources needed for successful commercialization of innovative products. Their overall results support the drawing of a causal link from Canada's lagging R&D performance to its lagging productivity performance.

The Effectiveness of Trade Promotion Programs

Given the complex inter-relationships between exporting, productivity and innovation, the importance of minimizing the hurdles that Canadian firms face in accessing foreign markets is made clear. Apart from trade negotiations aimed at reciprocal lowering of barriers to trade, the public policy tool bearing most directly on reducing barriers to exports is export promotion.

Since their introduction in 1919 in Finland, export promotion agencies have become a common part of the trade policy tool kit—a 2005 World Bank survey received responses from 88 such agencies (Lederman et al., 2010). In theory, public sector export promotion services address market failures arising from information spillovers and asymmetries and other market imperfections. If, for example, firms cannot fully capture the benefits of investments they make in acquiring knowledge of how to export a particular product to a given market because other firms costlessly follow their example, there will under-investment in acquiring such information and a resulting market failure in the form of under-exporting (Copeland, 2008). In this context, export promotion services would be welfare enhancing. However, over and above the question of whether or not public sector export promotion services improve welfare there is the question of whether or not they are effective. Two papers on this topic in this volume are part of a growing body of literature investigating this latter question; they shed light on the impact that accessing trade promotion services has on export sales and which types of firms benefit most from such services.

Van Biesebroeck, Yu and Chen, in their paper, "The Impact of Trade Promotion Services on Canadian Exporter Performance," examine the impact of trade promotion on export sales using a unique set of microdata created by linking three datasets: Statistics Canada's Exporter and Business Registers, which respectively provide information on export activity and firm characteristics; and the Canadian Trade Commissioner Service (TCS) client management database maintained by Foreign Affairs and International Trade Canada. TCS services, delivered through 140 offices around the world and 12 regional offices across Canada, include information on market prospects, key contacts and local companies as well as assistance with visits, face-to-face briefings and trouble shooting. The combined dataset provides, for each identified exporting firm, information on the trade promotion services it received, identified by location and time, its export sales by export destination and year, and its economic characteristics, over the period from 1999 to 2006.

These data show that only about 5 percent of Canadian exporters sought out TCS services over the period. The propensity to seek TCS assistance increased steadily with the size of the firm, rising from 3 percent of micro exporters (1 to 10 employees) to almost 17 percent of larger exporters (more than 200 employees). However, because most Canadian exporters belong to the small and medium-sized categories, small and medium-sized exporters predominate within the TCS clientele, accounting for more than 80 percent of the total client population. Further, firms exporting to non-U.S. markets relied more frequently on TCS assistance than those exporting to the United States. Firms specialized in the production of differentiated products also had a higher propensity to seek TCS assistance.

Applying the treatment effects analytical framework, the authors find that exporters that received assistance, on average, export 17.9 percent more than comparable exporters that did not receive assistance; importantly, the effects are found to persist over time. Assistance helps firms both to diversify into new markets and to introduce new products into export markets.

The results also give insight into the types of clients that benefit most from receiving TCS assistance. Firms that are "export-ready"—i.e., larger firms with more years in business but with fewer years of exporting experience and fewer products and markets—benefit more from TCS assistance.

Volpe Martincus, Carballo and Garcia, in their paper, "Firm Size and the Impact of Export Promotion Programs," examine the effects of trade promotion programs on the export performance of firms within different size segments. Their point of departure is that mission statements of export promotion agencies as well as public commentary by their lead officials typically identify, as a central goal, supporting small and medium-sized companies (SMEs) to access international markets. Since SMEs are more likely to have difficulty overcoming barriers to exporting, it is plausible to expect that trade promotion would benefit them more than larger firms.

The authors apply variants of the difference-in-differences approach to firm-level data on exports by product and destination and firm size over the period 2002-2006 for virtually the whole population of Argentinean exporters to address three questions: Are trade promotion programs effective in improving firms' export performance? Are impacts of these programs heterogeneous across firm size categories? Are these impacts larger for smaller firms?

They find that export promotion programs administered by Argentina's export promotion agency, Fundación ExportAR, increased Argentinean firms' exports, primarily by expanding the number of destination markets. Importantly, they find that these programs benefited smaller companies in terms of expanded export sales more than larger firms. Thus, trade-supporting actions are associated both with an increased rate of growth of total exports and an increased number of export destination countries in the case of SMEs. However, they appear to have little impact on the export outcomes of large firms. These results are robust across alternative specifications of the estimating equations, different definitions of size classes and different econometric methods.

Reading the two papers together highlights the difference in results for Canada versus for Argentina as regards the effect of trade promotion services by size of firm: in Canada, the effects are greater for larger firms; in Argentina, the effects are significant for SMEs but not for larger firms. This suggests that there are further degrees of heterogeneity to explore in order to reconcile results.

Canadian Trade and Investment Dynamics

The third part of this year's volume of Trade Policy Research is comprised of three papers that chart the dynamics of Canada's trade and investment performance in recent years.

As highlighted in our lead paper by Baldwin and Yan, the external environment for Canadian exports was much less favourable in the first part of the 2000s than in the 1980s and 1990s. The Canadian dollar rose in dramatic fashion in the years after 2002, coinciding with a global decline of the US dollar and divergent trends in Europe and Asia: the euro also rose steeply, paralleling the rise of the Canadian dollar, while the Asian currencies rose to a much lesser extent. At the same time, the global growth centre shifted to Asia, powered by the Chinese and Indian markets. For Canadian exporters, the relative attractiveness of the European and East Asian markets increased even as the U.S. market became more difficult to contest. Thus, where the 1990s featured growing continental integration, the 2000s featured market diversification. The Canadian economy still fared well in the 2000s, notwithstanding the challenges posed by a changed international environment. However, the composition of growth changed and Canadian firms faced adjustment costs.

The paper "Export Dynamics in Canada: Market Diversification in a Changing International Economic Environment," by Shenjie Chen and Emily Yu, tracks the remarkable shifts in Canada's global pattern of exports over the period 1999-2006. It documents the decline in the number of exporters and in the value of export sales by Canadian exporters to the U.S. market, and the diversification of Canadian exports, largely accomplished at the extensive margin by new entrants into third markets. The average number of export destinations served per firm and the proportion of multi-market exporters in the total Canadian exporter population both increased. In Asian markets, the diversification was led by small- and medium-sized exporters while in Europe it was led by established exporters.

Tracking cohorts of market entrants, they demonstrate that the attrition rate of firms that enter into export markets is high: of the cohort of 13,164 firms that were new entrants in 2000, only 3,234 or 24.6 percent were still exporting six years later. However, these survivors had increased their exports more than nine-fold from an average of about $150,000 to over $1.4 million.

Reflecting this feature, Chen and Yu find that new entrants played a significant role in limiting the extent of decline in Canadian export performance in the key U.S. market; this development underscores the vital importance of continuing export promotion in terms of helping new exporters overcome entry barriers, even in established markets. They conclude that, given firm-level export dynamics, a country that takes its existing export base for granted is liable to suffer erosion of its international trade performance.

The paper by Ram Acharya, "Canada's Share of U.S. Product Markets: Dissecting the 1998-2006 Trends," examines the changes in Canada's position in the U.S. market from a different perspective, that of product dynamics—product penetration, product churning (replacement of old product lines with new over the product life cycle) and product overlap (which Canadian products compete with which other country's products?). He evaluates Canada's market share in over 16,000 products imported by the United States (HS 10-digit level) and examines the source of competitive pressure on Canada's position in the U.S. market.

From 1998 to 2006, Canada's share of U.S. imports fell by three percentage points. Acharya finds that this decline reflected a fall in product penetration (the share of product categories in which Canada exports to the United States) from 73 to 70 percent. This decline is not, per se, a source of concern since advanced countries tend to specialize and thus reduce their export product palette. Moreover, the fact that Canada improved or maintained its product penetration rate in machinery, computers and electronic products, and electrical machinery and equipment, three of the more knowledge-intensive sectors, also tends to mitigate concern about the overall slide in product penetration rates. However, through the lens of product churning, this erosion is seen to reflect a failure of new product entries to offset product exits—Canada had fewer product entries than exits, while all the other major exporters to the U.S. at least broke even on this score. Canada's market share erosion was thus in good measure at the extensive margin and potentially a reflection of a weak innovation dynamic in Canada.

Acharya also examines the changes in Canada's presence in terms of the level of sophistication of products and the product categories in which Canada experienced competitive pressure from other market entrants. He documents the fact that China's penetration increased from 9,249 products in 1998 to 13,123 in 2006, an increase of 20 percentage points. Moreover, China made vast strides in the knowledge-intensive sectors, including in transportation equipment and chemicals, sectors in which Canada's product penetration rate fell. Of particular note is that China's product penetration rates surpassed Canada's in chemicals, computer and electronic products, and electrical equipment, three of the five industries that are considered relatively medium- and high-tech; moreover, China was not far short of matching Canada in the remaining two industries in this category, namely, machinery and transportation equipment.

China has thus established a beachhead in portions of the U.S. market that provides a basis for further gains in its international market share. As the Chen and Yu paper shows, the growth of exports by new exporters that survive is very powerful. Accordingly, the competition for Canada in the U.S.

market in knowledge-intensive goods could get much tougher in the coming decade.

The final paper in the book by Someshwar Rao, Malick Souare and Weimin Wang, "Canadian Inward and Outward Direct Investment: Assessing the Impacts," reviews trends in inward foreign direct investment and multinational production in Canada as well as Canada's direct investment abroad, and provides an assessment of their impact on the Canadian economy. They document that Canada has actively participated in the globalization process. Canada's inward and outward FDI stocks increased dramatically over the last three decades, although less steeply than global trends. In the second half of the 1990s and through the 2000s, Canada became a net exporter of capital, a dramatic reversal of its position in previous decades. Canada's deep integration into the global economy is also attested by the large share of production accounted for by multinational firms—about 30 percent of total business output and more than 50 percent of total manufacturing output.

Reviewing the empirical literature, they conclude, consistent with the prevailing consensus, that inward FDI benefits Canada through intra- and inter-industry productivity spillovers and through increased investments in physical and knowledge capital and skills upgrading. They note that Canadian MNEs are as productive as their foreign-owned counterparts—consistent with heterogeneous firm theory that only the most productive firms take the step to become multinationals.

As regards the issue of hollowing-out of corporate Canada, they conclude based on a review of the literature that the available evidence does not support the hollowing-out hypothesis; rather, the evidence suggests that head office functions in Canada have actually increased in recent years.

On balance, the authors conclude that the empirical evidence suggests that Canada would benefit by further liberalizing its regime relating to FDI and foreign ownership. However, the evidence on the impact of outward FDI on the Canadian economy is still scarce. Future research efforts should concentrate on closing this important knowledge gap.

Concluding thoughts

The economics of international trade and investment is going through a dynamic phase in both theoretical and empirical terms. The increasing availability of firm-level datasets is enabling an exploration of the micro-foundations of trade which is inspiring new theoretical developments that in turn feedback into empirical research as theory is tested against fact. The trade and investment policy community is confronted with new theories, new terminology and evidence developed using new statistical techniques. Research capacity is growing worldwide as reflected in the increasingly varied source of journal articles and working papers. If the dynamic in the trade literature is any guide, the knowledge-based economy is thriving. It is an exciting time to be involved in this field and perhaps to add a small contribution to the intellectual ferment.

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Part I

Exporter Dynamics and Productivity

Export Market Dynamics and Plant-level Productivity: Impact of Tariff Reductions and Exchange Rate Cycles

John Baldwin and Beiling Yan*

Abstract: This paper examines how trade liberalization and fluctuations in real exchange rates affect export-market entry/exit and plant-level productivity. It uses the experience of Canadian manufacturing plants over three separate periods that feature different rates of bilateral tariff reduction and differing movements in bilateral real exchange rates. The patterns of entry and exit responses as well as the productivity outcomes differ markedly in the three periods. Consistent with much of the recent literature, the paper finds that plants self-select into export markets—that is, more efficient plants are more likely to enter and less likely to exit export markets. Moreover, entrants to export markets improve their productivity performance relative to the population from which they originated and plants that stay in export markets do better than comparable plants that exited, lending support to the thesis that exporting boosts productivity. Finally, we find that overall market access conditions, including real exchange rate trends, significantly affect the extent of productivity gains to be derived from participating in export markets. In particular, the increase in the value of the Canadian dollar during the post-2002 period almost completely offset the productivity growth advantages that new export-market participants would otherwise have enjoyed.

Key words: tariff reduction, real exchange rate, export participation, productivity growth

JEL No.: F1, F3, L1, O4

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1. Introduction

Ascertaining whether entry into export markets leads to productivity gains has engaged the attention of a large number of researchers since the first micro-study by Bernard and Jensen (1995). In Canada, entry to export markets in the 1990s was associated with higher productivity growth (Baldwin and Gu, 2004). Studies for other countries have not produced uniform results. A similar outcome has been reported for countries such as Colombia, Indonesia, Korea, Morocco, Slovenia, Taiwan, Turkey and UK. But contrary results exist for countries such as Chile, China, Germany, Mexico, the United Kingdom, and the United States[1].

These cross-country differences may be the result of variations in the trading environments facing different countries. In particular, new opportunities offered by trade liberalization as well as currency depreciation vary across countries and time periods. The positive results for Canada during the 1990s came from a period when the country experienced dramatic new export opportunities in its principal market, the United States, as a result of currency depreciation as well as implementation of the Canada-U.S. Free Trade Agreement (CUSFTA) starting in 1989 and its successor, the North American Free Trade Agreement (NAFTA) starting in 1994.

In order to investigate the impact of different trading environments on the dynamics of participation in export markets, this study examines how the relationship between export-market participation and plant-level productivity growth in the Canadian manufacturing sector evolved over three time periods—the late 1980s, the early 1990s, and the period post-2000. These periods varied sharply in terms of the incremental

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[1] See Wagner (2007) for a survey of the literature. Based on a review of 54 studies for 34 countries published between 1995 and 2006, he concluded "exporters are found to be more productive than non-exporters, and the more productive firms self-select into export markets, while exporting does not necessarily improve productivity." For other recent surveys, see López (2005) and Greenaway and Kneller (2007).

export opportunities available in the U.S. market. In the first period, from 1984 to 1990, average tariffs in the manufacturing sector between Canada and the United States declined by 0.3 percentage points per year because of reductions negotiated in the Tokyo Round but Canadian exporters had to contend with an appreciation of the Canadian dollar from US$0.77 in 1984 to US$0.86 in 1990, an average annual nominal appreciation of 1.4 percentage points. In the second period, from 1990 to 1996, tariffs declined by 0.6 percentage points per year due to the FTA and NAFTA and export opportunities were further improved by a depreciation of the Canadian dollar to US$0.73, an annual average depreciation of 2.1 percentage points. The trading environment post-2000 was very different. Most of the tariff reductions pursuant to the Canada-U.S. free trade treaties had already been implemented; at the same time, trade costs rose due to post-9/11 border frictions. Moreover, the Canadian dollar appreciated steeply from US$0.67 in 2000 to US$0.88 in 2006, an average annual appreciation of 3.5 percentage points, powered by the world-wide resource boom which led to a dramatic expansion of the resource-based Western Canadian economy.

The second purpose of the study is to set export-market entry/exit into a broader context of firm renewal that is accomplished through experimentation with new activities. The focus of most studies in the literature has been on the impact of entry to export markets[2]. This study focuses on how *both* entry and exit to export markets affect productivity growth. The entry and exit process to export markets is part of a larger turnover process that occurs as firms renew themselves. As part of its investigation of entry and exit dynamics, the paper also revisits the question of whether export-market participation leads to better productivity performance. The entry and exit process is

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[2] Studies that have looked at the productivity performances of firms entering export markets as well as exiting include Baldwin and Gu (2003) for Canada, Clerides et al. (1998) for Colombia, Bernard and Wagner (1997) for Germany, and Girma, Greenaway and Kneller (2003) for the United Kingdom. For a complete list, please refer to Table A1 in Wagner (2007).

intrinsically interesting because of what it reveals about experimentation with new markets but also because of how movements into and out of exporting lead to improvements in productivity, either due to the exploitation of simple economies of scale, or due to the learning-by-exporting effect. Export markets offer new opportunities for entrepreneurs to grow and use new technologies and thus improve their productivity. In the case of small economies like Canada, the U.S. offers scope for expansion into a larger market. Expansion offers opportunities to exploit traditional scale or scope economies that come with the ability to grow. Export markets also offer opportunities to learn about and to develop new technologies and products and to become more innovative (Baldwin and Gu, 2004). The innovation process transfers ideas for improvements from customers to suppliers (Baldwin and Hanel, 2003). Expansion of firms into export markets puts firms in touch with a broader set of producers who are likely to contain new ideas. Baldwin and Gu (2004) report that entry to export markets leads firms to adopt advanced technologies. The adoption of new advanced technologies has been associated with productivity growth in Canadian firms (Baldwin, Sabourin and Smith, 2003; Baldwin and Sabourin 2004).

To evaluate the impact of exporting on productivity performance, we use two econometric techniques to address non-random sample selection problems: a standard OLS regression that compares productivity growth between exporters and non-exporters and that also takes into account plant characteristics, and a propensity-score matching technique along with the differences-in-differences method.

We focus on two sets of questions.

First, which firms enter new export markets and which firms exit export markets? Do good plants self-select into export markets and, conversely, do the weakest exporters self-select out of export markets? Most entry studies in the industrial organization literature suffer the disadvantage that the provenance of new firms is difficult to specify. That is not the case here because data on the pre-entry/pre-exit performance are available.

Second, how well do firms perform post-entry/post-exit? Does exporting improve productivity growth and to what extent are productivity improvements associated with exporting retained if firms subsequently exit from export markets (consistent with the notion that they reflect "learning by exporting")? Many entry studies in the industrial organization literature have focused on the extent to which entrants perform relatively well; however, much of this attention has focused on whether they grow relatively quickly compared to existing firms, not the group from which they came. The former comparison bears on the question whether there is evidence that entry should be considered as the purchase of an option[3] on ability—for then, those who find out they have the requisite ability will invest heavily after entry and grow rapidly in order to exploit this information. The existing trade literature focuses more on the notion that entry to export markets provides new opportunities—though the literature in the two areas can be merged. Entry to export markets does provide new opportunities but it probably involves the same type of options that are discussed in the traditional entry literature. The difference is that the export trade literature focuses on an additional phenomenon—whether growth not only is rapid post-entry but is fast relative to pre-entry conditions. That is, it asks whether entry itself stimulates progress because it provides a wider opportunity set.

Section 2 outlines the analytical framework that is used to investigate how changing market access conditions, as characterized by changes in tariffs and real exchange rates, impact on export-market entry/exit process and on the relative productivity performances of exporters and non-exporters. Section 3 introduces the data used in the study. Section 4 provides a preliminary comparison of productivity performance

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[3] As Dixit (1989) explained, drawing on the financial market literature on options pricing, given uncertainty about future tariffs and real exchange rates, the decision of firms to enter export markets is equivalent to a select group of plants with superior chances of succeeding in export markets choosing to exercise the option to experiment in these markets.

across three decades of adaptation. It finds that the productivity growth advantage enjoyed by export-participants in the earlier periods disappeared in the post-2000 period. Section 5 presents multivariate results. An important finding is that exchange-rate shifts explain almost all of the difference in the relative productivity performance across periods and that, after allowance is made for changes in tariffs and real exchange rates, export-market participants enjoy faster productivity growth than non-participants. Using matching techniques, section 6 further examines two sources of the superior productivity performance of exporters: the self-selection and learning-by-exporting effects. Section 7 concludes.

2. Analytical Framework

This section sets out the analytical framework that informs the subsequent analysis of the impact of trade liberalization and changes in the exchange rate on export market dynamics and productivity growth.

2.1 The impact of symmetric tariff cuts

In the heterogeneous-firm models of international trade (e.g., Bernard *et al.*, 2003; Melitz, 2003; Bernard, Jensen and Schott, 2005; Das, Roberts and Tybout, 2007; Melitz and Ottaviano 2008; and Baldwin and Gu 2009), the existence of sunk costs associated with breaking into export markets (such as initial marketing, setting up distribution networks, and addressing foreign regulatory requirements) means that firms will enter export markets only if the present value of their expected profits from exporting to those markets exceeds the fixed costs of entry. Therefore, only the more productive firms within a given population of firms will tend to enter export markets.

These models all generate the equilibrium property that a symmetric reduction in bilateral tariffs forces the least efficient domestic plants to exit altogether (i.e., close down), while simultaneously inducing an expansion of exports in two ways. Those firms already exporting expand sales due to the reduction in marginal costs of servicing the export market; at the same time, some firms that previously were just below the threshold of export profitability now can profitably enter the export market. Both the domestic-market selection effect (closure of the least productive firms) and the export-market selection effect (new entry of more productive plants into export markets and the additional export sales gained by existing exporters) reallocate market shares from less productive to more productive plants, contributing to an aggregate productivity gain.

Besides productivity gains generated by inter-firm reallocations within an industry, there are also within-plant productivity gains from trade liberalization. Bernard *et al*. (2003) adapt the Ricardian model to incorporate firm-specific comparative advantage. They calibrate their model to U.S. plant-level statistics and U.S trade data and simulate the impact of globalization and dollar appreciation on productivity and plant entry and exit in the U.S. manufacturing sector. A decline in tariffs leads to an increase in aggregate productivity. This is mainly the result of productivity gains within surviving plants: as prices of imported intermediates decline, surviving plants replace domestically produced inputs with cheaper imported inputs, which brings about within-plant productivity gains. Whether exporters benefit more than non-exporters depends on their differential ability to substitute cheaper intermediates for workers.

Another possible channel of within-plant productivity gain from trade liberalization (Krugman, 1979) is the link between market size and productivity growth. Trade liberalization expands growth opportunities leading to improvements in productivity. Both Kaldor (1966, 1975, 1978) and Verdoorn (1949, 1980) stress the connection between industry growth and productivity growth, primarily because of the existence of economies of scale. Exploiting the lower unit costs of a larger plant involves learning how to organize production on a larger scale—a process that requires more than simply scaling up factor inputs. Large firms differ from small firms in their organizational structure, in the amount of capital per worker employed, in the amount of intangible investments applied to the production process. Growth comes from being able to solve the problems that prevent firms from exploiting the benefits of scale. Scott's (1989) theory of economic growth focuses on how investment facilitates learning. In turn, growth facilitates experimentation with new techniques that can then be applied to infra-marginal production. Lileeva and Trefler (2007) find that market size matters for innovation and hence productivity.

The entry process involves experimentation with opportunities in new markets that result in entry but also exit. Studies on the dynamics of change in firms emphasize that differences in ultimate success—measured in such basic terms as survival or relative size (in terms of market share) are related to the success of firms in finding ways to adapt to change. More successful firms are differentiated from the less successful in terms of their innovativeness (Baldwin and Gellatly, 2003). Innovation in these studies is measured in terms of the ability to adopt new advanced technologies, or new products or new organizational methods. But ultimately being innovative requires a broader set of capabilities—flexibility and the ability to learn about new markets and new techniques. Entrepreneurship is at the heart of this dynamic process. Entrepreneurs have to be able to solve a host of problems—not the least of which is the choice of products and markets. This study focuses on one such new market for domestic firms—export markets. The study recognizes that not all forays into new products or new markets will be successful and asks what characteristics are related to success—that is, it examines both entry and exit.

Finally, improved access to foreign markets created by trade liberalization encourages firms not only to export but also to invest in order to raise productivity (Lileeva and Trefler 2007). Firms that enter export markets gain access to technical expertise, such as new product design and new process methods derived from new competitors, buyers and customers (Baldwin and Gu, 2004). Furthermore, the intense competition in international markets forces plants to operate more efficiently. Firms new to export markets are forced to grow more rapidly or face elimination.

2.2 *The impact of exchange rate fluctuations*

The heterogeneous-firm models of international trade also generate predictions regarding the impact of exchange rate changes on firm dynamics and productivity. Bernard *et al.* (2003) estimate their model using U.S. data and find that U.S. dollar appreciation raises aggregate U.S. manufacturing productivity. This gain is realized through several channels. Declining relative prices of imported intermediates lead to substitution of intermediates for labour and result in productivity growth in surviving plants. Reallocation is also important: the gain from the exit of less productive domestic producers is only partially offset by the loss due to reallocation of production away from the most productive firms (who lose export markets). Bernard *et al* (2003) illustrate, how even in a very large market such as the United States, changes in global access (from declining tariff rates or favourable exchange rate shifts) can substantially reshuffle production and have an important impact on manufacturing productivity.

Compared to the United States, Canada is not only more trade-dependent, but also more resource-dependent. Canada's economy relies heavily on the export of natural resource commodities such as natural gas, oil, metals and minerals, and forest and agricultural products to the United States. Commodities such as these represent almost 40 percent of Canadian exports. This results in a close association between swings in commodity prices and fluctuations in the Canadian dollar (Figure 1). When international commodity prices rose post-2002, the Canadian dollar appreciated substantially. Both the rising commodity prices and the increased value of the dollar led to gains in the terms of trade (lower import prices and higher export prices), which further stimulated the post-2002 resource-led domestic boom (MacDonald, 2008).

The relationships among the exchange rate, commodity prices, terms of trade, gross domestic income, personal expenditure and investment variables are summarized in Table 1. During the periods 1984-1990 and 2000-2006 when the Canadian dollar appreciated, there were simultaneous increases in commodity prices, the terms of trade, gross domestic income, and domestic expenditure; in particular, personal expenditure on semi-durable goods and investment in residential and non-residential structures. The opposite was true during the 1990-1996 period, when the Canadian dollar depreciated and all these variables experienced slower growth.

Periods when the Canadian dollar appreciates on the basis of global commodity prices, therefore, would be expected to feature at least two effects: reduced export sales as the rising dollar makes Canadian exports more expensive in U.S. markets; coupled with expanded domestic markets due to a resource-led domestic boom on the other. If growth is associated with productivity (either because of increasing returns to scale or because of increasing incentives to invest and to increase efficiency), we would expect domestic-oriented plants to perform relatively better than export plants during periods when the Canadian dollar appreciates.

2.3 *Hypotheses*

On the basis of the foregoing discussion, we derive two testable hypotheses:

> Hypothesis 1 (export-market selection effect): tariff cuts or a depreciation of the Canadian dollar (which has an effect equivalent to raising home tariffs and lowering foreign tariffs) make export markets more profitable, and hence increase the entry of more productive plants to export markets and decrease the exit rate from export markets.

> Hypothesis 2 (plant-level productivity effect): The impacts of tariff cuts and exchange rate movements on relative productivity performances of export market participants vs. non-participants are unclear. It depends on the model used. If plants substitute cheaper imported imports for labour as in model developed in Bernard *et al* (2003), we expect tariff cuts and currency appreciation to generate within-plant productivity gains. Whether exporters benefit more than non-exporters depends on their differential ability in substituting

cheaper intermediate inputs for workers. On the other hand, if productivity growth is positively associated with market growth, either due to increasing returns to scale or to growth-related behavioral changes such as increasing investment, we expect tariff cuts and currency depreciation to generate faster growth and more within-plant productivity gains for export market participants than for non-participants.

3. Data

3.1 Data source

The plant-level data used in this study come from Statistics Canada's Annual Survey of Manufacturers (ASM), a longitudinal database that tracks Canadian manufacturing plants over time. We use the entire sample from the ASM and include both plants with long forms and short forms[4]. Information on export status is available in 1979, 1984, 1990, 1993, 1996, 1997, 1998 and 1999 for plants that filled out the long form, and annually from 2000 onwards for all plants[5]. We therefore assume that small plants for the 1984-1990 and 1990-1996 periods (who filled in the short-form questionnaires) are non-exporters[6].

The ASM database has information on shipments, value-added, employment, age of plants, exports, and industry affiliation. Industry affiliation is at the 1980 four-digit Canadian Standard Industrial Classification (SIC) level from 1979 to 1997, and at the six-digit North American Industry Classification System (NAICS) level from 1997 onwards. The

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[4] The survey data are derived from long-form questionnaires (often given to larger plants) and short-form questionnaires (often given to smaller plants). The long-form questionnaires contain much more detailed information than the short-form questionnaires.

[5] For the post-2000 period, plants used in the analysis consist of those that fill in the long form and those whose data are from tax records. The former are typically larger plants, while the latter smaller ones.

[6] According to a 1974 survey that collected export data for all plants, only 0.4% of plants that filled in the short-form questionnaires reported exports (Baldwin and Gu, 2003).

paper uses the SIC version of the ASM for the 1984-1990 and 1990-1996 periods, and the NAICS version of the ASM for the post-2000 period (2000-2006). In the post-2000 micro dataset, some records are imputed. These imputed micro records have problematic measures of relative value-added and employment. They are therefore generally excluded from this analysis[7]. Labour productivity is defined as real value-added output[8] per employee, where the total number of employees is the sum of production and non-production workers.

Bilateral tariffs between Canada and the United States are available from 1980 to 1996 for 236 four-digit manufacturing industries. The data are constructed based on import duties by commodity. Commodities are linked to their primary industries of production. Average industry tariffs are then calculated using import values as weights[9].

The industry-specific real exchange rate (e_i) is constructed as the normal exchange rate (*NER*, expressed in terms of U.S. dollars per Canadian dollar) deflated by relative U.S. (p^u_i) and Canadian industry (p^c_i) prices. That is: $e_{it}=NER_t\,(p^c_i/p^u_i)$. The nominal exchange rate is taken from Statistics Canada's CANSIM database. Canadian industry prices are drawn from a database maintained by the Economic Analysis Division at Statistics Canada. They are gross output prices from the Input/Output system and cover 236 four-digit Canadian manufacturing industries from 1973 to 1997. The U.S. gross output prices are derived from the U.S. NBER-CES productivity databases. The NBER database covers 459 U.S. manufacturing industries from 1958-1996. They are matched and aggregated to the 236 Canadian manufacturing industries[10].

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[7] More specifically, they are excluded except in section 4.1, where we calculate the total entry and exit rate, and the total export participation rate.

[8] Real value-added is calculated using corresponding industry deflators.

[9] We are grateful to Alla Lileeva for providing us with the tariff data. For details on the sources and construction of the tariff data, see the Appendix in Trefler (2004).

[10] Other studies have used an alternative industry-specific real exchange rate, generated by calculating the weighted average of exchange rates between Canada and its trading partners, with weights being countries' trade

3.2 *Three episodes of adaptation*

To examine the linkages between exporting and productivity growth, we use three panels of continuing plants that differ in terms of the trading environment that each faced: the first covers the period 1984-1990; the second, the period 1990-1996; and the third, the period 2000-2006.

The three panels cover the period prior to, during, and after the implementation of the FTA between Canada and the United States. Tariff rates fell in both of the first two periods, but reductions became larger in the second period, following the FTA. In the 2000-2006 period, tariff reductions between Canada and the United States were completed. More importantly, this period was marked by an appreciation of the Canadian dollar against the U.S. dollar that made exporting to the U.S. market less advantageous.

Tariff reductions between Canada and the United States were large in the first two periods, with an annual average rate cut of 0.3 percentage points during 1984-1990 and 0.6 percentage points during 1990-1996 (Table 2). The Canadian dollar depreciated at an average annual rate of 2.1 percentage points in nominal terms from 1990 to 1996. It appreciated at an annual average rate of 1.4 percentage points from 1984 to 1990 and 3.5 percentage points from 2000 to 2006. The standard deviations for the real exchange rates across industries are large, indicating substantial variation in export market conditions across industries. The middle period, which featured relatively steep tariff cuts and exchange rate depreciation, was thus more

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shares for each industry (Baggs *et al.*, 2009). There are two problems with this approach. First, for Canada, trade-weighted industry-specific real exchange rates show little variability across industries since the U.S. trade weight dominates across manufacturing industries. Secondly, this approach assumes the same price adjustments to nominal exchange-rate movements across industries. However, Baldwin and Yan (2007, 2008) find a high degree of heterogeneity in industries' responses. The price-adjusted real exchange rate is a better indicator of an industry's international competitiveness. It measures the price spread between an industry's product price and the landed price charged by industries in other countries.

conducive to exporting than the other two periods, which featured smaller declines or no change in tariffs coupled with exchange rate appreciation.

3.3 *Plant groupings by export transition*

To examine the implications of export-market participation for productivity growth, we classify continuing plants over a period into four groups according to their transitions in export markets:

- continuing non-exporters (plants that do not export at the beginning and the end of a period).
- entrants to export markets (plants that do not export at the beginning of a period, but export at the end of the period).
- exiters from export markets (plants that export at the beginning of a period, but do not export at the end of the period).
- continuing exporters (plants that export at both the beginning and the end of a period).

We compare the productivity performance of two groups; first, continuing non-exporters to entrants into export markets, and second, continuing exporters to exiters from export markets. If export-market participation implies better productivity performance, we expect higher productivity growth for entrants as opposed to continuing non-exporters, and for continuing exporters as opposed to exiters.

4. Preliminary comparison of productivity performance

4.1 *Export-market dynamics*

The transition of Canadian manufacturing plants into and out of export markets over the three periods is presented in Table 3. Three facts emerge. First, of non-exporters at the beginning of a period, only about 10 percent broke into export markets during the period, while the rest of the plants either remained non-exporters (around 50 percent) or ceased operation (around 40 percent). These ratios were similar across the three periods. Second, of plants that were exporters at the beginning of a period, a large number exit from export markets and/or fail and the proportion of failing plants increases over time. Of exporters in 1984, around 19 percent exited export markets and became non-exporters by 1990. This increased to 26 percent and 28 percent for the 1990-1996 and 2000-2006 periods, respectively. More strikingly, of exporters in 1984, around 18 percent ceased operations altogether during the 1984-1990 period; the failure rate rose to 28 percent and 41 percent for the 1990-1996 and 2000-2006 periods, respectively. Third, an increasing percentage of start-up firms are active in export markets from their inception (i.e., they are "born global"): 11 percent of plants enter directly into export market during the 1984-1990 period; this increases to 14 percent and 38 percent for the 1990-1996 and 2000-2006 periods, respectively.

These data indicate that there have been considerable shifts over time in the nature of the export market entry/exit process. An increasing proportion of new plants have entered directly into export markets and an increasing proportion of exporters have ceased operations completely. The entry/exit process among continuing plants has remained relatively stable. This paper only focuses on the entry/exit process of continuing plants.

4.2 *Which plants participate in export market?*

The average productivity performance of plants with different transitions to export markets is summarized in Table 4. The results (column 1 of Table 4) are consistent with a self-selection process: over all three periods, entrants to export markets are significantly more productive than non-exporters, and exiters from export markets are significantly less productive than continuing exporters. Only the more productive plants enter and remain in export markets.

4.3 *Is exporting associated with better productivity growth?*

Export participants do not always have higher productivity growth than non-participants (column 2 of Table 4). Productivity growth is higher for entrants than for continuing non-exporters for the first two periods (1984-1990 and 1990-1996), but the difference becomes statistically insignificant for the 2000-2006 period. Moreover, the magnitude of the difference varies across the first two periods.

On average, annual labour productivity growth was around 5.0 percentage points faster for entrants over the period 1990-1996, when tariffs were falling and the exchange rate was depreciating. This compares to only 2.0 percentage points faster over the period 1984-1990, when tariffs were falling but the exchange rate was appreciating. Similar patterns emerge when we compare exiters and continuing exporters.

Thus, the size of the gap in productivity growth between export participants and non-participants varies depending on the period examined. The gap is largest in the early 1990s when new opportunities in export markets were greatest due to the size of tariff cuts and the coincident depreciation in the exchange rate. The superior performance is diminished in the late 1980s when appreciation of the Canadian dollar partially offsets the decline in tariffs. But significantly, the difference in performance becomes statistically insignificant in the post-2000 period (2000-2006), when the primary external influence on competitiveness was an appreciating dollar. Figure 2 plots the average annual change in the US/Canada nominal exchange rate and the productivity growth gaps between export participants and non-participants. The performance gaps become larger as the value of the Canadian dollar drops.

5. Multivariate results

To understand the forces behind these differences, we turn to multivariate analysis and examine the impact of tariff changes and exchange rate movements on plant dynamics. Two panels of continuing plants, one over the period of 1984-1990 and the other over the period of 1990-1996, are pooled. The 2000-2006 panel data are excluded since we do not have tariff data for this period. Tariff changes between Canada and the United States during this period were close to zero during this post-FTA and post-NAFTA period.

5.1 *Impact on entry/exit dynamics in the export market*

The probability of entering and exiting export markets is estimated as a function of industry-wide tariff changes ($\Delta\tau_{it}$), real exchange-rate changes (Δe_{it}), industry-level real gross output growth (ΔlnQ_{it})[11], and plant-specific characteristics (ΔZ_{pt0}) at the start of a period. To examine how the efficiency level of a plant affects these relationships, we interact changes in tariffs and real exchange rates with initial labour productivity (LP_{pt0}) and plant size (L_{pt0}). The probit model also controls for 3-digit industry-specific fixed effects (α_i) and period-specific fixed effects (α_t):

$$\text{Prob}(D_{pt}=1) = \Phi(\alpha_i + \alpha_t + \beta_1\Delta\tau_{it} + \beta_2\Delta e_{it} + \beta_3\Delta e_{it}*LP_{pt0} + \beta_4\Delta e_{it}*L_{pt0} + \beta_5\Delta lnQ_{it} + Z_{pt0}) \qquad (1)$$

where D_{pt} is a dummy variable which takes the value of one if a plant p enters export markets during the period and zero if it remains a non-exporter. Similarly D_{pt} equals one if a plant p exits export markets during the period and zero if it remains an exporter. The variables, $\Delta\tau_{it}$, Δe_{it}, ΔlnQ_{it}, are all 4-digit industry-wide average annual changes. Plant-level characteristics (Z_{pt0}) include relative productivity (LP_{pt0}, relative to the mean productivity of plants in the same SIC 4-digit industry), relative employment (L_{pt0}, relative to mean employment), age, and nationality of ownership (domestic vs. foreign-controlled) at the start of a period.

Two econometric issues need to be addressed. First, the inclusion of interaction terms in non-linear models, such as the probit model, makes the evaluation and interpretation of the results difficult and in the past has resulted in many incorrect estimates. Ai and Norton (2003) and Norton, Wang and Ai (2004) find that among 72 articles published between 1980 and 1999 in 13 economics journals listed on JSTOR that used

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[11] To prevent possible endogeneity, we measure industry-specific real gross output as the sum of real shipments at the 4-digit SIC level minus the real shipment of the plant itself.

interaction terms in nonlinear models, none of the studies interpreted the coefficient on the interaction term correctly[12]. We focus on the marginal effects when presenting results. Marginal effects for interaction terms are calculated according to the following formulae:

$$\frac{\partial^2 \Phi}{\partial(x_1)\partial(x_2)} = \Phi^{'}(x\beta)\frac{\partial^2(x\beta)}{\partial x_1 \partial x_2} + \Phi^{''}(x\beta)\frac{\partial(x\beta)}{\partial x_1}\frac{\partial(x\beta)}{\partial x_2} \quad (2)$$

The overall marginal effect of a variable is:

$$\frac{\partial \Phi}{\partial(x)} = \Phi^{'}(x\beta)\frac{\partial(x\beta)}{\partial(x)} \quad (3)$$

All marginal effects are evaluated at mean values of covariates.

The probability of a non-exporter entering export markets and the probability of an exporter exiting export markets are reported in Table 5. There are four significant findings. First, plants that are more productive, larger, and older are more likely to enter export markets, and less likely to exit export markets. This is consistent with the self-selection process described in previous sections: the more productive and larger plants become successful exporters.

Second, whether a plant shifts its export-status following declines in tariffs and real exchange rates depends on the efficiency level of the plant: non-exporters that are more efficient, as measured either by size or by labour productivity, are more likely to start exporting (significant negative interaction terms); while exporters that are less efficient are more likely to stop exporting (significant positive interaction

[12] This is because the statistical software packages, such as STATA's *mfx* and *dprobit* commands, do not know that a variable is an interaction term and thus do not take the full derivative. As a result, when a variable is interacted with another (or has higher order terms) in a nonlinear model, *mfx* and *dprobit* will give the wrong marginal effect of the interaction term. Instead, the marginal effect of the interaction term requires computing the cross derivative or cross difference as defined in equation (2).

terms). Thus, the trading environment impacts on the degree of experimentation.

Third, Canadian tariff reductions, on average, increase the likelihood that non-exporters enter export markets (overall average marginal effects). A one percentage point decline in Canadian tariffs increases the probability that a non-exporter will start exporting by around 1 percentage point. This is consistent with the view that import competition as well as cheaper imported intermediate inputs due to lower tariffs improve the competitive advantage of Canadian manufacturing plants and facilitate their entry into world markets. The overall impact of tariff cuts (as measured by Canadian tariff cuts or U.S tariff cuts or average tariff cuts) on exit is statistically insignificant[13].

Fourth, a real depreciation of the Canadian dollar increases the likelihood that non-exporters will start exporting: a 1 percentage point decline in the real exchange rate increases the likelihood by around 1 percentage point (overall average marginal effects). This is similar to the marginal impact of the reduction in tariffs. Similarly, a real appreciation of the Canadian dollar increases the likelihood that exporters will stop exporting: a 1 percentage point rise in the real exchange rate increases the likelihood by around 1 percentage point.

5.2 *Impact on within-plant productivity growth*

To examine if plants with varying export transitions perform differently when the trading environment changes, we model plant-level productivity growth as a function of tariff changes ($\Delta\tau_{it}$), real exchange rate changes (Δe_{it}), a dummy variable indicating export transition status (D_{pt}), and their interactions. We also control for industry-level real gross output growth (ΔlnQ_{it}), and plant-specific characteristics (Z_{pt0}).

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[13] Baldwin and Yan (2010) find a tariff reduction increases the probability that plants will close down completely, in particular for exporters. Here we further show that tariff reduction does not impact on the decision of an exporter to become a non-exporter among continuing plants.

$$\Delta ln(LP_{pt}) = \alpha_i + \alpha_t + \beta_1 \Delta \tau_{it} + \beta_2 \Delta e_{it} + \beta_3 D_{pt} + \beta_4 D_{pt} * \Delta e_{it} + \beta_5 D_{pt} * \Delta \tau_{it} + \beta_6 \Delta lnQ_{it} + \gamma Z_{pt0} \quad (4)$$

where $\Delta ln(LP_{pt})$ is the average annual log growth of labour productivity for plant p during period t. All other variables are defined as in equation (1).

Regression results are reported in Table 6. Four conclusions are noteworthy. First, plants that have a higher initial level of productivity have slower productivity growth, suggesting reversion to the mean. Plants that are larger and foreign-controlled have faster productivity growth. These findings are robust across specifications, and significant at the 5 percent level.

Second, had there been no changes in tariffs and real exchange rates, plants that enter export markets would have had an average of 4.0 percentage points faster productivity growth than that of non-exporters (significant positive coefficient on the dummy variable for entrants), and plants that exit export markets would have had on average 5.7 percentage points slower productivity growth than that of continuing exporters (significant negative coefficient on the dummy variable for exiters). The results are robust across specifications.

Third, tariff reductions (U.S. tariffs, Canadian tariffs or average tariffs) have no impact on the average productivity performance of plants, whether they are export market participants or non-participants. This is in contrast to Trefler (2004) and Lileeva (2008) who use the same plant level dataset (Canadian Annual Survey of Manufacturers) and tariff rates, but find that U.S. tariff cuts lead to plant-level productivity gains. The difference lies in the sample periods used. Their papers examine continuing plants between 1980 and 1996. This is more likely to capture long-run benefits of trade liberation, and in particular, the benefits on a small sub-group of a population who are typically large and successful and able to survive more than 15 years. This paper examines plant performance over 5-year periods. It is therefore more likely to capture short-run impacts. More importantly, it includes many small and less successful plants. Our sample size (about 20,000 plants per period) is twice as large as theirs (about 10,000 plants). Small plants may be impacted by trade liberation differently than large plants. As Lileeva and Trefler (2007) show, Canadian plants that gain from tariff cuts are those that engage in innovation. It is the large plants that tend to be more innovative: large plants are associated with greater financial, informational and technology-absorptive capabilities (Baldwin and Gu, 2004; Baldwin, Hanel and Sabourin, 2000; and Baldwin and Diverty, 1995). Tariff cuts therefore raise plant-level productivity only for some plants.

Fourth, fluctuations in real exchange rates have a significant impact on the relative productivity performances of export-market participants and non-participants. A real appreciation of the Canadian dollar decreases productivity growth for both non-exporters and entrants, but significantly more so for the latter. On average, a one percentage point appreciation in the real exchange rate decreases productivity growth of non-exporters by 0.7 percentage points, compared to 1.3 percentage points for plants that entered export markets. This suggests a narrowing of the productivity growth gap between non-exporters and entrants when the Canadian dollar appreciates against the U.S. dollar. The dramatic increase in the real value of the Canadian dollar during the 2000-2006 period (an average annual rate of 5.5 percentage points) explains why the difference in productivity growth between entrants and non-exporters becomes smaller and statistically insignificant during this period. If the exchange rate had appreciated by 6.7 percentage points annually, then the superior performance of entrants over non-exporters would have diminished to zero.

Similarly, a real appreciation of the Canadian dollar decreases productivity growth for both exiters and continuing exporters, but significantly more for the latter. On average, a one percentage point appreciation in the real exchange rate decreases productivity growth of continuing exporters by 0.8 percentage points, compared to only 0.2 percentage points for plants that exited export markets. When the Canadian dollar appreciates against the U.S. dollar, the productivity growth gap between continuing exporters and exiters is diminished. In the post-2000 period, the real exchange rate appreciated by 5.5

percentage points; this was enough to close the gap between continuing exporters and exiters by 3.0 percentage points.

To evaluate whether these impacts have economic significance, we conduct a counterfactual experiment (Table 7), which proceeds as follows. First, we assume there were no changes in tariffs and real exchange rates. Under this scenario, results from Table 6 indicate that entrants would have enjoyed an advantage of 4.1 percentage points over non-exporters in terms of average annual labour productivity growth, while exiters would have lagged behind continuing exporters by 5.7 percentage points. These productivity growth gaps reflect factors other than changes in tariffs and real exchange rates, indicating either inherent differences between export-market participants and non-participants or a possible learning-by-exporting effect. Second, we calculate predicted gaps induced by changes in tariffs and real exchange rates. The predicted gaps are estimated using the marginal impacts reported in Tables 6 and actual changes in tariffs and real exchange rates from Table 2. Since marginal impacts of tariffs are not statistically different from zero, the predicted gaps due to tariff cuts are assumed to be zero. Third, we compare the predicted with the actual growth gaps, which includes both the in-sample comparison (1984-1990 and 1990-1996 periods) and out-of-sample comparison (2000-2006 period).

We find that fluctuations in real exchange rates explain almost all the shifts in the productivity growth gaps between export-market participants and non-participants over the three decades. In the case of export-market entrants and non-exporters, the real exchange rate depreciation increased the relative advantage of entrants by 1.2 percentage points during the 1990-1996 period, but the superior productivity performance of entrants was offset partially during the 1984-1990 period and almost entirely during the post-2000 period when the Canadian dollar appreciated. In the case of exiters and continuing exporters, a depreciation of the real exchange rate increased the growth gap by 1 percentage point during the 1990-1996 period, but the appreciation during the 1984-1990 and 2000-2006 periods closed the gap by 0.85 percentage points and 2.96 percentage points respectively.

6. Self-selection or learning-by-exporting effects?

While the difference in productivity growth of export-market participants and non-participants varies systematically across the periods, it is nevertheless positive after allowance is made for changes in tariffs and real exchange rates. Plants that successfully enter export markets do better.

The literature suggests that there are at least two theoretical explanations why exporting is positively correlated with productivity growth. One is the self-selection hypothesis: larger, more productive and more innovative plants self-select into export markets. These plants are more likely to be successful and have higher productivity growth in general, both before and after entry. The other is the learning-by-exporting hypothesis. Exporting may improve productivity, since expansion to foreign markets offers opportunities to expand plant size and to learn how to exploit scale economies as well as opportunities to learn about new technologies and products and to become more innovative (see Baldwin and Gu, 2004). Intense international competitive pressure also forces plants to improve efficiency. In this case, productivity performance increases because of various learning effects.

Section 5.2 shows that exporters enjoy higher productivity growth even after accounting for plant characteristics like size and productivity. But the regression analysis used for this purpose may suffer from a selection bias problem. The binary variable that accounts for the differences between the two samples is essentially calculated as the effect at the mean of the population—both exporters and non exporters. Comparing the average of the exporters to the average of the entire population may yield biased estimates of the effect of exporting if the exporter group is selected in a non-random way.

In this section, we make use of the propensity-score matching approach to choose a sample for the control group to reduce the potential effects of selection bias. This approach has recently been applied to the analysis of exporting and firm performance (Wagner 2002; Girma *et al.*, 2004; and De Loecker, 2007) to test for a causal relationship between export participation and productivity.

6.1 *Methodology*

We need to estimate the difference between the productivity growth of plants that changed their export status (entered or exited export markets) and the outcome for the same plants had they not changed their status. The latter outcome is, however, an unobserved counterfactual.

Propensity-score matching is a way of constructing the counterfactual. From a pool of continuing non-exporters or continuing exporters, the technique selects plants that share similar characteristics with plants that changed export status, and calculates the productivity growth difference between the two groups—those plants that changed status ("treated" plants) and those that did not (control or "untreated" plants)[14]. If the matching process is successful, a causal interpretation can be given to the average difference in productivity growth between treated and control groups.

The control group is created on the basis of observable plant characteristics such as size, labour productivity, age, ownership status, as well as other factors that potentially influence the outcome of interest in the treated group such as industry-wide changes in tariffs, real exchange rates, output and industry-specific effects. Technically this is done by matching treated plants to control plants with the same or a very similar propensity score in order to identify a set of similar plants in the control group to those who received the treatment, defined here

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[14] The "treatment" terminology derives from medical experiments assessing the effects of new drugs or medical procedures using randomly assigned treated and control groups to allow accurate identification of the effect of the drug or procedure being tested. In the present application, given the absence of a randomly assigned control group, propensity scoring is used to construct such a control group.

as entry to or exit from export markets. The propensity score is the predicted probability of entering or exiting export markets. It collapses the set of characteristics that determine whether a plant entered or exited export markets to a single composite number that is used to identify plants in the control group that are similar in all respects to those treated except that they did not receive the treatment (i.e., did not change export status).

Propensity-score matching controls for selection bias by restricting the comparison to differences between treated and control plants with similar observable characteristics. This method, however, is still vulnerable to problems of non-random selection bias due to potential unobservable characteristics in the treated group. To address this, we further use a difference-in-differences method that controls for time-invariant unobservable characteristics.

The combination of matching and difference-in-differences approach allows us to assess whether there is a divergence in the paths of productivity growth between plants that changed export status and the matched control plants that have similar observable and unobservable, but constant, attributes.

6.2 *Results*

To avoid conflating the effects of export market entry and exit, we exclude plants that have changed export status in some earlier periods. Exporter starters and non-exporters are defined as follows: plants that did not export during the 1984-1990 period, but did start exporting during the 1990-1996 period are classified as export starters; non-exporters are those that did not export either during the 1984-1990 period or during the 1990-1996 period. Similarly, exporter stoppers and continuing exporters are defined as follows: plants that were exporters during the 1984-1990 period, but stopped exporting during the 1990-1996 period are classified as export stoppers; continuing exporters exported during both the 1984-1990 and the 1990-1996 periods.

Probit results that are used in the propensity-score approach to determine the probability of entry and exit from export markets during the 1990-1996 period are presented in Appendix 2[15]. The probability of entering and exiting export markets during the 1990-1996 period depends on plant characteristics at the beginning of the period and the changes in tariffs, exchange rates and industry real-shipment growth during the period. These equations are then used to determine a score to be used to choose a set of matching plants in the control group.

To assess how well the propensity-score matching performs, we check to see if there is a significant difference in each predictor used in the probit model between the treated and the control group. Before matching, differences are expected, but after matching, no significant differences should be found, if the covariates are balanced. If the tests for any predictor turn out to be significantly different between treated and control units, we modify the probit model by adding higher order terms of the covariate. Table 8 shows that all the differences after matching are small and statistically insignificant.

Of the population of 7,539 non-exporters, 1,410 are found to be good matches for the 1,410 export starters. Similarly, of the population of 1,853 continuing exporters, 402 are found to be good matches for the 403 export stoppers. Thus, about one in five non-exporters (or continuing exporters) is deemed to display observable characteristics that are similar to those that subsequently entered (or exited) the export market (Tables 9A-9B).

The primary results of interest are the average differences in labour productivity growth in the matched samples, net of the average initial differences before changes in export status (column 3 of Tables 8A-8B). The results reveal a causal effect of export-market participation on productivity growth. Productivity in plants entering export markets grew by 3.2

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[15] We use one-to-one nearest neighbour matching without replacement and with common support (i.e., there are both treated and non-treated plants for each characteristic which we want to compare. If the common support is not satisfied in the treatment group, then these plants are dropped from the sample).

percent, while productivity in similar plants that remained in the domestic market experienced negative growth of -0.8 percent (Table 9A). Plants that start exporting therefore enjoyed a productivity growth advantage over the control group of 4 percentage points. Plants that exit experienced slower productivity growth than plants that had an equivalent probability of exiting export markets but did not. Notably, productivity growth is much slower in the period when exit occurred. Plants that exit export markets experienced a loss in productivity of 6.8 percent, while similar plants that remained in export markets had productivity growth of 0.3 percent (Table 9B). This results in a disadvantage of 7.1 percentage points for plants that stopped exporting compared to the control group. The differences are all statistically significant at a 5 percent level.

7. Conclusions

Productivity growth in a globalized economy is affected by the nature of the reaction of different producers to events that affect the world trading system, including changes in tariffs associated with trade liberalization and movements in exchange rates. This paper looks at how entry into and exit from export markets affects productivity growth, and how entry and exit are affected by changes in the trading environment as characterized by changing tariff rates and real exchange rates. It examines the experience of Canadian manufacturing firms over three separate periods, which featured different combinations of changing tariff rates and real exchange rate trends.

The paper confirms previous findings. Plants self-select into export markets—that is, more efficient plants are more likely to enter and less likely to exit export markets. But the trading environment is found to impact on the degree of experimentation. Tariff reductions and currency depreciation increase the probability that more efficient non-exporters will enter export markets. Currency depreciation also increases the likelihood that less efficient exporters will stop exporting.

The paper also finds that entrants to export markets improved their productivity performance relative to the population from which they originated. This finding is robust to the estimation technique used. The first was an OLS regression of productivity growth that takes into account plant characteristics. The second was a propensity-score matching technique and difference-in-differences method. Both find that plants that enter export markets have higher productivity growth (by about 4 percentage points in both cases) than those not doing so. Similarly, plants that exited export markets had slower growth than similar firms that stayed in the export markets (a difference of 5.7 percentage points in the multivariate analysis and 7.1 percentage points in the propensity-score matching analysis).

This difference stems from a number of sources. The self-selection effect arises from the fact that it is the better plants that participate in export markets and they may be more adept at learning after entry. The learning-by-doing effect (export-participation facilitates growth) may also engender productivity improvements. And, of course, export markets may be more competitive in that they demand successful plants make more progress in closing the gap between themselves and established firms in those markets to avoid being eliminated from those markets.

The productivity growth advantage that in normal circumstances is enjoyed by export-market participants is reinforced or attenuated by macroeconomic events such as exchange rate fluctuations. Export-market participants gain more in productivity growth from currency depreciation than non-participants. The superior performance of Canadian export-starters or continuing exporters was reinforced in the 1990-1996 period, when the Canadian dollar depreciated. The advantage, however, was reduced in periods (1984-1990 and 2000-2006) when the Canadian dollar appreciated. In particular, the dramatic increase in the value of the Canadian dollar during the post-2000 period almost completely offset the advantages enjoyed by export-market participants. Our counterfactual exercise shows that fluctuations in real exchange rates explain almost all the shifts in productivity growth gaps between export-market participants and non-participants in this latter period.

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Table 1: Average annual growth: exchange rate, commodity prices and expenditures

	1984-1990	1990-1996	2000-2006
		Percent	
Nominal exchange rate	1.7	-2.6	4.5
Commodity prices			
Including energy	0.3	0.5	8.8
Excluding energy	3.4	1.3	5.7
Terms of trade[1]	0.3	-0.3	1.7
Real gross domestic product	3.1	1.7	2.6
Personal expenditure	3.6	1.5	3.3
Durable goods	5.1	1.4	4.9
Semi-durable goods	2.3	0.5	4.2
Non-durable goods	1.4	1.1	1.6
Services	4.7	2.0	3.5
Business gross fixed capital formation	5.5	-0.3	5.6
Residential structures	4.8	-2.6	6.8
Non-residential structures	2.6	-1.5	5.0
Machinery and equipment	8.8	2.6	5.6

Source: Authors' compilation from Statistics Canada's CANSIM tables 176-0001, 0064 and 380-0002. Average annual growth is calculated as the difference in the log of the variables between the first and last years, divided by the number of years.

[1] Export price relative to import price.

Table 2: Average annual changes in tariff rates and real exchange rates

	1984-1990	1990-1996	2000-2006
		Percent	
Nominal US/Canada exchange rate	1.4	-2.1	3.5
Real US/Canada exchange rate	1.6	-1.9	5.5
	(1.5)	(1.5)	(3.1)
Canadian tariff against U.S.	-0.4	-0.8	
	(0.3)	(0.4)	
U.S. tariff against Canada	-0.2	-0.4	
	(0.5)	(0.7)	
Average tariff between Canada and U.S.	-0.3	-0.6	
	(0.3)	(0.5)	

Source: Authors' compilation from various data sources: Statistics Canada's CANSIM Table 176-0064, NBER productivity database, Statistics Canada's gross output deflator, and Trefler's (2004) tariff rates. Average annual changes are calculated as hdifferences in the variables between the first and last years, divided by the number of years.

Table 3: Transition in export markets (in percent)

	End year status			
Beginning year status	Non-exporters	Exporters	Exiting plants	All
1984-1990				
Plants with no exports	48.0	11.3	40.7	100
Plants with exports	19.2	62.8	18.1	100
New plants	88.8	11.2		100
1990-1996				
Plants with no exports	52.1	8.9	39.0	100
Plants with exports	26.2	45.9	27.9	100
New plants	86.1	13.9		100
2000-2006				
Plants with no exports	48.0	12.1	39.9	100
Plants with exports	28.4	31.0	40.6	100
New plants	61.6	38.4		100

Source: Authors' compilation from the Canadian ASM (Annual Survey of Manufacturers) data.

Table 4: Differentials in productivity performance (in percentage points)

	Labour productivity level[1] (1)		Labour productivity growth[2] (2)	
Mean differences between entrants and non-exporters				
1984-1990	0.18	*	2.00	*
1990-1996	0.22	*	5.29	*
2000-2006	0.06	*	0.13	
Mean differences between exiters and continuing exporters				
1984-1990	-0.05	*	-3.06	*
1990-1996	-0.20	*	-6.87	*
2000-2006	-0.17	*	-0.16	

Source: Authors' compilation from the Canadian ASM (Annual Survey of Manufacturers) data.

* significant at the 5 percent

1. Log of real value-added per worker at the beginning of a period.
2. Annual log changes in real value-added per worker during a period.

Note: Mean differences are computed from regressions in the form of Y= $\alpha_i+\beta_1 D_{pt}$ where Y is the level or growth of labour productivity, and D_{pt} is a dummy variable which takes the value of one if a plant p enters export markets during the period and zero if it remains a non-exporter. Similarly D_{pt} equals one if a plant p exits export markets during the period and zero if it remains an exporter. The regression is run with industry-specific fixed effects (α_i).

Table 5: Probability of entering and exiting export markets (marginal impact)

	Entry						Exit					
	(1)			(2)			(1)			(2)		
Marginal effect of interaction terms												
Average tariff changes * relative labour productivity	-0.024	**	(0.009)				0.034	**	(0.017)			
Average tariff changes * relative employment	-0.022	**	(0.005)				0.068	**	(0.033)			
Canadian tariff changes * relative labour productivity				-0.013	**	(0.006)				0.019		(0.022)
Canadian tariff changes * relative employment				-0.001		(0.003)				0.056	**	(0.022)
US tariff changes * relative labour productivity				-0.015		(0.010)				0.014		(0.039)
US tariff changes * relative employment				-0.038	**	(0.007)				-0.004		(0.033)
Real exchange rate changes * relative labour productivity	0.003	*	(0.002)	0.003		(0.002)	0.004		(0.004)	0.004		(0.004)
Real exchange rate changes * relative employment	-0.007	**	(0.001)	-0.007	**	(0.001)	0.010	**	(0.005)	0.010	**	(0.005)
Overall marginal impact												
Average tariff changes	-0.007		(0.007)				-0.004		(0.023)			
Canadian tariff changes				-0.009	*	(0.005)				0.012		(0.016)
U.S tariff changes				0.009		(0.010)				-0.029		(0.026)
U.S/Canada real exchange rate changes	-0.010	**	(0.002)	-0.010	**	(0.002)	0.012	**	(0.004)	0.011	**	(0.004)
Relative labour productivity	0.031	**	(0.003)	0.032	**	(0.003)	-0.041	**	(0.008)	-0.041	**	(0.008)
Relative employment	0.043	**	(0.002)	0.043	**	(0.002)	-0.106	**	(0.012)	-0.107	**	(0.012)
Age	0.002	**	(0.000)	0.002	**	(0.000)	-0.004	**	(0.001)	-0.004	**	(0.001)
Foreign-control	0.004		(0.007)	0.003		(0.007)	-0.071	**	(0.012)	-0.071	**	(0.012)
Industry real-gross-shipment growth	0.000		(0.000)	0.000		(0.000)	-0.001		(0.001)	-0.001		(0.001)

Source: Authors' calculations.

** and * significant at the 5 percent and 10 percent levels, respectively.

Standard errors (corrected for clustering at the plant level) are reported in parentheses.

Note: Specification (1) uses average tariff changes between Canada and the United States in the probit regression, while specification (2) uses Canadian tariff changes and U.S. tariff changes. Marginal effects for interaction terms are calculated according to equation (2), and overall marginal impacts according to equation (3). They are based on estimated probit coefficients from Appendix 1 and evaluated at mean values of covariates.

Table 6: Impact of tariff and real exchange rate on labour productivity growth

	Entrants vs. continuing non-exporters						Exiters vs. continuing exporters					
	(1)			(2)			(1)			(2)		
Average tariff changes	0.26		(0.269)				0.09		(0.448)			
Canadian tariff changes				0.28		(0.181)				0.16		(0.324)
U.S tariff changes				-0.25		(0.358)				-0.23		(0.559)
U.S/Canada real exchange rate changes	-0.69	**	(0.068)	-0.71	**	(0.068)	-0.77	**	(0.122)	-0.78	**	(0.122)
Dummy (for entrants or exiters)	4.15	**	(0.356)	4.15	**	(0.357)	-5.70	**	(0.370)	-5.69	**	(0.371)
Dummy * average tariff changes	0.38		(0.398)				-0.29		(0.554)			
Dummy * Canadian tariff changes				0.05		(0.324)				0.02		(0.531)
Dummy * U.S tariff changes				0.48		(0.520)				-0.44		(0.863)
Dummy * real exchange rate changes	-0.69	**	(0.074)	-0.69	**	(0.074)	0.54	**	(0.122)	0.53	**	(0.123)
Relative labour productivity	-4.36	**	(1.408)	-4.36	**	(1.408)	-5.37	**	(0.821)	-5.37	**	(0.820)
Relative employment	0.38	**	(0.094)	0.38	**	(0.094)	0.45	**	(0.081)	0.45	**	(0.081)
Age	-0.06	**	(0.014)	-0.06	**	(0.014)	0.00		(0.025)	0.01		(0.025)
Foreign-control	2.81	**	(0.969)	2.82	**	(0.970)	1.20	**	(0.284)	1.20	**	(0.284)
Industry real-gross-shipment growth	0.05	**	(0.009)	0.05	**	(0.009)	0.02		(0.014)	0.02		(0.014)
Number of observations	34243			34243			10030			10030		
R2	0.20			0.20			0.24			0.24		

Source: Authors' calculations.
** and * significant at the 5 percent and 10 percent levels respectively. Standard errors are reported in parentheses.
Note: Specification (1) uses average tariff changes between Canada and the United States in the regression, while specification (2) uses Canadian tariff changes and U.S. tariff changes. "Dummy" is a dummy variable which takes the value of one if a plant enters export markets during the period and zero if it remains a non-exporter. Similarly "Dummy" equals one if a plant exits export markets during the period and zero if it remains an exporter.

Table 7: Contribution to productivity growth gaps: a counterfactual exercise (in percentage points)

	1984-1990	1990-1996	2000-2006
Entrants vs. continuing non-exporters			
Actual average gaps	2.0	5.3	0.1
Predicted gaps	3.0	5.4	0.3
Gaps if no changes in tariffs and real exchange rates	4.1	4.1	4.1
Gaps due to tariff changes	0.0	0.0	0.0
Gaps due to real exchange rate changes	-1.1	1.3	-3.8
Exiters vs. continuing exporters			
Actual average gaps	-3.1	-6.9	-0.2
Predicted gaps	-4.9	-6.7	-2.7
Gaps if no changes in tariffs and real exchange rates	-5.7	-5.7	-5.7
Gaps due to tariff changes	0.0	0.0	0.0
Gaps due to real exchange rate changes	0.8	-1.0	3.0

Note: Actual average gaps are from Table 4. Gaps when there had been no changes in tariffs and real exchange rates are from Table 6. Gaps due to tariff changes and real exchange rate changes are calculated using marginal impacts from Table 6 and actual changes of the variables from Table 2. Gaps due to tariff changes are set to zero, since marginal impacts of tariffs are not statistically different from zero. Source: Authors' calculations.

Table 8: Balancing test - comparisons of means for unmatched and matched samples

	export starters vs. non-exporters			export stoppers vs. continuing exporters		
Means	export starters	non-exporters	P-value on t-test of differences	export stoppers	continuing exporters	P-value on t-test of differences
Unmatched samples						
Sample size	1410	7539		403	1853	
Relative labour productivity	1.33	1.03	0	0.99	1.03	0.33
Relative employment	2.57	0.93	0	0.76	1.53	0
Relative employment ^{2}	15.68	5.56	0.15	1.61	4.77	0
Age	14.05	12.9	0	15.43	15.39	0.81
Foreign-controlled	0.13	0.05	0	0.26	0.37	0
Canadian tariff changes	-0.81	-0.74	0	-0.57	-0.53	0.24
U.S tariff changes	-0.34	-0.29	0	-0.29	-0.26	0.04
Real exchange rate changes	-1.97	-1.92	0.16	-1.43	-1.45	0.79
Real industry shipment changes	0.88	0.63	0.19	3.02	2.79	0.58
Matched samples						
Sample size	1410	1410		402	402	
Relative labour productivity	1.33	1.29	0.29	0.99	0.99	0.92
Relative employment	2.57	2.33	0.1	0.76	0.88	0.15
Relative employment ^{2}	15.68	26.9	0.49	1.62	2.42	0.43
Age	14.05	14.22	0.23	15.42	15.38	0.84
Foreign-controlled	0.13	0.12	0.43	0.26	0.26	0.81
Canadian tariff changes	-0.81	-0.81	0.93	-0.56	-0.58	0.66
U.S tariff changes	-0.34	-0.35	0.51	-0.29	-0.3	0.51
Real exchange rate changes	-1.97	-2	0.41	-1.43	-1.4	0.84
Real industry shipment changes	0.88	0.84	0.9	3.02	2.82	0.74

Source: Authors' calculations.

Table 9A: Comparison of export starters and non-exporters (in percentage points)

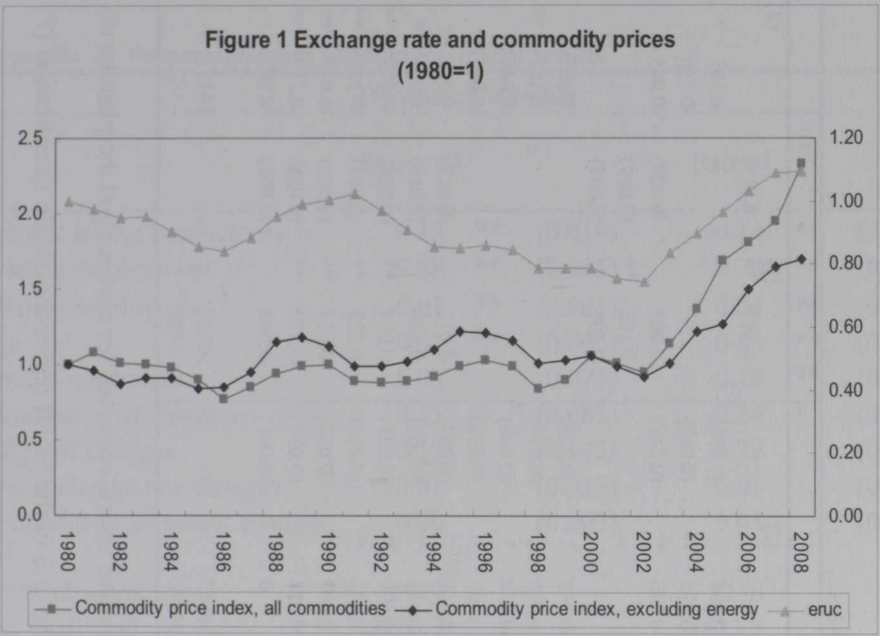
Means	labour productivity growth Pre-entry (1984-1990)		Post-entry (1990-1996)		Difference	
Unmatched sample						
• Plants that changed export status (export starters, n=1410)	-0.9		2.3		3.2	
• Plants that did not change export status (non-exporters, n=7539)	-1.4		-2.4		-1.0	
• Difference between exporters and non-exporters	0.5		4.7	*	4.2	*
Matched sample						
• Plants that changed export status (export starters, n=1410)	-0.9		2.3		3.2	
• Plants that did not change export status (non-exporters, n=1410)	-0.8		-1.6		-0.8	
• Difference between exporter starters and non-exporters	-0.1		3.9	*	4.0	*

Source: Authors' calculations. * significant at the 5 percent level.

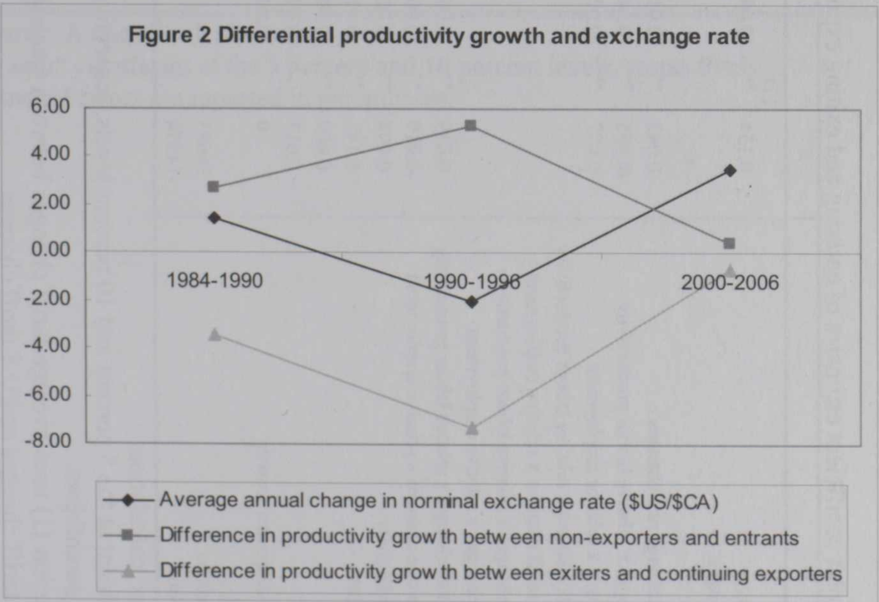
Table 9B: Comparison of export starters and non-exporters (in percentage points)

Means	labour productivity growth Pre-entry (1984-1990)		Post-entry (1990-1996)		Difference	
Unmatched sample						
• Plants that changed export status (export stoppers, n=403)	1.1		-5.7		-6.8	
• Plants that did not change export status (continuing exporters, n=1853)	1.2		2.1		0.9	
• Difference between export stoppers and continuing exporters	-0.1		-7.8	*	-7.7	*
Matched sample						
• Plants that changed export status (export stoppers, n=403)	1.1		-5.7		-6.8	
• Plants that did not change export status (continuing exporters, n=402)	1.0		1.3		0.3	
• Difference between export stoppers and continuing exporters	0.1		-7.0	*	-7.1	*

Source: Authors' calculations. * significant at the 5 percent level.



Source: Statistics Canada's CANSIM Tables 176-0001 and 176-0064



Source: Authors' calculations.

Appendix 1: Probit coefficient estimates of entering and exiting export markets

	Entry						Exit					
	(1)			(2)			(1)			(2)		
Average tariff changes	0.154	**	(0.056)				-0.317	**	(0.113)			
Canadian tariff changes				0.005		(0.036)				-0.183	*	(0.097)
U.S tariff changes				0.275	**	(0.067)				-0.130		(0.165)
U.S/Canada real exchange rate changes	-0.043	**	(0.011)	-0.040	**	(0.011)	-0.005		(0.020)	-0.005		(0.020)
Average tariff changes x relative labour productivity	-0.095	**	(0.040)				0.102	**	(0.051)			
Average tariff changes x relative employment	-0.087	**	(0.022)				0.205	**	(0.095)			
Ave. Canadian tariff changes x relative labour productivity				-0.049	*	(0.028)				0.055		(0.066)
Average Canadian tariff changes x relative employment				0.005		(0.014)				0.163	**	(0.065)
Average US tariff changes x relative labour productivity				-0.068	*	(0.040)				0.046		(0.117)
Average US tariff changes x relative employment				-0.168	**	(0.030)				-0.003		(0.095)
Ave. real-exchange-rate changes x relative labour productivity	0.019	**	(0.007)	0.018	**	(0.007)	0.012		(0.012)	0.012		(0.012)
Ave. real-exchange-rate changes x relative employment	-0.019	**	(0.005)	-0.020	**	(0.005)	0.028	**	(0.015)	0.027	*	(0.015)
Relative labour productivity	0.094	**	(0.026)	0.090	**	(0.025)	-0.077	**	(0.026)	-0.077	**	(0.026)
Relative employment	0.143	**	(0.015)	0.142	**	(0.014)	-0.223	**	(0.061)	-0.220	**	(0.060)
Age	0.009	**	(0.002)	0.009	**	(0.002)	-0.013	**	(0.003)	-0.013	**	(0.003)
Foreign-control	0.017		(0.031)	0.014		(0.031)	-0.219	**	(0.038)	-0.219	**	(0.038)
Industry real-gross-shipment growth	0		(0.001)	0		(0.001)	-0.003		(0.002)	-0.003		(0.002)
Number of observations	36683			36683			10137			10137		
Log pseudo-likelihood	-14974			-14978			-5428			-5427		

Source: Authors' calculation.

** and * significant at the 5 percent and 10 percent levels, respectively; standard errors (corrected for clustering at the plant level) are reported in parentheses.

Note: Specification (1) uses average tariff changes between Canada and the U.S in the probit regression, while specification (2) uses Canadian tariff changes and U.S tariff changes.

Appendix 2: Propensity-score matching— probit results

	Dependent variable					
	Entry = 1			Exit =1		
Relative labour productivity	0.15	**	(0.019)	-0.14	**	(0.060)
Relative employment	0.39	**	(0.015)	-0.70	**	(0.059)
Relative employment ^{2}	-0.01	**	(0.001)	0.04	**	(0.005)
Age	0.01	**	(0.005)	0.03	**	(0.011)
Foreign-controlled	0.03		(0.071)	-0.18	**	(0.083)
Canadian tariff changes	0.13		(0.083)	-0.34	*	(0.209)
U.S tariff changes	-0.18		(0.142)	0.22		(0.321)
Real exchange rate changes	-0.01		(0.033)	0.01		(0.031)
Real industry shipment changes	0.00		(0.003)	0.01		(0.005)
No. of observations	8949			2256		
Log likelihood	-3200.7			-872.5		
Pseudo R2	0.18			0.18		

Source: Authors' calculations.
** and * significant at the 5 percent and 10 percent levels, respectively.
Standard errors are reported in parentheses.

The Impact of Trade and Technology Adoption on Production Flexibility in Canadian Manufacturing

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Abstract: We exploit data on productivity, scale of operation and product diversification for Canadian manufacturing plants to investigate scale and scope economies. We find that plants face the following trade-off in their choice of production technology: higher output is generally associated with increased productivity, but larger product variety with lower productivity. The nature of this trade-off is heterogeneous across plants. Situations that are characterized by a very pronounced trade-off, i.e., where both premiums are large in absolute value, we call mass production technologies; and situations where scale economies and the penalty for variety are low we call flexible production systems. Our estimates indicate that, following increased adoption of advanced technologies and in response to U.S. tariff declines, mass production technology has gained in importance. Foreign-owned plants are also found to be less flexible than Canadian-owned plants.

Key Words: productivity, economies of scale, economies of scope, product diversification

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1. Introduction

With increasing globalization of markets, Canadian firms are facing fierce and growing competition. To remain internationally competitive, on the export market or competing with imports at home, Canadian firms are expected to produce high-quality, customized goods quickly and at a reasonable cost. Adoption of advanced technologies is generally thought to be a crucial ingredient to meet this challenge. A growing literature has examined the importance of innovation and the adoption of advanced technologies to productivity growth. While the early literature often failed to find strong evidence of the anticipated link, recent firm-level studies across many countries have shown a strong link between product innovation and firm productivity, although surprisingly not between process innovation and productivity (OECD, 2009)[1].

Studies in this literature generally consider only total output or total sales when measuring productivity and do not distinguish between different products produced by the same firm or within the same plant. We propose to study the impact of the adoption of advanced technologies on product lines directly. In particular, we conjecture that some technologies are able to lower the cost of producing multiple product lines within a plant, providing an important strategic advantage—see Van Biesebroeck (2007a) for an application to the automotive industry.

This channel of cost reduction is potentially at least as important as the reduction in the level of marginal production costs for individual products. Research into indirect effects of flexibility on market structure (Eaton and Schmidt, 1994) and on competitive interaction (Norman and Thisse, 1999), suggest far-reaching and long-lasting effects. Production flexibility is further expected to interact with outsourcing decisions and product introductions, as investigated by Van Biesebroeck (2007b) in the context of the North American automotive

[1] Evidence for Canada, indicating qualified support, is surveyed in Rao, Ahmad, Horsman, and Kaptein-Russell (2002) and Globerman (2002).

industry. Because the extent of trade openness also influences firms' optimal number of product lines (see Bernard, Redding, and Schott, 2009), observed technology decisions will interact with trade exposure.

The main message is that in differentiated product industries, cost changes have the potential to have a more complex impact than simply shifting the cost-intercept down. They can change the way firms compete and how they are organized more fundamentally. The studies cited above are theoretical or limited to the automotive industry. To draw policy conclusions one would have to investigate whether these findings can be generalized for other industries, which is what we propose to do in this study.

The rest of the paper is organized as follows. In Section 2, we introduce the empirical methodology, followed by a discussion of the Canadian plant-level data in Section 3. Estimation results are in Section 4 and we collect a few conclusions in the final section.

2. Empirical Methodology

It is widely documented—and is the standard assumption in any microeconomics textbook—that manufacturing sectors tend to be subject to positive scale economies, at least over an initial range. At the same time, it makes intuitive sense that costs will be lower if an entire plant's output consists of identical products. Producing many different products side by side on the same production line has to weakly increase production costs—Van Biesebroeck (2005, 2007a) provide evidence for the automotive industry and references to evidence for other industries. Informally, we will call this latter tendency "diseconomies of scope", even though this is not quite the textbook definition, as we will keep total output constant when we introduce additional distinct products[2].

[2] Carlton and Perloff (2005) contains an extensive discussion of the cost definitions for multiproduct firms in Chapter 2.

From the Canadian Annual Survey of Manufactures (ASM) we have information on the number of products each Canadian manufacturing plant produced between 1988 and 1996 as well as its total output. For ease of measurement, we will study the impact of scale and scope of operations on costs through its dual, productivity. If a large product line is associated with higher costs, this will translate into lower productivity or lower measures of efficiency. Implicitly, we assume that the production technology can be characterized as:

$$(1)\ \text{Productivity}_{it} = \alpha_0 + \alpha_1 \text{scale}_{\text{it}} + \alpha_2 \text{scope}_{\text{it}} + \alpha_3 \text{time} + \text{controls} + \varepsilon_{it}$$

As we can calculate plant-level productivity from the information in the ASM, we can directly estimate the coefficients in equation (1). Scale will be measured by the total output of a plant and scope by the number of product lines produced within the plant.

In a general sample of manufacturing firms, the coefficient α_1 is expected to be positive. By contrast, whether the coefficient α_2 is positive or negative might vary by industry. Moreover, the sign of α_2 might even depend on the level of aggregation in the analysis. For example, if important firm-level fixed costs such as design and R&D expenditures can be spread over multiple plants, there could be economies of scope at the *firm level*, notwithstanding diseconomies of scope at the *plant level*. Thus, the finding of diseconomies of scope at the plant level for the automotive industry by, *inter alia*, MacDuffie, Sethuraman, and Fisher (1996) is not inconsistent with the finding of economies of scope at the firm level for the same industry by Friedlaender, Winston, and Wang (1983).

Technology surveys and the innovation literature conventionally draw a distinction between product and process innovations[3]. The former are usually interpreted as affecting the demand a firm faces and the latter as influencing its supply decisions through cost reductions. As such, the effects of

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[3] See for example the guidelines for collecting and interpreting technological innovation data in the OECD's *Oslo Manual: The Measurement of Scientific and Technological Activities*.

product and process innovations are often analyzed independently; here we focus on process innovations. Even though an extensive product line leads to higher costs on average, technology adoption can shift that relationship. We study how scope economies are affected by the observed process technology adoption decisions.

A second factor that is expected to affect product line choice is the exposure to international trade through import competition or a firm's own export activities; see for example Baldwin and Gu (2006), Bernard, Jensen and Schott (2006), and Baldwin and Lileeva (2008). Indirectly, we should also expect trade exposure to influence technology adoption decisions through its effect on market shares, as modeled for example in Ederington and McCalman (2007). In the empirical work, we use the reduction in Canada-U.S. tariff rates following their Free Trade Agreement (FTA) to examine whether trade exposure influences the tradeoff between productivity and firm scale and scope.

We adopt two approaches to incorporate technology adoption and trade exposure in the estimation of equation (1). First, we investigate whether the scale-scope trade-off is uniform across all plants and over time. This can be accomplished easily by estimating equation (1) over different subsamples.

Previewing the results, we note that deterministically separating plants into subsamples based on several observable variables, in particular ownership and export status and the exposure to large or small tariff cuts, will lead to different coefficient estimates. In order to let the data determine which dimensions of heterogeneity across firms matter most, rather than the researcher imposing it, we use a flexible algorithm to separate firms into subsamples. To this end, we use the estimation method developed in Van Biesebroeck (2002, 2003), which allows for the presence of two different production technologies in the sample.

In an application to the U.S. automotive industry, Van Biesebroeck (2003) showed that the trend break in productivity growth in the early 1980s can be understood as plants switching between an older "mass" technology to a modern "flexible" technology. Initially, most plants used the mass technology, which is characterized by high scale economies, but which imposes a high productivity penalty if several product lines are produced in the plant—i.e. it has high diseconomies of scope. Starting in the early 1980s, new plants entered using a more flexible technology, where the diseconomy of scope penalty was reduced at the expense of lower scale economies. These entrants were predominantly Japanese-owned plants, but even continuing American-owned plants gradually switching from the mass to the lean technology, contributed positively to aggregate productivity growth.

Equation (1) is thus generalized to:

$$(2)\ \text{Productivity}_{it} = \alpha_0 + \alpha_1\text{scale}_{it} + \alpha_2\text{scope}_{it} + \alpha_3\text{time} + \varepsilon_{it}^F \quad \text{if } i \in \text{Flexible}$$
$$= \beta_0 + \beta_1\text{scale}_{it} + \beta_2\text{scope}_{it} + \beta_3\text{time} + \varepsilon_{it}^M \quad \text{if } i \in \text{Mass}$$

The distinction between the mass and flexible technology can be interpreted as a basic scale-scope trade-off in production technology. Both technologies are superior in one dimension: if only a few products need to be produced, firms should exploit scale economies to the fullest and use the mass technology. However, in the automotive industry, the proliferation of different car models over time gradually increased the attractiveness of the flexible technology for more and more plants. As a result, plants gravitated over time to the flexible technology, which has lower diseconomies of scope.

The difficulty in estimating equation (2) directly is that we generally cannot observe for each observation which of the two technologies is used, and hence whether the α or the β coefficients in equation (2) apply. This problem can, however, be addressed by using the maximum likelihood estimator developed in Van Biesebroeck (2003), which integrates out the unobserved technology state *i*. The probability that a new firm enters with the mass technology is modeled as a function of a few observable variables.

In addition, at each point in time there is, for each continuing mass technology plant, a probability that it switches from the mass to the lean technology. This probability is also modeled as a function of some (potentially different) observable variables. Adoption decisions on advanced technologies or variables capturing trade exposure can be used as shifters for the probability that either technology is used when a plant enters the sample, or for the likelihood of a technology switch for continuing plants. As such, we do not need to observe the actual technology choices of plants to estimate equation (2). Instead, we infer the probability that either type of production technology is used by each plant-year observation based on the co-movements between productivity, the number of commodities produced, and total output, together with the technology and trade variables.

One benefit of this approach is that we can estimate a model that incorporates two production technologies, even for plants for which no information on advanced technology adoption is observable[4]. Note that we use the term "technology" in two ways. On the one hand, the two characterizations of productivity in equation (2) are dubbed production technologies, which can be mass or flexible. On the other hand, specific advanced technologies can be adopted and this is observable for a subset of our sample. These will be discussed in greater detail in the data section.

We also employ a second approach to incorporate technology adoption and trade exposure in the estimation of equation (1). We can model the coefficients of the scale and scope variables in equation (1) as being explicit functions of the observed technologies used by the plants. This approach is straightforward to implement, but is only possible for the limited sample of plants for which we observe technology use directly; moreover, this approach requires a lot of degrees of freedom. The implicit assumption is that economies of scope vary continuously and firms can gradually adjust their production process to match their (evolving) product line. Tariff levels or tariff reductions might also influence the scale and scope parameters as they are likely to influence other

[4] Only about 10 percent of plants with available data on output and commodities fill in the technology survey questionnaire.

unobservable aspects of a plant's operation. Such effects can easily be incorporated by modifying the definition of the scale and scope coefficients further.

(3) $$\alpha_{2i} = \alpha_{20} + \alpha_{2i} I_{ki} + \alpha_{2t} tariff_i$$

The 1993 Survey of Advanced Technologies records past adoption decisions for a list of technologies for a subset of the plants in our dataset. Merging in this technology adoption information, we can allow the coefficients *α1* and *α2* in (1) to vary with some observed technology adoption decision (*Ii*) and with the tariff faced by the firm. Equation (3) illustrates this for the scope coefficient.

3. Data

The paper uses data from three sources. The Canadian Annual Survey of Manufactures (ASM) has data on the key plant-level variables: output, employment, productivity, 4-digit Canadian Standard Industrial Classification (SIC) industry codes, export status and foreign ownership. Productivity is defined as real value added per worker, since the ASM does not collect data on capital stock or investment and thus does not allow the calculation of total factor productivity. The ASM has commodity-level information for 'long-form' plants. These plants, which typically are larger, receive an extended survey questionnaire; only for these do we have data on the number of commodities produced at the 6-digit Standard Classification of Goods (SCG) level[5]. Our sample pools data on all plants with available commodity data for the years 1988, 1993 and 1996. This gives us an unbalanced panel with 46,324 observations on 24,789 unique plants; i.e., there are fewer than two observations per plant on average.

Information on the use of advanced technologies is taken from the 1993 Survey of Innovation and Advanced

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[5] The level of detail of the 6-digit SCG is about 5,000 commodities.

Technology[6]. This survey has data on plants' use of twenty two advanced technologies, which are divided into five groups: Design and Engineering (DE), Fabrication and Assembly (FA), Automated Material Handling (AMH), Inspection and Communications (IC) and the combined groups of Manufacturing Information Systems and Integration and Control (MIS). The number of plants included in this survey is much smaller than our full sample; we call this the technology sample (N=3,887)[7].

Finally, we also use industry-level information at the 4-digit 1980 Canadian SIC level on Canadian tariffs against the United States and on U.S. tariffs against Canada in 1988, 1993 and 1996. These data were created by Daniel Trefler and used in Trefler (2004)[8].

Descriptive statistics for the principle variables used to estimate equation (1), both for the full and the technology sample, are in Table 1. The average number of commodities produced per plant is similar in both samples (2.437 and 2.720 commodities respectively). Plants in the technology sample are larger and more productive, they are more likely to be foreign-controlled and are more likely to export: 32.4 percent of the plants in the technology sample are foreign-controlled, compared to 18.5 percent in the sample of all plants; and 31.7 percent of plants in the full sample and 39.4 percent of plants in technology sample are exporters.

Technology use is summarized in Table 2. There are large differences across technologies in many dimensions: popularity, size of users and numbers of commodities produced by users. DE, FA and MIS technologies are relatively popular, used by over 30 percent of plants, versus only 5.7 percent for AMH technology. Of the DE technologies, a1 (*Computer-Aided*

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[6] The list of technologies surveyed is in Appendix Table A.1; the entire survey questionnaire can be found in Baldwin and Sabourin (1995).

[7] Note that the survey contains sample weights for estimation of the characteristic means of the population of manufacturing plants.

[8] We would like to thank Daniel Trefler for providing us with the detailed tariff data.

Design/Computer-Aided Engineering), is the most popular technology, used in 806, or 21 percent of observations. It is closely followed by a16 (*Programmable controller/s*), of the IC group, which is used in 804 observations. On the opposite side, only about 3 percent of observations indicate the use of a6 (*Material Working Lasers*, of the FA group) and a22 (*Artificial Intelligence* and/or *Expert Systems*, of the MIS group) technologies[9].

The average number of commodities per user is higher for IC and MIS technologies. This may indicate that these technologies increase flexibility of production. The average size of user, measured by shipments, is the largest also for IC and MIS technologies, and is the lowest for DE technologies. So the use of IC and MIS technologies might be associated with economies of scale. (Note that these relationships can be industry-specific, rather than plant-specific.) In general, at a technology level, there appears to be a positive correlation between output and the number of commodities. This makes it more difficult to distinguish which technologies are more likely to be flexible, as opposed to mass-production, using standard linear methods.

The technology survey contains the number of years in use for each technology type. Since we want to use technology information to explain the level of productivity, we only use information on technologies adopted at least three years before the year productivity was observed. This lead time should account for learning, training, and implementation effects. For observed productivity in 1988, we use data on technologies in use by 1985; for 1993 productivity we use data on technologies in use by 1990; for 1996 productivity we use data on technologies in use by 1993. Note that, in the survey, technology use accumulates over time, so plants can adopt technologies, but they cannot discard them. As a result we have the following increasing technology use rates: 28 percent of plants used at least one technology in 1988, 46.3 percent in 1993, and 54.6 percent in 1996.

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[9] Note: The MIS group includes software such as Manufacturing Information Systems and Integration and Control.

4. Estimation Results

4.1 The fundamental trade-off

Table 3 contains a first set of estimates of equation (1) on the full sample and the technology sample. It lists both results controlling for industry-specific fixed effects (at the 4-digit SIC level, which includes 235 dummies) and for plant-level fixed effects. Recall that the panel is not balanced; accordingly, approximately one third of plants that are observed only once are dropped when plant fixed effects are included.

The estimated coefficients all have the expected signs. The number of commodities is negatively related to productivity in all specifications, indicating a productivity penalty for diversification at the plant level. In contrast, the level of total shipments is positively related to productivity, which is consistent with positive scale economies.

Note that we do not want to attach any causal interpretation to these results. One should definitely not try to infer from the estimated coefficients what the expected productivity gains would be if a plant's level of operation were exogenously enlarged, or if the number of products in production were exogenously reduced.

This becomes apparent when we control for plant fixed effects—see results in column (2) of Table 3. Compared to the results with only industry fixed effects in column (1), the productivity penalty for variety becomes notably smaller. The reverse happens for the magnitude of the positive productivity premium for higher output, which increases when plant-specific productivity fixed effects are controlled for. The changes in the estimated coefficients are consistent with plants that face increasing returns to scale expanding operations, and plants facing lower than average diseconomies of scope adding new product lines.

Estimates on the technology sample are very similar in magnitude to those for the full sample. As the sample size is more than ten times smaller, it should not come as a surprise that significance levels are lower.

Because productivity is measured by value added per worker and scale by total shipments, the latter variable is endogenous by construction in equation (1). In Table 4, we report estimation results using an instrumental variable estimator for the technology sample and industry fixed effects. Output is instrumented either with the log of average output for a plant's industry,[10] the results of which are presented in column (1) of Table 4, or with a plant's own use of heat and power, results in column (2).

Using the average industry scale as the instrument, estimates of both scope and scale coefficients are remarkably similar to the original estimates in Table 3. The absolute magnitudes of both coefficients are larger, but changes are minimal. Using the cost of heat and power as instrument, both coefficients become smaller, but the principal finding survives: scale is associated with higher productivity while breadth of the product line results in a productivity penalty.

The important result is that, in all specifications, irrespective of the type of controls, the sample, and whether or not instrumental variables were used, plants face a fundamental trade-off. There are potential productivity gains from exploiting scale economies and operating at a higher level but, if this requires the introduction of additional product lines, there will be a negative counteracting force on productivity. We believe this scale-scope interaction is a fundamental trade-off that all manufacturing firms face.

4.2 *Discrete technology types*

We now investigate whether all plant-year observations face the same scale-scope trade-off or whether there are important heterogeneities.

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[10] The average industry output for each plant is constructed as log of the sum of shipment of plants in the 4-digit SIC industry minus output of a given plant, divided by the number of plants in this industry minus one. The own output is netted out to avoid endogeneity.

The first dimensions of heterogeneity that we investigate are ownership and export status. A large literature has already documented that plants that are foreign-owned and/or are exporters are unusual in many respects: they tend to be larger, pay higher wages, use more advanced technologies, and have higher productivity levels. The results in Table 5 indicate that, for a given plant, falling into these categories (i.e., being foreign owned or being an exporter) does not translate into a monotonic relationship for the scale or scope effects on productivity. We estimated equation (1) separating the (full) sample into four mutually exclusive groups of plants: domestically-controlled non-exporters, domestically-controlled exporters, foreign-controlled non-exporters, and foreign-controlled exporters. The estimates are reported for specifications with either industry or with plant fixed effects.

First, it should be noted that, for each of the four sub-groups, and using either set of controls, the scale coefficients are estimated to be positive and the scope coefficients to be negative. The scale-scope trade-off appears to be a pervasive phenomenon.

Further, we interpret a combination of large scale and scope coefficients—in absolute value for scope—to be indicative of an inflexible production process, or mass technology. Foreign-owned plants operating only for the Canadian market (non-exporters) are found to face the highest returns to scale, but also the highest productivity penalty associated with breadth of product line. On average, these plants seem to have installed production systems that favour producing large quantities of the same product—mass technology. This observation holds using either type of controls.

For the other types of plants, the ordering depends on whether we eliminate the variation across plants—i.e., whether we include plant fixed effects or not. If we do not, foreign-owned exporters are at the other extreme of foreign-owned non-exporters. They have the lowest scale coefficients, and by far the lowest scope coefficient (in absolute value). This suggests that they have chosen an entirely different strategy, namely to set up flexible production systems that can easily accommodate additional product lines without incurring much of a productivity penalty. Perhaps they are using Canada as a more flexible production base to serve the domestic, U.S., and other markets, while their highest volume plants are located in the United States to save on transportation costs. Of course, this is little more than speculation.

The above finding seems to be at odds with those in Baldwin and Gu (2006), who found that, in response to the Canada-U.S. FTA, Canadian plants shed product lines and increased scale, which led to sizeable productivity gains. The results in Table 5, column (2), which control for plant-level fixed effects, do indicate that identifying the scale effect for foreign-owned exporters solely from plant-level changes over time does lead to a high estimate for the coefficient on scale economies.

Results in Table 5, column (2) are on the whole consistent with Canadian-owned plants enjoying less potential to realize scale economies when they expand production. This could be the result of different technology adoption decisions or inexperience in scaling up the level of operations. It could also reflect a residual difference in outlook as Canadian industries have produced for years at a lower scale and with more diverse product portfolios for the much smaller Canadian market.

Comparing Canadian-owned exporters and non-exporters, the differences are small, but we do find in both specifications that the point estimates for the scope coefficients are higher (in absolute value) for exporters, as expected. This implies that exporters should be focusing on their comparative advantage and worrying less about producing a wide range of products. At least with plant-level fixed effects included, this strategy does seem to come with higher scale economies.

Note that 'exporter' status in Table 5 does not capture the effect of the FTA per se, since this group combines new exporters (who entered export markets after 1988) with continuing exporters. We revisit the particular effect of the 1988 trade liberalization event later, when we allow the scale and scope coefficients to vary continuously. We can, however, already note that industries that received the largest tariff cuts were slightly more flexible than those that had received the lowest cuts, but the differences were small for the two groups of plants. We do not go further into those issues here as U.S. and Canadian tariff cuts should also have different effects and we can incorporate this feature later on.

We expect the scale-scope trade-off to differ across industries. For example, industries producing large varieties of complex products should have greater incentives to invest in flexible technologies to mitigate some of the scope effects. We estimated equation (1) on all 2-digit SIC industries but, to conserve space, we only indicate a few of the findings[11]. Industries that show a high penalty for product variety include *Primary Textile* SIC18, *Electrical and Electronic Products* SIC33, *Chemical Products* SIC37. The highest economies of scale are observed in *Chemical Products* SIC37, *Petroleum Products* SIC36, *Beverages* SIC11, *Rubber* SIC15 and *Wood* SIC25. Virtually all industries show a positive sign on the scale coefficient and a negative sign for scope, but the positive relationship between output and productivity tends to be far more robust.

4.3 Discrete technology types with endogenous assignment

We now estimate the model with two technology types, allowing the data to self-select into two groups, using the estimation methodology from Van Biesebroeck (2003) that was described earlier. The first time a plant is observed in the sample the algorithm assigns a probability that the production technology is of the old type (with one minus that probability being assigned to the new technology type). Going forward, a second probability applies which determines the likelihood that plants still using the old technology are updating to the new one. While we do not observe the actual production technologies used, we rely on observable variables to parameterize the two probabilities, which together imply a probability for both technologies for each plant at each point in time. In the algorithm, the new technology is an absorbing

[11] The complete set of estimates is available upon request.

state—i.e., once a plant adopts the new technology, it will not subsequently switch to the alternative technology. We do not impose any restrictions on the nature of the scale-scope trade-off for the two technologies.

Two questions are important. First, do both technologies have the characteristics illustrated in Tables 3, 4, and 5 of positive scale and negative scope economies? Second, if one of the two technologies can be characterized as more flexible—i.e. has lower absolute values of both the scale and scope coefficients—is it the new or the old technology?

In the results presented in Table 6, the initial probability of a plant using the new technology is modeled as a function of a year trend and the foreign ownership dummy. As foreign-controlled plants have easier access to new technologies, they might be more likely to operate with the new technology, and thus not be open to the possibility of a technology switch. On the other hand, Canadian-controlled plants are more likely to focus on the domestic market and to produce a greater variety of products, which would favour the flexible technology, be it the old or new one.

As in Van Biesebroeck (2003), we use the average number of commodities produced by competitors to predict the probability of technology switching. This variable should be a good predictor for the demand for the comparative advantage of the new technology, be it higher scale or scope economies.

The results of this non-linear maximum likelihood estimation are presented in Table 6. Both scale coefficients are estimated to be positive and both scope coefficients to be negative, indicating that both technologies are characterized by the same scale-scope trade-off as before[12].

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[12] Note that the coefficients of the old technology are estimated directly, and reported in column (1) of Table 6, while the coefficients of the new technology are calculated as the sum of the old technology coefficients and two difference coefficients. The latter are estimated directly and results are reported in column (2). As a result, no t-statistic for the new technology coefficients in column (3) are reported, but the very high t-statistics on the difference coefficients indicate that the scale and scope effects are significantly different for the two technologies.

The estimates indicate very starkly that the 'old' production technology is the one characterized by greater flexibility. The productivity penalty for variety increases tremendously, from -0.077 to -0.785, for the new technology. The advantage of the new technology is a corresponding increase in the scale effect, with a coefficient on total shipments of 0.498, more than double the 0.226 estimate for the old technology.

The estimates on the parameters governing the probabilities for either technology (not presented) suggest that the likelihood of new plants entering with the mass technology increases over time; although the increase is not statistically significant. If plants change their operations, switches tend to make the production technology less flexible, but with higher scale effects.

The finding of plants switching towards the mass technology differs from the pattern observed for the U.S. automotive industry, but it is a plausible response to the Canada-U.S. FTA. As a result of the FTA, Canadian plants obtained easier access to the much larger U.S. market, which is consistent with the finding in Table 6 that over time they become more likely to choose the technology with the highest scale economies. The finding is also consistent with the FTA-induced increase in specialization of production found by Baldwin and Gu (2006). They found that tariff cuts reduced product diversification and increased production runs for exporters, which should be expected to focus on a few comparative advantage products. For non-exporters, tariff cuts are also found to reduce product diversification, which is consistent with the greater domestic competition they are facing from U.S. firms.

4.4 A continuum of production technologies

The final step in our analysis is to analyze what the patterns in the productivity distribution look like, if we allow the scale and scope parameters to vary continuously as a function of observed technology adoption decisions. This analysis can only be conducted on the limited technology sample, because only for those plants do we observe technology use directly. As a robustness check, we allow the coefficients on scale and scope to vary with the Canadian and U.S. import tariffs, as in equation (3). The latter regression can be estimated on the full sample. Plants that are subject to greater import competition or enhanced export opportunities will have different demands for technology to boost their potential scale and/or scope economies; this should show up in the coefficient estimates.

For the technology sample, we have information on the use of twenty-two advanced technologies—the full list is in the Appendix. Some of these technologies could reduce the productivity penalty associated with product variety, while some others could even increase them. There is no way for us to determine *a priori* the expected effect of each technology based on its description—although the patterns in Table 2 provide some hints.

For simplicity, we create an aggregated binary variable, which equals one if any of the twenty-two advanced technologies is adopted, and zero otherwise. We then estimate equation (1) for the technology sample, allowing for interaction between technology use and the scale and scope variables. The estimates are reported in the top panel of Table 7 for the entire technology sample.

With either industry or plant fixed effects, technology adoption is found to be related to higher returns to scale. We already know from the summary statistics in Table 2 that large firms are a lot more likely to adopt advanced technologies; nonetheless, the estimate in Table 7 indicates that this does not mean that they have exploited all scale economies. On the contrary, advanced technology use is associated with higher scale economies even if the adopting plants are larger. Note that the direction of causality could go either way. It could be that new technologies boost scale economies, but it might just as well be that firms facing higher scale economies are upgrading their technologies most rapidly.

The coefficient on the interaction between technology use and the number of commodities, “Scope x Technology”, is estimated to be negative with either set of controls; the effect is especially important in the specification with plant fixed effects.

When plants increase the number of commodities and at the same time adopt new technologies, their productivity takes a large hit. We find that technology adoption is more prevalent for inflexible mass technology plants that face scale economies; interpreted differently, new technologies tend to make the production technology less flexible[13].

We estimated the same specification separately for two groups of industries, which are sorted based on the extent of tariff cuts in the Canada-U.S. FTA. The results in panels (b) and (c) of Table 7 demonstrate that the above effects are driven by industries that experienced large tariff cuts. For industries that experienced small cuts, the interaction terms between technology and the scale and scope effects are always insignificant. For industries subject to large tariff cuts, the association between technology adoption and inflexible production becomes even stronger.

We next seek to evaluate the impact of the individual twenty-two technologies on production flexibility by including a full set of technology use dummies and interactions between their use and the scale and scope variables. Unfortunately, this analysis is complicated by serious multicollinearity; the vast majority of the coefficients on the interaction terms are not statistically significant.

One promising line of future research on this issue is to use factor analysis to reduce the dimensionality of the technology adoption decision. We found that 74 percent of the variation in adoption rates is explained by a single factor, and 90 percent by the first two factors. The first factor puts non-zero weights on most technologies, but the highest weight falls on technologies a16 and a17 from the *Inspection and Communications* group, and technologies a18 and a21 from *Manufacturing Information Systems* group[14]. In follow-up work, we plan to estimate

[13] Distinguishing between these two causal interpretations is beyond the scope of this paper.

[14] The second factor explains 15 percent of variation, but places substantial weights only on 5 technologies (four of which are from the *Design and Engineering Group*).

equations (1) and (3) using just the first two factors as interaction terms for the scale and scope variables.

Finally, we take a closer look at the direct impact of tariff cuts. In the full sample, we include Canadian and U.S. tariffs into equation (1), as well as interactions between tariffs and output, and tariffs and the numbers of products, as in equation (3). As we use actual tariff levels, low values of the tariff variables indicate liberalized trade. Over time, tariff levels have come down; in 1996, most tariffs were at or very close to zero.

The results in Table 8 for the specification with only industry fixed effects yields mostly insignificant results; accordingly, we focus on the results for the specification with plant-level fixed effects. The estimates on the uninteracted tariff variables in column (2) imply that plants in industries initially protected by high Canadian tariffs had on average higher productivity growth, while those facing higher U.S. tariffs had lower growth. Viewed differently, plants in industries where Canadian tariff concessions were large enjoyed on average higher rates of productivity growth—potentially due to stronger competition post-FTA.

Interacting the U.S. tariff with the variables of interest yields a very small point estimate for the impact on labour productivity of increased scope which is not significantly different from zero. The interaction with scale, on the other hand, exerts a large, positive, and statistically very significant impact on labour productivity. This may reflect the presence of large potential scale economies for plants that initially faced higher U.S. tariffs. When export opportunities to the United States opened up, plants either invested in new technology needed to access these potential scale economies or—more plausibly in our view—simply expanded output, exploiting and exhausting the scale economies that their existing technologies provided.

The reverse was taking place on the domestic Canadian market. Plants in industries where Canadian tariffs declined significantly saw their available scale economies grow. A plausible explanation is that competition from expanding U.S. imports reduced the *actual* scale of operations of many domestic plants, which would imply increased available *potential* scale economies, if production technology did not adjust. An additional finding for these industries is that the coefficient on the interaction between the Canadian tariff level and the number of commodities is negative. Initially, when tariffs were high, there were sizeable diseconomies of scope, but as tariffs declined to zero, these diseconomies disappeared. Canadian plants seem to have adjusted to trade liberalization by making their production process more flexible and by reducing the productivity penalty associated with a large product portfolio. Another process that might have contributed to the observed pattern is that these plants cut product lines and the lower diversification brought their product portfolio back into an area where they could more efficiently handle the variety.

5. Conclusion

The results indicate that Canadian manufacturing plants face a trade-off in terms of productivity: higher output increases productivity, but a larger product variety reduces it. No matter how one cuts the data, this pattern is robust, but the productivity premium for scale and the penalty for variety does vary across plants.

We can discern situations where both premiums are large in absolute value, which we call mass production or inflexible plants. In other situations, which we call flexible production technologies, both premiums are low indicating low returns to scale, but also lower diseconomies of scope. Either technology can be ideal for a plant, depending on its scale of operation and production mix. For example, we find that foreign-controlled plants that do not export seem to choose the least flexible technology, i.e. have the highest productivity premiums on both scale (positive) and scope (negative).

We estimated a model that allows for two parameterizations of the scale-scope trade-off in the production technology available to plants in our sample. The estimation algorithm lets the data decide which technology is most appropriate for each plant-year observation and incorporates one-way technology switching. The two technologies thus estimated can clearly be identified as one mass and one flexible technology.

Our results suggest that the mass technology is gaining in importance over time. The exploitation of higher scale economies seems to have become more valuable over time than maintaining production flexibility.

When we allow the scale and scope premiums to vary continuously with technology adoption and tariff rates, similar conclusions emerge. Technology adoption is associated with less flexible production, especially for plants in industries that saw large tariff cuts as a result of the Canada-U.S. FTA. In particular, the reduction of U.S. tariffs is associated with a decrease in available scale economies, consistent with the large expansion in output by Canadian exporters. The reduction of Canadian import tariffs, on the other hand, has the reverse effect on scale economies for import-competing industries, but it also reduced the productivity penalty associated with product variety in those industries—either due to operational changes or due to the elimination of product lines.

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Table 1: Descriptive Statistics

	MEAN	STD	MIN	MAX
	Full sample[1], N=46,324			
Log of productivity	10.952	0.759	2.526	18.759
Number of commodities	2.437	2.109	1.000	33.000
Log of no. of commodities	0.660	0.634	0.000	3.497
Log of shipments	15.189	1.800	8.854	23.575
Foreign-control dummy	0.185	0.388	0.000	1.000
Export status dummy	0.317	0.465	0.000	1.000
	Technology sample[2], N=3.887			
Log of productivity	11.160	0.791	4.920	16.532
Number of commodities	2.720	2.671	1.000	33.000
Log of no. of commodities	0.727	0.689	0.000	3.497
Log of shipments	16.115	1.687	10.309	21.637
Foreign-control dummy	0.324	0.468	0.000	1.000
Export status dummy	0.394	0.489	0.000	1.000

Notes:

1. All plants in the ASM with available commodity data for 1988, 1993 and 1996.
2. Plants that were both in the ASM with available commodity data for 1988, 1993 and 1996, and in the 1993 Survey of Innovation and Advanced Technology.

Table 2: Technologies Adoption Rates (Technology Sample, N=3,887)

	MEAN	SE		MEAN	SE	No. of Adopters	Average No. of Commodities	Average shipments of adopters
DE	0.360	0.480	a1	0.334	0.472	806	2.78	91,853,924
			a2	0.121	0.326	294	2.83	70,004,980
			a3	0.070	0.255	148	2.81	92,429,905
FA	0.252	0.434	a4	0.076	0.266	180	2.68	146,984,000
			a5	0.175	0.380	512	2.55	59,700,646
			a6	0.028	0.165	72	2.60	145,206,917
			a7	0.054	0.226	130	2.38	175,467,823
			a8	0.053	0.224	138	2.43	111,251,007
AMH	0.057	0.232	a9	0.057	0.232	165	2.98	102,421,818
			a10	0.000	0.000	55	2.85	149,016,473
IC	0.398	0.490	a11	0.091	0.288	255	3.40	187,672,427
			a12	0.118	0.322	332	3.14	180,070,018
			a13	0.169	0.375	369	2.97	146,316,293
			a14	0.134	0.340	303	3.21	154,873,426
			a15	0.112	0.315	240	3.38	125,131,825
			a16	0.277	0.447	804	3.10	119,722,148
			a17	0.232	0.422	624	3.13	136,557,646
MIS	0.308	0.462	a18	0.220	0.415	577	3.11	118,056,711
			a19	0.127	0.333	307	3.21	148,108,186
			a20	0.089	0.284	233	2.87	132,275,386
			a21	0.134	0.340	351	3.26	179,371,903
			a22	0.032	0.177	73	3.32	135,253,575

Notes:

1. Average shipments of adopters is in current Canadian dollars.
2. The MIS group includes software such as Manufacturing Information Systems and Integration and Control.

Table 3: Impact of Scale and Scope on Plant Productivity

	Dependent variable is the log of labour productivity			
	Estimate	t-statistic	Estimate	t-statistic
	(1)		(2)	
Fixed effects:	Industry		Plant	
Full Sample, N=46,324				
Scope	-0.091	(18.48)	-0.025	(-2.86)
Scale	0.220	(114.26)	0.428	(55.28)
Year1993	0.153	(20.20)	0.114	(16.64)
Year1996	0.202	(26.80)	0.106	(14.50)
Technology Sample, N=3,887				
Scope	-0.117	(-6.97)	-0.051	(-1.94)
Scale	0.229	(28.91)	0.537	(21.88)
Year1993	0.145	(5.99)	0.110	(5.61)
Year1996	0.196	(7.90)	0.096	(4.45)

Note: Estimates of equation (1). Scope is measured by the log of number of commodities; scale by the log of shipments

Table 4: Estimates of Scale and Scope Effects using Instrumental Variables, Technology Sample, N=3,887

	Dependent variable is the log of labour productivity			
	Estimate	t-statistic	Estimate	t-statistic
	(1)		(2)	
Fixed effects:	Industry		Plant's own	
Instruments	Mean industry-level scale		Heat & power expenditure	
Scope	-0.124	(-7.14)	-0.087	(-5.00)
Scale	0.248	(17.19)	0.151	(15.01)

Note: Estimates of equation (1) using instrumental variables for scale (total shipments). Variables are measured as in Table 3 and year dummies are included, but coefficient estimates not reported.

Table 5: Estimates of the scale-scope trade-off for different types of plants (Full sample)

		Dependent variable is the log of labour productivity				
		Estimate	t-statistic	Estimate	t-statistic	N
		(1)		(2)		
Fixed Effects		Industry		Plant		
Domestic-owned, Non-exporters	Scope	-0.080	(-10.90)	-0.026	(-1.63)	24,488
	Scale	0.220	(73.94)	0.413	(30.72)	
Domestic-owned, Exporters	Scope	-0.097	(-12.12)	-0.030	(-1.73)	13,289
	Scale	0.205	(47.98)	0.442	(26.51)	
Foreign-owned, Non-exporters	Scope	-0.163	(-7.58)	-0.058	(-1.34)	3,602
	Scale	0.255	(22.80)	0.570	(17.67)	
Foreign-owned, Exporters	Scope	-0.048	(-3.34)	-0.043	(-1.56)	4,945
	Scale	0.197	(24.82)	0.523	(20.25)	

Notes: OLS estimation results for equation (1), with firms split in four mutually exclusive categories. Year dummies included as controls.

Table 6: Nonlinear Estimation of Two Technologies with Technology Switching (Technology sample, N=3,887)

	Dependent variable is labour productivity				
	Old technology		Difference		New technology
	Estimate	t-statistic	Estimate	t-statistic	Implied Estimate
	(1)		(2)		(3)
Scope	-0.077	(-6.47)	-0.708	(-3.68)	-0.785
Scale	0.226	(46.04)	0.272	(3.85)	0.498

Note: Maximum likelihood estimation of the coefficients on the old technology, column (1), and the difference between the coefficients of the old and new technologies, column (2). The implied estimates for the coefficients on the new technology are in column (3). The old technology is the one that plants can still switch out of.

Table 7: Scale-scope Trade-off with Coefficients Varying with Technology Use

	Dependent variable is log of labour productivity			
	Estimate	t-statistic	Estimate	t-statistic
	(1)		(2)	
Fixed effects:	Industry		Plant	
(a) Entire technology sample (N = 3,887)				
Scope	-0.110	(-5.08)	-0.015	(-0.48)
Scale	0.218	(20.87)	0.512	(18.99)
Technology use	-0.627	(-2.72)	-0.818	(-2.13)
Scope x Technology	-0.019	(-0.61)	-0.080	(-2.15)
Scale x Technology	0.037	(2.59)	0.053	(2.25)
(b) Industries with large tariff cuts (N = 2,242)				
Scope	-0.098	(-3.44)	-0.006	(-0.14)
Scale	0.213	(16.23)	0.532	(14.96)
Technology use	-1.259	(-4.11)	-1.024	(-2.06)
Scope x Technology	-0.064	(-1.62)	-0.116	(-2.35)
Scale x Technology	0.077	(4.05)	0.066	(2.19)
(c) Industries with small tariff cuts (N = 1,453)				
Scope	-0.140	(-4.04)	-0.033	(-0.66)
Scale	0.234	(13.27)	0.458	(10.02)
Technology use	0.182	(0.49)	-0.719	(-1.11)
Scope x Technology	0.072	(1.43)	-0.019	(-0.31)
Scale x Technology	-0.017	(-0.73)	0.042	(1.06)

Table 8 Scale-scope Trade-off as a Function of Canadian and U.S. Tariffs (full sample)

	Dependent variable is log of labour productivity			
	Estimate	t-statistic	Estimate	t-statistic
	(1)		(2)	
Fixed effects:	Industry		Plant	
Scope	-0.078	(-12.89)	-0.010	(-1.00)
Scale	0.220	(97.62)	0.428	(53.05)
Tariff into Canada (TC)	-0.504	(-0.52)	5.159	(3.40)
Scope x TC	-0.134	(-0.82)	-0.356	(-1.83)
Scale x TC	0.010	(0.17)	-0.321	(-3.39)
Tariff into U.S. (TUS)	1.913	(0.97)	-7.606	(-2.39)
Scope x TUS	-0.338	(-1.21)	0.018	(0.05)
Scale x TUS	-0.088	(-0.72)	0.448	(2.24)

Appendix

Table A.1 List of advanced manufacturing technologies

Code	Description
Design and Engineering	
A1	Computer aided design (CAD) and /or Computer aided engineering (CAE)
A2	CAD output used to control manufacturing machines (CAD/CAM)
A3	Digital representation of CAD output used in procurement activities
Fabrication and Automation	
A4	Flexible manufacturing cell(s) (FMC) or systems (FMS)
A5	Numerically controlled and computer numerically controlled machines
A6	Material working laser(s)
A7	Pick and place robots(s)
A8	Other robots
Advanced Material Handling	
A9	Automated storage and retrieval systems (AS/RS)
A10	Automated guided vehicle systems (AGVS)
Inspection and Communications	
A11	Automated sensor-based equipment used for inspection/testing of incoming or in-process materials
A12	Automated sensor-based equipment used for inspection/testing of final product
A13	Local area network for technical data
A14	Local area network for factory use
A15	Inter-company computer network linking plant to subcontractors, suppliers and/or customers
A16	Programmable controller(s)
A17	Computer(s) used for control on factory floor
Manufacturing Information Systems	
A18	Material requirement planning (MRP)
A19	Manufacturing resource planning (MRP II)
Integration and Control	
A20	Computer integrated manufacturing (CIM)
A21	Supervisory control and data acquisition (SCADA)
A22	Artificial intelligence and/or expert systems

Innovation and Productivity in Canadian Manufacturing Establishments

Pierre Therrien and Petr Hanel*

Abstract: This paper builds on the Canadian contribution to the OECD Innovation Microdata Project, which analyzes the impact of innovation on labour productivity using firm-level data from national innovation and administrative surveys. We use an expanded data set with additional information on manufacturing establishments from the Canadian Survey of Innovation 2005 linked with the Annual Survey of Manufactures and Logging (ASML). The estimated econometric model controls for selection bias, simultaneity, size of firm and industry effects. The main findings are as follows: (1) Exporting to non-US markets, size of the firm and use of government support increase the probability to innovate and having positive innovation sales. (2) Exporting (both to the U.S. and other markets), cooperation with other firms and organizations, and a high share of firm revenues coming from sales to a firm's most important client correlate with higher innovation expenditure per employee. Firms with a higher market share at the beginning of the period tend to spend more on innovation by the end of the period. (3) Firms with higher innovation expenditure per employee generate more innovation sales per employee. Other factors increasing innovation sales are human and physical capital and introduction of process innovations. (4) Finally, firms generating more innovation sales per employee achieve higher labour productivity, even when size of firm, intensity of human and physical capital, and labour productivity at the beginning of the period are taken into account. The results add to, and are in line with, the findings based on the simpler model applied in the 18-country OECD study. The paper concludes with a discussion of policy implications.

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1. Introduction

The standard of living and the quality of life in a country are closely related to its level of labour productivity. Improving labour productivity not only supports increased wages but is also the best guarantor of capacity to provide public services such as health care, education, and environmental initiatives, the top priorities of Canadians. However, both the level and growth rate of Canada's labour productivity have been a source of concern for some time (Hanel, 2008). Innovation is one of the principal sources of productivity growth and is also an area where Canadian industry lags behind many of its competitors according to the European Innovation Scoreboard (Pro-Inno, 2008)[1]. Accordingly, Canada has joined research efforts of other OECD countries to reach a better understanding of the process from the decision to innovate up to the effect of innovation on productivity and other performance indicators.

To understand what is behind the aggregate statistics, it is necessary to examine innovation and productivity at the firm level. After all, it is there that labour and capital—the principal factors of production—are put to work more or less efficiently. By introducing new and improved products and production processes, innovating firms expand existing and create new markets, as well as improve the efficiency of their production and marketing activities—i.e., improve their productivity.

The analysis of microdata using innovation surveys, which started in the 1990s, has focused on the innovation process, its characteristics, and the conditions that encourage or impede innovation[2]. However, use of microdata for international

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[1] According to the European Innovation Scoreboard 2007, Canada ranks in the middle of the OECD, with a Summary Innovation Index reading just below that of the EU 27. Note that Canada's score is based mostly on R&D-related variables; innovation survey-related factors were not taken into account, due to issues of data availability.

[2] The OECD in collaboration with EUROSTAT launched, in the early 1990s, a concerted effort to collect information on the whole innovation process at the firm level (Community Innovation Survey in Europe, Innovation Surveys in Australia, Canada, etc). Availability of data on

comparisons is hampered by national laws that protect confidentiality of firm-level information. To get around this problem, the OECD launched in 2006 the Innovation Microdata Project (OECD, 2009). As part of this project, research teams from 18 OECD countries used a common methodology first introduced by Crépon, Duguet and Mairesse (CDM) to analyze the impact of innovation on labour productivity using firm-level data from their national innovation and administrative surveys.

This paper extends the Canadian model used for the OECD project. It follows the same methodology as the OECD model but uses to the full extent all information available on manufacturing establishments from the Canadian Survey of Innovation 2005 (linked with the Annual Survey of Manufactures and Logging (ASML). The extended Canadian model tests and refines relationships found in the OECD project and focuses on the policy implications of the Canadian results.

This paper is organized as follows: Section 2 reviews the literature dealing with the issue of innovation and productivity at the firm level, including a summary of the main results of the OECD project with particular emphasis on the Canadian results. The third section presents in more detail the proposed refinement of the econometric model for application to Canada, while Section 4 analyzes the results from the extended Canadian model. Finally, Section 5 concludes by considering policy implications of the results and by proposing alternative avenues for future research.

2. Overview of the literature

2.1 Background and CDM model

Initially, the difficulty of measuring technical progress directly led economists studying the link between innovation and

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innovation spurred new research aimed at understanding the innovation process, its sources, results and effects. For examples of such studies see Kleinknecht (1987 and 1989); for specifically Canadian studies, see Baldwin and Hanel (2003) and Gault (2003).

productivity at the firm level to focus their attention on research and development (R&D), an input into the innovation process. However, as Mairesse and Sassenou (1991) who surveyed these studies noted, the methodological difficulties faced in modeling the complex relationships involved, in addition to the issues of obtaining high quality data, made it quite challenging to arrive at satisfactory interpretations and conclusions.

The introduction of innovation surveys in most OECD countries[3] in the early 1990s provided data that enabled researchers to statistically document the multiple sources of innovation, the variety of types of innovation, and their relationship with the expected and achieved impact of innovation results on the performance of innovating firms. Crépon, Duguet and Mairesse (1998), inspired by earlier work of Pakes and Griliches (1984), integrated these relationships into a single system of three stages with four recursive equations:

(i) The first stage captures the firm's decisions regarding research activities—i.e., whether to engage in R&D and, if yes, what level of resources to allocate to this purpose. The Heckman selection equation estimates the probability that the firm performs R&D activities. Given that a firm engages in R&D, the second equation in the first stage estimates the intensity of these activities.

(ii) The second stage models innovation as a function of R&D and other variables. Innovation outcomes are measured by patents in one variant of this equation and by the percentage of innovation sales in a firm's total sales in another variant.

(iii) The third stage of the model expresses productivity as a function of innovation output—measured either by the

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[3] The notable exception being the United States, which until recently had not conducted nationwide innovation surveys. However, the U.S. National Science Foundation has just released its first ever Business R&D and Innovation Survey (BRDIS) developed jointly with the U.S. Census Bureau (see National Science Foundation Press Release 10-089, "New Survey Facilitates Better U.S. Business Competition in Global Economy", 26 May 2010).

expected number of patents per employee or by the share of innovative sales over total sales—and other determinants of productivity, including capital, labour and skill composition, using an augmented Cobb-Douglas production function.

The estimating model uses appropriate methods to deal with selection bias, the endogenous nature of innovation and R&D and the statistical properties of the underlying data. The CDM results show, for French manufacturing firms, a clear link between the innovation input intensity (R&D capital intensity), innovation output (patents or innovation sales), and firm productivity:

> "The probability of engaging in research (R&D) for a firm increases with its size (number of employees), its market share and diversification, and with the demand pull and technology push indicators. The research effort (R&D capital intensity) of a firm engaged in research increases with the same variables, except for size (its research capital being strictly proportional to size). The firm innovation output, as measured by patent numbers or innovative sales, rises with its research effort and with the demand pull and technology indicators, either directly or indirectly through their effects on research. Finally, firm productivity correlates positively with a higher innovation output, even when controlling for the skill composition of labour as well as for physical capital intensity" (Crépon, Duguet and Mairesse, 1998).

2.2 *Variants of the CDM model*

The CDM model has inspired several similar studies, all based on the harmonized innovation survey data collected according to guidelines provided by the Oslo Manual for collecting and interpreting innovation data. Interesting variants of the CDM framework are found in: Lööf and Heshmati (2006), who examine the link between innovation and labour productivity in Swedish manufacturing and services firms; Griffith et al. (2006), who compare the innovation-labour productivity nexus for France, Germany, Spain and the UK; and Van Leeuwen and

Klomp (2006), who estimate the contribution of innovation to multifactor productivity growth in the Netherlands.

The Swedish study is of particular interest. It uses the CDM model as the theoretical framework but adopts a different econometric strategy to overcome the problem of endogenous explanatory variables, using instrumental variable analysis instead of the asymptotic least squares method used by CDM. As well, the study conducts various types of sensitivity analysis, including by using, *inter alia*, different data sources, different classifications of firms' performance, different classifications of innovation and by estimating models in growth terms as well as well as in level terms. Results show that various productivity measures such as sales per employee, value added per employee, growth of value added per employee, growth of sales, growth of profit per employee, growth of employment and, to a lesser degree, sales margins are all positively linked to innovation; of course, the estimated elasticity coefficients vary. In contrast to earlier studies that considered R&D as the sole innovation expenditure, the innovation input variable in this study includes expenditures on all aspects of innovation. The elasticity of labour productivity to innovation sales in manufacturing and in services is found to be rather similar, respectively 0.12 and 0.09. A debatable feature of the study is the inclusion of various obstacles to innovation in the vector of exogenous variables. By definition, in the case of innovating firms, obstacles to innovation are not independent from innovation; thus, this specification potentially results in a simultaneity bias in the coefficient estimates.

Griffith et al. (2006) analyze 1998-2000 data from innovation surveys in France, Germany, Spain and the UK. In contrast to the original CDM, this study estimates separate innovation functions for process and product innovations. Product innovation has a positive effect on labour productivity (measured as sales per employee) in three out of four countries (Germany being the exception). Process innovation appears to have a positive effect only in the case of French firms. Another original feature of this application of the CDM model is the inclusion of local, national and EU funding of R&D in the equation modeling the decision to engage in R&D. However, only national funding appears to affect R&D intensity[4].

Finally, Van Leeuwen and Klomp (2006) examine the impact of innovation on multifactor productivity (MFP) growth using data for the Netherlands. Among other features, this study models the feedback from firms' sales back to innovation activity. The authors argue that revenue per employee is a more appropriate basis for assessing the link between the results of the innovation process and firm performance because the results of innovation are measured in revenue terms rather than in value added terms. The study also finds that the estimation of return on innovation investment benefits from the inclusion of more information on the technological environment of the firm.

2.3 The OECD variant of the CDM model to benchmark countries

Using the Lööf and Heshmati (2006) variant of the three stage, four equation CDM approach, teams of researchers from 18 OECD countries, including Canada, estimated a simplified common model[5]. The requirement of estimating a common model for all participating countries limited the choice of available variables. The OECD model used the standard dependent variables related to innovation input (innovation expenditures per employee); innovation output (innovation sales

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[4] In the case of France, national funding appears with a negative coefficient while EU funding comes with a positive one.

[5] The results of this unique joint research initiative were coordinated in a series of workshops by the WPIA-NESTI (OECD) with econometric programming and coordination by Chiara Criscuolo from the London School of Economics. A short summary of results has been published in Chapter 5 of the OECD's *Science, Technology and Industry Outlook 2008* and detailed analysis can be found in OECD (2009), Chapter 3. We present in Appendix 1 summary results for the 18 countries. See Therrien and Hanel (2008) for more information on preliminary results for Canada. Therrien and Hanel (2009) present an overview of extensions of the 'core' model for the United Kingdom, Germany, the Netherlands and Canada.

per employee) and labour productivity (measured by sales per employee). However, owing to unavailable data in some countries, it was impossible to include in the productivity equation the usual factors of production (such as intermediate inputs and human and physical capital) or alternatively to use a better dependent variable (value added per employee). Nonetheless, the main independent variables in the four equations (such as firm size, exporting, cooperation, government support for innovation, etc.) were included in the model. Selection bias and endogeneity issues between innovation sales and productivity were taken into account.

The main finding of the OECD initiative is that innovative firms in all participating countries seem to behave in similar ways. Exporting, large size and being part of a group are characteristics that increase the probability that a plant or firm is innovating. These characteristics, in addition to cooperating on innovation and receiving public financial support, determine the intensity of investment in innovation. Sales of innovative products contribute significantly to labour productivity. The main elasticities—between innovation expenditures and innovation sales and between innovation sales and labour productivity—are usually positive and within the same broad range.

Looking more specifically at each stage and comparing Canada to other countries (see Appendix 1 for the specification of the model and summary tables), the following results emerge:

<u>First stage – decision to innovate and investment in innovation</u>

In Canada, as in the other countries, the decision to innovate is positively correlated with exporting and firm size (as measured by number of employees); however, in contrast to most OECD countries, being part of a larger group results in Canadian plants being less likely to innovate.

The intensity of investment in innovation is, in most OECD countries, increased by exporting, group membership, cooperation in innovation activities with other firms and research institutions, and by government financial support for innovation. In Canada, as in most countries, the largest effect on investment in innovation—as measured by innovation expenditures per employee—comes from sales to foreign markets (regression coefficient of 0.45). The next most significant determinant is use of government support (0.18), followed by cooperating (0.17) and being part of a larger enterprise (0.15). In most countries, including Canada, selection bias has been detected and corrected following Heckman's procedure by including the Mills ratio in the innovation output and productivity equations.

Second stage – Innovation production function

The log of innovative sales per employee is positively correlated with innovation expenditures per employee in all countries except Switzerland, meaning that firms spending more per employee on innovation activities have more innovative sales per employee. The coefficients range from 0.14 for Denmark to 0.52 for New Zealand; the estimated elasticity for Canada is in the mid-range (0.37)[6]. In Canada, as in some other countries (Finland, France and the UK for instance), firms that introduced process innovations in addition to product innovations have higher innovative sales per employee. Other factors, including the size of firm, membership in a group and collaboration with others, do not have any consistent effect on innovation sales across the OECD countries.

Third stage – contribution of innovation to productivity

Labour productivity is positively correlated with innovation sales. Firms with high innovation sales per employee have a higher productivity level than other firms. The estimated elasticity for all countries ranges from 0.23 to 0.86, with Canada's coefficient (0.44) in the middle of the range. Larger firms have somewhat higher productivity, but the effect of size is modest. Being part of a group is also associated with higher productivity. More surprising is the negative, often statistically

[6] With the exception of Austria, the elasticity of innovation sales to innovation expenditures is statistically significant at the 1% level for all countries. Note that the positive and statistically significant coefficients hold only when the endogeneity between innovation expenditures and innovation sales is rejected. The endogeneity issue when using Canadian data is addressed in the next section.

significant, coefficient of process innovation. Process innovation appears to have a positive effect on productivity only indirectly through its positive correlation with innovation sales in the 2nd stage equation.

Summarizing the Canada results, the OECD model suggests that exporting firms are more likely to introduce new and improved products and that they invest more in innovation than non-exporters. Firms that cooperate in innovation and those that receive financial support from government spend more on innovation per employee than others, but the effect of these two variables is notably smaller and less significant in Canada than in other countries. The innovation sales equation shows that higher innovation expenditures and cooperation with private partners are linked to better performance on product innovation, which in turn is linked to higher labour productivity. Larger firms are significantly more likely to innovate and to achieve higher productivity than smaller firms. In Canada, as in most countries, process innovation enhances productivity only indirectly through its positive impact on product innovation; the direct effect of process innovation on productivity appears to be small and, contrary to expectations, negative.

Overall, when statistically significant, the estimated regression coefficients are remarkably similar for all countries, not only for the productivity equation but also for the elasticity of innovation sales to innovation expenditures and for the equation describing investment in innovation and the decision to innovate as well. Thus, in spite of the constraints on the range and choice of variables imposed for the sake of international comparability, the estimated model yields broadly comparable results for the OECD countries included in the sample.

Nonetheless, because of data constraints, the results from the OECD model must be interpreted with caution. The obvious examples of sub-optimal aspects in the OECD-wide study are: the use of a sub-optimal productivity measure (value added or total factor productivity variables would have been better candidates for the productivity measure than total turnover per employee); the specification of the equation would have been improved by inclusion of important production factors such as human and physical capital; and the use of binary variables when quantitative ones were available for some countries (e.g., percentage of sales exported).

In addition, the lack of robustness of important elasticities (those between innovation output and innovation input, and between productivity and innovation output) calls for further analysis and correction of potential biases that might be caused by endogeneity between innovation-related variables. Finally, further work is needed before accepting the puzzling negative coefficients of process innovation in the productivity equation.

In the following sections, the model is refined in order to assess whether the results obtained with the OECD model hold for Canada when important relationships are added and better suited variables are used.

3. The extended Canadian model

By using Canadian data not constrained by the imperatives of international comparability, we are able to introduce a more complete model, including all relevant available variables, to get more reliable results. The modifications of the core OECD model include:

- a better measure of productivity (value added per employee instead of revenue per employee);
- human and physical capital variables in the productivity equation;
- whenever possible, replacement of binary variables with quantitative variables; and
- addition of other relevant control variables such as outsourcing R&D.

We perform in-depth econometric tests to assess robustness of core results on the links between innovation input, innovation output and firms' productivity (by testing the potential "endogeneity" problems between these variables that would bias results). Finally, we test different variables and different models to assess the counter-intuitive preliminary result of a negative coefficient of process innovation on firms' productivity.

3.1 *The model*

The extended Canadian model includes additional and refined relationships at each stage of the analysis, and a better modeling of the productivity equation. The specification of each equation is presented below:

(A0) $innov\_strict = \beta_0^0 + \sum_n \beta_n^0 X_n^0 + \varepsilon^0$
If $innov\_strict = 1$:
(A1) $\log(inn\_exp/emp) = \beta_0^1 + \sum_m \beta_m^1 X_m^1 + \varepsilon^1$
(A2) $\log(inn\_sale/emp) = \beta_0^2 + \beta^2 \log(inn\_exp/emp) + \beta_{MR} MR + \sum_l \beta_l^2 X_l^2 + \varepsilon^2$
(A3) $\log(VA/emp) = \beta_0^3 + \beta^3 \log(inn\_sale/emp) + \beta_{MR} MR + \sum_i \beta_i^3 X_i^3 + \varepsilon^3$

The dependent variables in these equations are defined as follows:

(A0)	innov_strict	= 1 if inn_exp>0 and inn_sale>0; otherwise = 0
(A1)	LRTOTPE log(inn_exp/emp)*	= log(total innovation expenditures per employee)
(A2)	LISPE log(inn_sale/emp)*	= log(innovation sales per employee)
(A3)	LVAPE log(value added/emp)	= log(total revenue per employee)

*Potentially endogenous variables

Explanatory variables for each equation are set out below:

For equation A0, the vector of explanatory variables X_n^0 includes:
- employment in log form *(LEMP);*
- percentage of sales exported to the U.S. *(EXPORT_US);*
- percentage of sales exported to other foreign markets *(EXPORT_OT)*;
- share of total revenue from other plants in the group *(INTRA_SALE);*
- government support by grant *(GRANT)* or by R&D tax credit *(GTXC);*

and important success factors such as:
- seeking new markets *(FAC_NEW)*;
- satisfying existing customers *(FAC_EXIST);*
- developing custom designed products *(FAC_CUSTOM);*
- plant's market share at beginning of period *(MKTSH02);*

and
- industry dummy variables *(SIC_stan)*.

For equation A1, the vector of explanatory variables X_m^1 includes:
- employment in log form (*LEMP) or* log of employment at the *beginning* of period (*LEMP02*);
- percentage of export to U.S. (*EXPORT_US);*
- percentage of export to other foreign markets (*EXPORT_OT*);
- share of total revenue from sales to the most important customer or client which is not part of the firm (*MIC);*
- cooperation on innovation (*COOP);*
- government support by grant *(GRANT)* or by R&D tax credit *(GTXC);*
- plant's market share at beginning of period *(MKTSH02);*
- R&D contracted-out *(RD_OUT)*; and
- industry dummy variables *(SIC_stan)*.

For equation A2, the vector of explanatory variables X_l^2 includes:
- employment in log form (*LEMP);*
- the plant is part of a group, *(GP)*;
- innovation expenditures per employee in log form (*LRTOTPE*)*;
- introduction of a process innovation (*PROCESS)*;
- sources of information on innovation from public institutions *(S_PUB)*, from market sources (*S_MARKET)*, or in-house *(S_INTRA)*;
- human capital (*HC)*;
- physical capital per employee in log form (*LGIPE);*
- Mills ratio (*MR); and*
- industry dummy variables (*SIC_stan)*;

For equation A3, the vector of explanatory variables X_j^3 includes:
- employment in log form (*LEMP);*
- the plant is part of a group, *(GP*);
- log of innovation sales per employee (*LISPE*)*;
- introduction of a process innovation (*PROCESS);*
- Mills ratio (*MR);*

- human capital (*HC)*;
- physical capital per employee in log form (*LGIPE);*
- labour productivity at the beginning of the period (2002) *(LVAPE02);* and
- industry dummy variables (*SIC_stan)*.

The instrumental variable for innovation sales, *LISPE,* in equation A3 is:

Z (LISPE) = [*LRTOTPE*, *S_INTRA; S_PUB; S_MARKET*]

For estimation purposes, we use the two-stage Heckman procedure (Heckit) for equations A0 and A1. The Mills ratio variable estimated from the first stage (equation A0, which models selection into innovation) is used to correct for selection bias in modeling innovation expenditure in equation A2. Equation A2, which models innovation sales, is estimated using simple OLS, as the hypothesis of exogeneity of innovation expenditures as a determinant of innovation sales could not be rejected[7]. Therefore, there was no need to introduce an instrument for innovation expenditures in this equation. In contrast, tests showed that innovation sales were endogenous in the productivity equation (A3). Therefore, the latter equation was estimated using a two-stage least squares procedure with an instrumental variable used for innovation sales. The Mills ratio generated in the first stage is included as an explanatory variable in equation A3 as well.

A brief discussion of the exogenous variables used in the four equations follows.

[7] An earlier version of this paper (Therrien-Hanel, 2008) described all the tests performed to assess whether the potential endogeneity between innovation expenditures and innovation sales was important enough to require using IV regression. Suffice to say for now that tests showed no need to use IV regression. More details on tests and results are provided in the next sections. Exhaustive results are available upon request.

Decision to innovate and innovation inputs

Instead of merely identifying export activity by a dummy variable as in the OECD core model, data from the Canadian Survey of Innovation 2005 allow for the use of the actual percentage of sales to the U.S. market *(EXPORT_US)* and to other foreign markets (*EXPORT_OT)*. In general, exporters tend to be more innovative (Becker and Egger, 2007) and more productive (Tybout, 2001; Wagner 2007). This is partly due to the *selection effect* since only the most competitive firms can challenge foreign competition and succeed in exporting. Owing to Canada's close integration with the U.S. economy, sales to the U.S. market may present less of a challenge than exports to other areas. The latter may require more specific competencies, including the capacity to innovate. As well, consistent with the *learning by exporting* hypothesis, there is evidence that participation in foreign markets allows firms to acquire new knowledge that makes them more efficient (De Loecker, 2006). According to Baldwin and Gu (2003), Canadian-owned exporters of manufactured products, especially new entrants to foreign markets and young firms, appear to benefit from both of these effects.

Previous results (OECD 2008, Peters, 2008) show that establishments that are part of a larger entity are more likely to innovate and to spend more on innovation. This may be the case for many smaller establishments that can tap into a firm's resources and expertise. We test whether the "strength" of the link with the larger enterprise plays a role in an establishment's behaviour with regard to innovation and innovation spending. The strength of the link is expressed as the share of total revenue that comes from other establishments of the enterprise (*INTRA_SALE*).

Finally, as stressed in the management literature, choosing to focus on one important client or to diversify the number of clients is believed to have an impact on the innovation behaviour of establishments. Firms generating a high proportion of total revenue from their most important client *(MIC)* are likely to face less incertitude with regard to the adoption of their innovation by their dominant client. Often, the innovation may have been created in collaboration with, or in response to the demand of, their most important client. The hypothesis behind this variable can be traced back to the characterization of the customer and specialized supplier relationship in Pavitt (1984).

Factors that are deemed by a firm to be responsible for its success (i.e., in terms of ranking "high" on the Lickert scale) are likely to be related to the decision to innovate. The active search for new markets (*FAC_NEW),* satisfying existing customers (*FAC_EXIST),* and developing custom-designed products *(FAC_CUSTOM)* are success strategies believed to be closely associated with the decision to innovate[8].

Government support reduces the marginal cost of innovation and hence reduces one of the principal obstacles to innovation (Czarnitzki, Hanel and Rosa, 2005). The decision to innovate may be induced by government support as is the case in some European countries (Griffith et al., 2006). Two dummy variables identifying whether a firm claimed R&D tax credits (*GTXC)* and/or received R&D grants (*GRANT)* are included in the selection and innovation expenditure equations[9].

Establishments, especially smaller ones that do not conduct regular R&D activity, may contract out specific research and development tasks to private or public R&D institutes. On the other hand, access to external R&D may complement a firm's internal R&D competencies. Thus, it is not *a priori* clear whether contracting out R&D is a substitute for, or a complement to, intensity of innovation expenditures. In case the firm contracts out R&D, the sign and statistical significance of the regression coefficient of the dummy variable (*RD_OUT)* indicate whether and how strongly this strategy affects the firm's investment in

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[8] The inclusion of those variables also serves another purpose. To identify and separate innovative and non-innovative firms (for the selection equation), information on all firms is required and unfortunately, few questions in innovation surveys are met with responses from both innovative and non-innovative firms. Success factors are one of the few questions answered by both types of firms; using them was helpful in getting a better result for the entire model.

[9] Unfortunately, quantitative information on the amounts of the subsidies and tax credits are not available from our data base.

innovation activity. The profitability of innovation is expected to be higher the greater the firm's market share *(MKTSH02)*.

Innovation output equation

The output of innovation is measured by the log of sales of new and improved products and services per employee *(LISPE)*. The specification of explanatory variables in this equation is similar to the OECD core model. In addition to the log of innovation expenditures per employee (*LRTOTPE)* and the log of firm employment (*LEMP),* it includes three specific sources of information on innovation (*S_INTRA, S_PUB,* and *S_MARKET)* in replacement of the four specific cooperation variables that did not perform very well for Canada in the OECD core model. Earlier studies show that innovation feeds not only on R&D competencies, but also often on ideas and suggestions from other internal sources such as management (especially in smaller firms without a regular R&D division) and sales and marketing and production staff, as well as from various external sources. Since the measure of innovation outcomes (*LISPE)* is the value of new and improved product sales per employee, it is expected that it is closely associated with information from market partners such as clients and suppliers and from public research institutions (Baldwin and Hanel, 2003; Landry and Amara, 2003).

Productivity equation

We measure labour productivity as value added per employee, a more appropriate measure of labour productivity than total revenue per employee as used in the OECD core model. We further improve on the OECD model by including in the productivity equation, in conformity with production function theory, both human capital, which is represented by the proportion of university graduates in the firm's total employment (*HC)*, and physical capital, which is represented by the cost of fuel and energy per employee (*LGIPE)* in log form[10].

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[10] Due to data constraints, we used expenditure on power and fuel in manufacturing activities as a proxy for physical capital. Energy consumption

A firm's labour productivity is also expected to be affected by its innovation activity—i.e., by the outcome of product innovation (*LISPE)* and of process innovation (*PROCESS*). Firms with higher productivity at the beginning of the period (*LVAPE02)* are likely to report higher productivity at the end of the period.

3.2 The data

The data are from the Canadian Survey of Innovation 2005 on manufacturing and logging industries (reference period 2002 to 2004) linked to the Annual Survey of Manufactures and Logging[11]. The target population of the survey is establishments with more than 19 employees and at least $250,000 in revenues according to Statistics Canada's Business Register (June 2005 version). The linked survey has a total of 6,109 observations.

From the 6,109 observations, we kept only those in the manufacturing sector with positive revenue and with more than 9 employees according to data from the Annual Survey of Manufactures and Logging to standardize the target population in accordance with criteria adopted for all OECD countries[12]. The Canadian final sample thus consisted of 5,355 observations.

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is closely related to physical capital and has been successfully used as a surrogate for capital (e.g., Hillman and Bullard, 1978).

[11] The Statistics Canada Survey of Innovation 2005 does not survey services firms. The innovation survey data are linked to principal statistics from the Annual Survey of Manufactures and Logging, 2002 and 2004. For more information on the survey, go to http://www.statcan.ca/english/sdds/4218.htm.

[12] Some firms with less than 20 employees (and also less than 9 employees) were found in the database. The survey population was defined using the June 2005 version of Statistics Canada's Business Register. The annual Survey of Manufactures and Logging includes data from 2002 and 2005.

Box 1: List of variables

Symbol	Description
COOP	Plant co-operated on innovation activities
EXPORT_OT	Percentage of plant's total revenue exported to other destinations
EXPORT_US	Percentage of plant's total revenue exported to the U.S.
FAC_CUSTOM	Developing custom-designed products is the most important factor for plant's success
FAC_EXIST	Satisfying existing clients is the most important factor for plant's success
FAC_NEW	Seeking new markets is the most important factor for plant's success
INTRA_SALE	% of plant's total revenue in 2004 from other plants in the firm
GP	Operations of plant are part of a larger firm
GRANT	The plant (firm) used government R&D grants
GTXC	The plant (firm) used R&D tax credits
HC	Human capital (percentage of full-time employees with university degree)
LEMP (*LEMP02)*	Log of employment (Log of employment for beginning of period (2002))
LGIPE	Proxy for physical capital (Cost of energy and fuel per employee), in log form
LISPE	Log of innovation sales per employee
LRTOTPE	Log of total innovation expenditures per employee
LVAPE	Log of value added per employee
LVAPE02	Log of value added per employee at beginning of period (2002)
MIC	% of plant's total revenue in 2004 from the most important customer
MKTSH02	Plant's market share at beginning of period (share of plant's output over industry output)
PROCESS	Plant introduced a new or significantly improved production process, distribution method, or support activity for its goods or services
RD_OUT	R&D contracted out
S_INTRA	Information on innovation from internal sources
S_PUB	Information on innovation from public sources
S_MARKET	Information on innovation from market sources

INDUSTRY	Industry dummy variables are included in all equations.
Food + Tobacco	Food and Tobacco (NAICS: 311-312)
Textile	Textile, Clothing and Leather (NAICS: 313-316)
Wood	Wood products (NAICS: 321)
Paper	Paper and Printing (NAICS: 322-323)
Petro + Chem	Petroleum, Chemical and Plastics & Rubber (324-326)
Non-metal	Non-metal products (NAICS: 327)
Fab-metal	Primary metal and Fabricated metal products (NAICS: 331-332)
M&E + Telecom	Machinery, Electrical, Electronic computer and communication (NAICS: 334-335)
Transport	Transportation (including aerospace) (NAICS: 336)
NEC	Furniture and NEC manufacturing industries (NAICS: 337-339)

3.3 Comparison of innovating and non-innovating firms

Before turning to the analysis of the econometric results, we first provide a brief descriptive analysis of the data presented in Table 1. First, 66% of the Canadian establishments described themselves as innovators in terms of having introduced either a new or improved product or process in the previous three years. The average productivity level *(VAPE)* of the innovators is 11% higher (i.e., $10,000 value added per employee higher) than for non-innovators[13].

As regards firm characteristics, innovators tend to be larger (*EMP:* average of 109 employees for innovators versus 70 employees for non-innovators) and more likely to be part of a larger enterprise (*GP*: 37% vs. 31%). Innovators have, on average, a higher share of university graduates in their workforce (*HC:* 10% vs. 7%). There is, however, no statistically significant difference in physical capital intensity (*GIPE*) between the two groups. Innovators are also more exposed to

[13] Note: the result of innovative firms being more productive than non-innovative firms also holds when computing a simple regression model where firm size and human and physical capital are taken into account.

the international market by exporting a higher share of their products (to the United States as well as to other foreign markets) than non-innovators. Regarding firms' business strategies, both innovators and non-innovators devote a similar share of sales to their most important client (*MIC*: at a little less than 30% of their sales); but innovators are more likely to see the active search for new markets *(FAC_NEW)* and developing custom-designed products *(FAC_CUSTOM)* as important success factors than non-innovators. Satisfying existing clients is seen as equally important for innovators and non-innovators.

Table 2 provides information on the sub-sample of firms and plants that are considered to be innovators in the "strict sense"—i.e., that reported both innovation expenditures and innovation sales. This is the sub-sample that is used in the econometric model (more specifically in equations A1 through A3). The average labour productivity of "strict" innovators is slightly lower (103.76) than productivity (106.99) of all firms that declared to have innovated (cf. Column 1 in Table 1). Strict innovators spent on average 11% of their total expenditures on innovation activities and 22% of their total sales came from sales of innovative products[14].

The comparison with all innovators shows that a slightly larger proportion of the "strict" innovators used various government support programs; however, only the difference with respect to R&D tax credits is statistically significant. The average log of innovation sales per employee (*LISPE*) is 3.21 or roughly $25,000 per employee[15]. More than one out of four firms cooperated on innovation activities with other firms and institutions and almost one in five contracted out R&D.

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[14] According to a Statistics Canada protocol, it was not possible to publish the average spending on innovation activities per employee (coefficient of variation of this descriptive variable too high). We therefore present the average share of innovation expenditures and innovation sales. Note, however, that the intensity of innovation expenditures and sales by employee in dollar terms was used in the regressions.

[15] See footnote above. The same issue (Statistics Canada protocol) prevented us from presenting a more precise figure.

4. Interpretation of the estimated model

The results of the three stage, four equation model using the expanded Canadian dataset are presented in Table 3. Four variants of the model are estimated.

The first two, presented in columns (1) and (2), are based on a data set that includes firms of all sizes. The main difference between these two variants is the use in variant (2) of variables (employment, market share and productivity level) describing firms' characteristics *at the beginning of the period*. Introducing the productivity level at the beginning of the period (*LVAPE02*) among the explanatory variables separates the effect of innovation on productivity in 2004 from the effect of the pre-existing level of productivity in 2002, while adding the firm's market share (*MKTSH02)*[16] gives useful information on whether the firm has a dominant position in the Canadian market. Note, however, that not all firms are in both the 2002 ASML and the 2004 ASML. Using the data for the years 2002 and 2004 thus results in a loss of about one thousand observations. This is why the results obtained using the whole sample are also presented and analyzed.

Finally, since other studies suggest that the size of the firm matters both for innovation and for productivity, separate estimates were also made for small and medium sized firms (SMEs), those employing less than 150 persons, and the large ones; these results are presented in columns (3) and (4) respectively. The interpretation of these variants follows the discussion of the first two.

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[16] Note that the denominator of that variable is the 2002 gross output (in current prices) by industry, sourced from Statistics Canada "Industry Productivity KLEMS 1961-2003", a data base made available to researchers under the Data Liberation Initiative on a CD support (January 2008).

4.1 *Overview of estimation results: model variants with firms of all sizes*

The probability that a firm is a strict innovator increases with the size of firm as measured by employment. This corroborates findings from other Canadian innovation studies (Baldwin and Hanel, 2003; Baldwin and Gellatly, 2003; Gault, 2003).

According to the OECD core model, exporters are more likely to innovate than non-exporters[17]. The more detailed data on export activity used in the present model show, however, that the probability of a firm being a strict innovator increases only with the proportion of exports to destinations other than the familiar U.S. market. This presumably suggests that exporting to overseas markets is more demanding but also more rewarding.

The integration of the plant within the firm matters as well, even though its effect on innovation is limited. Plants that generate an important proportion of their revenues from sales to other plants of their firm (*INTRA_SALE)* are marginally more likely to be strict innovators.

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[17] The relationship between exporting and innovating is very likely endogenous. Exporting firms benefit in their innovation activities from knowledge spillovers from foreign markets and exporting provides both incentives to innovate by extending the market size on which to sell innovations and the competitive stimuli which often makes innovation a *sine qua non* condition for survival and expansion on the export market. On the other hand, a firm may be in the export market thanks to former or current innovations that opened new markets and/or increased its productivity and foreign competiveness. Causality certainly goes both ways and our model does not attempt to disentangle the complex relationship between exporting and innovation. A study of a large sample of Dutch firms found that a firm's export intensity has a positive impact on the probability of, and the intensity of, R&D activity. The other direction of causality was found as well. A firm's R&D activity (but in this case not the intensity of this activity) increases the probability of exporting (Kleinknecht and Oostendorp, 2002). In Canada, Baldwin and Gu (2003) have shown that learning through exporting is particularly present for Canadian-owned and 'young' firms. Exporting is also found to improve productivity, especially in domestically controlled plants.

The strategic orientation of a firm is an important determinant of innovation. Firms that attribute their success to strategies based on the search for new markets are more likely to innovate, as are firms that develop custom-designed products. In contrast, firms that focus their strategies on satisfying existing clients are less likely to innovate.

Public support for innovation through R&D tax credits or grants encourages R&D activity and increases the probability of a firm being a strict innovator.

Finally, the statistically significant value of *rho* (the correlation coefficient between the error terms of the selection and outcome equations) shows the importance of correcting for selection bias by using the Heckit procedure.

Results from Model (2) show that the positive effect of size on the probability of being a strict innovator almost vanishes (the coefficient is barely statistically significant at the 10% level) when we control for the size of the firm at the beginning of the period. Other than the reduced coefficient of the employment variable, and some changes in the effect of exporting on the decision to innovate, there is not much difference between the two models.

<u>Innovation input equation</u>

The equation (A1) is the outcome equation of the Heckman procedure that models firm's innovation expenditures per employee. The estimated regression coefficients are presented in the second block of Table 3.

Since investment in innovation is to a large extent a fixed cost, the intensity of investment in innovation as measured by total innovation expenditures per employee is understandably decreasing with the size of employment.

The strong link between exporting outside the U.S. and investment in innovation is confirmed. However, even firms that export to the U.S. market spend more per employee on innovation than non-exporters.

Firms that cooperate on innovation are more likely to spend more on innovation than those that do not. This suggests that cooperation is unlikely to be undertaken as a cost-saving measure, but rather to increase the scope of the project or to complement the firm's competency.

Similarly, contracting out R&D does not seem to be a cost-reducing strategy. The positive elasticity estimate suggests that firms with higher innovation expenditure intensity are also more likely to contract out R&D instead of using R&D contracts as substitutes for their own innovation activities.

Interestingly, while fiscal incentives and direct subsidies to innovation are positively associated with the probability of being a strict innovator (cf. the interpretation of the selection equation above), they are not associated with greater innovation expenditure intensity[18].

As suggested by microeconomic analysis, firms with a larger market share at the beginning of the period invest in innovation more per employee than those with a smaller market share.

<u>Innovation output equation</u>

The innovation output equation shows the contribution of various variables to innovation output (*LISPE)* measured as the value of new and improved products—product innovations—per employee. This equation assesses, among other factors, the importance of innovation expenditures (*LRTOTPE*) for innovation sales. The elasticity of *LISPE* with respect to *LRTOTPE* is 0.33, very similar to the elasticity estimated by the OECD core model (0.37)[19].

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[18] When using the OECD model, the coefficient of public R&D financial support for Canada was positive and significant but with a weaker correlation (significant at the 10% level only) than for other countries (see Appendix 1 for details). The effect vanished when we use the extended model. It should be noted that quantitative variables (real amount of R&D grants and tax credit) would be needed to get a better idea of the real causal effect on firms' innovation expenditure intensity. As noted before, such data were not available with the database used.

[19] The innovation expenditure variable (*LRTOTPE)* is potentially endogenously determined with the innovation sales variable (*LISPE)*. However, tests (the "difference-in-Sargan C statistic" and a manual test regressing the estimated residuals of *LRTOTPE* on *LISPE*) indicate that the hypothesis of exogeneity cannot be rejected. Furthermore, the Stock-Yogo relative bias test shows that the potential bias introduced by using the OLS procedure would still be lower than the bias introduced by using the IV

Several other variables have an important effect on the output of innovation. First of all, only innovations inspired by ideas from market partners (customers, suppliers, competitors, consultants and commercial R&D laboratories) enhance the commercial success of innovation. This finding corroborates earlier results by Baldwin and Hanel (2003), underlining the importance of the commercial orientation of innovation. The fact that sources of information internal to the firm (sales, marketing, production) do not seem to contribute to innovation sales may be interpreted as an indication that their contribution is already included in total innovation expenditures.

More capital-intensive firms, especially those with high levels of human capital, are more successful at commercializing innovations.

As well, innovating firms that introduce process as well as product innovations derive more sales from innovation than those introducing only product innovations.

Finally, firms with a higher productivity level at the beginning of the period (model variant (2)) derive more sales from innovation at the end of period than those with a lower initial productivity level. This means that firms that were already outperforming other firms in terms of productivity are more likely to be successful innovators (measured by innovation sales) in the next period. Also, it is interesting to note that adding productivity at the beginning of the period does not change the sign and impact of other core variables; in particular, the impact of innovation expenditure intensity remains similar.

Productivity equation

Finally, the productivity equation shows that firms with higher innovation sales per employee (*LISPE*) obtain higher labour productivity expressed as log of value added per employee (*LVAPE*). The elasticity of the instrumented[20] variable (*LISPE*)

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regression. Therefore equation (3) was estimated by OLS using the observed rather than the instrumented *LRTOTPE* variable.

[20] According to the tests (the “difference-in-Sargan C statistic" and a manual test regressing the estimated residuals of *LISPE* on *LRTOTPE*),

is positive and statistically significant; its value of 0.21 is about half that estimated in the OECD core model. Productivity increases slightly with the size of establishment and when the establishment is part of a larger enterprise. Conforming to economic theory, both human and physical capital intensity are important co-determinants of labour productivity.

As in the core model, firms introducing a process innovation in addition to a product innovation have lower labour productivity than other innovative firms[21]. While this result is counterintuitive and stands in contrast with other studies (see Griliches, 1998 for the U.S.; Criscuolo and Gaskell, 2003 for the UK; and Hanel, 2000 and Baldwin and Gu, 2004 for Canada), some explanations can be proposed. First, the model used focuses primarily on product innovators, and therefore the negative coefficient on productivity is relative to product innovators that do not introduce process innovation. It is therefore possible to think that firms introducing both product

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LISPE and value added per employee *LVAPE* are endogenous. Therefore the productivity equation is estimated as a 2SLS system with *LISPE* instrumented in the 1st stage.

[21] In the OECD core model, the estimated regression coefficient of the *PROCESS* innovation dummy variable is negative and statistically significant for all countries. To explore further the relationship between labour productivity and process innovation we experimented by replacing *PROCESS* by specific forms of process innovation such as:

(i) new or significantly improved method of producing goods or services;
(ii) new or significantly improved logistic, delivery or distribution methods;
(iii) new or significantly improved supporting activities for firm's processes such as maintenance system, or operations for purchasing, accounting or computing;
(iv) process innovation increased flexibility of production; and
(v) process innovation increased speed of supplying and/or delivering goods and services.

Among the first three types of process innovation, only the new or improved manufacturing method (i) has a significantly negative correlation coefficient. The other two types of process innovation are not correlated with labour productivity. When labour productivity is regressed on the specific effects of process innovations such as increased production flexibility and increased speed of delivery of goods and services, the correlation is still negative and statistically significant.

and process innovations are introducing complex change (and maybe more radical innovations) in their manufacturing processes, leading to a short-term negative impact on labour productivity. Second, the effect of process innovation is not as well captured in the Canadian survey as the effect of product innovation. To mirror the measurable effect of product innovation (as measured by sales per employee from innovative products), we would need a variable that would assess the cost saving from process innovation[22]. Without such a variable, it is hard to assess the effect of process innovation that would lead directly to productivity gains.

Finally, including labour productivity at the beginning of the period as an additional explanatory variable (model variant (2)) does not change the results discussed above. Even though labour productivity in 2002 is an important determinant of productivity in 2004, it does not significantly change the effect of innovation sales on labour productivity. The estimated elasticity of productivity on innovation sales is slightly lower (0.17), but within the same range as the elasticity estimated in the first model (0.21) with contemporaneous variables.

In conclusion, the better specification and improved estimation procedures of the extended Canadian model provide robust results that confirm, with added detail, the principal conclusions of the OECD core model. These results show, in no uncertain terms, that product innovation contributes significantly to higher productivity.

4.2 Overview of estimation results for SMEs and large firms

Previous studies suggested that the size of firm is an important determinant of innovation and that SMEs do not innovate in the same way as large firms (Acs and Audretsch, 1988; Baldwin and Hanel, 2003; Baldwin and Gellatly, 2003). This raises the question of whether the effect of innovation on productivity is

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[22] The elasticity of productivity on the cost saving from process innovation, an estimate of which is available in the German innovation survey, is positive and statistically significant (see Peters, 2008).

also different between the two groups. To determine to what extent the size of firm matters, the model was estimated separately for small and medium sized firms employing less than 150 persons and for the larger firms.

The results for SMEs and large firms are presented respectively in the 3th and 4th columns in Table 3; they indeed show some notable differences between the two size categories. First, since most large firms export, exporting does not discriminate between innovators and non-innovators and investment in innovation for large firms.

Similarly, human capital does not have a significant effect on innovation sales and labour productivity in large firms. In contrast, human capital increases innovation sales, but not labour productivity, in SMEs.

While the elasticity of innovation sales to innovation expenditures is comparable between the two groups, the elasticity of labour productivity to innovation sales per employee (*LISPE)* is twice as large in big firms (0.35) as in the SME group (0.18).

5. Conclusions and Policy Implications

This paper extends and refines the Canadian model applied in the 18-country OECD study of the relationship between innovation and productivity performance at the firm level (OECD STI-Outlook 2008, Chapter 5; see Appendix 1 for details). Results from both models (the simpler model used for benchmarking Canada internationally and the more robust model using all available information from the Canadian database presented here) show that higher innovation expenditure intensity is conducive to better innovation outcomes (higher innovation sales per employee); and in turn highly innovative firms are more productive. The main difference between the two models is that both the estimated elasticity of innovation output to innovation input and the elasticity of labour productivity to innovation sales are smaller, though still positive and statistically significant in the more robust model run exclusively on Canadian data. Therefore, the coefficients from the OECD model should be used with caution and treated as upper bound values.

Our model also confirmed, with more detail, the main factors leading to higher innovation and productivity performance. Factors directly contributing to higher productivity are: a skilled workforce; higher physical capital intensity; and, as noted above, higher intensity of innovation sales. Results from this study also showed that high innovation expenditure intensity is the best predictor of high innovation sales. Finally, factors contributing indirectly (through innovation expenditure intensity) to higher productivity are: tapping into global markets as shown by export variables, cooperation to access external expertise, and relying on market-oriented external sources of information to guide innovation activity.

Our main results suggest that export (only outside of the U.S. market), size of firm, and use of direct or indirect government support are factors increasing the probability to innovate and having positive innovation sales.

Exports (both to the U.S. and outside of the U.S. market), cooperation with other firms and organizations, and a high share of the firm's revenue coming from sales to its most important client are all factors correlated with higher innovation expenditures per employee. Moreover, firms with a higher market share at the beginning of the period tend to spend more on innovation by the end of the period.

Firms with higher innovation expenditures per employee also generate more innovation sales per employee (an increase of 1% of innovation expenditures per employee is linked with an increase of 0.33% of innovation sales per employee). Firms introducing both product and process innovations also generate more innovation sales per employee than those introducing only product innovations. Other factors increasing innovation sales are human and physical capital and introduction of process innovations.

Finally, results from the model show that more successful product innovators (those generating more innovation sales per employee) achieve higher labour productivity, even when the size of firms and intensity of human and physical capital are taken into account (an increase of 1% of innovation sales per employee is linked to an increase of labour productivity of 0.22%). It is worth noting that firms that are more productive at the beginning of the period derive more sales from innovation and are also still more productive by the end of the period.

The policy implication of these results is certainly interesting given that aggregate productivity growth in the Canadian business sector has been considered weak in recent years (with multi-factor productivity being the main culprit). New evidence (OECD, 2007) confirms results highly publicized a few years ago (Government of Canada, 2002) which show that Canada has a high percentage of innovators (using a broad definition, including technology adopters) but realizes lower innovation sales than most OECD countries. This weak performance in selling innovative products seems to be an important barrier for higher productivity performance as shown by this study.

Also of interest is the result that highly successful innovative firms (those that have high innovation sales per employee) devote more resources to innovation. Transposing this firm-level result to the country level, it is hard not to make the link between the sub-par Canadian performance in business R&D and weak productivity performance in international comparison. R&D is only one, though often the most important, of several activities leading to successful innovation. According to Statistics Canada (Schelling and Gault, 2006) a large percentage of firms reporting R&D activity and claiming R&D tax credits spend less than $100,000 per year, an amount barely covering the wage cost of one full time equivalent senior researcher. This suggests a suboptimal level of R&D activity, below the critical mass of human and complementary resources needed for successful innovation and its commercialization.

In conclusion, this study confirms the importance of innovation to productivity at the establishment level. However, some results require further investigation. First, Canadian firms do not increase their innovation expenditure intensity as much as firms in other OECD countries when collaborating or when receiving public funding. This could be symptomatic of weak coordination/design of existing government programs involving collaboration or support to business innovation and cooperation.

Second, our results suggest that past productivity performance improves both subsequent innovation sales and productivity. More investigation is needed to understand why some firms started with higher productivity performance than others. Would this be because these are firms permanently engaged in innovation or because of the complementarities between different business strategies? Would it be the case that firms with higher productivity at the beginning of the period started by being cost effective before turning to a more innovation-based business strategy? Answers to these questions would be relevant to policymakers, so it is necessary to research more on the causes of higher productivity level at the beginning of the period.

Third, results for Canada and for most OECD countries show that firms introducing product and process innovation have a lower productivity performance in the short term than those that introduced only a product innovation. Partial explanations for this counter-intuitive result have been proposed, one suggestion being that firms introducing complex changes in manufacturing processes suffer a short-term negative impact on labour productivity. Whether or not this effect would be reversed in the long run would also be relevant information for policymakers.

New and better firm-level databases would be needed to answer these questions. Panel data (data linking innovation survey databases in time) and information on different business strategies (other than those based on innovation) are examples of the types of data needed to better explore the complex issue of innovation and productivity in the long term.

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Table 1: Comparison of Innovators and Non-Innovators

Variable	*Innovators* *Mean*	*SE*	*Non-innovators* *Mean*	*SE*	*Mean difference* *p-value**
VAPE	107.00	2.00	96.27	2.20	**0.000**
INNOV_STRICT	61.09	1.00	0.00	0.00	**0.000**
EMP	109.10	2.70	70.14	2.10	**0.000**
EXPORT_US	0.29	0.00	0.21	0.00	**0.000**
EXPORT_OT	0.06	0.00	0.03	0.00	**0.000**
GP	0.37	1.20	0.31	1.60	**0.001**
INTRA-SALE	0.06	0.50	0.04	0.50	**0.001**
HC	0.10	0.00	0.07	0.00	**0.000**
GIPE	7.09	0.40	6.73	0.60	0.303
MIC	0.27	0.50	0.29	0.80	**0.008**
GTXC	0.52	1.20	0.15	1.20	**0.000**
GRANT	0.12	0.80	0.02	0.50	**0.000**
FAC_NEW	0.40	1.20	0.24	1.40	**0.000**
FAC_EXIST	0.88	0.80	0.89	1.10	0.325
FAC_CUSTOM	0.45	1.20	0.28	1.50	**0.000**
FOOD + TOBACCO	0.12	0.50	0.11	0.90	0.290
TEXTILE	0.05	0.20	0.09	0.40	**0.000**
WOOD	0.08	0.50	0.10	0.80	**0.014**
PAPER	0.09	0.30	0.08	0.50	0.116
PETRO + CHEM	0.13	0.40	0.10	0.70	**0.000**
NON-METAL	0.04	0.20	0.04	0.40	0.415
FAB-METAL	0.15	0.70	0.20	1.30	**0.001**
M&E + TELECOM	0.19	0.50	0.11	0.90	**0.000**
TRANSPORT	0.06	0.30	0.06	0.60	0.315
NEC	0.10	0.40	0.12	0.70	**0.010**
No. of obs.**	3,629		1,726		

*P value from critical Z score at one tail; bold means significant at the 5% level.

**Because of missing data and the use of logs, the number of observations used in the econometric model for VAPE is 3,611 (instead of 3629) for the sub-sample of innovators.

Source: Authors' calculations based on Statistics Canada Survey of Innovation 2005.

Table 2: Comparative Data for "strict" Innovators

Variable	*Mean*	*SE*
VAPE	103.76	1.56
LISPE	3.21	0.04
LRTOTPE	2.42	0.04
EMP	111.22	2.89
EXPORT_US	0.29	0.01
EXPORT_OT	0.07	0.00
GP	0.37	1.30
INTRA-SALE	0.06	0.55
HC	0.11	0.00
GIPE	5.62	0.17
MIC	0.27	0.67
GTXC	0.61	1.40
GRANT	0.14	1.00
COOP	0.27	1.30
RD_OUT	0.19	1.10
PROCESS	0.72	0.73
S_INTRA	0.23	1.20
S_PUB	0.03	0.40
S_MARKET	0.20	1.10
FAC_NEW	0.45	1.40
FAC_EXIST	0.86	1.00
FAC_CUSTOM	0.51	1.40
FOOD + TOBACCO	0.13	0.90
TEXTILE	0.05	0.20
WOOD	0.06	0.50
PAPER	0.08	0.50
PETRO + CHEM	0.14	0.60
NON-METAL	0.04	0.40
FAB-METAL	0.13	1.00
M&E + TELECOM	0.22	0.90
TRANSPORT	0.05	0.50
NEC	0.11	0.50
No. of obs.**	2,273	

**Because of missing data and the use of logs, the number of observations used in the econometric model for VAPE is 2,261 (instead of 2273) for the sub-sample of innovators.

Source: Authors' calculations based on Statistics Canada Survey of Innovation 2005.

Table 3: Econometric Results

Equation A0: Decision to innovate (Innovation "strict") – Two-stage Heckman (Heckit) Procedure

	without lag (1)	*with lag (2)*	*SME only (3)*	*Large only (4)*
LEMP (LEMP02)	0.0657**	0.0613*	0.0493	0.1161
EXPORT_US	-0.1611	-0.2233*	-0.1572	-0.3018
EXPORT_OT	0.5300**	0.4425*	0.6892***	-0.2507
INTRA-SALE	0.0033**	0.0033*	0.0037*	0.0003
FAC_NEW	0.4380***	0.4211***	0.4539***	0.3617***
FAC_EXIST	-0.156*	-0.156	-0.126	-0.1808
FAC_CUSTOM	0.4112***	0.4396***	0.3434***	0.7966***
GTXC	0.8129***	0.8217***	0.8741***	0.6409***
GRANT	0.3161***	0.3100***	0.2350**	0.7248***
MKTSH02		-0.0011		
rho	-0.27**	-0.33**	-0.351**	0.001
N (unweighted)	5,355	4,312	4,417	938

Equation A1: Innovation input – Log (Innovation expenditures/employee) (LRTOTPE)

	without lag (1)	*with lag (2)*	*SME only (3)*	*Large only (4)*
LEMP (LEMP02)	-0.1255***	-0.1957***	-0.1914***	0.0398
EXPORT_US	0.2745**	0.3717***	0.4192***	-0.1588
EXPORT_OT	1.055***	1.055***	1.1223***	0.4933
MIC	0.0034**	0.0049**	0.0042**	-0.0001
COOP	0.1534**	0.1415*	0.1302	-0..2318
GTXC	-0.1041	-0.2089	-0.159	-0.025
GRANT	0.091	0.041	0.0813	0.2261
RD_OUT	.2349***	0.1443	0.2018**	0.2841*
MKTSH02		0.057***		
N (unweighted)	2,273	1,789	1,786	476

Equation A2: Innovation output – Log (Innovation sales/employee) (LISPE)

	without lag (1)	*with lag* (2)	*SME only* (3)	*Large only* (4)
GP	0.006	0.0108	-0.0175	0.1454
LEMP	-0.0438	-0.03	-0.0659	-0.077
PROCESS	0.2257**	0.3558***	0.1756**	0.2718
HC	0.6730**	.5723*	0.5855**	0.6802
LGIPE	0.2710***	0.2462***	0.2654***	0.2415***
S_INTRA	0.1236	0.2041*	0.2131**	-0.1123
S_PUB	-0.0237	-0.0976	-0.0429	-0.0402
S_MARKET	0.3565***	0.3942***	0.3200***	0.3919**
LRTOTPE	0.3256***	0.3108***	0.3259***	0.3649***
LVAPE02		0.131*		
N (unweighted)	2,243	1,745	1,755	476

Equation A3: Productivity – Log (Value Added/employee) (LVAPE)

	without lag (1)	*with lag* (2)	*SME only* (3)	*Large only* (4)
GP	0.1618***	0.1360***	0.1516***	0.1264
LEMP	0.0328**	-0.0191	-0.0001	0.1038*
LISPE	0.2214***	0.1777**	0.1778***	0.3500***
PROCESS	-0.1134***	-0.089**	-0.077**	-0.224**
HC	0.1495**	0.2132*	0.1539	0.1294
LGIPE	0.1795**	0.1501***	0.1826***	0.1625***
LVAPE02		0.2689***		

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Source: Authors' calculations based on Statistics Canada Survey of Innovation 2005.

Appendix 1:
Results from the OECD model (results from 18 countries)

Several OECD countries including Canada combined their research efforts in order to reach a better understanding of the process from the decision to innovate up to the effect of innovation on productivity and other performance indicators.

To ensure the international comparability of results, as far as possible given the data constraints, each team used the same variables from national innovation surveys and applied the same methodology. Based on the data collected by a near-identical survey design and questionnaire and analyzed by means of a common econometric methodology, the joint project yields internationally comparable results of interest to innovating firms, policy makers and academic researchers.

The following models were estimated for each country:

Specification of the OECD core model

(B0) innovator strict = $\beta_0^0 + \sum_n \beta_n^0 X_n^0 + \varepsilon^0$

If innovator strict=1:

(B1) log(inn_exp/emp) = $\beta_0^1 + \sum_m \beta_m^1 X_m^1 + \varepsilon^1$

(B2) log(inn_sale/emp) = $\beta_0^2 + \beta^2$ log(inn_exp/emp) + $\beta_{MR}MR + \sum_l \beta_l^2 X_l^2 + \varepsilon^2$

(B3) log(total rev/emp) = $\beta_0 3 + \beta^3$ log(inn_sale/emp) + $\beta_{MR}MR + \sum j\ \beta^{j3} X^{j3} + \varepsilon^3$

The dependent variables are:

(B0) innovator strict = 1 if innovation expenditures and innovation sales are positive;

(B1) log(inn_exp/emp)* = log(total innovation expenditures/employee),

(B2) log(inn_sale/emp)* = log(share of innovation sales in total revenue/employee)

(B3) log(total rev/emp) = log(plant's total revenue per employee), The independent variables are:

X_n^0 = log(employment); part of a group; export sales; industry;

X_l^1 = part of a group; export sales; cooperation on innovation; government support for innovation; industry;

X_m^2 = log(employment); part of a group; process innovation; four types of cooperation; industry;

X_j^3 = log(employment), part of a group; innovation process, human capital; log(physical capital per employee); industry

MR= Mills ratio

*Potentially endogenous variable

B0 (Selection Equation): Which firms are more likely to be innovative?

	Belonging to a group	Operating in a foreign market	Being large (size)	Barriers related to knowledge (1)	Barriers related to markets (2)	Barriers related to costs (3)	Rho (4)	No. Obs.	P-value (5)
Australia	0.352***		0.153***	0.232***	0.207***	0.348***		3 697	0.522
Austria	0.213*	0.454***	0.253***	-0.0765	-0.182	-0.00122	0.223	1 001	0.226
Belgium	0.198***	0.617***	0.267***	0.0427	-0.05	0.455***	0.41	2 695	0.0012
Brazil	0.424***	-0.264***	0.123***	0.152***	0.131***	0.032	2.019***	9 384	0
Canada	-0.105*	0.290***	0.140***				1.005***	5 355	0
Denmark	0.186**	0.637***	0.253***	0.243**	0.0288	0.391***	0.324**	1 729	0.0202
Finland	0.0649	0.532***	0.254***	0.190**	0.259***	-0.0266	0.477***	2 155	0.00178
France	0.227***	0.778***	0.204***	0.201***	0.0678***	0.227***	0.643***	18 056	0
Germany	0.144***	0.529***	0.0884***	0.0144	-0.107	0.173***	0.256**	3 242	0.0656
Italy	0.203***	0.478***	0.185***	0.110***	-0.0680**	0.0908***	0.753***	15 915	0
Korea	-0.064		0.202***	0.201***	0.006	0.136*	0.662	1 335	0.007
Luxembourg	0.267*	0.314**	0.248***	0.191	-0.101	0.359*	0.192	545	0.701
Netherlands	0.164***	0.546***	0.213***	0.175***	-0.111**	0.0123	0.727***	6 858	0
NZ	0.113**	0.349***	0.0785***	0.0892*	0.027	0.138***	1.337***	3 426	0
Norway	-0.0724	0.643***	0.320***	0.301***	0.0478	0.301***	0.739***	1 852	0
Sweden	0.173***	0.576***	0.09***	0.556***	0.16***	0.119**		2 954	0.563
Switzerland		0.312***	0.045*	0.075	0.201*	-0.065	0.927***	1 964	0
UK	0.174***	0.464***	0.0468***	0.287***	0.0883**	0.0883**	-0.04	11 162	0.261

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.
Source: OECD STI Outlook, 2008, p.242

Notes:

Coefficients reported are marginal effects, i.e. they predict the likelihood of being innovative. For example, an Austrian firm operating on a foreign market is 45% more likely to be innovative than an Austrian firm only active in the local market. For Canada and Brazil the regressions are weighted to the population. Results are based on 2004 innovation surveys (CIS-4 for European countries), except for Austria which used CIS3 data and Australia where the innovation survey has 2005 as the reference year. For Australia the group variable is imputed. Switzerland does not have information on whether firms belong to groups; Australia does not have information on whether firms serve a foreign market and in Canada the survey does not ask about obstacles to innovation.

(1) Knowledge factors are defined e.g. as lack of qualified personnel, lack of technological and/or market information or lack of co-operation partners).

(2) Market factors refer e.g. to market dominated by established enterprises or uncertain demand for innovative goods or services.

(3) Cost factors refer e.g. to lack of internal funds, lack of external finance and costs of innovation too high). All three variables are defined as a 0/1 dummy that equals one if any of the factors included was a very important obstacle.

(4) "rho" is the correlation coefficient between the error terms of the selection and outcome equation.

(5) The p-value is used to test whether correction for selection bias is necessary or not. The null hypothesis, rho = 0, assumes that there is no link between the selection and outcome equations. The null hypothesis is rejected at the 10% level in most countries, hence correcting for selection improves the model, except for Australia, Austria, Luxembourg and the United Kingdom. Industry dummies included but not reported.

B1 (Innovation Input Equation): Which firms spend more on innovation?

	Belonging to a group	Operating in a foreign market	Being engaged in co-operation	Receiving financial public support	No. Obs.
Australia	0.443**		-0.161	-0.0334	3 697
Austria	0.161	0.737***	0.408***	0.746***	1 001
Belgium	0.233*	0.524***	-0.0205	0.714***	2 695
Brazil	0.875***	-0.204*	0.384***	0.332***	9 384
Canada	0.145*	0.448***	0.173**	0.183*	5 355
Denmark	0.477***	0.762***	0.182	0.735***	1 729
Finland	0.260**	0.361*	0.495***	0.460***	2 155
France	0.231***	1.158***	0.427***	0.683***	18 056
Germany	0.0538	0.610***	0.402***	0.469***	3 242
Italy	0.268***	0.511***	0.310***	0.412***	15 915
Korea	-0.167		0.079	0.407***	1 335
Luxembourg	0.212	0.434	0.102	0.352	545
Netherlands	0.247***	0.675***	0.389***	0.569***	6 858
NZ	0.664***	0.740***	0.225***	Confidential	3 426
Norway	-0.0436	0.706***	0.354***	0.657***	1 852
Sweden	0.173***		0.576***		2 954
Switzerland		-0.717**	0.370**	-0.128	1 964
UK	0.0508	0.513***	0.377***	0.537***	11 162

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Source: OECD STI Outlook, 2008, p.244

Notes:

Coefficients reported are marginal effects for the co-operation and financial support variables but not for the group and foreign markets variables because the latter enter both the selection (probability to innovate) and the outcome (innovation intensity) equation. When variables enter both the selection and outcome equations their marginal effect can be broken down into two parts: the first is the direct effect on the mean of the dependent variable (which is reported in this table) and the second comes from its effect through its presence in the selection equation.

For Canada and Brazil, the regressions are weighted to the population. Results are based on 2004 innovation surveys (CIS-4 for European countries), except for Austria which used CIS3 data and Australia where the innovation survey has 2005 as the reference.

Belonging to a group; operating in a foreign market; being engaged in co-operation and receiving financial support are 0/1 dummies.

For Australia the group variable is imputed from responses to the question about whether the enterprise collaborated with other members of their group and is underreported as it omits enterprises that are part of an enterprise group but did not collaborate.

For New Zealand information on innovation expenditure is codified as a categorical variable; to transform it to a continuous variable midpoints of each range are used and multiplied by total reported expenditure.

Industry dummies included but not reported.

B2 (Innovation output Equation): Does spending in innovation inputs translate into sales from product innovation?*

"Investing in innovation increases sales from product innovation in all countries except Switzerland. The impact on sales is greater than 40% in Australia, New Zealand and Norway and ranges from 14 to 35% for the other countries."

"The preliminary analysis provides mixed results [for other factors]: size is positively correlated, negatively correlated or not correlated with sales from product innovation depending on the country. Economies of scope and scale and knowledge flows within the firm (the group variable) seem to play a role in commercialisation in most countries, but not in all. Finally, there is little evidence that firms that engage in collaboration with different partners have significantly more innovative sales."

* *No econometric tables were provided for the Innovation Output Equation in the OECD STI-Outlook so we provided the text associated with the equation.*

B3 (Productivity Equation): What is the impact of product innovation on labour productivity?

	Belonging to a group	Being large (Size)	Having implemented a process innovation	Log innovation sales per worker (product innovation)	No. Obs.
Australia	0.12	0.144***	-0.089	0.557***	509
Austria	0.182**	0.0111	0.0443	0.312***	359
Belgium	0.303***	0.002	-0.119**	0.543***	718
Brazil	0.183**	0.140***	-0.211***	0.647***	1 954
Canada	0.250***	0.0772**	-0.122**	0.436***	2 273
Denmark	0.186**	0.0732***	-0.0405	0.345***	584
Finland	0.244***	0.0859**	-0.0677	0.314***	698
France	0.232***	0.0536***	-0.129***	0.474***	2 511
Germany	0.0838**	0.0625***	-0.116***	0.500***	1390
Italy	0.093	0.00391	-0.192**	0.485***	747
Korea	0.152*	0.045	-0.118*	0.859***	628
Luxembourg	0.434***	0.0349	-0.142	0.226*	207
Netherlands	0.0219	0.0902***	-0.044	0.409***	1 374
NZ	0.128**	0.0662***	-0.135***	0.682***	993
Norway	0.256***	0.0407	-0.0716	0.344***	672
Switzerland		0.113***	-0.091	0.295	394
UK	0.150***	0.0580***	-0.121***	0.550***	2 989

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Source: OECD STI Outlook, 2008, p.245

Notes:

For Canada and Brazil the regressions are weighted to the population. Results are based on 2004 innovation surveys (CIS-4 for European countries), except for Austria which used CIS3 data and Australia where the innovation survey has 2005 as the reference year.

Belonging to a group; and having implemented process innovation are 0/1 dummies. Size is measured as log employment.

Industry dummies and inverse Mills ratio are included but not reported.

For Australia the group variable is imputed from responses to the question about whether the enterprise collaborated with other members of their group and is underreported as it omits enterprises that are part of an enterprise group but did not collaborate with other enterprises within the group on innovation projects.

For New Zealand information on innovation sales is codified as a categorical variable; to transform it to a continuous variable midpoints of each range are used and multiplied by total reported expenditure.

Part II

The Effectiveness of Trade Promotion

The Impact of Trade Promotion Services on Canadian Exporter Performance

Johannes Van Biesebroeck, Emily Yu and Shenjie Chen*

Abstract: We evaluate the impact of the programs delivered by the Canadian Trade Commissioner Service (TCS) on export performance by Canadian firms. We draw on a unique set of microdata created by linking three separate firm-level databases: Statistics Canada's Exporter Register and its Business Register, which provide information on export activity and firm characteristics, and the TCS client management database maintained by Foreign Affairs and International Trade Canada, which contains details on trade promotion services provided to Canadian firms. We apply the treatment effects analytical framework to isolate the effects of public sector trade promotion. We find that TCS programs have a consistent and positive impact on Canadian exporter performance, both in terms of the value of exports and the growth of exports. In our preferred specification, exporters that access TCS services export, on average, 17.9 percent more than comparable exporters that do not. Furthermore, we also find that TCS assistance benefits exporters in terms of product and market diversification.

Key words: Export Promotion, Heterogeneous Firms, Canada
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1. Introduction

The recent firm-level trade literature emphasizes the role of sunk costs in the presence of uncertainty about future market conditions to explain why the proportion of firms that participate in international trade is (at least in some countries[1]) surprisingly low. Sunk costs of entering foreign markets are distinct from those incurred to serve home markets; they must be borne to make export sales. They are not recoverable if the attempt to export fails. These include costs of obtaining market information for foreign countries, identifying foreign customers, finding reliable suppliers, developing distribution channels in foreign markets, dealing with the local regulations, learning how to adapt a product to local market conditions, and many others (Rauch, 2001 and Copeland, 2008 provide surveys).

Recognizing that firms have to overcome additional costs to break into foreign markets, governments worldwide operate export promotion programs to assist their exporters (see Lederman et al., 2010 for an international overview). These export promotion programs aim in general to reduce sunk costs by providing information on foreign markets, and by helping firms to adapt a product to local market conditions.

From an economic welfare perspective, such intervention is only justified if there is market failure[2]. This paper does not explore the welfare dimensions of public sector trade promotion programs; rather it simply seeks to ascertain if they have an

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[1] For example, Bernard et al. (2007) found only 18 percent of U.S. manufacturing firms exported in 2002, while Baldwin and Gu (2003) found that only 24 percent of Canadian manufacturers exported in 1996. By contrast, Wagner (2007) reports that 64.4 percent of West German manufacturing firms exported in 2004.

[2] Copeland (2008) sets out the theoretical case for trade and investment promotion policy. He argues that general information relevant for doing business abroad has many of the characteristics of a public good in the sense that there are information spillovers. Such spillovers could result in under-provision of services, a market failure that would result in less exporting than is economically efficient. As well, if there are economies of scale in maintaining a base of knowledge about foreign markets, new entrants and small firms would be at a disadvantage, another source of market failure.

impact on export performance, an important question given the resource implications of funding export promotion programs.

The empirical literature on the effectiveness of trade promotion services has not reached consistent conclusions. For example, Bernard and Jensen (2004) found that U.S. state-level export promotion expenditures had no significant effect on the probability of local firms exporting. On the contrary, Rose (2007) used a gravity model to show that diplomatic representation abroad did appear to boost trade; bilateral exports were approximately 6 to 10 percent higher for each additional consulate in a foreign market. A number of studies using microdata for various countries also tended to show more positive results. Alvarez and Crespi (2000) found that Chilean export promotion programs had a direct positive effect in terms of expanding the number of markets and an indirect effect on product diversification. Görg et al. (2008) using Irish manufacturing firm data from 1983-2002 found that grants to promote investments in technology, training and physical capital were effective in increasing exports of continuing exporters but ineffective in promoting market diversification. Volpe Martincus and Carballo (2008) found that Peru's export promotion agency had a positive effect on the value of exports and the effect was significant on both market and product diversification. Finally, Volpe Martincus, Carballo and Garcia (2010) found that trade promotion boost exports primarily by smaller exporters.

In this paper, we assess the impact of the Canadian Trade Commissioner Service (TCS) on Canadian exporter performance by linking TCS client data with Statistics Canada's firm-level data in the Exporter Register and the Business Register. We take particular pains to control for reverse causality in the sense that characteristics of the firm that lead it to seek TCS assistance may also influence the post-assistance performance.

TCS programs are offered through 140 offices around the world and 12 regional offices across Canada. The services provided can be subdivided into six groups: information on market prospects, key contacts search, local company information, visits information, face-to-face briefings and trouble shooting. The first three information-related services are those most-requested by TCS clients.

The TCS client management database is maintained by Foreign Affairs and International Trade Canada; it provides descriptive details on trade promotion services delivered by Canadian trade commissioners in Canada and abroad. This information can be broken down by mission, country, sector, the size and age of firms, their financial resources, and types of TCS services they accessed, all at the firm level.

The first channel through which TCS programs affect exporters' performance is initial assistance to new exporter clients; this, we infer, involves reducing entry barriers and thus impacts on exports along the *extensive* margin of trade. A second channel is continuing assistance to existing exporters; this, we infer, involves helping clients to adapt products to local market conditions and to build market presence which results in export growth along the *intensive* margin.

Unfortunately, our TCS assistance dataset does not allow us to identify the impact of TCS services separately on the extensive and intensive margins of trade. That is, the dataset does not indicate whether the service provided was for a returning client is for the same product and same market (in which case the evaluated increase in value sales would be along the intensive margin) or if the service was intended for a different product in a different market (in which case the impact on sales would be along the extensive margin).

In this paper, we focus on the impact of TCS on overall export flows. In, particular, we seek to answer the following two questions: Did exporters that received TCS assistance export more compared to those without TCS assistance? Did previously received TCS assistance continue to enhance exporter performance? We contribute to the literature by linking the detailed firm-level export promotion data to firm characteristics and examining the TCS impact on the performance of Canadian exporters using the statistical tools from the treatment effects literature. We examine the effect of TCS assistance in three time frames: concurrent, lagged and lingering. Our analysis shows that TCS assistance has a lasting positive effect on Canadian export performance.

The rest of the paper is organized as follows. Section 2 presents a detailed overview of our data. Section 3 describes the econometric framework. Section 4 presents the estimation results. Section 5 concludes.

2. Canadian Exporters and Trade Commissioner Services

The data for this study come from three sources: 1) Statistics Canada's Exporter Register which produces annual estimates of the number of firms exporting, their province of residence and the value of their domestic exports by industry, product, and export destination; 2) Statistics Canada's Business Register, which contains information on the characteristics of firms that operate in Canada; and 3) The TCS client management database maintained by Foreign Affairs and International Trade Canada.

We link these datasets as follows. First, each exporter registered in the Exporter Register database is identified by an assigned enterprise number that is common to both the Exporter Register and the Business Register. This allows us to associate the detailed enterprise-level characteristics data from the Business Register with each exporting firm. Second, if an identified exporter is a TCS client, its information is linked to the TCS client management database through name and address matching. The combined dataset provides, for each identified exporting firm, information on the trade promotion services it received, identified by location and time, its export sales by export destination and year, and its economic characteristics. The linked dataset covers the period from 1999 to 2006.

In the following discussion, we summarize the key characteristics and export performance of the Canadian exporter population in general and of those that were TCS clients in particular.

2.1 *Canadian Exporter Population*

From 1999 to 2006, there were on average 47,174 active exporters in Canada. The number of exporters increased from 43,568 in 1999 to 49,314 in 2004 before dropping to 44,127 in 2006[3]. Total export values increased almost 20 percent over the same period. However, only marginal increases in the total number of export markets and number of products exported were observed during this period (see Table 1).

Table 1: Canadian Exporters by Number of Markets, Products and Value of Sales

Year	Number of Exporters	Number of Markets	Number of Products	Value of Exports (CAD billions.)
1999	43,568	225	5,422	321
2000	46,465	221	5,435	373
2001	48,140	226	5,429	360
2002	49,146	227	5,457	351
2003	48,504	230	5,528	337
2004	49,314	231	5,551	366
2005	48,126	234	5,557	388
2006	44,127	230	5,539	381
Ave.	**47,174**	**228**	**5,490**	**360**

Source: Calculated from the Exporter Register.

Over the period 1999-2006, a Canadian exporter was, on average, in business for 8.8 years, employed 73 people, exported 4.6 products to 2.0 countries, and generated total export sales worth $7.6 million (see Table 2). The main trends in this period were in the average number of markets per exporter, which grew from an average of 1.7 at the beginning of the period to 2.5 at the end, and the age of exporters, which doubled from 6 years at the beginning of the period to almost 12 years at the end. The picture is thus one of a stable population of maturing firms gradually diversifying their export markets but not their product palette.

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[3] Statistics Canada's annual publication on the profile of Canadian exporters excludes firms with annual exports less than $30,000. In this study, all exporters are included; therefore, the number of exporters (enterprises) reported in this paper is greater than that reported by Statistics Canada.

Table 2: Characteristics of the Average Canadian Exporter

Year	Number of Markets	Number of Products	Employees	Value of Exports (CAD millions)	Firm Age
1999	1.7	4.8	76.5	7.4	6.0
2000	1.7	4.7	73.3	8.0	6.8
2001	1.8	4.6	72.5	7.5	7.5
2002	1.8	4.2	69.8	7.2	8.3
2003	2.0	4.4	70.0	6.9	9.1
2004	2.2	4.6	71.2	7.4	9.8
2005	2.4	4.8	74.4	8.0	10.8
2006	2.5	5.0	77.0	8.6	11.9
Ave.	**2.0**	**4.6**	**73.1**	**7.6**	**8.8**

Source: Calculated from the Exporter Register.

Canada has a large share of single market (country) exporters (first column of Table 3). They accounted for about three-quarters of all exporters and 30 percent of the value of exports on average over the period[4]. Reflecting the trend to increased market diversification noted in Table 2, the share of single market exporters fell by almost 10 percentage points from 1999 to 2006. It is also noted that, in Canada, there are more multi-product firms than multi-market firms (Table 4).

Table 3: Percentage of Exporters by Number of Export Markets

Year	Number of Markets						
	1	2	3	4	5	6 to 10	11 or more
1999	82.0	8.0	3.2	1.8	1.0	2.2	1.8
2000	82.8	7.8	3.1	1.7	1.0	2.1	1.7
2001	82.2	7.8	3.2	1.6	1.0	2.2	1.9
2002	81.1	8.2	3.2	1.8	1.1	2.5	2.1
2003	77.5	9.2	3.8	2.2	1.3	3.2	2.8
2004	75.3	9.7	4.3	2.4	1.5	3.6	3.2
2005	74.0	9.8	4.2	2.6	1.7	3.9	3.8
2006	73.2	9.7	4.6	2.7	1.6	4.1	4.2
Ave.	**78.5**	**8.8**	**3.7**	**2.1**	**1.3**	**2.9**	**2.7**

Source: Calculated from the Exporter Register.

[4] By comparison, single market exporters accounted for 60 percent of all exporters in Peru (Volpe Martincus and Carballo, 2008) and about 30-40 percent in Ireland (Lawless, 2009) and France (Eaton et al., 2004). Single market exporters also account for a much smaller share of total exports in some other countries; e.g., 3.7 percent in the United States in 2000 (Bernard et al., 2005).

Table 4: Percentage of Exporters by Number of Products

Year	Number of Products							
	1	2	3	4	5	6 to 10	11 to 20	21 or more
1999	37.3	18.0	10.6	7.2	5.0	11.9	6.6	3.5
2000	38.6	17.9	10.5	6.9	4.7	11.4	6.4	3.6
2001	39.9	17.8	10.5	6.8	4.8	10.8	6.0	3.4
2002	41.1	18.3	10.4	6.8	4.6	10.8	5.2	2.7
2003	41.2	17.6	10.4	6.7	4.7	10.8	5.5	3.0
2004	41.2	17.6	10.2	6.7	4.5	10.8	5.7	3.2
2005	40.0	17.6	10.3	6.8	4.7	11.0	6.0	3.6
2006	38.5	17.7	10.7	6.8	4.8	11.4	6.4	3.8
Ave.	**39.7**	**17.8**	**10.5**	**6.8**	**4.7**	**11.1**	**6.0**	**3.4**

Source: Calculated from the Exporter Register.

Table 5 shows that most new exporters start in a single market, usually with a single product. Thus, of the 13,164 new exporters in 2000, 96 percent started in one market and about two-thirds started in one market with a single product. Even as the number of new entrants plummeted to no more than 4,736 in 2006, these ratios remained stable, with the share of single market entrants falling only marginally to 92 percent and the share of single market and single product entrants rising marginally to about 71 percent over the period. The single most notable trend in Table 5 is the decline in the share of the exporter population accounted for by firms exporting to a single market and the associated rise of the multi-market (in most cases also multi-product) firm.

In terms of firm size, we divide the Canadian exporter population into four groups: micro (1 to 10 employees), small (11 to 50 employees), medium (51 to 200 employees) and large (more than 200 employees). It can be seen from Table 6 that most Canadian exporters belong to the micro and small size categories. Exporters of these two sizes made up almost four-fifths of the exporter population. Large size exporters constitute a very small proportion of the total, around 5 percent. This size distribution did not change much from 1999 to 2006.

Table 5: Market and Product Diversification—Entrants versus Continuing Exporters

Year	Single Market and Single Product		Single Market and Multiple Products		Total Single market
	Entrant	Continuing	Entrant	Continuing	
2000	8,842	8,702	3,803	17,131	38,478
2001	7,888	10,828	2,995	17,880	39,591
2002	7,638	11,945	2,666	17,587	39,836
2003	6,525	12,518	2,075	16,457	37,575
2004	6,495	12,669	2,112	15,877	37,153
2005	5,349	12,733	1,676	15,841	35,599
2006	3,275	12,549	1,105	15,367	32,296
	Multiple Markets and Single Product		Multiple Markets and Multiple Products		Total Multiple Market
	Entrant	Continuing	Entrant	Continuing	
2000	69	336	450	7,132	7,987
2001	81	420	354	7,694	8,549
2002	116	524	535	8,135	9,310
2003	168	796	579	9,386	10,929
2004	181	964	641	10,375	12,161
2005	151	1,011	524	10,841	12,527
2006	86	1,061	270	10,414	11,831

Source: Calculated from the Exporter Register.

Table 6: Canadian Exporters by Size

Year	Micro	Small	Medium	Large
1999	22,379	11,541	7,304	2,344
2000	24,019	12,357	7,648	2,441
2001	24,920	12,959	7,821	2,440
2002	25,310	13,423	7,981	2,432
2003	24,655	13,492	7,918	2,439
2004	25,060	13,842	7,933	2,479
2005	24,257	13,613	7,703	2,553
2006	21,254	13,037	7,429	2,407
Ave	**23,982**	**13,033**	**7,717**	**2,442**
Memo: Ave. Percent Share	50.8%	27.6%	16.4%	5.2%

Source: Calculated from the Exporter Register.

Table 7 shows the average export value, the average number of markets and the average number of products of Canadian exporters by size.

Table 7: Average Exports, Number of Markets and Number of Products by Size

Year	Average Export (CAD millions)	Average Number of Markets	Average Number of Products
		Micro	
1999	1.2	1.3	2.9
2000	1.6	1.2	2.8
2001	1.5	1.2	2.7
2002	1.3	1.3	2.5
2003	1.4	1.4	2.6
2004	1.6	1.5	2.7
2005	2.1	1.6	2.9
2006	2.1	1.7	3.0
		Small	
1999	1.6	1.6	4.3
2000	1.7	1.5	4.2
2001	1.7	1.6	4.1
2002	1.8	1.7	3.8
2003	1.7	1.9	4.0
2004	1.8	2.0	4.2
2005	2.1	2.2	4.3
2006	2.5	2.3	4.5
		Medium	
1999	5.5	2.2	6.9
2000	6.4	2.3	7.0
2001	6.5	2.3	6.9
2002	6.7	2.5	6.3
2003	6.7	2.9	6.5
2004	7.3	3.1	6.7
2005	7.9	3.3	7.0
2006	7.7	3.4	7.2
		Large	
1999	100.2	5.8	19.0
2000	108.8	5.6	19.0
2001	102.0	6.0	18.4
2002	99.6	6.3	17.0
2003	92.6	7.1	17.5
2004	98.5	7.6	18.3
2005	96.4	7.7	18.8
2006	102.6	7.7	19.5

Source: Calculated from the Exporter Register.

Large exporters account for almost 70 percent of exports even though they made up only around 5 percent of the exporter population. A typical large Canadian export firm in this period shipped about 18 products to about 7 markets, generating about $100 million in export revenues. By contrast, a typical medium-sized firm shipped about 7 products to 3 markets and generated only about $7 million in export revenues. Thus, in Canada, larger firms tend to export more products to more destinations and generate much higher export revenues than smaller firms.

These findings mirror those in other country studies[5]. The most notable feature from Table 7 in terms of trends is again the stability in terms of product diversification but the increasing market diversification, across all sizes of exporters.

Table 8 shows the geographic dimension of Canada's exports. As can be seen, the share of exporters that exported to

Table 8: Exporters by Region of Destination

Year	United States	Asia Pacific	Europe	Latin America
		Number of Exporters		
1999	38,862	4,502	6,371	2,675
2000	41,578	4,731	6,451	2,675
2001	42,876	5,166	6,973	2,888
2002	43,111	5,880	7,638	3,118
2003	41,219	6,798	9,092	3,784
2004	40,553	7,853	10,169	4,508
2005	39,519	8,126	10,253	4,903
2006	36,276	7,784	9,552	4,670
		Percentage of Total Exporters		
1999	89.2	10.3	14.6	6.1
2000	89.5	10.2	13.9	5.8
2001	89.1	10.7	14.5	6.0
2002	87.7	12.0	15.5	6.3
2003	85.0	14.0	18.7	7.8
2004	82.2	15.9	20.6	9.1
2005	82.1	16.9	21.3	10.2
2006	82.2	17.6	21.6	10.6

Source: Calculated from the Exporter Register. Note: percentages do not add to 100, as firms can be exporting to more than one region at the same time.

[5] See Bernard, Jensen and Schott (2005), Buono, Fadinger and Berger (2008) and Lawless (2009).

the United States fell from nearly 90 percent in the period 1999-2001 to 82 percent in 2006, mainly due to some exporters exiting from the U.S. market[6]. The biggest increase in number of exporters can be observed for Asia Pacific destinations, followed by Europe and then Latin America.

2.2 *TCS Clients vs. Non-Clients*

This section compares exporters that utilized the Canadian Trade Commissioner Service (TCS) to those that did not. From Table 9, it can be seen that only about 5 percent of exporters each year sought assistance, while from Table 10 we see that the propensity to seek TCS assistance increases steadily with size of firm, rising from only about 3 percent of the micro-sized exporters to almost 17 percent of the large-sized exporters.

Table 9: Number of Exporters with TCS Assistance

Year	TCS Assisted	Percentage of Total
1999	1,356	3.1
2000	2,640	5.7
2001	2,316	4.8
2002	2,159	4.4
2003	2,298	4.7
2004	2,654	5.4
2005	2,281	4.7
2006	2,452	5.6
Average	**2,270**	**4.8**

Source: Calculated from the Exporter Register, Business Register and DFAIT Client Information. Note: The number of firms in this and the following tables only includes firms that have been successfully matched to the Exporter Register. Some TCS clients could not be matched, implying that they did not record exports of goods (they might have exported services, or been assisted of investment activities) or that matching of the firm's identifiers in the two datasets was not possible.

[6] Note that exporters exiting the U.S. market might continue to export to other markets, e.g., faster-growing emerging markets.

Table 10: TCS-Assisted Exporters by Size Group

Year	Number	Percentage	Number	Percentage
	Micro		Small	
1999	345	1.5	362	3.1
2000	691	2.9	767	6.2
2001	598	2.4	667	5.1
2002	589	2.3	643	4.8
2003	637	2.6	681	5.0
2004	778	3.1	808	5.8
2005	634	2.6	683	5.0
2006	685	3.2	732	5.6
Average	**620**	**2.6**	**668**	**5.1**
	Medium		Large	
1999	366	5.0	283	12.1
2000	721	9.4	461	18.9
2001	618	7.9	433	17.7
2002	548	6.9	379	15.6
2003	571	7.2	409	16.8
2004	631	8.0	437	17.6
2005	531	6.9	433	17.0
2006	588	7.9	447	18.6
Average	**572**	**7.4**	**410**	**16.8**

Source: See Table 9.

Table 11 compares average firm-level characteristics of TCS-assisted and non-TCS-assisted exporters. On average, TCS-assisted firms were older, larger, exported more products to more destinations, but were only marginally more productive and, perhaps surprisingly in light of the foregoing, had only marginally more experience in the export market than non-TCS-assisted exporters.

Table 11: Characteristics of TCS Clients versus Non-Clients

Year	Number of Markets		Number of Products	
	TCS	Non-TCS	TCS	Non-TCS
1999	5.4	1.6	13.9	4.5
2000	4.2	1.5	11.8	4.3
2001	5.0	1.6	12.2	4.2
2002	5.5	1.7	11.5	3.9
2003	6.3	1.9	12.2	4.0
2004	6.9	2.0	12.4	4.1
2005	7.8	2.1	13.3	4.3
2006	7.5	2.2	13.5	4.5
Year	Productivity (in log)		Employment (in log)	
	TCS	Non-TCS	TCS	Non-TCS
1999	11.8	11.6	432	65
2000	12.0	11.8	263	62
2001	12.1	11.8	300	61
2002	12.0	11.8	290	60
2003	12.0	11.8	287	59
2004	12.0	11.8	286	59
2005	12.1	11.8	332	62
2006	-	-	335	62
Year	Export Experience*		Age of Firm	
	TCS	Non-TCS	TCS	Non-TCS
1999	-	-	8.3	6.0
2000	0.89	0.71	9.7	6.6
2001	1.74	1.39	10.0	7.4
2002	2.48	2.02	10.0	8.2
2003	3.19	2.67	10.9	9.0
2004	3.96	3.23	11.7	9.7
2005	4.69	3.91	12.5	10.7
2006	5.59	4.78	13.5	11.8

Source: See Table 9. * Export experience is 0 years in the first year of entry.

Table 12 shows that firms that export to non-U.S. markets rely more frequently on TCS assistance. Only 5 percent of firms that exported to the U.S. market accessed TCS assistance, compared to 12 percent of those that exported to Europe, 13.5 percent of those that exported to Asia-Pacific and 16 percent of those that exported to Latin America. This indicates that the sunk costs for market access were typically higher in more remote markets that in nearby markets.

Table 12: TCS Clients by Export Destination, Number & Percent

Year	TCS Assisted	Percentage of Total	TCS Assisted	Percentage of Total
	United States		Europe	
1999	1,203	3.1	580	9.1
2000	2,357	5.7	908	14.1
2001	2,065	4.8	908	13.0
2002	1,894	4.4	897	11.7
2003	2,006	4.9	1,035	11.4
2004	2,223	5.5	1,267	12.5
2005	1,897	4.8	1,149	11.2
2006	2,078	5.7	1,234	12.9
Ave.	**1,965**	**4.9**	**997**	**12.0**
	Asia-Pacific		Latin America	
1999	434	9.6	317	11.9
2000	741	15.7	524	19.6
2001	733	14.2	523	18.1
2002	771	13.1	492	15.8
2003	911	13.4	599	15.8
2004	1,140	14.5	782	17.3
2005	1,058	13.0	712	14.5
2006	1,108	14.2	751	16.1
Ave.	**862**	**13.5**	**588**	**16.1**

Source: See Table 9. Note: the number of clients by region does not add to the total number of clients as firms can be exporting to more than one region at the same time.

Table 13 shows the sectoral distribution of TCS-assisted and non-TCS-assisted exporters. The sectoral distribution of TCS assisted exporters was fairly stable in the sample years. The *Wholesale & Retail* and *Other Services* sectors had the largest number of firms, but these firms were proportionately less likely to seek TCS assistance. The merchandise sectors with the largest number of TCS clients were *Food & Beverage*, *Petroleum, Chemical and Plastics*, *Computer, Electronics & Electrical Equipment*, and *Miscellaneous Manufacturing*. Exporters in the *Food & Beverage* and *Computer, Electronic & Electrical Equipment* sectors, which produce differentiated products, were proportionately more likely to seek assistance.

Table 13: Distribution of Exporters by Sector—TCS Clients and Non-Clients (Average Annual Percentage Share, 1999-2006)

Sector (NAICS code)	Non-TCS	TCS
Agriculture (100)	5.5	3.0
Mining (200)	4.3	4.0
Food & Beverage (311-312)	2.4	9.1
Textiles & Clothing (313-315)	3.3	3.2
Wood & Paper Products (321-323)	5.3	4.0
Petroleum, Chemicals & Plastics (324-327)	6.1	8.7
Primary & Fabricated Metal (331-332)	6.3	5.3
Machinery (333)	5.4	8.6
Computer, Electronic & Electrical Equipment (334-335)	3.6	8.2
Transportation Equipment (336)	2.1	2.5
Miscellaneous Manufacturing (316, 337-339)	5.7	6.1
Wholesale & Retail (400)	32.1	20.9
Other Services (500-900)	17.9	16.6

Source: See Table 9.

Tables 14 and 15 show that firms that seek TCS assistance are much more likely to be multi-market and multi-product firms, respectively; a much larger proportion of the non-TCS-assisted exporters were single-market and/or single-product exporters as compared to the TCS-assisted exporters. In both cases, TCS clients are roughly half as likely as the general population to be single-market or single-product exporters.

Table 14: Single-Market Exporters, TCS Clients and Non-Clients

Year	TCS Assisted	Percentage of Total TCS clients	Non-TCS	Percentage of Total Non-TCS clients
1999	643	47.4	35,079	83.1
2000	1,402	53.1	37,076	84.6
2001	1,115	48.1	38,476	84.0
2002	993	46.0	38,843	82.7
2003	957	41.6	36,618	79.2
2004	1,019	38.4	36,134	77.4
2005	849	37.2	34,750	75.8
2006	920	37.5	31,376	75.3
Ave.	**987**	**43.7**	**36,044**	**80.3**

Source: See Table 9.

Table 15: Single-Product Exporters

Year	TCS Assisted	Percentage of Total	Non-TCS	Percentage of Total
1999	229	16.9	16,022	38.0
2000	464	17.6	17,485	39.9
2001	403	17.4	18,814	41.1
2002	391	18.1	19,832	42.2
2003	431	18.8	19,576	42.4
2004	492	18.5	19,817	42.5
2005	444	19.5	19,800	41.0
2006	425	17.3	16,546	39.7
Ave.	**410**	**18.0**	**18,487**	**40.9**

Source: See Table 9.

Finally, Table 16 shows that Market Prospect Information and Key Contacts Search are the most frequently requested types of assistance, which suggests that information asymmetry is a key factor for firms seeking to expand in export markets.

Table 16: Number of Exporters by TCS Service Type

Year	Type of TCS Service		
	Key Contacts Search	Local Company Information	Market Prospect Information
1999	638	539	768
2000	882	817	1,987
2001	952	871	1,513
2002	1,075	907	1,213
2003	1,239	998	1,241
2004	1,434	965	1,520
2005	1,257	799	1,238
2006	1,249	732	1,186
	Face-to-face Briefing	Visit Information	Troubleshooting
1999	499	214	160
2000	643	298	162
2001	870	431	293
2002	945	471	330
2003	1,073	401	330
2004	1,292	521	350
2005	1,101	392	322
2006	1,145	365	327

Source: DFAIT Client Information

3. Econometric Analytical Framework

We have shown that Canadian exporters, over our sample period, became more diversified in terms of markets but not in terms of products. While only a small proportion of Canadian exporters sought TCS services (about 5 percent on average), we have also shown that exporters that did seek out TCS assistance were older, larger, more likely to be multi-market and/or multi-product exporters, but only marginally more experienced in export market and marginally more productive compared to the general population of exporters. Firms that export to Asia, Europe and Latin America relied more frequently on TCS assistance than those exporting to the United States. We have also learned that the most important reasons for seeking TCS assistance appear to be related to reducing information-related sunk costs.

We now address the question of whether TCS assistance is able to enhance exporter performance. The main analytical issue is to establish causality. Is the observed tendency of TCS clients to achieve a more diversified export-market presence a result of TCS assistance? Or do firms that are generally more committed to export-market development, and thus tend to be multi-market and multi-product exporters in the first place, self-select into the TCS client category? Similarly, does TCS assistance promote growth of export sales in established markets?

Consistent with other studies of this question we adopt as our empirical framework the treatment effects approach[7]. That is, exporters that accessed TCS assistance are considered as having received a treatment of "export promotion assistance". As we are unable to observe what the value of exports of the treated

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[7] The treatment effects technique is an adaption of studies with randomized experimental trials, as in medical clinical trials, which involve a treatment group and a randomly assigned control group. For use with observed (non-experimental) data, statistical techniques have to be used to identify a counterpart to the control group. See Wooldridge (2002); Imbens (2004) provides a survey of this literature. See Volpe Martincus et.al. (2008 and 2010), Lederman et al. (2010), and Girma et al. (2009) for applications of this technique to identify the effects of trade promotion activities.

would be if they had not received the assistance, we must compare their performance to firms that did not receive such treatment. However, the effect of treatment cannot be estimated directly by comparing the value of exports for firms in the two groups, since we cannot exclude the possibility that factors that caused a firm to seek out assistance also affect its success in export markets. To address this issue, we proceed as follows.

Assume that y_i^j is the potential value of exports by exporter i if it receives treatment j, $i = 1, 2, ..., N$ and $j = 0, 1$. Thus, y_i^1 is the value of exports by exporter i with treatment and y_i^0 is the value of exports by the same exporter i without treatment. Of course, only one of these two quantities will be observed. Next, let ω_i be the treatment variable such that $\omega_i = 1$ if exporter i has received TCS assistance and $\omega_i = 0$ otherwise. There is a vector of **x**-covariates of observed firm characteristics.

To evaluate the effect of the treatment, we estimate the Average Treatment Effect (ATE) which measures the expected effect of treatment on a random sample of the population or the average effect across the entire population. ATE is estimated as the expected difference between y^1 and y^0, i.e. $E[y^1 - y^0]$. An alternative object of policy interest, especially if treatment effects are heterogeneous and firms can self-select into treatment, is the Average Treatment Effect on the Treated (ATT). This measures the average effect of the treatment only for those firms that received the treatment, compared to the counterfactual case, if the firm had not received the treatment. ATT is estimated as the expected difference between y^1 and y^0 given that treatment is received: i.e., $E[y^1 - y^0 \mid \mathbf{x}, \omega = 1]$.

Because an exporter chooses to receive or not to receive TCS assistance, the effects of such assistance are subject to selection bias. Characteristics of the firm that lead it to seek TCS assistance may also influence the measured post-assistance performance. In the treatment effect framework with potential outcomes, this is basically a missing data problem. We cannot hope to observe the sample analog of $E[y^1] - E[y^0]$. At best, we can estimate the sample analog of: $E[y^1 \mid \omega = 1] - E[y^0 \mid \omega = 0]$. If the treatment regime is not independent of the potential outcome under the regime, which is highly likely, the two differences will not be equal.

One way out is to apply an, admittedly very strong, assumption that the treatment variable, ω_i is independent of y_i^0. This additional assumption implies that the choice of receiving TCS assistance is independent of the values of export without TCS assistance, i.e., $E[y^0 \mid \omega] = E[y^0]$, in which case the problem is basically assumed away.

A weaker version of the assumption is "ignorability of treatment" that assumes that ω_i and y_i^1 are only independent after conditioning on a set of covariates **x**, or more generally,

$$E[y^0 \mid \mathbf{x}, \omega] = E[y^0 \mid \mathbf{x}] \quad (1)$$

and

$$E[y^1 \mid \mathbf{x}, \omega] = E[y^1 \mid \mathbf{x}] \quad (2)$$

Essentially, this means, conditional on observable **x**-covariates, y_i^1 and y_i^0 are mean independent of ω_i, for all exporters *i*. Therefore, under this weaker assumption, we can estimate the sample analog to:

$$\text{ATE} = E[y^1 - y^0 \mid \mathbf{x}], \text{ and}$$

$$\text{ATT} = E[y^1 - y^0 \mid \mathbf{x}, \omega = 1].$$

By applying the weak "ignorability" assumption both ATE and ATT become estimable, in the sense that we can make direct comparisons of export performance between TCS clients and non-TCS clients based on the observable **x**-covariates.

There are different ways to carry out the conditioning covariates—see Wooldridge (2002) for an extensive discussion. We perform propensity score matching estimators as a robustness check, but in the benchmark case, we regress the value of exports y_i, or another outcome variable of interest, on ω_i, $\mathbf{x}$ and $\omega_i(\mathbf{x}-\bar{\mathbf{x}})$ such that the estimating equation is,

$$E[y \mid \omega, \mathbf{x}] = \gamma + \alpha\omega + \mathbf{x}\boldsymbol{\beta} + \omega(\mathbf{x} - \psi)\delta \tag{3}$$

where $\psi \equiv E[\mathbf{x}]$.

The introduction of the demeaned term $(\mathbf{x} - \psi)$ into the estimating equation allows for a straightforward recovering of the ATE and ATT after conditioning on the **x**-covariates. The estimated regression coefficient of ω_i, $\hat{\alpha}$ measures the ATE effect—the population average effect of treatment relative to not being treated. To calculate the ATT effect—the same estimate, but only for the firms that actually opted for treatment—we need to control for the fact that treated firms might differ from average firms in terms of observables. It can be calculated as,[8]

$$ATT = \hat{\alpha} + \left(\sum_{i=1}^{N} \omega_i\right)^{-1} \left[\sum_{i=1}^{N} \omega_i (\mathrm{x}_i - \bar{\mathrm{x}})\hat{\delta}\right] \tag{4}$$

Finally, we can calculate the ATE given **x**, which shows the average treatment effect on a given level of **x** as the following,

$$ATE(\mathbf{x}) = E[y^1 - y^0 \mid \mathbf{x}] = \hat{\alpha} + (\mathbf{x} - \bar{\mathbf{x}})\hat{\delta} \tag{5}$$

This measures the additional benefits of treatment, on top of the estimated $\hat{\alpha}$. Through the cross term (given **x**-covariates and $\omega = 1$), we can evaluate which group of TCS clients benefits most from TCS assistance.

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[8] This boils down to averaging the interaction terms only over the sample of treated firms, evaluating the **x**-covariates at the appropriate values for the treated firms (which will not generally average to the total sample average and hence not drop out).

We assess the impact of export promotion on Canadian exporter performance using five specifications of equation (3) while using the value of total exports per firm in a given year as an dependent variable, except as noted below in specifications 4), 6a) and 6b). Each specification includes the same **x**-covariates except for the treatment variable, which varies as follows:

1) The concurrent effect of TCS on the values of exports. The treatment variable under this specification, *TCS*, is a dummy variable that indicates if an exporter had received TCS assistance in the current year.
2) The lagged effect of TCS on the values of exports. The treatment variable under this specification, *TCSlag*, is a dummy variable that indicates if an exporter received TCS assistance in the preceding year.
3) The lingering effect of TCS on the value of exports. The treatment variable under this specification, *TCSever*, is a dummy variable that indicates if an exporter received TCS assistance in any of the years preceding the current period, but not in the current period.
4) The location effect of TCS on the value of exports. The treatment variable, *TCSloc*, indicates if an exporter received concurrent TCS assistance from a post in the market or markets to which it exported. The estimated export promotion effect in this case represents the effect of TCS assistance received at posts, while the impact of the assistance provided in Canada is excluded in this specification.
5) The panel fixed effect model. This specification uses the panel fixed effect model as a robustness check to control for possible unobservable firm characteristics in the panel data setup that are by definition not captured in the **x**-covariates. Failing to control for unobservable firm characteristics could result in correlation in error terms and bias the results. The panel fixed effect model is only applied to exporters who export consecutively at least for two years. This reduces the sample size significantly compared to other pooled regressions. Further, the estimation result is expressed as the impact of the TCS on the growth rather than the level of exports and is therefore not directly comparable to the results

from the other specifications. The treatment under this specification, *TCS*, is a dummy variable that indicates if an exporter had received TCS assistance in the current year.

We next assess the impact of export promotion services on market and product diversification:

6a) The market diversification effect of TCS. In this case the treatment variable is *TCS*, but the dependent variable is the number of markets served by the exporter, rather than the value of total exports by that exporter.

6b) The product diversification effect of TCS. In this case, the treatment variable is *TCS*, but the dependent variable is the number of products exported by the exporter, rather than the value of total exports by that exporter.

We also assess the impact of export promotion services controlling for the possibility of spillovers from the export activity of peer exporters, and using non-parametric techniques:

7) The effect of TCS controlling for peer influence. In this specification, we use the treatment variable *TCSlag* and include a control that is equal to the lagged total export value of fellow exporters that export to the same destination as the exporter in the current year.

8) The effect of TCS evaluated with non-parametric techniques. Finally, we apply propensity score matching using the kernel matching algorithm as a robustness check to further validate the ATE estimation results.

All **x**-covariate variables are organized at the firm level in a given year. They include the age of enterprise, number of export products, number of export markets, number of employees, lagged value-added productivity and years of export experience.

Age of enterprise is the number of years of business operation; it is calculated as the difference between the observation year and the year the exporter registered as a business in Canada.

The number of export products is the number of different products (as defined by the 10-digit Harmonized System) that an exporter exports in an observation year.

The number of markets is the number of different countries to which an exporter exports in an observation year.

An exporter's value-added productivity in an observation year is calculated by dividing the value-added by the number of employees. We chose to use lagged productivity in the regression analysis because there is a possible endogeneity issue with productivity[9].

Years of export experience is calculated as the difference between the observation year and the year that the exporter began to export. As noted above, years of export experience for all exporters equals zero in the first year of our data; for new entrants during the sample period, it equals zero in the first year of exporting.

To capture the possibility of diminishing returns of explanatory factors, we include the quadratic terms of **x**, except for productivity. Diminishing returns would be indicated by a negative coefficient on the quadratic version of the explanatory variable (a positive coefficient would of course indicate increasing returns).

4. Empirical Results

In this section, we describe and discuss the empirical results obtained using the different specifications and the alternative empirical strategies described above. We organize this discussion in seven subsections following the numbering at the end of the previous section.

4.1 The concurrent effect of TCS on export values

Table 17a provides the regression results for the concurrent effect of export promotion services (*TCS*) on export values. The coefficient of the variable *TCS* in the regression is equal to the estimated ATE, in this case, 0.165. This indicates that,

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[9] Endogeneity arises from the possibility that more productive firms choose to export (self-selection effect), and in turn firms improve their productivity through exporting (learning by exporting effect). Sorting out these two effects is the subject of an extensive literature. See Wagner (2007) for a recent survey.

conditioned on all **x**-covariates, the average value of exports for firms that received assistance is 17.9 percent (17.9= (exp(0.165)−1)*100) higher than those that had not received assistance. It should be noted that the reported ATE coefficient captures more than the concurrent effect. For instance, for exporters that received the assistance continuously over the sample period, the estimated ATE coefficient might capture both the concurrent and any lagged effects (it will be shown later that the lagged effect is stronger than the current effect).

The calculated ATT is averaged only across the assisted exporters. It includes the average deviations for this group from the population means of the **x**-covariates, as treatment effects vary with differing characteristics. The ATT of 0.148 implies a 16 percent boost to exports (16.0 = (exp(0.148)−1)*100), not very different from the estimated ATE effect.

The following summarizes the additional benefits of TCS given particular values of the **x**-covariates, namely the treatment effect plus the interaction terms as expressed in (5). This calculation will tell us which groups of TCS clients benefit most from TCS assistance. The ATE given values of **x**-covariates is:

- <u>increasing</u> with the age of enterprise—thus the positive effect of TCS assistance is larger for clients with more years of business operation experience compared to younger clients;
- <u>increasing</u> with the number of employees—so the effect of TCS assistance is greater for larger-size clients;
- <u>decreasing</u> with the number of markets—thus TCS assistance is more effective for exporters serving fewer destinations;
- d<u>ecreasing</u> with the number of products—so exporters with few products benefit more from TCS assistance than assisted exporters with a small number of products; and
- <u>decreasing</u> with lagged productivity and export experience—thus TCS assistance is stronger for exporters with lower productivity and less export experience.

We find the decreasing effect of TCS for exporters with a greater number of markets or products to be intuitively plausible. This indicates that firms with already a wide export portfolio stand to benefit less from the programs. We provide evidence below that TCS support is particularly helpful to diversify exports (see section 4.5).

Table 17a: Regression Results with Treatment Variable *TCS*

Variable	Estimated Coefficient	Standard Error
TCS	0.165[a]	0.027
Age of enterprise	–0.087[a]	0.018
(Age of enterprise)^2	–0.023[a]	0.005
Number of products	1.858[a]	0.012
(Number of products)^2	–0.196[a]	0.004
Number of markets	0.351[a]	0.017
(Number of markets)^2	0.077[a]	0.007
Number of employees	0.090[a]	0.009
(Number of employees)^2	0.034[a]	0.001
Lagged Productivity	0.081[a]	0.004
Export experience	0.140[a]	0.015
(Export experience)^2	–0.002[b]	0.001
TCS*Age of enterprise	0.107	0.069
TCS* (Age of enterprise)^2	0.012	0.017
TCS* Number of products	–0.320[a]	0.046
TCS* (Number of products)^2	0.067[a]	0.011
TCS* Number of markets	0.083[c]	0.049
TCS* (Number of markets)^2	–0.033[b]	0.015
TCS* Number of employees	0.081[b]	0.033
TCS* (Number of employees)^2	–0.006	0.004
TCS* Lagged Productivity	–0.003	0.013
TCS* Export experience	–0.207[a]	0.057
TCS* (Export experience)^2	0.002	0.002

Source: Authors' calculations. Note that variables ending in superscript "2" are entered in quadratic form. Note also that a, b and c represent significance levels of 1 percent, 5 percent and 10 percent, respectively.

Table 17b: Treatment Effects for Concurrent TCS Support

	Coefficient	Export Gain
Average Treatment Effect (ATE)	0.165	17.9%
Average Treatment Effect on the Treated (ATT)	0.148	16.0%

Source: Authors' calculations.

4.2 The lagged effects of TCS on export values

We now examine the effect of TCS assistance received in the preceding year on the value of exports in the current year, after controlling for TCS assistance received in the current year. We interact the treatment variables *TCS* and *TCSlag* with the current and lagged values of the **x**-covariates respectively. This allows us to isolate the effect of *TCSlag*[10]. The estimated results based on *TCS* and *TCSlag* are listed in Table 18a. Table 18b provides the summary treatment effect results.

The estimation results show that assistance received in a previous year increases clients' exports by 12.4 percent (12.4=(exp(0.117)−1)*100) compared to non-clients. The estimated coefficient for the current year is only 0.052, which indicates that TCS assistance received in a preceding year has a stronger effect on current exports than does concurrent assistance, at least if assistance is ongoing. This suggests that it takes time for the full effect of TCS to be realized: i.e., an exporter that received TCS assistance last year can expect a stronger boost in export values this year.

However, the lagged effect and current effect reported here are not additive; hence we cannot calculate the cumulative effect of TCS assistance. The estimation includes firms that received assistance only in the previous period, only in the current period, or in both periods. We would need to isolate at least two of these three groups to identify both TCS coefficients. As a result, the estimation does not solely trace back any assistance received in the preceding periods. As in the previous specification for the concurrent effect, the estimated coefficient here represents a combination of current and lagged TCS effects. What we learn from this is that the effect of TCS builds with time.

[10] The treatment variables for lagged two and three periods have been included in the estimation but this approach results in a singular matrix and OLS estimates could not be calculated.

Table 18a: Regression Results with Two Treatment Variables *TCS* and *TCSlag*

Variable	Estimated Coefficient	Standard Error
TCS	0.052	0.038
TCSlag	0.117[a]	0.029
Age of enterprise	−0.679[a]	0.133
(Age of enterprise)^2	−0.114[c]	0.060
Number of products	1.480[a]	0.018
(Number of products)^2	0.156[a]	0.006
Number of markets	0.294[a]	0.025
(Number of markets)^2	0.045[a]	0.011
Number of employees	0.026	0.061
(Number of employees)^2	0.024[a]	0.007
Lagged Productivity	0.061[a]	0.008
Export experience	−1.943[a]	0.115
(Export experience)^2	−0.009[a]	0.003
Lagged Age of enterprise	0.357a	0.078
(Lagged Age of enterprise)^2	0.119	0.054
Lagged Number of products	0.344a	0.018
(Lagged Number of products)^2	−0.044a	0.007
Lagged Number of markets	−0.068[a]	0.026
(Lagged Number of markets)^2	0.065[a]	0.012
Lagged Number of employees	0.064	0.061
(Lagged Number of employees)^2	0.011[c]	0.007
Lag2 Productivity	0.029[a]	0.007
Lagged Export experience	0.945[a]	0.071
(Lagged Export experience)^2	0.380[a]	0.045
TCS*Age of enterprise	0.324[b]	0.145
TCS* (Age of enterprise)^2	−0.049	0.032
TCS* Number of products	−0.230[a]	0.057
TCS* (Number of products)^2	0.051[a]	0.014
TCS* Number of markets	0.106[c]	0.060
TCS* (Number of markets)^2	−0.030	0.019
TCS* Number of employees	0.058	0.045
TCS* (Number of employees)^2	−0.009	0.006
TCS* Lagged Productivity	−0.005	0.018
TCS* Export experience	−0.043	0.153
TCS* (Export experience)^2	−0.001	0.004
TCSlag* Lagged Age of enterprise	−0.007	0.087
TCSlag* (Lagged Age of enterprise)^2	0.029	0.022
TCSlag* Lagged Number of products	−0.199[a]	0.058
TCSlag* (Lagged Number of products)^2	0.036[b]	0.015
TCSlag* Lagged Number of markets	0.039	0.059
TCSlag* (Lagged Number of markets)^2	−0.023	0.020
TCSlag* Lagged Number of employees	0.056	0.046
TCSlag* (Lagged Number of employees)^2	0.001	0.006
TCSlag* Lag2 Productivity	−0.023	0.017
TCSlag* Lagged Export experience	−0.177	0.122
TCSlag* (Lagged Export experience)^2	0.045	0.068

Sources and notes: See Table 17a.

We again calculate the effect of ATE for given values of the **x**-covariates. We find that the ATE results given **x**-covariates with the presence of lagged effects have the same signs as those we found for the concurrent effect estimation. The TCS-assisted exporters with the following characteristics benefit more from TCS assistance: older, less efficient, and larger firms with little exporting experience that exported fewer products to fewer export destinations.

The calculated ATT is again very close to the ATE (see Table 18b).

Table 18b: Treatment Effects with Two Treatment Variables *TCS* and *TCSlag*

	Coefficient	Export Gain
Average Treatment Effect (ATE)	0.117	12.4%
Average Treatment Effect on the Treated (ATT)	0.119	12.6%

Source: Authors' calculations.

4.3 The lingering effect of TCS on export values

Next we examine how previously received TCS assistance affects the performance of an exporter on a longer-term basis—i.e., we look at the effect of all TCS assistance received previously on exporter performance in all following years. In this estimation, we define a new treatment variable *TCSever* that is equal to one when an exporter had received TCS assistance at least once in any of the preceding years, and zero otherwise. This estimation only includes exporters that are active in the export market more than one year over the sample period. Table 19a lists the regression results for the specifications with the treatment variable *TCSever*. The estimated coefficient of *TCSever* is positive and highly significant; this suggests that TCS assistance received at any time in the (recent) past has a lingering effect, boosting exports on average by around 25.6 percent (25.6 =(exp(0.228)−1)*100) compared to comparable firms that had never received TCS assistance.

Table 19a: Regression Results with Treatment Variable *TCSever*

Variable	Estimated Coefficient	Standard Error
TCSever	0.228[a]	0.018
Age of enterprise	–0.094[a]	0.018
(Age of enterprise)^2	–0.025[a]	0.005
Number of products	1.864[a]	0.013
(Number of products)^2	–0.196[a]	0.005
Number of markets	0.339[a]	0.019
(Number of markets)^2	0.087[a]	0.008
Number of employees	0.095[a]	0.009
(Number of employees)^2	0.030[a]	0.001
Lagged Productivity	0.080[a]	0.004
Export experience	0.132[a]	0.016
(Export experience)^2	–0.001[b]	0.001
TCSever*Age of enterprise	0.214[a]	0.055
TCSever* (Age of enterprise)^2	–0.017	0.013
TCSever* Number of products	–0.285[a]	0.033
TCSever* (Number of products)^2	0.046[a]	0.009
TCSever* Number of markets	0.013	0.037
TCSever* (Number of markets)^2	–0.030[b]	0.013
TCSever* Number of employees	0.104[a]	0.025
TCSever* (Number of employees)^2	0.000	0.003
TCSever* Lagged Productivity	–0.003	0.01
TCSever* Export experience	–0.122[a]	0.045
TCSever* (Export experience)^2	0.001	0.002

Sources and notes: See Table 17a.

In this specification, the estimated ATE coefficient for the population is greater than the corresponding coefficients estimated for the concurrent or the lagged effects. This is primarily because the specification is applied only to continuing exporters. The estimated lingering effect of TCS may include overlapping lagged TCS effects if an exporter had received assistance multiple times prior to the current year.

The calculated ATT of 0.202 (Table 19b) is marginally smaller than, but still very close to, the estimated ATE effect.

Table 19b: Treatment Effects with *TCSever*

	Coefficient	Export Gain
Average Treatment Effect (ATE)	0.228	25.6%
Average Treatment Effect on the Treated (ATT)	0.202	22.4%

Source: Authors' calculations.

We again calculate the effect of ATE for given values of the **x**-covariates. We find that the ATE results given **x**-covariates for the specification of lingering effects have the same signs as those we found in other specifications. The TCS-assisted exporters with the following characteristics benefit more from TCS assistance: older, less efficient, and larger firms with little exporting experience that exported fewer products to fewer export destinations.

We repeated the regression of *TCSever* but including two additional variables, *Times of TCS* which represents the number of times an exporter had received TCS assistance before the observation year, and *Years since first TCS* which represents the number of years since an exporter first received TCS assistance. As neither variable is found to be significant statistically and the coefficient estimates are little changed, we do not report the results, but they are available upon request.

4.4 Location effect of TCS on export values

We now test the effect of the location at which TCS assistance is obtained. The treatment variable is a dummy variable, *TCSloc,* that takes on a value of one only if an exporter received concurrent TCS assistance from a post in the market or markets to which it exported. The results of these regressions are provided in Tables 20a and 20b.

The estimated export promotion effect in this case represents the combined effect of TCS assistance and the location effect. As before, the coefficient is positive and highly significant. Receiving TCS assistance in the destination market boosts exports by about 19.2 percent (19.2=(exp(0.176)-1)*100) compared to comparable exporters without TCS assistance. As would be expected, the estimated TCS effect with the presence of the location effect is larger than the general effect reported in Table 17 as the assistance is now tied to an export flow to a market.

The ATE effect under this specification is stronger than the ATT effect, compared to the previous specifications. These estimates suggest that firms already exporting to a foreign market would benefit more from TCS assistance at the posts in that country than they might realize. The effect for non-clients would be higher than for the clients that already take advantage of the services.

Table 20a: Regression Results with *TCSloc*

Variable	Estimated Coefficient	Standard Error
TCSloc	0.176[a]	0.038
Age of enterprise	–0.077[a]	0.017
(Age of enterprise)^2	–0.025[a]	0.004
Number of products	1.854[a]	0.012
(Number of products)^2	–0.193[a]	0.004
Number of markets	0.346[a]	0.017
(Number of markets)^2	0.077[a]	0.007
Number of employees	0.097[a]	0.009
(Number of employees)^2	0.032[a]	0.001
Lagged Productivity	0.077[a]	0.004
Export experience	0.126[a]	0.015
(Export experience)^2	–0.001[b]	0.001
TCSloc*Age of enterprise	0.044	0.087
TCSloc* (Age of enterprise)^2	0.029	0.021
TCSloc* Number of products	–0.551[a]	0.060
TCSloc* (Number of products)^2	0.087[a]	0.013
TCSloc* Number of markets	0.276[a]	0.061
TCSloc* (Number of markets)^2	–0.073[b]	0.017
TCSloc* Number of employees	0.085[b]	0.040
TCSloc* (Number of employees)^2	–0.001	0.005
TCSloc* Lagged Productivity	0.070[a]	0.017
TCSloc* Export experience	–0.118[c]	0.071
TCSloc* (Export experience)^2	–0.002	0.003

Sources and notes: see Table 17a.

Table 20b: Summary Treatment Effect Results, *TCSloc*

	Coefficient	Export Gain
Average Treatment Effect (ATE)	0.176	19.2%
Average Treatment Effect on the Treated (ATT)	0.115	12.2%

Source: Authors' calculations.

We again calculate the effect of ATE for given values of the **x**-covariates. We find that the ATE results given **x**-covariates have the same sign as those we found in other specifications.

The TCS-assisted exporters with the following characteristics benefit more from TCS assistance: older, less efficient, and larger firms with little exporting experience that exported fewer products to fewer export destinations.

In summary, the four specifications presented above show that the effect of TCS assistance on exporter performance is consistently positive. Each specification provides an insight into the TCS impact from a different perspective. The lingering effect estimation is applied only to continuous exporters. The lagged effect estimation reports the lagging effect, but it is not additive to the current effect. The location effect estimation is designed to identify the effect of assistance received only at the destination market. Given these limitations, we prefer the first one—the concurrent effect as it captures both the current effect and some lagged effects.

The estimation results show that controlling for firm-level characteristics, exporters that receive TCS assistance, on average, export 17.9 percent more than those that do not receive assistance. We also show, through the lagged effect estimation, that the effects of TCS assistance build up with time. The assistance received in the preceding year has a stronger effect on current exports than current assistance. Once TCS assistance starts to influence export performance, the effect can continue to provide benefits as long as the exporter continues to export.

We also show that regardless of which treatment variable is considered, the TCS-assisted exporters with the following characteristics benefit more from TCS assistance: older, less efficient, and larger firms with little exporting experience that exported fewer products to fewer export destinations.

4.5. The firm fixed effects model

In this specification, we examine the effect of TCS received in the current year on the growth of exports in the following year. The specification is only applied to a group of exporters who export consecutively at least for two years. As a result, the sample size in this specification is significantly smaller than those in pooled regressions. The estimation is implemented by using the panel fixed effect model to control for unobservable factors that do not change over time, and that are not captured by specified x-covariates in the data setup. With this specification, TCS is assumed to have the same effect for each firm and the effect is constant over time. Further, the weak ignorability assumption required in the pooled regression is no longer needed in the panel data setup, as unobserved time constant factors are assumed to be cancelled out in the growth calculation. Table 21 shows the estimation results of the panel regression.

Table 21: Panel Regression Results with Treatment Variable *TCS*

Variable	Estimated Coefficient	Standard Error
TCS	0.046[b]	0.018
Age of enterprise	–0.082[a]	0.018
(Age of enterprise)^2	–0.016	0.014
Number of products	1.158[a]	0.010
(Number of products)^2	–0.095[a]	0.004
Number of markets	0.330[a]	0.014
(Number of markets)^2	0.057[a]	0.006
Number of employees	0.151[a]	0.040
(Number of employees)^2	–0.039	0.004
Lagged Productivity	0.050[a]	0.004
Export experience	0.011	0.010
(Export experience)^2	–0.006[a]	0.001
TCS*Age of enterprise	–0.003	0.046
TCS* (Age of enterprise)^2	0.012	0.011
TCS* Number of products	–0.063[b]	0.031
TCS* (Number of products)^2	0.010	0.008
TCS* Number of markets	–0.013	0.032
TCS* (Number of markets)^2	–0.002	0.011
TCS* Number of employees	–0.026	0.026
TCS* (Number of employees)^2	0.003	0.003
TCS* Lagged Productivity	0.001	0.009
TCS* Export experience	0.002	0.032
TCS* (Export experience)^2	0.002[c]	0.001

Source: Authors' calculations. Note that variables ending in superscript "2" are entered in quadratic form. Note also that a, b and c represent significance levels of 1 percent, 5 percent and 10 percent, respectively.

The estimated ATE in the panel regression is 0.046, which indicates, conditional on x-covariates, that exports by exporters who received assistance grew on average 4.7 percentage points faster (4.7=(exp(0.046)-1)*100) than those of exporters who did not receive assistance. As in the case of the level comparison in the concurrent effect estimation, the estimated ATE coefficient may capture more than just the current effect, as some exporters might receive assistance consecutively over the sample period.

4.6 Export Markets and Products

The summary statistics at the start of the paper indicated that Canadian exporters have diversified in terms of serving, on average a greater number of markets but that there has been little evidence of a trend towards greater diversification of the product palette. We now extend our analysis to examine the impact of TCS on export diversification in terms of number of markets and number of products, or the extensive margin of trade. This is a narrowly defined "extensive margin of trade" in the sense that it captures only the diversification of existing exporters into other markets or other products, which translates into a higher average number of markets or products. It does not include the new entries from non-exporters to new exporters[11] or from non-tradable products to tradable products. The regressions in Tables 22a and 22b inform us on the effect of TCS assistance on market and product diversification of only those firms that were exporters in the reference period of our dataset.

The estimated coefficient of the treatment variable is larger in both cases, indicating the TCS has a positive impact on both market and product diversification. The coefficient is larger when the dependent variable is the number of export markets rather than the number of products, consistent with the observation that product diversification has not been as dynamic as market diversification[12]. Exporters that accessed TCS

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[11] This reflects a basic limitation of our dataset; firms that sought out TCS assistance but did not become exporters may not be captured in our dataset as the TCS data could not then be linked to the Exporter Register data. See notes to Table 9.

[12] Clearly, production technology will play a role as it will be a lot harder for many firms to export different products than to export to different markets.

assistance export on average to 35.7 percent more markets than comparable exporters that did not access TCS services (35.7 = (exp(0.305)−1)*100). Similarly, exporters with TCS assistance export on average 15.5 percent more products than comparable exporters without assistance (15.5 = (exp(0.144)−1)*100).

Table 22a: Regression Results: Market and Product Diversification as Dependent Variables

Variable	Dependent Variable: Number of Markets		Dependent Variable: Number of Products	
	Estimated Coefficient	Standard Error	Estimated Coefficient	Standard Error
TCS	0.305[a]	0.008	0.144[a]	0.013
Age of enterprise	0.042[a]	0.006	–0.008	0.008
(Age of enterprise)^2	–0.013[a]	0.001	–0.010[a]	0.002
Number of products	0.074[a]	0.004		
(Number of products)^2	0.083[a]	0.001		
Number of markets			0.713[a]	0.008
(Number of markets)^2			–0.068[a]	0.003
Number of employees	–0.025[a]	0.003	0.086[a]	0.004
(Number of employees)^2	0.010[a]	0.000	0.013[a]	0.001
Lagged Productivity	0.024[a]	0.001	0.053[a]	0.002
Export experience	0.045[a]	0.005	–0.028[a]	0.008
(Export experience)^2	0.003[a]	0.000	0.002[a]	0.000
TCS*Age of enterprise	0.103[a]	0.023	–0.009	0.034
TCS* (Age of enterprise)^2	–0.028[a]	0.006	0.01	0.008
TCS* Number of products	0.263[a]	0.014		
TCS* (Number of products)^2	–0.034[a]	0.004		
TCS* Number of markets			–0.123[a]	0.023
TCS* (Number of markets)^2			0.030[a]	0.007
TCS* Number of employees	0.048[a]	0.011	0.083[a]	0.017
TCS* (Number of employees)^2	–0.007[a]	0.001	–0.003[c]	0.002
TCS* Lagged Productivity	–0.008[c]	0.004	0.035[a]	0.007
TCS* Export experience	0.185[a]	0.019	–0.088[c]	0.028
TCS* (Export experience)^2	–0.001[c]	0.000	0.001	0.001

Source and notes: See Table 17a.

Table 22b: Treatment Effects, Market and Product Diversification as Dependent Variables

	Market Diversification		Product Diversification	
	Coeff.	Export Gain	Coeff.	Export Gain
Average Treatment Effect (ATE)	0.305	35.7%	0.144	15.5%
Average Treatment Effect for the Treated (ATT)	0.442	55.6%	0.189	20.8%

These two specifications show some interesting results in terms of the ATE, given particular values of the **x**-covariates. If an exporter is market-diversified, TCS assistance is particularly advantageous in terms of expanding product diversification. Similarly, if an exporter is product-diversified, TCS assistance is helpful in diversifying markets. In other words, TCS is beneficial to extending one dimension of export performance if an exporter is already diversified on the other dimension.

Unlike the results in the previous sets of regressions using value of exports as the dependent variable, here ATT is larger than ATE in both specifications. The mean effect on those exporters that actually received TCS assistance is stronger than what it would have been on the general population of exporters. This is consistent with the diversifying effects discussed above. Selecting into treatment is not random. Firms that have a high market concentration and opt for TCS support see a large effect in that dimension; similar effects hold for the product dimension.

4.7 Peer Influences

In the following estimation, we examine whether the effect of TCS is reduced if we control for the influence of other exporters (peer influences). To this end, we first identify all the exporters that export to the same market destination as the exporter in each observation at time *t*. Then we construct a variable that equals the sum of the lagged export value of these peer exporters. By including the value of exports by peer exporters in the preceding period, we control for the spillover effect from peers. For treatment variables, we include both *TCS* and *TCSlag*. Tables 23a and b show the regression results.

Table 23a: Regression Results, Controlling for Peer Influence

Variable	Estimated Coefficient	Standard Error
TCS	0.079[b]	0.038
TCSlag	0.136[a]	0.029
Lagged Total Export of Peer Exporters	0.099[a]	0.003
Age of enterprise	−0.704[a]	0.132
(Age of enterprise)^2	0.376[a]	0.078
Number of products	1.463[a]	0.018
(Number of products)^2	−0.151[a]	0.006
Number of markets	0.375[a]	0.025
(Number of markets)^2	0.022[b]	0.011
Number of employees	0.029	0.061
(Number of employees)^2	0.023[a]	0.007
Lagged Productivity	0.063[a]	0.008
Export experience	−1.909[a]	0.114
(Export experience)^2	−0.010[a]	0.002
Lagged Age of enterprise	0.376[a]	0.078
(Lagged Age of enterprise)^2	0.090[c]	0.053
Lagged Number of products	0.303[a]	0.018
(Lagged Number of products)^2	−0.037[a]	0.007
Lagged Number of markets	−0.046[c]	0.025
(Lagged Number of markets)^2	0.056[a]	0.012
Lagged Number of employees	0.038	0.061
(Lagged Number of employees)^2	0.014[b]	0.007
Lag2 Productivity	0.030[a]	0.007
Lagged Export experience	0.922[a]	0.070
(Lagged Export experience)^2	0.381[a]	0.045
TCS*Age of enterprise	0.320[b]	0.145
TCS* (Age of enterprise)^2	−0.048	0.032
TCS* Number of products	−0.247[a]	0.058
TCS* (Number of products)^2	0.052[a]	0.014
TCS* Number of markets	0.072	0.060
TCS* (Number of markets)^2	−0.019	0.019
TCS* Number of employees	0.051	0.045
TCS* (Number of employees)^2	−0.009	0.006
TCS* Lagged Productivity	−0.007	0.018
TCS* Export experience	−0.054	0.152
TCS* (Export experience)^2	−0.001	0.004
TCS* Lagged Total Export of Peer Exporters	0.000	0.012
TCSlag* Lagged Age of enterprise	−0.012	0.087
TCSlag* (Lagged Age of enterprise)^2	0.030	0.022
TCSlag* Lagged Number of products	−0.220[a]	0.058
TCSlag* (Lagged Number of products)^2	0.040[a]	0.015
TCSlag* Lagged Number of markets	0.015	0.059
TCSlag* (Lagged Number of markets)^2	−0.015	0.020
TCSlag* Lagged Number of employees	0.049	0.046
TCSlag* (Lagged Number of employees)^2	0.002	0.006
TCSlag* Lag2 Productivity	−0.024	0.017
TCSlag* Lagged Export experience	−0.175	0.122
TCSlag* (Lagged Export experience)^2	0.046	0.068

Source and notes: See Table 17a.

Table 23b: Treatment Effects, Controlling for Peer Influence

	Coefficient	Export Gain
TCSlag Average Treatment Effect (ATE)	0.136	14.6%
TCSlag Average Treatment Effect for the Treated (ATT)	0.123	13.1%

The estimated coefficient for the value of exports by peer exporters is positive and significance, which indicates the presence of the influence of peer exporters. The lagged TCS assistance is also positive and significant, which means an exporter with TCS assistance in the preceding year exports on average 14.6 percent more than one without assistance that year. (14.6% = (exp(0.136)−1)*100). Surprisingly, the estimate of *TCSlag* with a control for peer influence is even higher than the earlier estimate without the control for peer influence reported in Table 18a (12.4 percent). Thus, controlling for peer influence, the effect of lagged TCS assistance does not disappear or decline; in fact, it becomes marginally higher.

The estimated ATE coefficient is equal to 0.136 and that for ATT is 0.123. The mean effect of lagged TCS assistance relative to the whole population of exporters is similar to the mean effect on the treated, given their specific characteristics.

The ATE results given **x** with the presence of peer influence have the same signs as those we found for the lagged effect estimation.

4.8 Non-parametric Estimation

In this section, we apply a non-parametric method—propensity score matching—as an alternative estimation approach to validate our treatment effects estimates obtained using regression analysis. Propensity score matching was developed to reduce the potential for bias in estimating treatment effects by identifying a suitable untreated control group with similar characteristics to the treated group (Rosenbaum and Rubin, 1983). Propensity score matching is carried out in two stages. The first stage is a probit regression that converts all characteristics of the firms in the population into a single index, the propensity score. In the second stage, each treated subject is matched with an untreated subject based on their respective scores to ensure that the control group has equivalent characteristics other than having received the "treatment". A number of different matching algorithms are available, such as "nearest neighbour", "kernel" and "stratification/ intervals", to name a few (see, for example, Caliendo and Kopeinig, 2005, Figure 2). We chose kernel matching, which has the advantage that good matches receive a heavier weight than poor matches.

We repeat the analysis of each treatment variable with the same set of firm-specific characteristics; the results of all specifications are shown in Table 23.

The recent literature expresses some reservations on the propensity scoring matching approach[13]. If the propensity score estimated in the first stage (probit regression) is parametric, which is necessarily the case with many covariates, the collapsing of all information in the **x**-covariates into a single dimension will not be satisfactory. In particular, a linear or a low order polynomial for the estimation of such scores does not provide good approximation to the conditional expectations $E[y^j \mid \mathrm{x}]$. Nevertheless, this method provides an alternative approach to validate our ATE parametric estimation.

The non-parametric estimation shows consistent results with our parametric estimation. Both ATE and ATT are positive. However, the magnitudes of the effects are higher than those estimated using the parametric method, with TCS clients exporting 54 percent more than comparable non-TCS clients.

Table 24: Propensity Score Matching Estimation

Treatment Variable	ATE		ATT	
	Coefficient	Export Gain	Coefficient	Export Gain
TCS	0.432	54.0%	0.329	39.0%
TCSever	0.270	31.0%	0.243	27.5%
TCSloc	0.507	66.0%	0.313	36.8%

Source: Authors' calculations.

[13] Imbens and Wooldridge (2009) based on a recent review of the literature recommend that this method not be used in practice.

4.9 Caveats

Two cautionary notes should be taken into account in interpreting the results. First, as noted in Section 2, the dataset links TCS clients with the Exporter Register. Therefore, firms that receive TCS services but do not export are excluded. In many cases, this is appropriate in that the service provided could be in support of a commercial activity other than export of merchandise and therefore outside the scope of this study (e.g., export of services, or support for investment abroad). However, there may be cases where service was provided for export of merchandise but no merchandise was exported by the client. In these cases, arguably the dataset should have included these firms with zeros for their export values, as to not do so could bias the result upwards. This issue could be addressed in future work by separating TCS services that are directed at merchandise exports from other services in the client management database and by including firms that receive services aimed at merchandise exports but that do not succeed in making export sales.

Second, as noted in the introduction, the issue of reverse causality must be taken into account in studies of this nature. Unlike controlled experiments where subjects are "blind" in terms of whether they are given the treatment, impact evaluation in economic studies usually involves subjects that are well aware of the purpose of the treatment (for instance, unemployed are given the job training in order to obtain future employment). In our case, clients self-select into treatment—the TCS assistance. There is a potential endogeneity issue that might bias the estimation results upward in the sense that exporters are successful not because of TCS assistance, but because they are more successful exporters.

The average treatment effect estimation adopted in this study is designed to address this type of the endogeneity problem. Firms are self-selected (not randomly) into the "treatment", but the outcome of the treatment is random—firms are not able to predict the outcomes from their treatments. This is the essential element underlying the weak ignorability of treatment assumption used in our analysis—the independence between treatment and outcome of treatment conditioning on x-covariates. This assumption allows us to compare the performance of exporters who received treatment with that of comparable exporters who never received assistance, conditional upon the x-covariates.

Clearly, the quality of comparisons and treatment effect estimation critically depends on the choice of x-covariates. In our analysis, the choice of x-covariates is guided by economic theory, empirical firm-level research and available data. Research on firm heterogeneity shows that successful exporters are often those with higher productivity, which in turn allows these exporters to bring down destination-specific sunk costs associated with accessing foreign markets. Similarly, the size of firms, the years of exporting experiences, the number of export markets and the number of products are also found to be qualities associated with exporting. Thus, by controlling for these firm-level characteristics, we should be able to ensure comparison of "like" exporters. Nevertheless, it is still possible that there are unobservable firm characteristics influencing the success of exporting firms, leading to biased estimation results.

5. Concluding Remarks

In this paper, we use detailed firm-level data to assess the impact of Canadian Trade Commissioner Service (TCS) programs on Canadian exporter performance. Our results show that TCS assistance has a positive and consistent effect on the value of exports and the growth of exports. Exporters that received assistance, on average, export 17.9 percent more than comparable exporters that never received assistance. Further, the assistance received in the preceding year has a stronger effect on current exports than assistance in the current year. Once TCS assistance starts to influence export performance, the effect can continue to provide benefits as long as the exporter continues to export. The estimated TCS impact that takes into account the location where assistance is received is marginally stronger than the one without considering the location effect.

TCS assistance plays a very strong role in helping firms to diversify into new markets and to introduce new products into export markets, to facilitate transition from mature markets to emerging markets, and to support product innovation by encouraging export sales of new products.

As a robustness check, we examined the effect of TCS received in the current year on the growth of exports in the following year using the panel fixed effect model. We found that clients' exports grew faster than that of non-clients. We further examined whether the effect of TCS is diminished if we control for the influence of other exporters (peer influences). Again, we found that, after controlling for peer influence, the TCS impact remains significant and positive. A second robustness check using an alternative non-parametric method (propensity score matching) corroborates our findings.

Among all TCS-assisted exporters, the following clients tend to benefit more from TCS assistance: older, larger and less productive firms, those with little export experience, and those that export fewer products to fewer export destinations. The age and size indicators suggest export readiness is a factor in how effective TCS assistance is in practice. As well, the benefits of TCS assistance are greater for firms with lower productivity, less export experience, and exporting fewer products to fewer markets, all indicators suggesting a greater need for assistance.

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Firm Size and the Impact of Export Promotion Programs

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Abstract

Many countries have implemented programs to support their firms' internationalization efforts. The impacts are likely to be heterogeneous over firm size categories because these programs are primarily intended and expected to benefit smaller companies. Whether or not this is the case is still an open question. In this paper, we aim at filling this gap in the literature by providing evidence on the effects of trade promotion programs on the export performance of firms within different size segments, using a rich firm-level dataset for Argentina over the period 2002-2006. We find that these effects are indeed larger for smaller firms.

Key words: Public Programs, Export Promotion, Heterogeneous Effects, Argentina

JEL No.: F13, F14, L15, L25, D21, H32, H43.

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1. Introduction

Many countries around the world have established public agencies to promote their firms' exports. These agencies are endowed with annual budgets ranging from a few hundred thousand dollars to as much as USD 1.3 billion spread over nine agencies in the United States (see Jordana et al., 2009; GAO, 2009). The economic rationale usually advanced for their activities is that there are significant costs associated with the acquisition of information on foreign markets, which private firms will be reluctant to incur to the extent that competitors can benefit from their experience through information spillovers. Such externalities result in market failures, which in turn establish the basis for public sector involvement (see, e.g., Rauch, 1996)[1]. In particular, supporting participation of small and medium-sized companies (SMEs) in international markets is a common goal of export promotion agencies as declared by their lead officials and even in their legal statements of purposes. Indeed, these companies are more likely to be affected by barriers to exporting in general, and those related to imperfect information in particular; accordingly they would appear to be the primary beneficiaries of public trade promotion programs. Hence, the valued added by such programs to firms' own internationalization efforts can be expected to differ depending on firm size. In other words, heterogeneous effects of export assistance actions over firm size categories can be anticipated.

Is this really the case? Although there are some previous attempts to uncover the distributional impacts of export promotion programs (see, e.g., Volpe Martincus and Carballo, 2009), no study to our knowledge systematically examines whether there is a relationship between the size of the firms as conventionally measured in public policy (i.e., number of employees) and the size of these impacts. This paper aims at

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[1] Some authors argue, in addition, that informational asymmetries provide a rationale for trade policy (see, e.g., Mayer, 1984; Grossman and Horn, 1988; Bagwell and Staiger, 1989). See Copeland (2008) for a recent survey of the literature.

filling this gap in the literature. We assess whether the effects of trade supporting activities by Argentina's national agency Fundación ExportAR on firms' export performance varies with their size and, specifically, whether these effects are larger for smaller companies, in accordance to both what could be expected *a priori* given the differential deterring impacts of export obstacles for firms featuring different scales of production and what policymakers usually declare regarding whom these activities are primarily intended to benefit.

Relevant, accurate, and timely information is a key input to effective marketing decisions. Given the diversity of business environments, the multiplicity of factors to be considered when selling abroad, and, in particular, the need to deal with elements not involved in domestic operations, this is especially true for firms transcending national boundaries (see Czinkota and Ronkainen, 2001; and Leonidou and Theodosiou, 2004). A shortfall of information can accordingly cause major marketing difficulties and erect a barrier to increased international activities (see Suárez-Ortega, 2003). In fact, lack of information is one of the most significant export barriers both in terms of frequency of incidence and degree of severity (see, e.g., Leonidou, 1995). In order to successfully enter foreign markets, firms need to learn about foreign business practices and foreign consumer preferences; identify business opportunities abroad; contact and communicate with overseas customers; and access appropriate distribution and advertising channels (see, e.g., Rabino, 1980; Albaum, 1983; Czinkota and Ricks, 1983; Katiskeas and Morgan, 1994; and Leonidou, 2004). Associated information problems are perceived to have a high to very high impact on exporting (see, e.g., Keng and Jiuan, 1988; Katsikeas and Morgan, 1994; Suárez-Ortega, 2003; Leonidou, 2004).

Export promotion agencies run a variety of programs intending to help firms overcome these informational barriers. This is precisely the case of Fundación ExportAR[2]. This agency

[2] An appendix explaining the institutional organization of Fundación ExportAR and describing the export promotion programs that this agency runs is available from the authors upon request.

underneath the Ministry of Foreign Relations and International Trade has about 85 employees and an annual budget of approximately 4.5 million dollars (see Jordana et al., 2009). These resources are used to finance a series of activities aiming at supporting firms in selling their goods in foreign markets, including: providing training in the export process to firms that are new to the trade business; providing market intelligence, including relevant background information and information on specific commercial opportunities abroad; organizing and co-financing the participation of Argentinean firms in international marketing events such as trade fairs, exhibitions, and missions; arranging meetings with potential foreign buyers; and supporting the association of small companies to operate more effectively in external markets.

Smaller firms face greater limitations than larger firms in trading across borders (see, e.g., Roberts and Tybout, 1997; Bernard and Jensen, 1999, 2004; and Wagner, 2001, 2007). These differences across firm sizes are likely to be at least partially related to heterogeneity in access to and ability to use information[3]. More concretely, gathering information about and communicating with foreign markets seem to be greater obstacles for smaller than for larger firms (see, e.g., Katsikeas and Morgan, 1994). Thus, for instance, collecting information requires performing market studies which entail fixed costs. Larger firms are in a better position to absorb these costs because they can distribute them over a greater number of units sold; as well, they are better able to absorb the information from such studies and to use it to formulate an effective export market strategy (see Wagner 1995, 2001)[4]. Furthermore,

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[3] Other factors that may also play a role are, e.g., the ability to cope with other sunk costs of entry such as those involved in setting up an export department or redesigning products for foreign customers and differences in terms of access to management capability and to financial resources in capital markets.

[4] Hirsch and Adar (1974) show that large firms can afford to assume more risks than small ones. Further, their risks from foreign operations are smaller than those of small firms because the large firms benefit from

information about a company such as its reliability as a provider and the quality of its products, which is a critical input for business decisions by potential clients, is likely to be poorer in respect of smaller firms.

As noted, given that information-related impediments are likely to have differential deterring effects for firms of different sizes, trade-supporting actions geared to overcoming informational problems may potentially have heterogeneous impacts on firms' export performance over firm size categories. The existing empirical literature bearing on this issue is, however, thin and inconclusive.

Some studies have examined the effects of public policies on firm export performance without distinguishing the effects across firms of different sizes; the conclusions reached have been contradictory. Volpe Martincus and Carballo (2008a) find that export promotion actions are associated with increased exports, primarily along the extensive margin, both in terms of markets and products. Conversely, Bernard and Jensen (2004) find that US state export promotion expenditures have no significant effect on the probability of exporting. Several other studies have examined the impact of production subsidies on export performance (see, e.g., Girma et al., 2007; Görg et al., 2008; and Girma et al., 2009). They find that subsidies have little effect on the probability of a firm entering into export markets but do increase exports by those already active (i.e., they impact positively, but on the intensive margin). Helmers and Trofimenko (2009) also find some evidence of a positive impact of firm-specific subsidies, which they interpret as export subsidies, on export volumes based on Colombian data.

Another strand of the literature focused exclusively on small and medium-sized companies provides some evidence that trade promotion programs can improve export performance of small

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economies of scale in foreign marketing. Hence, the risk premium demanded by large firms when considering entering foreign markets is less than the premium insisted upon by small firms. As a result the former export a larger fraction of their output.

firms[5]. Moreover, Volpe Martincus and Carballo (2009), who examine the distributional impacts of trade promotion activities using highly disaggregated export data for Chilean exporters over the 2002–2006 period, find that smaller firms as measured by their total exports seem to benefit more from export promotion than do larger firms.

However, there is as yet no systematic examination of the potential existence of different effects for firms in different size segments as conventionally defined in public policy, i.e., in terms of employment levels. In this paper we precisely aim at providing insights on these effects. Hence, we contribute to the existing literature primarily by assessing, for the first time to our knowledge, whether and how the effects of public export promotion programs on firms' export performance vary with firm size, either for a developed or a developing country. Our results are relevant to resource allocation and policy design in the area of export promotion since policymakers will tend to evaluate differently two programs with the same average positive effect but whose benefits mostly accrue to smaller firms in the first case and to larger firms in the second.

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[5] For the most part, these studies are based on small samples and the results vary across different types of export promotion programs. For example, Gençtürk and Kotabe (2001) find that firms' usage of government export assistance programs are important export success factors but the relevance of export assistance programs and the role they play vary depending on the dimension of export performance being considered. Álvarez (2004) finds that the utilization of export promotion programs contributes positively to export performance in SMEs but also concludes that some forms of intervention are better than others: market studies and introductions to clients and authorities have a positive and significant impact but trade shows and trade missions do not affect the probability of exporting permanently. By contrast, Wilkinson and Brouthers (2006) find that the use of trade shows as well as programs identifying agents and distributors contribute positively to SME satisfaction with export performance. Meanwhile, Francis and Collins-Dodd (2004) find that using a greater number of government programs enhances export marketing competencies and that sporadic and active exporters gain the most from export promotion programs, while more experienced firms that derive most of their incomes from exporting derive little in the way of benefits.

We specifically address three main questions: Are trade promotion programs effective in improving firms' export performance? Are impacts of these programs heterogeneous across firm size categories? Are these impacts larger for smaller firms? In answering these questions, we apply variants of the difference-in-differences approach on a rich firm-level dataset containing data on exports by product and destination countries and employment over the period 2002-2006 for virtually the whole population of Argentinean exporters.

We find that export promotion programs administered by Fundación ExportAR have been effective in supporting the growth of Argentinean firms' exports, primarily along the country-extensive margin, i.e., the number of destination markets. Importantly, these programs do not seem to have affected all firms to the same extent. More specifically, as expected, smaller companies derive larger benefits from these public initiatives than larger firms in terms of improved export performance. Thus, trade-supporting actions are associated with an increased rate of growth of total exports and an increased number of export destination countries in the case of small and medium-sized companies, but they do not seem to have any distinguishable impact on the export outcomes of large firms. These results are robust across alternative specifications of the estimating equations and different econometric methods.

The remainder of the paper is organized as follows: Section 2 explains the empirical methodology. Section 3 presents the dataset and descriptive evidence. Section 4 reports and discusses the econometric results, and Section 5 concludes.

2. Empirical Methodology

We aim at estimating the effects of trade promotion assistance provided by Fundación ExportAR on Argentinean firms' export performance and assessing whether these effects are heterogeneous across firms within different size categories. In order to identify such effects, one would need to compare a firm's export outcomes when receiving export support with those when not receiving such support. Since export outcomes under both states cannot be simultaneously observed for the same firm, the individual treatment effect can never be observed. This is the so-called fundamental problem of causal inference (see Holland, 1986). However, given information on a population of firms, some of which receive assistance and some of which do not, the average effect of assistance, or "treatment effect"[6] can be identified.

Formally, let Y_{it} be (the natural logarithm of) firm *i*'s total exports in year *t*.[7] Each year, firm *i* may either participate in export promotion programs ("1") or not participate in these programs ("0"), but not both. Hence, firm *i* has two potential export outcomes: Y_{it}^1 and Y_{it}^0, which correspond to the participation and non-participation states, respectively. Further, let D_{it} be an indicator codifying information on assistance by Fundación ExportAR. Specifically, D_{it} takes the value 1 if firm *i*

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[6] The term "treatment effect" originated in the medical literature concerned with assessing the effects of new drugs or medical procedures. Typically, these studies involved controlled experiments with randomly assigned treated and control groups to allow accurate identification of the effect of the drug or procedure being tested. The term has come into general usage in analyses of public policy instruments in non-experimental contexts on the basis of observational data, such as in the present case. In such applications, given the absence of a randomly assigned control group and experimentally controlled conditions, statistical methods are used to isolate the effect of the policy measure in question by controlling for factors that might cause firms to seek assistance and that also influence trade outcomes (i.e., firms that seek assistance may have different characteristics than the population in general, which results in selection bias in the estimate of the effect of the program in question).

[7] The use of (natural) logarithm is partially motivated by the scale problem originated in the fact that our binary variable D does not capture the size of the assistance (see Lach, 2002). The presentation hereafter focuses on firms' total exports, but *mutatis mutandis* also applies to measures of export performance along the extensive margin (number of destination countries and the number of products exported) and the intensive margin (average exports per country, average exports per product, and average exports per country and product).

has been assisted by the agency in year t and 0 otherwise[8]. In this case, firm *i*'s observed export outcome can be expressed as follows:[9]

$$Y_{it} = D_{it}Y_{it}^{1} + (1 - D_{it})Y_{it}^{0} \quad (1)$$

The impact of trade support is therefore given by:

$$\Delta Y_{it} = Y_{it}^{1} - Y_{it}^{0}.$$

Since it is impossible to observe both Y_{it}^{1} and Y_{it}^{0} for the same firm, information on the population of firms, including those that did not receive assistance, is used to learn about the properties of the potential trade outcomes, on the basis of which an average treatment effect (ATE) is computed. In particular, given that participation in the programs under consideration is voluntary and that the number of firms receiving assistance is small relative to the overall population of exporting firms, it seems more relevant to determine the effects of the program on firms that participated. Accordingly, we estimate an average treatment effect on the treated firms (ATT):

$$\gamma = E\left(Y_{it}^{1} \mid D_{it} = 1\right) - E\left(Y_{it}^{0} \mid D_{it} = 1\right) = E\left(\Delta Y_{it} \mid D_{it} = 1\right), \quad (2)$$

where E(·) denotes the mathematical expectation operator, i.e., the average of a random variable, and the parameter γ measures the average percentage change between the actual exports of firms that were assisted by Fundación ExportAR and what the exports of these firms would have been had they not been assisted by Fundación ExportAR (see Lach, 2002). Clearly, when $\gamma > 0\ (= 0)$, the export promotion service stimulates (does not have any impact on) firms' exports.

In the empirical exercise below we use the firms that do not receive a service from Fundación ExportAR as the control group to derive the counterfactual and accordingly estimate γ.

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[8] We will use interchangeably the terms assistance, support, treatment, and participation throughout the paper.

[9] This is the potential outcomes framework due to, among others, Fisher (1935), Roy (1951), and Rubin (1974).

The main issue to deal with when proceeding so is that there may be non-random differences between supported and non-supported firms that are potentially correlated with export performance (see Galiani et al., 2008; and Volpe Martincus and Carballo, 2008a). Failure to account for these differences would clearly produce a selection bias in estimated impacts (see, e.g., Heckman et al., 1998; Klette et al., 2000). Thus, firm heterogeneous characteristics need to be controlled for to get comparable groups of firms and a consistent estimate of γ.[10] Notice that many of these characteristics (e.g., sector of activity, location of headquarters, etc.) are likely to be fixed over time, especially over relatively short horizons such as those considered here. When repeated observations on firms are available, this time-invariant heterogeneity can be properly accounted for using the *difference-in-differences* estimator. This estimator is a measure of the average difference between the before and after change in exports for assisted firms and the corresponding change for non-assisted firms (see Smith, 2000; Jaffe, 2002). The latter change serves here as an estimate of the true counterfactual, i.e., the export outcome that the firms in the treatment group would have realized if they had not received

[10] In this exercise, we ignore general equilibrium effects so that outcomes for each firm do not depend on the overall level of participation in the activities performed by the agency (see Heckman et al., 1998). Further, we also do not take into account possible effects of information spillovers. It is well known that firms may learn about export opportunities from other firms through employee circulation, customs documents, customer lists, and other referrals (see Rauch, 1996). Evidence on spillovers has been presented in several papers. Thus, Aitken et al. (1997) and Greenaway et al. (2004) report significant spillovers from multinational enterprises (MNEs) to domestic firms in Mexico and the United Kingdom, respectively. More precisely, MNE activity is positively related to export propensity of local firms. Álvarez et al. (2007) find that the probability that firms introduce given products to new countries or different products to the same countries increases with the number of firms exporting those products and to those destinations, respectively. If similar spillover effects were associated with participation in export promotion activities, i.e., if untreated firms obtain business information from treated firms, then the treatment effects, as estimated here, would be underestimated.

trade promotion support. This allows identifying temporal variations in outcomes that are not due to exposure to treatment (see Abadie, 2005). Hence, by comparing the aforementioned changes, the difference-in-differences estimator permits controlling for observed and unobserved time-invariant firm characteristics as well as time-varying factors common to both treated and control firms that might be correlated with participation in export promotion programs and export outcomes (see, e.g., Galiani et al., 2008).

In general, in order to calculate standard errors and to perform weighted estimations aiming at addressing potential biases of this estimator, we implement it through a regression approach (see Ravallion, 2008). Thus, allowing for covariates X and assuming that the conditional expectation function $E(Y|X,D)$ is linear and that unobserved characteristics, μ_{it}, can be decomposed into a firm-specific fixed-effect, λ_i; a year, common macroeconomic effect, ρ_t; and a temporary firm specific effect, ε_{it}, leads to the following error-components specification:

$$Y_{it} = X_{it}\theta + \gamma D_{it} + \lambda_i + \rho_t + \varepsilon_{it} \quad (3)$$

This specification allows selection into treatment on unobservable characteristics thus permitting for correlation between time-invariant firm-specific and time-specific effects and D_{it}, the binary variable indicating assistance by Fundación ExportAR. Identification of the effects is therefore based on the assumption that selection into the treatment is independent of the temporary firm-specific effect. We estimate this equation on the whole sample and, to create a common "baseline" before-treatment period, on two alternative sub-samples, namely, the sub-samples formed by those firms that were never treated before or those that were not treated in the previous period (see Lach, 2002).

Estimation of Equation (3) can be potentially affected by severe serial correlation problems (see Bertrand, et al., 2004). First, estimation of this kind of equation relies on non-trivial time series. Second, exports (and number of countries and products as well) tend to be highly positively serially correlated (see, e.g., Roberts and Tybout, 1997; Bernard and Jensen, 2004). We therefore allow for an unrestricted covariance structure over time within firms, which may differ across them (see Bertrand et al., 2004).

Importantly, so far we have assumed a common treatment effect, i.e., $\gamma = \gamma_i \forall i$. However, as discussed in Section 1, effects can be anticipated to systematically vary with firm size. More formally, they are likely to be heterogeneous by observed covariates. We therefore test whether this is the case using the non-parametric test proposed by Crump et al. (2008). This test is based on a sieve approach to non-parametric estimation for average treatment effects (see, e.g., Hahn, 1998; Imbens et al., 2006; Chen et al., 2008). Given the particular choice of the sieve, the null hypothesis of interest can be formulated as equality restrictions on subsets of the parameters. Specifically, in our case, the null hypothesis is that the average treatment effect conditional on the covariates is identical for all subpopulations. If heterogeneity were to be detected, then the correct specification of the estimating equation would be (see Djebbari and Smith, 2008):

$$Y_{it} = X_{it}\theta + (\gamma + \gamma_X X_{it})D_{it} + \lambda_i + \rho_t + \varepsilon_{it} \quad (4)$$

In Section 4 we estimate Equation (3) and, since we do find evidence of impact heterogeneity, we also estimate Equation (4) for both the whole sample and the two sub-samples with common pre-intervention states.

3. Data and Descriptive Evidence

Our dataset combines three main databases. The first database has annual firm-level export data disaggregated by product (at the 10-digit HS level) and destination country over the period 2002-2006 from Argentinean customs. Second, Fundación ExportAR kindly provided us with a list of the firms assisted by the agency in each year of the period 2002-2006. It is worth mentioning that this list primarily includes firms that have interacted closely with the agency[11]. Finally, we have data on employment and location from the National Administration of Public Revenues, AFIP[12]. These databases have been merged using the firms' tax ID. We have been granted access to the combined dataset after these IDs had been removed and replaced with generic firm identifiers. This dataset covers almost the whole population of Argentinean exporters. In particular, the sum of these firms' exports virtually adds up to the total merchandise exports as reported by the National Statistical Office, INDEC, with the annual difference being always less than 4.0 percent. Moreover, the total number of destination countries and products exported are virtually the same as the national totals.

Table 1 presents the evolution of aggregate export indicators from 2002 to 2006. Exports grew approximately 81.0 percent between 2002 and 2006. Even though there have been increases in the number of countries to which the firms export and in the number of products exported, most of this expansion is accounted for at the intensive margin, i.e., through larger average shipments by product and country.

The first panel of Table 2 characterizes the average Argentinean exporter over the sample period. The number of exporters rose 19.2 percent from 2002 to 2006. These firms had on average 92 employees. The average exporter sold abroad 9.2 products to 3.6 countries. These figures are similar to those of

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[11] More concretely, these firms have had more than one direct contact with Fundación ExportAR within the year being considered. The typical cases are those that participated in international fairs and missions. Thus, for instance, firms just visiting the agency's website to access public reports on foreign trade or requesting specific information (e.g., tariff applied on a given good in a certain destination country) are not identified as assisted. Data on these cases of assistance are unfortunately not consistently available over the sample period.

[12] These data can then be seen as a census of formal Argentinean employment. There is of course some risk of misreporting, which would generate measurement errors. As long as these are systematic across firms, they will be eliminated by the time differentiation implemented in the estimation methods used in this paper.

the United States in 2000 – 8.9 and 3.5, respectively – but larger than those of Peru in 2005 – 7.5 and 2.6, respectively (see Bernard et al., 2005; and Volpe Martincus and Carballo, 2008a). The proportion of exporters assisted by Fundación ExportAR moved up from 1.5 percent to 4.2 percent over the period; given the larger presence of Argentinean firms in export markets, this implies a significant increase in the absolute number of firms being supported.

The second to fourth panels of Table 2 present basic statistics on the relationship between size and exports for Argentina. Specifically, this table breaks down the export and treatment indicators into three size categories defined in terms of employment: up to 50 employees (small), between 51 and 200 employees (medium), and more than 200 employees (large)[13]. We observe that, on average, larger firms export more; they export to more countries and more products[14]. These firms represent approximately 7 percent of the exporting population but explain together more than 75 percent of aggregate exports. Small firms meanwhile account for approximately 73 percent of the exporters but only for 7.8 percent of Argentinean total exports. In addition, these firms represent the largest category in the group of firms assisted by Fundación ExportAR, i.e., 56.1 percent in 2002 and 59.0 percent in 2006. Together, small and medium-sized firms, explain for more than 80 percent of the firms supported by this agency over the period.

Figures 1 and 2 provide a detailed visual representation of the distribution of firms' exports discriminating over size categories for the final sample year, 2006, thus going beyond the simple averages presented before. Figure 1 shows that most Argentinean exporters are small firms selling abroad a few goods to a few countries. In particular, approximately 60

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[13] This is the standard classification used in the literature (see, e.g., Álvarez, 2004; Hollenstein, 2005; and Observatorio PyME, 2008).

[14] This adds to the evidence reported in the empirical international trade literature suggesting that larger firms are more likely to export (see, e.g., Roberts and Tybout, 1997; Bernard and Jensen, 2004), tend to export more (see, e.g., Görg et al., 2007), and have a higher export intensity (see, e.g., Barrios et al., 2003).

percent of the exporters are small companies trading fewer than 10 products to fewer than 10 countries. Remarkably, about 20 percent are small firms exporting just one good to one external market. Further, 37.6 percent of the exporting companies are small ones that only trade with one country and 23.0 percent are similar firms that only ship one product abroad. In contrast, the fewer large firms have more diversified export patterns along both the country and product dimensions. Thus, in 2006 these companies traded with up to 118 countries and dealt in up to 510 products. Figure 2 reveals that these firms account for the larger shares of Argentinean total exports. More specifically, in 2006, the 303 large companies that exported more than 10 products to more than 10 countries explained 64.7 percent of aggregate exports as reported in our dataset.

In this section, we have presented basic evidence of export outcomes for the companies engaged in international trade and on the number and profile of the firms assisted by Fundación ExportAR. Next, we will econometrically explore whether and how trade promotion programs run by this agency have affected these export outcomes both overall and across different firm size categories.

4. Econometric Results

In this section, we first present the estimation results when pooling over all firms. In particular, we report the average assistance effect of trade support programs on the assisted firms as obtained with the difference-in-differences estimator from both the whole sample and the two sub-samples with common pre-intervention states for the two groups of firms. Second, we assess whether there is impact heterogeneity and evaluate the effectiveness of these programs for the three firm size categories previously identified, small, medium, and large. Finally, we go through several robustness check exercises.

4.1 Average Assistance Effect

The top panel of Table 3 reports difference-in-difference estimates of the average treatment effects on the treated, i.e., the average effect of assistance by Fundación ExportAR on assisted firms for six firm-level export performance indicators, namely, total exports, the number of destination countries, the number of products exported, average exports per country and product, average exports per country, and average exports per product, for two alternative specifications, with and without time-varying (one year lagged) binary variables accounting for the firm's size category[15]. The adjusted R^2s of these regressions range between 0.825 and 0.894, with an average of 0.857.

The estimated treatment effects are similar in order of magnitude across specifications, but, as expected, they are smaller when these firm level time-varying covariates are included. Overall the estimates clearly suggest that participation in export promotion programs managed by Fundación ExportAR is associated with an increased rate of growth of firms' total exports, number of countries the firms export to, and number of products exported. In particular, according to the specification including the binary variables that control for the companies' size, the rate of growth of exports is 14.1 percent ($(e^{0.132}$-1)x100=14.1) higher for firms assisted by Fundación ExportAR, while those of the number of countries and the number of products are 10.4 percent ($(e^{0.099}$-1)x100=10.4) and 9.7 percent ($(e^{0.093}$-1)x100=9.7) higher, respectively. Given that the sample average (logarithm) annual growth rate of total exports is 11.9 percent, this implies that treated firms would

[15] There might be other attributes that are, unfortunately, not observable to us but are observable to both Fundación ExportAR officials and firms. Typical examples in this regard are the managerial attitudes, qualification profile of personnel, and innovation capabilities. Admittedly, these unobserved characteristics may play a role in determining both service usage and export performance. Notice, however, that these features only change slowly over time. Given the length of our sample period, they can be safely considered as mostly fixed and therefore controlled for by the firm fixed effects.

have a rate 1.7 percentage points higher than non-treated firms. In contrast, the impact on the remaining export outcomes is substantially weaker and evidently less robust. These results are consistent with our priors. Export promotion activities aiming at attenuating information problems are likely to have a stronger effect when these problems are more acute, namely, when entering new markets rather than when expanding operations in already served markets[16]. Moreover, they are broadly similar to those found in Peru (see Volpe Martincus and Carballo, 2008a).

We then replicate these estimations on two alternative samples: first, we exclude those firms that have been assisted by Fundación ExportAR in the previous year; second, we exclude those firms that have been assisted by Fundación ExportAR (at least once) in the past. This allows us to generate a common "before treatment" period and to consider a more homogeneous set of firms in this period[17]. Estimation results are shown in the second and third panels of Table 3[18]. These results essentially confirm our main findings. Notice, however, that, in this case, the effect on product diversification appears to be weaker and less robust. Hence, export promotion programs seem to have been effective in facilitating an increase of firms' exports along the extensive margin, primarily in terms of destination countries, but not along the intensive margin[19].

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[16] In general, it can be expected that, over time, growth in the number of total destinations (products) will be associated with introduction of new trade partners (products). In particular, this is indeed the case in our sample.

[17] While the original sample corresponds to the period 2002-2006 and has 41,224 observations, these restricted samples only cover the period 2003-2006 and have 39,286 and 37,217 observations, respectively.

[18] The R^2s are similar to those reported for our benchmark estimations.

[19] It is well known that the conventional difference-in-differences estimator is based on the assumption that, in absence of the treatment, the average outcomes for firms participating in export promotion programs and firms not participating in these programs would have followed parallel paths over time, i.e., both average outcomes would have experienced the same variation over time (see Abadie, 2005). This can be informally assessed by performing a so-called "placebo test". If we are accurately identifying the impact of these programs, we should see no difference between the average export outcomes of the treated and control groups in the pre-intervention

So far we have assumed that trade promotion programs have a common effect for firms with different sizes and have accordingly just estimated an overall average treatment effect. As discussed before, these effects may be heterogeneous over size categories. In the next sub-section, we will explicitly investigate whether this is the case.

4.2 Are there Heterogeneous Effects by Firm Size Category?

In order to assess whether there are heterogeneous treatment effects by observed covariates, we use the non-parametric test proposed by Crump et al. (2008). This is formally a test for the null hypothesis that the average effect conditional on the covariates is identical for all subpopulations. The test statistics and the corresponding p-values under both the standard normal distribution and the approximation, the chi-squared distribution with degrees of freedom equal to the number of covariates minus one, obtained when applied to our data are presented in Table 4. These tests clearly indicate that there is indeed strong evidence of heterogeneity for all export outcomes, except for the growth of the number of products sold abroad.

We therefore turn to estimating Equation (4), which expands Equation (3) by adding interactions between the treatment indicator and the binary variables capturing firm size categories. The estimated coefficients on these interactions are presented in the first panel of Table 5. The estimation results suggest that the positive effects of export promotion programs administered by Fundación ExportAR on total exports and number of destination countries are clearly stronger for small and medium-sized firms.

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period. We therefore compare the rate of change of each export indicator for firms that have been assisted in at least one sample year with those of non-assisted firms over periods in which the former have not received yet their first assistance. More specifically, we carry out t-tests for differences in means for the logarithmic differences of the variables in question. Reassuringly, the relevant test statistics suggest that these differences are not significant, i.e., supported and never-supported firms seem to behave similarly when no participation in export promotion programs takes place. A table with these test statistics is available from the authors upon request.

Thus, the growth rates of exports and number of countries are 10.7 percent ($(e^{0.102}$-1)x100=10.7) and 10.4 percent ($(e^{0.099}$-1)x100=10.4) higher, respectively, for small firms that have participated in these programs than for comparable non-participating firms. Similarly, these rates are 16.2 percent ($(e^{0.150}$-1)x100=16.2) and 8.9 percent ($(e^{0.085}$-1)x100=8.9) higher, respectively, for medium-sized companies assisted by Fundación ExportAR than for companies within the same size category that have not received this assistance. With average growth rates of total exports of 10.8 percent and 14.7 percent for small and medium-sized firms respectively, these estimates mean that supported firms in these size segments would have growth rates 1.2 and 2.4 percentage points higher than non-supported counterparts, respectively. Finally, we note that, with the exception of a weak impact on the change in the number of goods sold abroad, no significant impacts are observed on the export outcomes of large firms.

As before, we replicate these estimations for the two sub-samples with common pre-intervention states, i.e., on the sample excluding for each year firms that have been assisted in the past, either in the year immediately before or in some other previous year. Results from these estimations are shown in the second and third panels of Table 5. They essentially confirm our main conclusions. Notice that now no significant effects are detected on the export performance of large firms.

Hence, in the previous sub-section we have seen that trade promotion actions performed by Fundación ExportAR help firms expand their total exports primarily along the country-extensive margin. In this sub-section we have learned that these positive effects are mainly concentrated in small and medium-sized companies. This is also consistent with what one would expect *a priori*. As mentioned above, imperfect information is a more important deterrent for small and medium-sized companies; accordingly, public programs aiming at overcoming limited information problems are more likely to benefit their export performance as compared with that of larger firms, which in principle have the scale and resources to address these problems by themselves.

4.3 *Robustness*

In this subsection, we examine the robustness of our findings to changes in the definitions of the firm types as well as to corrections for potential econometric problems by performing several checks.

Although our classification of firm sizes is standard in the empirical literature, there are of course alternative classifications[20]. We therefore explore whether our results are sensitive to variations in the thresholds delimiting the size categories. In particular, we re-estimate Equations (3) and (4) using the following specification of these categories: (i) large firms are those whose number of employees exceeds 250 and small firms are those whose number of employees does not exceed 40; (ii) large firms are those whose number of employees exceeds 150 and small firms are those whose number of employees does not exceed 60; and (iii) small and medium-sized firms are pooled together and large firms are defined as those whose number of number of employees exceeds 250.[21] We report the estimation results based on these size classifications in Table 6. These results do not significantly differ from those presented before, which makes as confident that our estimates do not depend on the specific employee levels used to define the firm size classes.

Systematic differences between the treated and control groups in terms of firm characteristics influencing the dynamics of the export outcome variables may create non-parallel trajectories in these variables, thus contaminating the difference-in-differences estimates (see Abadie, 2005). This

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[20] See, e.g., Wagner (1995), Argentinean Law 24.476/1995 (reformed), Burdisso et al. (2001), OECD (2005), and Gallup (2007).

[21] We have also performed estimations based on alternative definitions that only change one of the limits, namely, (i') large firms are those whose number of employees exceeds 250; (ii') small firms are those whose number of employees does not exceed 40; (iii') larger firms are those whose number of employees exceeds 150; (iv') small firms are those whose number of employees does not exceed 60. The estimation results are similar to those reported here and are available from the authors upon request.

would happen if a relevant covariate is omitted, resulting in misspecification of the parametric models defined in Equations (3) and (4). For instance, if a temporary fall in exports causes firms to seek support from export promotion programs run by Fundación ExportAR, the process determining D_{it} would involve lagged dependent variables. A return to normal export levels would then result in higher export growth among the treated even without the effect of participation[22]. In this case, the difference-in-differences estimator would likely overestimate the impact of the programs and would be inconsistent (see Blundell and Costa Dias, 2002).

The possibility of such misspecification can be addressed by using the so-called *double robust estimation* procedure (see, e.g., Robins and Rotznisky, 1995; Imbens, 2004; Imbens and Wooldridge, 2008: and Chen et al., 2009)[23]. This consists of combining regression with weighting by the propensity score, in our case, the probability to participate in trade promotion activities organized by Fundación ExportAR conditional on observed covariates, including lagged export outcomes, i.e., lagged total exports, lagged number of destination countries, and lagged number of exported products. In particular, this estimator eliminates remaining biases leading to a consistent estimate of the treatment effect as long as the parametric model for the propensity score or the regression function is specified correctly (see Robins and Ritov, 1997)[24]. Further, precision can be improved when covariates are incorporated to the regression function (see Imbens, 2004). Hence, as a robustness check, we also estimate Equations (3) and (4) with weights equal to unity

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[22] In the labour market literature, this is known as Ashenfelter's dip (see Ashenfelter, 1978).

[23] Estimators of treatment effects that weight on functions of the probability of treatment are based on the statistic proposed by Horvitz and Thompson (1952) (see Abadie, 2005).

[24] More precisely, combining regression with weighting can lead to additional robustness by both removing the correlation between omitted variables and by reducing the correlation between omitted and included variables (see Imbens and Wooldridge, 2008).

for assisted firms and $\hat{P}(X)/1-\hat{P}(X)$ for non-assisted firms, where $\hat{P}(X)=P(D_i=1 \mid X_i)$ is a consistent estimate of $P(X)$ and $0 \langle \hat{P}(X) \langle 1$ (see, e.g., Hirano and Imbens, 2001; Hirano et al., 2003; and Chen et al., 2009). Estimates of these equations, based on both the whole sample and the two sub-samples excluding previously assisted firms, are presented in Table 7.[25] These estimates essentially convey the same message as those shown in Table 5.[26]

As additional robustness checks, we also compare our baseline estimates with those obtained using estimators that impose fewer parametric restrictions, namely, the semi-parametric difference-in-differences estimator proposed by Abadie (2005) and the matching difference-in-differences estimator proposed by, among others, Blundell and Costa Dias (2002). In both cases, the initial step consists of estimating the propensity scores. In the second step, the before and after differences for assisted and non-assisted firms are re-weighted to account for their differences in the distribution of observed characteristics using the propensity scores[27]. In particular, the second estimator compares the change in exports of assisted firms with that of paired non-assisted firms as determined on the basis of their propensity scores; the significance of the resulting treatment effect is assessed using both analytical and bootstrapped standard errors[28]. We present the results from

[25] The estimation of the propensity score is discussed in detail in an appendix available from the authors upon request.

[26] Notice that, despite the fact that we are including lagged values controlling for previous export performance, these estimates are also based on the period 2002-2006 because we are using export data from 2001 as firms' export outcomes antecedents in 2002.

[27] These procedures also rely for identification on the assumption that there are no time-varying unobserved effects influencing selection into trade promotion programs and exports.

[28] We use here a result from Rosenbaum and Rubin (1983), according to which matching can be performed on the propensity score instead of on the whole set of observable characteristics. This significantly reduces the dimensionality problem associated with comparison of multiple characteristics. Notice, however, that the propensity score is in fact generated by fitting a parameter structure (probit or logit). It is, therefore, necessary to

applying the aforementioned methods in Tables 8 and 9, respectively. These results also corroborate our main findings.

By using the propensity score as defined above, we are in principle able to control for firm size and previous export experience. However, there may be additional time-varying characteristics that are correlated with selection into trade promotion programs and export outcomes, thus generating a violation of the main identifying assumption behind the estimators used in this paper. We address below two important cases. First, the export promotion agency may prioritize specific sectors and specific destination countries in particular years. We account for this possibility by adding two control variables in the propensity score, namely, for each firm-year we include the shares of exporters participating in export support programs in the main 2-digit sectors and in the main country market in which the firm is an active exporter, and re-estimating the assistance effects applying the methods that use this score, namely, weighted difference-in-differences, semiparametric difference-in-differences à la Abadie (2005), and matching difference-in-differences.

Second, a similar problem would arise if firms' changing mix of products results in differences in demand for promotion services over time. It is well known that firms selling abroad differentiated products tend to face more severe information problems. Thus, firms with an increasing share of these products in their export baskets are more likely to resort to support. The same argument can apply to firms exporting to more sophisticated markets such as those in the OECD

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test whether the estimated propensity score is successful in balancing the values of covariates between matched treatment and comparison groups. We assess the matching quality using five alternative tests: the stratification test; the standardized differences test; the t-test for equality of means in the matched sample; the test for joint equality of means in the matched sample or Hotelling test; and the pseudo R^2 and the joint insignificance test of all regressors included in the propensity score specification (see, e.g., Smith and Todd, 2005b; Girma and Görg, 2007; and Caliendo and Kopeinig, 2008). These tests are reported in an appendix available from the authors upon request.

countries. Types of goods traded and destination may also help shape export outcomes. Differentiated goods are heterogeneous both in terms of their characteristics and their quality. This interferes with the signalling function of prices, thus creating trade frictions. This is especially important for firms from a developing country such as Argentina, whose products, due to national reputation effects, might be perceived by buyers as less technologically advanced and of poorer quality than those from developed countries (see, e.g., Chiang and Masson, 1988; Hudson and Jones, 2003)[29]. Challenges involved in exporting to familiar neighbouring countries tend to be smaller for than those faced when exporting to more distant, developed country markets. Firms may have to upgrade products as well as marketing strategies to succeed in exporting goods to these latter markets[30]. We therefore re-estimate the treatment effects using the propensity score-based procedures, but this time including in the set of regressors (a) the lagged ratio of exports of differentiated products (as defined in terms of the liberal version of the classification proposed by Rauch, 1999) to firms' total exports; and (b) the lagged ratio of exports to OECD countries also to firms' total exports. Estimation results based on these two modified versions of the propensity score are fully consistent with our baseline estimates[31].

To sum up, there is strong robust evidence that trade supporting programs managed by Fundación ExportAR have promoted Argentinean firms' export growth mainly by

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[29] Export promotion activities are likely to have different effects on export performance over firms exporting bundles of products with different degrees of differentiation and thus facing varying levels of information incompleteness (see Volpe Martincus and Carballo, 2008b).

[30] Properly shaping the marketing strategy to meet these markets' requirements is an information-intensive activity. For instance, firms need to learn and understand the preferences of foreign consumers; the nature of competition in foreign markets; the structure of distribution networks, and the requirements, incentives and constraints of the distributors (see, e.g., Artopoulos et al., 2007).

[31] Detailed tables reporting these estimation results are available from the authors upon request.

facilitating an increase in the number of countries they sell to. However, these effects are not distributed uniformly over firm size categories. More concretely, as expected, the positive impacts are primarily observed in small and medium-sized companies.

5. Concluding Remarks

Trade impediments such as informational barriers may affect differently firms of different sizes. In particular, they are likely to have stronger deterring effects on smaller companies because these lack the scale and thus the resources to acquire the needed information by themselves. Public programs aiming at addressing such information problems can therefore be expected to have larger impacts on these firms' export performance than on that of large firms. In fact, smaller companies are the declared primary beneficiaries of these public interventions. The overall effectiveness of trade promotion initiatives has been assessed in a number of studies and there is some partial and limited evidence on the impact of such services specifically on small and medium-sized enterprises. However, the empirical literature is still silent on whether these effects are heterogeneous over firm size categories as conventionally defined by policymakers, i.e., in term of employment levels. Knowing this is critical to assess to what extent these public activities are well targeted.

In this paper, we contribute to this literature by carefully examining whether and how export promotion programs executed by Argentina's national agency Fundación ExportAR affect export outcomes of firms belonging to different size segments. In doing this, we have performed conventional difference-in-differences estimation along with several variants of this method on a rich dataset including firm-level data on exports by product and country of destination and employment for virtually the whole population of Argentinean exporters.

We find that indeed these public programs have non-uniform effects over the size distribution of firms. They seem to be well targeted in the sense that significant effects are only registered for small and medium-sized companies. More specifically, support from Fundación ExportAR seems to have resulted in increased exports from firms within these size categories and this has mainly taken place through an expansion of the set of destination countries. This is consistent with our priors since information barriers tend to be more severe when attempting to enter new export markets than when attempting to expand exports to countries that are already among firms' destination markets and, as noted above, their trade inhibiting effects are especially strong for smaller business units.

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Table 1

Aggregate Export Indicators

Year	Total Exports	Number of Countries	Number of Products
2002	25,218	181	11,883
2003	28,996	185	11,289
2004	33,837	196	11,669
2005	38,887	193	12,031
2006	45,504	194	12,128

Source: Own calculations on data from UMCE-SICP, Fundación ExportAR and AFIP.

Notes: Total exports are expressed in millions of US dollars. The number of products is based on the HS 10-digit classification.

Table 2

Average Exports and Assistance Indicators					
Year	Number of Firms	Average Exports	Average No. of Countries	Average No. of Products	No. of Firms Assisted
All Firms					
2002	10,216	2,468.49	3.34	9.51	155
2003	10,797	2,685.51	3.51	8.93	319
2004	11,408	2,966.09	3.62	8.99	419
2005	12,173	3,194.53	3.78	9.22	423
2006	12,649	3,597.41	3.79	9.35	526
Small (<=50 Employees)					
2002	7,868	302.84	2.35	6.89	87
2003	8,169	334.13	2.45	6.45	198
2004	8,494	369.00	2.51	6.28	242
2005	9,004	382.48	2.62	6.38	217
2006	9,256	381.43	2.61	6.40	312
Medium (50<Employees<=200)					
2002	1,698	2,507.17	5.07	12.67	43
2003	1,890	2,308.11	5.20	11.96	77
2004	2,104	2,158.53	5.23	12.00	114
2005	2,257	2,413.05	5.40	12.05	128
2006	2,421	2,637.44	5.31	11.78	143
Large (>200 Employees)					
2002	650	28,581.85	10.86	32.93	25
2003	738	29,679.76	10.93	28.61	44
2004	810	32,297.90	11.13	29.69	63
2005	912	32,891.40	11.21	30.20	78
2006	972	36,613.02	11.24	31.38	71

Source: Own calculations on data from UMCE-SICP, Fundación ExportAR, and AFIP.

Notes: Average exports are expressed in thousands of US dollars.

Table 3

Average Effect of Assistance by Fundación ExportAR
Difference-in-Differences Estimates

Full Sample, 2002-2006

Export Outcome	**Without Covariates Controlling for Size**	**With Covariates Controlling for Size**
Total Exports	0.193*** (0.0304)	0.132*** (0.037)
Number of Countries	0.137*** (0.0140)	0.099*** (0.017)
Number of Products	0.098*** (0.018)	0.093*** (0.024)
Average Exports per Country and Product	-0.042 (0.026)	-0.006 (0.035)
Average Exports per Country	0.056** (0.024)	0.034 (0.032)
Average Exports per Product	0.095*** (0.028)	0.039 (0.034)

Firms Not Assisted the Previous Year, 2003-2006

Export Outcome	**Without Covariates Controlling for Size**	**With Covariates Controlling for Size**
Total Exports	0.228*** (0.054)	0.141*** (0.051)
Number of Countries	0.136*** (0.024)	0.080*** (0.022)
Number of Products	0.104*** (0.032)	0.060* (0.033)
Average Exports per Country and Product	-0.0132 (0.049)	-0.0490 (0.047)
Average Exports per Country	0.091** (0.046)	0.011 (0.044)
Average Exports per Product	0.123** (0.050)	0.031 (0.047)

Firms Never Assisted Before, 2003-2006		
Export Outcome	**Without Covariates Controlling for Size**	**With Covariates Controlling for Size**
Total Exports	0.202***	0.177**
	(0.050)	(0.081)
Number of Countries	0.180***	0.123**
	(0.062)	(0.068)
Number of Products	0.091***	0.069
	(0.033)	(0.095)
Average Exports per Country and Product	-0.004	-0.0150
	(0.047)	(0.147)
Average Exports per Country	0.018	0.055
	(0.044)	(0.139)
Average Exports per Product	0.031	0.208
	(0.047)	(0.154)

Source: Own calculations on data from UMCE-SICP, Fundación ExportAR, and AFIP.

Notes: The table reports estimates of Equation (3). The dependent variables are the natural logarithm of the export performance indicators listed in the first column. The firm-level time-varying covariates controlling for size are two binary variables identifying whether the firm is small (up to 50 employees) or medium-sized (between 51 and 200 employees). The large category is the omitted variable. Firm fixed effects and year fixed effects are included but not reported. Robust standard errors, clustered by firm, are reported in parentheses below the estimated coefficients. Significance levels: * significant at the 10 percent level; ** significant at the 5 percent level; *** significant at the 1 percent level.

Table 4:

Non-Parametric Test for Heterogeneous Effects
Constant Conditional ATE

Export Outcome	Test	Chi-square	Normal
Total Exports	Statistics	19.751	3.970
	p-value	[0.003]	[0.000]
Number of Countries	Statistics	20.597	4.214
	p-value	[0.002]	[0.000]
Number of Products	Statistics	2.213	-1.093
	p-value	[0.899]	[0.137]
Average Exports per Country and Product	Statistics	13.641	2.206
	p-value	[0.034]	[0.014]
Average Exports per Country	Statistics	17.146	3.217
	p-value	[0.009]	[0.001]
Average Exports per Product	Statistics	23.196	4.964
	p-value	[0.001]	[0.000]

Source: Own calculations on data from UMCE-SICP, Fundación ExportAR and AFIP.

Notes: The table reports the test statistics and the p-values of the non-parametric test of the null hypothesis that the average effect conditional on the covariates is identical for all subpopulations proposed by Crump et al. (2008), under both the standard normal distribution and the approximation, the chi-squared distribution with degrees of freedom equal to K-1 where K is the number of covariates.

Table 5

Average Effect of Assistance by Fundación ExportAR by Size Category
Difference-in-Differences Estimates
Full Sample, 2002-2006

Export Outcomes	Small	Medium	Large
Total Exports	0.102*	0.150**	0.138
	(0.053)	(0.069)	(0.088)
Number of Countries	0.099***	0.085***	0.061*
	(0.026)	(0.032)	(0.028)
Number of Products	0.071*	0.103**	0.079
	(0.036)	(0.044)	(0.052)
Average Exports per Country and Product	-0.068	-0.038	-0.022
	(0.050)	(0.065)	(0.090)
Average Exports per Country	0.003	0.065	0.057
	(0.046)	(0.061)	(0.080)
Average Exports per Product	0.032	0.047	0.059
	(0.048)	(0.065)	(0.090)

Firms not Assisted the Previous Year, 2003-2006

Export Outcomes	Small	Medium	Large
Total Exports	0.077**	0.126**	0.104
	(0.036)	(0.064)	(0.133)
Number of Countries	0.099***	0.050	0.064
	(0.034)	(0.044)	(0.046)
Number of Products	0.040	0.060	0.073
	(0.051)	(0.065)	(0.069)
Average Exports per Country and Product	-0.062	0.016	-0.033
	(0.071)	(0.079)	(0.138)
Average Exports per Country	-0.022	0.076	0.040
	(0.068)	(0.071)	(0.119)
Average Exports per Product	0.037	0.067	0.031
	(0.072)	(0.076)	(0.143)

Firms Never Assisted Before, 2003-2006			
Export Outcomes	**Small**	**Medium**	**Large**
Total Exports	0.130**	0.252**	0.389
	(0.061)	(0.123)	(0.300)
Number of Countries	0.170**	0.233**	0.264
	(0.080)	(0.100)	(0.167)
Number of Products	0.025	0.108	0.513
	(0.116)	(0.162)	(0.466)
Average Exports per Country and Product	-0.065	0.027	-0.066
	(0.163)	(0.036)	(0.079)
Average Exports per Country	-0.040	0.038	-0.144
	(0.158)	(0.040)	(0.493)
Average Exports per Product	0.105	0.054	-0.124
	(0.179)	(0.064)	(0.194)

Source: Own calculations on data from UMCE-SICP, Fundación ExportAR, and AFIP.

Notes: The table reports estimates of Equation (4). The dependent variables are the natural logarithm of the export performance indicators listed in the first column. The firm-level time-varying covariates controlling for size are two binary variables identifying whether the firm is small (up to 50 employees) or medium-sized (between 51 and 200 employees). The category "large" is the omitted variable. Firm fixed effects and year fixed effects are included but not reported. Robust standard errors, clustered by firm, are reported in parentheses below the estimated coefficients. Significance levels: * significant at the 10 percent level; ** significant at the 5 percent level; *** significant at the 1 percent level.

Table 6

Average Effect of Assistance by Fundación ExportAR by Size Category

Difference-in-Differences Estimates, Alternative Definitions of Size Categories

Category Definition	**Small: <= 40 Employees; Large > 250 Employees**				**Small: <= 60 Employees; Large > 150 Employees**				**Small and Medium Pooled Together**		
Full Sample, 2002-2006											
Export Outcomes	**All Firms**	**Small**	**Medium**	**Large**	**All Firms**	**Small**	**Medium**	**Large**	**All Firms**	**Non-Large**	**Large**
Total Exports	0.133***	0.101*	0.149**	0.137	0.130***	0.104*	0.152**	0.14	0.135***	0.156***	0.138
	(0.037)	(0.053)	(0.069)	(0.088)	(0.037)	(0.053)	(0.069)	(0.088)	(0.037)	(0.064)	(0.088)
No. of Countries	0.099***	0.099***	0.085***	0.061**	0.098***	0.100***	0.086***	0.062**	0.100***	0.098***	0.061**
	(0.017)	(0.026)	(0.032)	(0.028)	(0.017)	(0.026)	(0.032)	(0.028)	(0.017)	(0.029)	(0.028)
No. of Products	0.094***	0.070*	0.102**	0.078	0.092***	0.072**	0.104***	0.080	0.078**	0.123***	0.079
	(0.024)	(0.036)	(0.044)	(0.052)	(0.024)	(0.036)	(0.044)	(0.052)	(0.037)	(0.029)	(0.052)
Ave. Exports per Country and Product	-0.006	-0.068	-0.038	-0.022	-0.060*	-0.007	-0.004	-0.002	0.076	0.003	-0.022
	(0.035)	(0.05)	(0.065)	(0.090)	(0.035)	(0.050)	(0.065)	(0.09)	(0.052)	(0.044)	(0.09)
Average Exports per Country	0.034	0.003	0.065	0.057	0.032	0.003	0.069	0.061	0.035	0.054	0.057
	(0.032)	(0.046)	(0.061)	(0.080)	(0.032)	(0.046)	(0.061)	(0.08)	(0.032)	(0.054)	(0.080)
Average Exports per Product	0.039	0.032	0.047	0.059	0.038	0.033	0.048	0.061	0.040	0.087	0.059
	(0.034)	(0.048)	(0.065)	(0.090)	(0.034)	(0.048)	(0.065)	(0.09)	(0.034)	(0.058)	(0.090)

Average Effect of Assistance by Fundación ExportAR by Size Category (cont)											
Category Definition	**Small: <= 40 Employees; Large > 250 Employees**				**Small: <= 60 Employees; Large > 150 Employees**				**Small and Medium Pooled Together**		
Firms Not Assisted the Previous Year, 2003-2006											
Export Outcomes	**All Firms**	**Small**	**Medium**	**Large**	**All Firms**	**Small**	**Medium**	**Large**	**All Firms**	**Non-Large**	**Large**
Total Exports	0.188***	0.082**	0.134**	0.111	0.188***	0.082**	0.134**	0.111	0.190**	0.083**	0.104
	(0.051)	(0.036)	(0.064)	(0.133)	(0.050)	(0.035)	(0.063)	(0.130)	(0.051)	(0.036)	(0.133)
No. of Countries	0.079***	0.098***	0.049	0.063	0.079***	0.098***	0.049	0.063	0.080***	0.099***	0.064
	(0.022)	(0.034)	(0.044)	(0.046)	(0.022)	(0.034)	(0.044)	(0.046)	(0.022)	(0.034)	(0.046)
No. of Products	0.059*	0.039	0.059	0.072	0.059*	0.039	0.059	0.072	0.060*	0.040	0.073
	(0.033)	(0.051)	(0.065)	(0.069)	(0.033)	(0.051)	(0.065)	(0.069)	(0.033)	(0.051)	(0.069)
Average Exports per Country and Product	-0.050	-0.063	0.016	-0.034	-0.050	-0.063	0.016	-0.034	-0.049	-0.062	-0.033
	(0.047)	(0.071)	(0.079)	(0.138)	(0.047)	(0.071)	(0.079)	(0.138)	(0.047)	(0.071)	(0.138)
Average Exports per Country	0.009	-0.018	0.062	0.033	0.009	-0.018	0.062	0.033	0.010	-0.020	0.040
	(0.044)	(0.068)	(0.071)	(0.119)	(0.044)	(0.068)	(0.071)	(0.119)	(0.044)	(0.068)	(0.119)
Average Exports per Product	0.029	0.035	0.063	0.029	0.029	0.035	0.063	0.029	0.031	0.037	0.031
	(0.047)	(0.072)	(0.076)	(0.143)	(0.047)	(0.072)	(0.076)	(0.143)	(0.047)	(0.072)	(0.143)

Average Effect of Assistance by Fundación ExportAR by Size Category (cont)											
Category Definition	**Small: <= 40 Employees; Large > 250 Employees**				**Small: <= 60 Employees; Large > 150 Employees**				**Small and Medium Pooled Together**		
Firms not previously assisted by Fundación ExportAR											
Export Outcomes	**All Firms**	**Small**	**Medium**	**Large**	**All Firms**	**Small**	**Medium**	**Large**	**All Firms**	**Non-Large**	**Large**
Total Exports	0.273*	0.124**	0.241*	0.372	0.265*	0.147**	0.286**	0.441	0.282**	0.186**	0.389
	(0.161)	(0.061)	(0.123)	(0.300)	(0.160)	(0.064)	(0.129)	(0.315)	(0.120)	(0.090)	(0.300)
No. of Countries	0.221***	0.214***	0.293***	0.302	0.217***	0.210***	0.288***	0.296	0.225***	0.218***	0.240
	(0.068)	(0.080)	(0.100)	(0.190)	(0.068)	(0.080)	(0.100)	(0.190)	(0.068)	(0.080)	(0.19)
No. of Products	0.066	0.024	0.103	0.491	0.063	0.023	0.099	0.468	0.071	0.026	0.513
	(0.095)	(0.116)	(0.162)	(0.466)	(0.095)	(0.116)	(0.162)	(0.466)	(0.095)	(0.116)	(0.466)
Average Exports per Country and Product	-0.015	-0.065	0.027	-0.066	-0.016	-0.069	0.029	-0.070	-0.014	-0.061	-0.066
	(0.147)	(0.163)	(0.036)	(0.079)	(0.147)	(0.163)	(0.036)	(0.079)	(0.147)	(0.163)	(0.079)
Average Exports per Country	0.052	-0.038	0.036	-0.136	0.047	-0.034	0.032	-0.123	0.058	-0.042	-0.144
	(0.140)	(0.159)	(0.040)	(0.497)	(0.139)	(0.158)	(0.040)	(0.493)	(0.139)	(0.158)	(0.493)
Average Exports per Product	0.207	0.104	0.054	-0.123	0.202	0.102	0.052	-0.120	0.211	0.107	-0.124
	(0.154)	(0.179)	(0.064)	(0.194)	(0.153)	(0.178)	(0.064)	(0.193)	(0.153)	(0.178)	(0.194)

Source: Own calculations on data from UMCE-SICP, Fundación ExportAR, and AFIP.

Notes: The table reports estimates of Equations (3) and (4) for alternative definitions of the firm size categories. The dependent variables are the natural logarithm of the export performance indicators listed in the first column. Firm fixed effects and year fixed effects are included but not reported. Robust standard errors, clustered by firm, are reported in parentheses below the estimated coefficients. Significance levels: * significant at the 10 percent level; ** significant at the 5 percent level; *** significant at the 1 percent level.

Table 7

Average Effect of Assistance by Fundación ExportAR by Size Category
Propensity Score-Weighted Difference-in-Differences Estimates

Full Sample, 2002-2006

Export Outcomes	All Firms	Small	Medium	Large
Total Exports	0.237***	0.214***	0.302***	0.176
	(0.042)	(0.057)	(0.067)	(0.109)
Number of Countries	0.162***	0.180***	0.167***	0.140***
	(0.022)	(0.030)	(0.036)	(0.047)
Number of Products	0.140***	0.142***	0.180***	0.110**
	(0.027)	(0.040)	(0.042)	(0.061)
Average Exports per	-0.055	-0.053	-0.044	-0.147
Country and Product	(0.041)	(0.054)	(0.068)	(0.107)
Average Exports per	0.085**	0.056	0.135**	-0.004
Country	(0.037)	(0.048)	(0.062)	(0.105)
Average Exports per	0.098**	0.104**	0.122*	0.033
Product	(0.038)	(0.051)	(0.064)	(0.100)

Firms Not Assisted the Previous Year, 2003-2006

Export Outcomes	All Firms	Small	Medium	Large
Total Exports	0.148**	0.119**	0.146**	0.203
	(0.046)	(0.062)	(0.073)	(0.384)
Number of Countries	0.126***	0.165**	0.114**	0.251
	(0.024)	(0.079)	(0.057)	(0.205)
Number of Products	0.065*	0.016	0.087	0.348
	(0.035)	(0.119)	(0.154)	(0.499)
Average Exports per	-0.053	-0.062	-0.024	-0.070
Country and Product	(0.050)	(0.166)	(0.041)	(0.072)
Average Exports per	0.012	-0.046	0.332	-0.348
Country	(0.049)	(0.160)	(0.386)	(0.568)
Average Exports per	0.044	0.103	0.458	-0.145
Product	(0.052)	(0.177)	(0.386)	(0.222)

Table 7 (continued)

Firms Never Assisted Before, 2003-2006				
Export Outcomes	All Firms	Small	Medium	Large
Total Exports	0.147*** (0.062)	0.124** (0.053)	0.166** (0.083)	0.163 (0.144)
Number of Countries	0.169*** (0.068)	0.145** (0.069)	0.121** (0.050)	0.214 (0.167)
Number of Products	0.069 (0.098)	0.023 (0.089)	0.065 (0.099)	0.148 (0.141)
Average Exports per Country and Product	-0.021 (0.146)	-0.042 (0.106)	0.0245 (0.048)	-0.0696 (0.102)
Average Exports per Country	0.038 (0.140)	-0.06 (0.097)	0.132 (0.086)	-0.084 (0.068)
Average Exports per Product	0.108 (0.151)	0.103 (0.177)	0.108 (0.106)	-0.095 (0.102)

Source: Own calculations on data from UMCE-SICP, Fundación ExportAR, and AFIP.

The table reports estimates of Equations (3) and (4) weighted by the propensity score as indicated in the text. The dependent variables are the natural logarithm of the export performance indicators listed in the first column. Firm fixed effects and year fixed effects included (not reported). Robust standard errors, clustered by firm, reported in parentheses below the estimated coefficients. * significant at the 10 percent level; ** significant at the 5 percent level; *** significant at the 1 percent level.

Table 8

Average Effect of Assistance by Fundación ExportAR by Size Category Semiparametric Difference-in-Differences Estimates based on the Abadie (2005) Estimator

Export Outcomes	All Firms	Small	Medium	Large
Full Sample, 2002-2006				
Total Exports	0.143*** (0.045)	0.165*** (0.04)	0.147*** (0.044)	0.116** (0.051)
Number of Countries	0.162*** (0.020)	0.228*** (0.018)	0.150*** (0.023)	0.109*** (0.019)
Number of Products	0.088*** (0.028)	0.086*** (0.025)	0.120*** (0.028)	0.058* (0.031)
Average Exports per Country and Product	-0.012 (0.046)	-0.015 (0.04)	-0.015 (0.041)	-0.005 (0.057)
Average Exports per Country	-0.03 (0.044)	-0.063 (0.045)	-0.033 (0.037)	0.007 (0.049)
Average Exports per Product	0.044 (0.046)	0.078* (0.04)	-0.003 (0.043)	0.058 (0.055)
Firms Not Assisted the Previous Year, 2003-2006				
Export Outcomes	**All Firms**	**Small**	**Medium**	**Large**
Total Exports	0.074** (0.037)	0.121*** (0.036)	0.080** (0.035)	0.020 (0.046)
Number of Countries	0.124*** (0.017)	0.191*** (0.015)	0.114*** (0.018)	0.068*** (0.017)
Number of Products	0.058*** (0.024)	0.069*** (0.021)	0.074*** (0.024)	0.032 (0.027)
Average Exports per Country and Product	-0.012 (0.039)	-0.014 (0.034)	-0.015 (0.034)	-0.008 (0.048)
Average Exports per Country	-0.006 (0.035)	-0.007 (0.032)	-0.007 (0.03)	-0.005 (0.043)
Average Exports per Product	0.000 (0.039)	0.005 (0.035)	-0.003 (0.034)	-0.001 (0.048)

Table 8 continued

Firms Never Assisted Before, 2003-2006				
Export Outcomes	**All Firms**	**Small**	**Medium**	**Large**
Total Exports	0.057*** (0.022)	0.134*** (0.019)	0.060*** (0.02)	-0.022 (0.028)
Number of Countries	0.068*** (0.010)	0.116*** (0.011)	0.061*** (0.01)	0.028*** (0.01)
Number of Products	-0.002 (0.025)	0.024* (0.014)	0.012 (0.012)	-0.041 (0.05)
Average Exports per Country and Product	-0.015 (0.021)	-0.016 (0.024)	-0.016 (0.02)	-0.012 (0.02)
Average Exports per Country	-0.015 (0.020)	-0.014 (0.024)	-0.015 (0.018)	-0.016 (0.017)
Average Exports per Product	-0.022 (0.026)	-0.046 (0.036)	-0.01 (0.02)	-0.009 (0.021)

Source: Own calculations on data from UMCE-SICP, Fundación ExportAR , and AFIP.

Notes: The table reports semiparametric difference-in-differences estimates (see Abadie, 2005) of the average assistance effect on assisted firms both pooling over firms and discriminating across their size categories for the six export performance indicators. Standard errors are reported in parentheses below the estimated coefficients. Significance levels: * significant at the 10 percent level; ** significant at the 5 percent level; *** significant at the 1 percent level.

Table 9

Average Effect of Assistance by Fundación ExportAR by Size Category Matching Difference-in-Differences Estimates based on the Kernel Estimator

	Full Sample, 2002-2006			
Export Outcomes	**All Firms**	**Small**	**Medium**	**Large**
Total Exports	0.160 (0.028)*** (0.033)***	0.169 (0.039)*** (0.036)***	0.124 (0.047)*** (0.042)***	0.106 (0.066) (0.053)*
Number of Countries	0.177 (0.013)*** (0.016)***	0.195 (0.018)*** (0.015)***	0.143 (0.024)*** (0.021)***	0.123 (0.024)*** (0.021)***
Number of Products	0.074 (0.017)*** (0.019)***	0.086 (0.025)*** (0.027)***	0.109 (0.029)*** (0.028)***	0.072 (0.037)* (0.036)**
Average Exports per Country and Product	-0.009 (0.028) (0.031)	-0.011 (0.04) (0.033)	-0.015 (0.045) (0.043)	-0.007 (0.07) (0.061)
Average Exports per Country	-0.017 (0.025) (0.029)	-0.026 (0.035) (0.039)	-0.038 (0.042) (0.038)	0.000 (0.064) (0.055)
Average Exports per Product	0.086 (0.028)*** (0.031)***	0.083 (0.039)** (0.037)**	-0.003 (0.045) (0.042)	0.051 (0.068) (0.058)

Table 9 continued

Firms Not Assisted the Previous Year, 2003-2006				
Export Outcomes	**All Firms**	**Small**	**Medium**	**Large**
Total Exports	0.240	0.214	0.141	0.204
	(0.037)***	(0.067)***	(0.061)**	(0.123)
	(0.039)***	(0.098)**	(0.063)**	(0.136)
Number of Countries	0.187	0.181	0.106	0.062
	(0.016)***	(0.028)***	(0.036)***	(0.037)
	(0.018)***	(0.04)***	(0.037)***	(0.055)
Number of Products	0.105	0.107	0.112	0.113
	(0.022)***	(0.039)***	(0.048)***	(0.08)
	(0.024)***	(0.052)**	(0.054)**	(0.089)
Average Exports per Country and Product	0.053	-0.073	-0.077	-0.010
	(0.037)	(0.065)	(0.067)	(0.131)
	(0.039)	(0.092)	(0.099)	(0.159)
Average Exports per Country	0.052	0.033	0.035	0.103
	(0.033)	(0.06)	(0.055)	(0.117)
	(0.035)	(0.085)	(0.085)	(0.135)
Average Exports per Product	0.135	0.107	0.029	0.092
	(0.036)***	(0.066)	(0.064)	(0.133)
	(0.038)***	(0.097)	(0.096)	(0.153)

Table 9 continued

Firms Never Assisted Before, 2003-2006				
Export Outcomes	**All Firms**	**Small**	**Medium**	**Large**
Total Exports	0.468 (0.102)*** (0.107)***	0.383 (0.117)*** (0.161)*	0.513 (0.172)*** (0.177)***	0.238 (0.041)*** (0.078)***
Number of Countries	0.251 (0.042)*** (0.049)***	0.204 (0.046)*** (0.061)***	0.272 (0.102)*** (0.106)***	0.057 (0.301) (0.31)
Number of Products	0.113 (0.052)** (0.055)**	0.100 (0.059)* (0.084)	0.158 (0.111) (0.116)	0.374 (0.414) (0.463)
Average Exports per Country and Product	0.104 (0.095) (0.098)	0.079 (0.106) (0.14)	0.083 (0.213) (0.279)	-0.107 (0.087) (0.103)
Average Exports per Country	0.217 (0.092)*** (0.095)**	0.179 (0.103)* (0.144)	0.241 (0.178) (0.24)	-0.196 (0.332) (0.362)
Average Exports per Product	0.355 (0.097)*** (0.099)***	0.283 (0.110)*** (0.146)**	0.355 (0.189)* (0.204)	0.004 (0.385) (0.407)

Source: Own calculations on data from UMCE-SICP, Fundación ExportAR, and AFIP.

Notes: The table reports matching difference-in-differences estimates of the average assistance effect on assisted firms both pooling over firms and discriminating across their size categories for the six export performance indicators. Kernel matching is based on the Epanechnikov kernel with a bandwidth of 0.04. Analytical and bootstrapped standard errors based on 500 replications are reported in parentheses. Significance levels: * significant at the 10 percent level; ** significant at the 5 percent level; *** significant at the 1 percent level. The significance indicator is reported with the standard errors corresponding to each method used to compute these errors.

Figure 1

Distribution of Firms across Product-Market Export Patterns (2006)

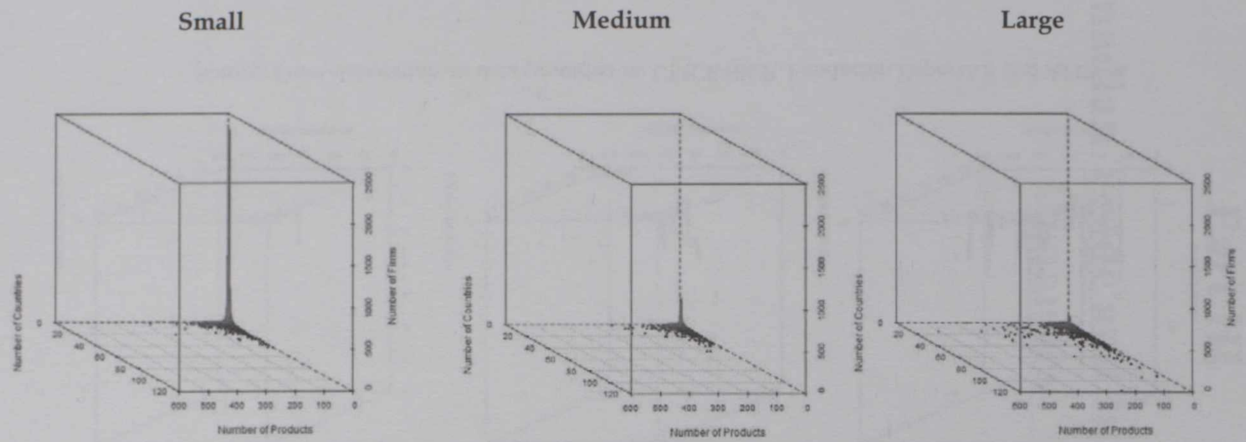
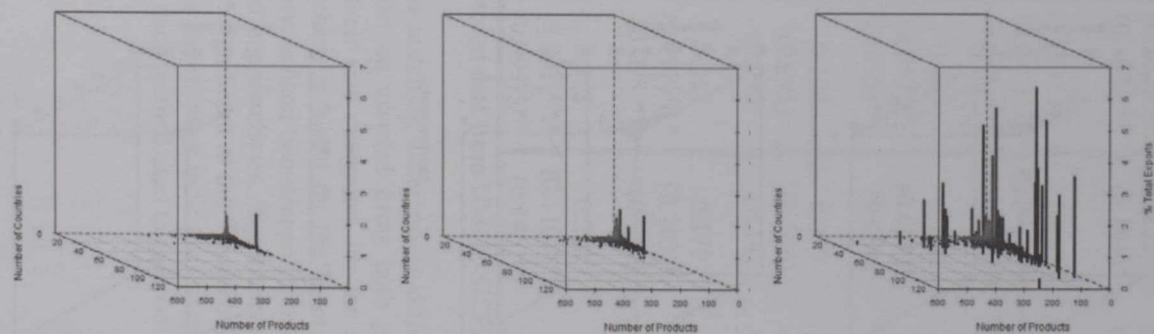


Figure 2

Distribution of Export Shares across Firms with Different Product-Market Export Patterns

Small **Medium** **Large**



Source: Own elaboration on data provided by UMCE-SICP, Fundación ExportAR and AFIP.

Part III

Canadian Trade and Investment Dynamics

Export Dynamics in Canada: Market Diversification in a Changing International Economic Environment

Shenjie Chen and Emily Yu*

Abstract: Motivated by the remarkable shifts in Canada's global pattern of exports from the 1990s to the 2000s, this paper analyses the dynamics of Canadian exporters in a changing international economic environment. It takes its cue from recent contributions to the international trade literature that have emphasized the role of new entrants into export markets in contributing to trade growth and the role of international macroeconomic conditions, especially the evolution of real exchange rates, in shaping firms' decisions on export market participation. We document the decline in export sales by Canadian exporters to the U.S. market and the diversification, largely accomplished at the extensive margin (by new entrants) into third markets, especially Europe and Asia, in response to exchange rate realignments (the European story) and shifting growth dynamics (the Asian story). We highlight the role of new entrants in sustaining Canadian export performance in the key U.S. market; this development underscores the vital importance of continuing export promotion even in established markets. We conclude that, given firm-level export dynamics, a country that takes its existing export base for granted is liable to suffer erosion of its international trade performance.

Key Words: exports, entry, exit, intensive and extensive margin.

JEL No.: F14, F19, D23, D29

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1. Introduction

This paper analyses the dynamics of Canadian exporters in a changing international economic environment. Motivated by the remarkable shifts in Canada's global pattern of exports from the 1990s to the 2000s, it takes its conceptual cue from recent contributions to the international trade literature that emphasize the role of new entrants into export markets and the general importance of the extensive margin in contributing to trade growth; and the role of international macroeconomic conditions, especially the evolution of real exchange rates, in shaping firms' decisions on export market participation.

Because of economic geography, the United States has always been Canada's major export destination, both in terms of its share of Canada's total exports and its position as destination of choice for Canadian exporters. These economic ties reached their peaks around 2000; at that time, the U.S. market accounted for 87 percent of total Canadian merchandise exports, nearly 90 percent of Canadian exporters shipped their products to the United States, and about 85 percent of new Canadian entrants to export markets chose the United States as the export destination in which to gain their first export experience. However, the environment that fostered these developments changed abruptly in the 2000s. With the completion of the tariff cuts mandated under the North American Free Trade Agreement (NAFTA), the impetus to cross-border trade from trade liberalization waned. Meanwhile surging commodity prices driven by an Asian-led global economic boom supported a steep appreciation of the Canadian dollar relative to the U.S. dollar. Canada's trade pattern changed sharply in this period. Exports became more diversified in terms of destination markets and the share of Canadian exports accounted for by the United States declined steeply, retracing most of the increase witnessed in the 1990s.

To investigate how this diversification was achieved and the role that the changing trade environment may have played in shaping it, we draw on firm-level data from Statistics Canada's Exporter and Business Register databases for the years 1999 to 2006, a period that covers the peak years of Canada's U.S.

market engagement and the beginning of the diversification to third markets. These two databases combined enable us to track entry and exit of firms into the various export markets and the evolution of their sales in these markets, and to link these features of export performance to firm-level characteristics such as the firm's size, age, and sector of operations.

The theoretical context in which we frame our study is provided by Ghironi and Melitz (2005). They integrate international macroeconomic shocks into the now conventional model of international trade with micro foundations in which firms operate with differing levels of productivity and face sunk costs of entry into export markets as well as both fixed and per-unit export costs. In this framework, only the relatively more productive firms export and exogenous shocks induce firms to enter and exit both their domestic and export markets. Consistent with Baldwin and Lyons (1994) who identified the potential for hysteresis in trade patterns from prolonged periods of large exchange rate misalignment, this framework allows for persistent deviations of the real exchange rate from purchasing power parity equilibrium (which Ghironi and Melitz derive from firm-level responses to transient aggregate shocks) to influence the endogenously determined size of the traded sector and firm-level decisions to enter or exit export markets.

For an empirical methodology, we follow Eaton, Eslava, Kugler and Tybout (2007) who decompose export growth into changes in exports by incumbent exporters (i.e., the intensive margin) and changes in the set of exporting firms (the extensive margin), and track the performance of cohorts of exporters defined by the year of their entry into export markets.

Our empirical analysis mainly focuses on the dynamics of Canadian exporters, interpreted in light of the international macroeconomic changes. Our data set does not include non-exporters; accordingly, we establish an empirical link between international macroeconomic shocks and export entry decisions of non-exporters. This is a topic for future research

Nevertheless, by examining the exporter data alone, we are able to uncover many interesting patterns of Canadian exporters. Our principle finding regarding the dynamics of

Canadian exporters is that the global market diversification by Canadian exporters in the first half of the 2000s was largely accomplished by expansion of trade at the extensive margin. Consistent with the theoretical prediction of Ghironi and Melitz (2005 and 2007), the diversification was accompanied by an increase in the average number of export destinations served per firm and the proportion of multi-market exporters in the total Canadian exporter population. Particularly in the Asian market, the diversification was led by small- and medium-sized exporters. In the more mature European market, in which real exchange rate developments played more of a role, established exporters and thus the intensive margin of trade remained a more significant factor in explaining trade growth. Importantly, we find that new entrants played a significant role in limiting the extent of decline in Canadian export performance in the key U.S. market; this development underscores the vital importance of continuing export promotion in terms of helping new exporters overcome entry barriers, even in established markets. We conclude that, given firm-level export dynamics, a country that takes its existing export base for granted is liable to suffer erosion of its international trade performance.

The rest of the paper is organized as follows. Section 2 lays out the theoretical and empirical background to the study. Section 3 provides a detailed overview of the data, profiling Canadian exporters from 1999 to 2006 in terms of firm size and sector of activity, and describing their dynamics in terms of export-market entry and exit and market diversification. Section 4 sets out our decomposition of change in trade into extensive and intensive margins by region. Section 5 concludes.

2. Background

The 1990s and 2000s witnessed a remarkable rise and then fall in the U.S. share of Canada's exports. Economists attribute the intensification of Canada's trade with the United States in the 1990s to several factors. Trefler (2004) traces a portion of the export gains reported in Canada to the tariffs cuts made pursuant to the Free Trade Agreement between Canada and the

United States (CUSFTA) starting in 1989 and later under the North American Free Trade Agreement (NAFTA) between Canada, Mexico and the United States, starting in 1995. Baldwin and Yan (2010) using microdata find that currency depreciation increased the probability that more efficient non-exporters would enter export markets, suggesting part of the increase in Canada's exports to the United States in the 1990s was due to the decline in Canada's exchange rate. Moreover, it is widely recognized that Canada's increased exports to the United States in the late 1990s were part of a global picture of surging U.S. imports and the burgeoning U.S. trade deficit which developed at that time and continued well into the 2000s.

By 2008, the relative importance of the U.S. market in total Canadian merchandise exports had declined by 10 percentage points, from about 87 percent in the late 1990s and early 2000s to 77.6 percent. On a balance of payments basis, the importance of the U.S. market in total Canadian goods exports declined to 76 percent from 84 percent over the same period. The percentage of exporters who export to the United States in the total Canadian exporter population dropped to 82.2 percent in 2006 from 89.2 percent in 1999. On the other hand, the share of exports to Asia in total Canadian merchandise exports increased from 5.7 percent in 1999 to 9 percent in 2008; and to Europe from less than 5 percent in 1999 to 7.5 percent in 2008. At the same time, the share of exporters that export to Asia in the Canadian exporter population rose to 17.6 percent in 2006 from 10.3 percent in 1999, and the percentage that export to Europe increased to 21.6 percent from 14.6 percent. Clearly, Canadian exporters diversified into non-U.S. markets

Why—and how—was this diversification effected?

Business cycle dynamics and real exchange rate fluctuations influence national trade flows, or so casual empiricism would suggest. Accordingly, developments such as the rise of Asia and the Canadian dollar's stunning rise in the post-2002 period seem to provide ready-made answers as to what prompted the diversification of Canada's exports. However, neither traditional international trade theory nor the models of international macroeconomics formally address the determinants and evolution of a nation's trade patterns in the context of such developments[1]. This gap between formal theory and observed dynamics was recently bridged by the pioneering work of Ghironi and Melitz (2005 and 2007). Starting with the Melitz (2003) model of international trade which incorporates monopolistic competition and allows for firms with varying levels of productivity to co-exist in any given market, they develop a model of international trade in the context of international macroeconomic dynamics. Given irreversible sunk investments to gain market entry, only a subset of relatively more productive firms export, while the remaining less productive firms serve only their domestic market. In this framework, exogenous shocks induce firms to enter and exit both their domestic and export markets.

The key element of the Ghironi and Melitz model from our perspective is endogenous entry/exit into and out of export markets in response to macroeconomic shocks or changes in trade costs. This feature, in fact, explains the extensive margin of trade that has been extensively studied in the trade literature—changes in trade due to changes in trading relationships such as new firms entering the export market, or declines of the existing trading relationships through exit of exporters, narrowing the range of export products or export destination countries. Eaton, Kortum, and Kramarz (2004), Broda, Greenfield and Weinstein (2006), Broda and Weinstein (2006), and Bernard, Redding and Schott (2006) all have provided convincing evidence of the co-movement between trade flows, imported varieties and the extensive margin of trade[2].

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[1] Theories based on comparative advantage elucidate the commodity composition of trade between unlike trading partners; theories based on market structure (imperfect competition in the presence of differentiated products) explain trade between like partners; and the gravity model describes the general spatial organization of trade based on variations in trade costs between various trading partners due to the physical and figurative distance between them. However, these theories do not incorporate the persistent disequilibria often observed in international macroeconomic cycles.

[2] Many studies have highlighted the role of the extensive margin in explaining international economic phenomena. See for example, Kehoe and

Eaton, Eslava, Kugler and Tybout (2007) provide a simple empirical framework in which to decompose the aggregate growth in export sales into contributions at the extensive and intensive margins. Details of the decomposition methodology are set out in Box 1. This decomposition allows us to calculate the overall contribution to export expansion of continuing exporters and new entrants together with the negative impact of those firms that are exiting export markets. Further, this decomposition provides the basis for insights concerning the endogenous response of Canadian exporters to changes in the international macroeconomic environment. The decomposition by regional market of Canada's exports over the 1999-2006 period is guided by the following intuitions.

First, after falling in the 1990s, costs of Canada-U.S. trade appear to have risen in the 2000s because of increased border transit costs (e.g., increased border wait times; direct fees for crossing the border; additional and duplicative border programs; and increased inspection times). While the empirical literature on the impact of the border "thickening" on trade to date gives mixed results, to the extent that trade costs rose, it would induce some firms to exit the U.S. market, the Ghironi-Melitz model would predict that some firms that might otherwise have entered the U.S. market to direct their attentions to other markets which had become relatively more attractive. This would, predictably result in diversification of Canadian exports.

Second, the exchange rate depreciation of the U.S. dollar from its 2002:Q1 peak resulted in very different impacts on various currencies. The floating currencies, including the Canadian dollar and the euro, rose disproportionately to their weight in U.S. trade, while the Asian currencies by and large maintained their parities to the greenback. Accordingly, large and sudden changes emerged in relative profitability of exporting to different destinations.

Ruhl (2009), Helpman, Melitz and Rubinstein (2008), Chaney (2008), Bernard, Redding and Schott (2006) and Broda and Weinstein (2006).

Box 1: Export Growth Decomposition

The calculation of growth contribution by new entrants (exporters who exported in year t but not in any of the previous years), continuers (exporters who exported both in years t–1 and t), and exiters (those who exported in year t–1 but not any year after) follows Eaton et al. (2007).

Define Y_t to represent the value of exports by all exporters in year *t*; $y(j,t)$ to represent the value of exports by the subgroup *j* of exporters in year *t*; $CN^{t-1,t}$ as the group of continuers who export both in year *t*–1 and *t*; $EN^{t-1,t}$ as the group of entrants who export in year *t* but not *t*–1; and $EX^{t-1,t}$ as the group of exiters who export in year *t*–1 but not *t*.

The growth rate of total exports, G_T, is calculated as,

$$G_T = \frac{Y_t - Y_{t-1}}{(Y_t + Y_{t-1})/2}$$

where

$$Y_t = \sum_{j \in N} y(j,t)$$

The share of continuers in period $(t-1)$ exports, S_T, is calculated as,

$$S_T = \frac{\displaystyle\sum_{j \in CN^{t-1,t}} \frac{[y(j,t-1) + y(j,t)]}{2}}{\dfrac{Y_t + Y_{t-1}}{2}}$$

Growth of exports contributed by continuers, G_{CN}, is calculated as,

$$G_{CN} = \frac{\sum_{j \in CN^{t-1,t}} [y(j,t) - y(j,t-1)]}{\sum_{j \in CN^{t-1,t}} \frac{y(j,t-1) + y(j,t)}{2}}$$

Growth of exports contributed by increased number of firms, G_{EN}, is calculated as,

$$G_{EN} = \frac{\bar{y}(t-1) \cdot \sum_{j \in EN^{t-1,t}} j}{\left(\frac{Y_t + Y_{t-1}}{2} \right)}$$

The value of exports by entrants relative to the average, M_{EN}, is,

$$M_{EN} = \frac{\sum_{j \in EN^{t-1,t}} [y(i,t) - \bar{y}(t-1)]}{\left(\frac{Y_t + Y_{t-1}}{2} \right)}$$

Growth of exports contributed by the decreased number of firms, G_{EX}, is calculated as,

$$G_{EX} = -\frac{\sum_{j \in EX^{t-1,t}} [y(j,t-1) - \bar{y}(t-1)]}{\frac{Y_t + Y_{t-1}}{2}}$$

The value of exports by exiters relative to the average, M_{EX}, is,

$$M_{EX} = -\frac{\bar{y}(t-1) \sum_{j \in EX^{t-1,t}} j}{\frac{Y_t + Y_{t-1}}{2}}$$

The growth rate of total exports can be decomposed as follows,

$$G_T = S_{CN} \cdot G_{CN} + G_{EN} + M_{EN} + G_{EX} + M_{EX}$$

For example, the rise of the Canadian dollar from a value of about US.0.62 at the beginning of 2002 to near parity with the U.S. dollar by the end of 2007 represented an appreciation of approximately 60 percent over a six-year period. Since inflation rates in the United States and Canada were similar in this period, there was an equivalent appreciation in the real exchange rate. In other words, average prices of goods and services in Canada increased by 60 percent, relative to those in the United States. As noted by Devereaux (2008), this was an unprecedented movement in relative prices for countries that trade so much with one another. For the most part, this development also must be considered to be unanticipated.

Similarly, the euro depreciated from its launch valuation of 1.17 to the USD at the beginning of 1999 to as low as US$0.827 in October 2000, before starting a meteoric rise that would take it as high as US$1.601 in April 2008. Since eurozone and U.S. inflation rates also were similar throughout this period, almost all of the nominal variation translated into real variation. Accordingly, the cross-rate between the Canadian dollar and the euro remained relatively stable as both the Canadian dollar and the euro appreciated against the U.S. dollar after 2002. The euro appreciated marginally against the Canadian dollar from €0.71 in 2002:Q1 to an annual average of €0.70 in 2006. This translates into much greater relative profitability of sales to Europe as compared to the U.S. which should generate the export market entry/exit and expansion behavioural responses contemplated in the Ghironi-Melitz model.

Third, the rise of the "BRICs" (Brazil, Russia, India and China) as global economic powers, led by China's spectacular post-WTO accession boom, significantly re-weighted the global economy. The improved macroeconomic environments in the rapidly expanding emerging markets reduced the entry threshold to these markets, which encouraged the entry of Canadian exporters to these markets.

Taken together, these developments constitute a natural experiment that should throw light on exporter dynamics. We examine the response of Canadian exporters to these developments below.

3. Canadian exporter dynamics

The analysis reported in this paper is based on data derived from Statistics Canada's Exporter and Business Register databases in the years from 1999 to 2006. Statistics Canada's Exporter Register produces annual estimates of the number of firms exporting, and the value of their domestic exports by industry, product, export destination and province of residence[3]. The database is then linked to Statistics Canada's Business Register—a central repository of information on business operating in Canada to obtain the firm-level information of exporting firms. These two databases combined enable us to see not only the export performance of exporting firms but also the characteristics of these firms such as the size of the firm by employment, the year the firm established, and many others.

3.1 General profile of Canadian exporters

Table 1 reports the overall profile of Canadian exporters from 1999 to 2006. During that period, there was an average of 47,173 Canadian firms per year active in the export market[4]. The total number of Canadian exporters increased strongly in the early part of this period, from 43,568 in 1999 to 49,146 in 2002, or a total of 12.8 percent. However, the number fell back sharply to 44,127 by 2006 following the rise in the Canadian dollar. Although the number of exporters increased only marginally over this period, the value of exports per exporter increased steadily, rising to $8.6 million per firm in 2006 from

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[3] The Exporter Register includes only the value of domestically produced exports that covers more than 95 percent of these domestic exports. Transactions unrelated to business activity such as exports by individuals for personal, non-business uses are excluded in the database. For detailed information, see Statistics Canada's publication "A Profile of Canadian Exporters" http://www.statcan.gc.ca/pub/65-506-x/65-506-x2008001-eng.pdf.

[4] Statistics Canada's annual publication on the profile of Canadian exporters excludes the firms with annual exports less than $30,000. In this study, all exporters are included; therefore, the number of exporters reported in this paper is greater than that reported by Statistics Canada.

$7.4 million per firm in 1999. Canadian exporting firms employed on average 3.4 million people, which accounted for a fourth of total Canadian employment. The number of people employed by these exporting firms barely changed over the period. This period witnessed an increasing trend of globalization of Canadian exporters, both in terms of the number of products exported per firm and the number of export destinations served by each firm. The average number of products exported per firm increased to 5.0 in 2006 from 4.4 in 1999. Over the same period, the average number of markets served per exporter increased to 2.5 markets from 1.7 markets.

Table 1: Profile of Canadian Exporters, 1999-2006

Year	No. of Exporters	Ave. Value of Exports ($Mil)	No of Employees	Ave. No. of Markets	Ave. No. of Products
1999	43,568	7.4	3,332,952	1.7	4.4
2000	46,465	8.0	3,405,885	1.7	4.4
2001	48,140	7.5	3,490,150	1.8	4.6
2002	49,146	7.2	3,430,391	1.8	4.6
2003	48,504	6.9	3,395,280	2.1	4.7
2004	49,314	7.4	3,511,157	2.2	4.8
2005	48,126	8.0	3,580,574	2.4	4.8
2006	44,127	8.6	3,397,779	2.5	5.0

Source: Statistics Canada.

The average number of destination markets served per Canadian exporter is lower than what has been observed for U.S. exporters[5]. This is probably the result of the Canadian exporter population being skewed by a large number of exporters who are single-market exporters to the U.S. market. However, as Canadian firms increasingly enter non-U.S. markets, the number of single-market exporters fell steadily. In 1999, the number of single-market exporters accounted for 82 percent of the total Canadian exporter population, while in 2006 this share came down to 73 percent. By the same token, there was a steady increase of multi-country exporters. In 1999, only

[5] Bernard, Jensen and Schott (2005) found U.S. exporters exported to an average of 3.3 markets in 2000.

10 percent of Canadian exporters shipped their products to at least 3 destinations, while in 2006 the importance of this group in total Canadian exporters increased to 17 percent.

2.2 *Exporter characteristics by size of establishment*

About 95 percent of all Canadian exporters in our data set fall into the category of small- and medium-sized (SMEs, up to 200 employees), however, they accounted for 35 percent of total export sales in 2006 (see Table 2).

Table 2: Canadian Exporters by Size, 1999-2006

Year	Number of Exporters	% of total exporters	Value of Exports (CAD Mil)	% of total exports
		SMEs		
1999	41,224	94.6	85,747	26.7
2000	44,024	94.7	107,322	28.8
2001	45,700	94.9	111,599	31.0
2002	46,714	95.1	109,353	31.1
2003	46,065	95.0	110,793	32.9
2004	46,835	95.0	121,811	33.3
2005	45,573	94.7	139,722	36.2
2006	41,720	94.5	134,198	35.2
		Large-sized Exporters		
1999	2,344	5.4	234,819	73.3
2000	2,441	5.3	265,503	71.2
2001	2,440	5.1	248,896	69.0
2002	2,432	4.9	242,116	68.9
2003	2,439	5.0	225,830	67.1
2004	2,479	5.0	244,143	66.7
2005	2,553	5.3	246,000	63.8
2006	2,407	5.5	246,863	64.8

Source: Statistics Canada.

Similar to the findings in other countries,[6] the majority of Canadian exports are accounted for by a relatively small number of larger-sized firms. Exporters with more than 200 employees made up only 5 percent of the entire exporter population but they contributed nearly 65 percent of the value of total exports recorded in the Register in 2006. In comparison, Bernard et al. (2007) report an even more skewed distribution of export flows across U.S. firms than we observe for Canada: the top 1 percent of U.S. exporters accounts for 81 percent of the value of U.S. exports, and the top 10 percent for over 95 percent. They suggest two alternative explanations for the high concentration of trade in a small number of firms: an extremely unequal distribution of productivity levels across firms, or economies of scale in overseas distribution.

On average, larger Canadian exporters reported a value of exports nearly 50 times greater per firm than the SME exporters (see Table 3). Large-sized exporters employed 67 percent of the export industry workforce, twice as much as the SME exporters. This distribution of employment shares between large-sized and SME exporters barely changed during the examined period.

Large-sized Canadian firms also exported more products to more countries. The average number of products exported by large-sized firm and the average number of export destinations served by large-sized exporters were 18 and 6.7 respectively, compared to only 3.9 and 2 for SME exporters. About 84 percent of SME exporters exported only to one country, compared to less than 50 percent of large-sized exporters (see Table 4). Bernard et al. (2007) note that this pattern, also seen in the U.S. data, is consistent with sunk costs specific to individual destinations resulting in only the relatively more productive exporters exporting to more destinations.

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[6] See Bernard, Jensen and Schott (2005), Buono, Fadinger and Berger (2008) and Lawless (2009).

Table 3: Average Exports, Number of Markets and Number of Products by Size, 1999-2006

Year	Average Value of Exports (CAD Mil)	Average Number of Markets	Average Number of Products
		SMEs	
1999	2.1	1.5	4
2000	2.4	1.5	3.9
2001	2.4	1.5	3.8
2002	2.3	1.6	3.5
2003	2.4	1.8	3.7
2004	2.6	1.9	3.8
2005	3.1	2.1	4
2006	3.2	2.2	4.2
Average	2.6	1.8	3.9
		Large-sized Exporters	
1999	100.2	5.8	19
2000	108.8	5.6	19
2001	102	6	18.4
2002	99.6	6.3	17
2003	92.6	7.1	17.5
2004	98.5	7.6	18.3
2005	96.4	7.7	18.8
2006	102.6	7.7	19.5
Average	100.1	6.7	18.4

Source: Statistics Canada.

The performance of Canadian SME exporters improved during the period examined. The share of SME exporters in the Canadian exporter population remained stable, but their contribution to total Canadian exports increased to 35 percent in 2006 from slightly more than a quarter in 1999. Many SME single-market exporters expanded into non-U.S. markets and become multi-market exporters. The share of multi-market exporters in the total SME exporter group increased to 25 percent in 2006 from 16 percent in 1999. In comparison, the share of multi-market exporters among larger-sized firms increased only 5 percentage points (see Table 2). These trends suggest that SME exporters were leading market diversification.

Table 4: Single- and Multi-market Exporters by Size, 1999-2006

Year	SMEs		Large-sized Exporter	
	Single-market	Multi-market	Single-market	Multi-market
1999	34,635	6,589	1,087	1,257
2000	37,313	6,711	1,165	1,276
2001	38,454	7,246	1,137	1,303
2002	38,751	7,963	1,085	1,347
2003	36,577	9,508	1,018	1,421
2004	36,161	10,674	992	1,487
2005	34,597	10,976	1,002	1,551
2006	31,314	10,406	982	1,425

Source: Statistics Canada.

It is noteworthy that the total number of multi-market exporters within the SME group rose continuously until 2005 whereas the number of single-market SMEs (principally exporting to the U.S. market) first surged in the early 2000s and then fell back sharply as macroeconomic conditions in the United States became much less favourable post-2002. It is especially remarkable that the rate of expansion of multi-market SMEs accelerated in 2003 and 2004, the first two years of the Canadian dollar appreciation, coinciding with a decline in the single-market group. This suggests that market diversification was a response to the changing macroeconomic conditions. This result is consistent with the argument advanced by Baldwin and Lyons (1994) that large, sustained misalignments of the exchange rate can induce industrial dislocation and the scrapping of sunk assets. In this case, the expansion of Canadian firms into export markets during the low exchange rate era proved not to be sustainable for many firms. Notably, the retrenchment was sharper amongst single-market exporters.

2.3 *Sectoral Composition*

Table 5 shows a sectoral profile of Canadian exporters in 2006. Manufacturing plants made up about 42 percent of the entire exporter population, but accounted for a substantially greater share of total Canadian exports (62.5 percent). This was largely due to the highly concentrated transportation equipment sector that constituted only 2.3 percent of the total Canadian exporter population but generated 20 percent of total export values. Primary industries (agriculture and mining) accounted for about 10 percent of exports and a slightly smaller share of exporters. Tertiary industries (wholesale and retail distribution and the services sector) accounted for a large share of total exporters, but contributed a much lower proportion of total export values.

Table 5: Sector Profile of Canadian Exporters by North American Industry Classification (NAICS) in 2006

Sector (NAICS)	Number of Exporters	% of all Exporters	Value of Exports ($bn)	% of all Exports
Agriculture (100)	2,021	4.5	4.1	1.1
Mining (200)	1,729	3.9	34.8	9.2
Food & Beverages (311-312)	1,233	2.8	12.2	3.2
Textile & Clothing (313-315)	1,479	3.3	3.1	0.8
Wood & Paper (321-323)	2,283	5.1	29.3	7.7
Petroleum, Chemical & Plastics (324-327)	2,941	6.6	41.9	11.0
Primary & Fabricated Metal (331-332)	2,985	6.7	37.5	9.9
Machinery (333)	2,726	6.1	13.5	3.5
Computer, Electronics & Electrical Equip. (334-335)	1,754	3.9	14.7	3.9
Transportation Equip. (336)	1,016	2.3	78.3	20.6
Miscellaneous Manufacturing (316, 337-339)	2,493	5.6	7.4	1.9
Wholesale & Retail (400)	13,880	31.0	63.5	16.7
Other Services (500-900)	8,245	18.4	40.0	10.5

Source: Statistics Canada..

Within manufacturing, resource-based sectors (wood and paper products, petroleum, chemical and plastics, primary and fabricated metal) accounted for 18 percent of total Canadian exporters and represented over 28 percent of total Canadian export values. On the other side of the spectrum are the textile and apparel and miscellaneous manufacturing sectors. These sectors are dominated by SMEs which are relatively numerous, but which account for a relatively small share of total export values. Over the examined period, the sectoral composition of Canadian exporters was relatively stable.

2.4 *Entry and exit dynamics*

On average, about 9,000 new Canadian firms entered the export market every year in the period 1999-2006, accounting for almost one quarter of total Canadian exporter population. At the same time, there was an equivalent number of exporting firms that exited the export market every year (See Table 6).

Table 6: Entry and Exit of Canadian Exporters 1999-2006

	Entrants		Continuers		Exiters	
Year	Number of Exporters	Value of Exports (CAD Mil)	Number of Exporters	Value of Exports (CAD Mil)	Number of Exporters	Value of Exports (CAD Mil)
2000	13,164	1,984	33,300	370,841	5,642	766
2001	11,318	1,660	36,822	358,834	7,355	1104
2002	10,955	5,233	38,191	346,236	8,721	1200
2003	9,347	3,866	39,157	332,757	9,775	2152
2004	9,429	2,036	39,885	363,918	9,911	1767
2005	7,700	3,406	40,426	382,307	11,365	1414
2006	4,736	1,338	39,391	379,722	13,311	2450
Ave.	**9,521**	**2,789**	**38,167**	**362,088**	**9,440**	**1,550**

Source: Statistics Canada.

The number of entrants initially far exceeded the number of exiters; however, by the end of the period, the reverse was true. The dramatic decrease in the number of new entrants combined with the sharp increase in the number of exiters resulted in a net decrease of the number of exporters. However, the net decrease in number of exporters was a phenomenon exclusive to the U.S. market. Non-U.S. markets continued to see a net increase in number of exporters. Notably, the increase in the number of continuing exporters in the early 2000s was not reversed in the second half of the period.

The impact on total exports of the flux of entrants and exiters was modest on an annual basis since, on average, continuing exporters accounted for 99 percent of total export value. Over 35 percent of all exporters are habitual exporters; i.e., they export every year. These habitual exporters contributed 90 percent of the total value of exports each year. Notably, 90 percent of these habitual exporters are small- and medium-sized firms.

New exporters often started with one export destination and with very small export sales. Over 90 percent of all new exporters in Canada started with one export destination and in most cases, the United States was their first export destination. In 2000, exports by all new entrants summed to $1.98 billion, which is equivalent to 0.6 percent of total exports in that year. That percentage shrank to only 0.4 percent in 2006.

New trading relationships are much more likely to fail than the existing ones. About 50 percent of new exporters who started in 2000 would have failed by the end of the second year in the export market. Only a quarter of new exporters would have survived and become established continuing exporters by the end of the sixth year (See Table 7).

Table 7: New Entrants by Cohort: Persistence and Growth

	Cohort Entering Export Market			Export Value per Firm
	2000	2001	2002	
	Number of firms			Current dollars
Entry	13,164	11,318	10,955	150,697
Year 1	6,070	4,676	4,585	566,841
Year 2	5,031	3,822	3,884	804,456
Year 3	4,361	3,395	3,441	839,738
Year 4	3,963	3,100	2,977	1,108,436
Year 5	3,626	2,662		1,257,768
Year 6	3,234			1,414,082

Source: Statistics Canada.

However, once the new exporters established themselves in the export market, their export revenues increased significantly. This implies that difficulty of entering export markets may not be the main reason for lack of export growth; the more significant issue may be sustaining trading relationships.

2.5 *Market diversification*

The most remarkable feature of Canadian exporter dynamics over the examined period is the market diversification into Europe, Asia and Latin America in response to changes in the trading environment facing Canadian exporters. Table 8 reports the market diversification pattern of Canadian exporters. As can be seen, between 2001 and 2006, the number of Canadian firms that exported to the dominant U.S. market fell by 6,600, while the number of exporters shipping to Asia, Europe, and Latin America increased by 2,618, 2,579, and 1,782, respectively.

Table 8: Canadian Exporters by Destinations 1999-2006—Number and Percent of Total Canadian Exporters

Year	United States	Europe	Asia Pacific	Latin America	Other
		Number			
1999	38,862	6,371	4,502	2,675	4,383
2000	41,578	6,451	4,731	2,675	4,416
2001	42,876	6,973	5,166	2,888	4,926
2002	43,111	7,638	5,880	3,118	5,647
2003	41,219	9,092	6,798	3,784	7,152
2004	40,553	10,169	7,853	4,508	8,434
2005	39,519	10,253	8,126	4,903	9,038
2006	36,276	9,552	7,784	4,670	8,548
2001-06	-6,600	2,579	2,618	1,782	3,622
2001-06 %	-15.4	37.0	50.7	61.7	73.5
		Percent distribution			
1999	89.2	14.6	10.3	6.1	10.1
2000	89.5	13.9	10.2	5.8	9.5
2001	89.1	14.5	10.7	6.0	10.2
2002	87.7	15.5	12.0	6.3	11.5
2003	85.0	18.7	14.0	7.8	14.7
2004	82.2	20.6	15.9	9.1	17.1
2005	82.1	21.3	16.9	10.2	18.8
2006	82.2	21.6	17.6	10.6	19.4
2001-06 %	-7.0	7.0	7.3	4.4	9.3

Source: Statistics Canada.

Market diversification of Canadian exporters was driven by the entry and exit dynamics in the four regional markets (See

Table 9). Between 2000 and 2006, there was net exit from the U.S. market as total number of new entrants (49,336) was less than the total number of exiters (51,091). Conversely, the new entrants outnumbered exiters in each of the other major regional markets. The number of net entries was 792 for Asia, 821 for Europe, and 345 for Latin America.

Table 9: Entry, Exit and Continuers by Region

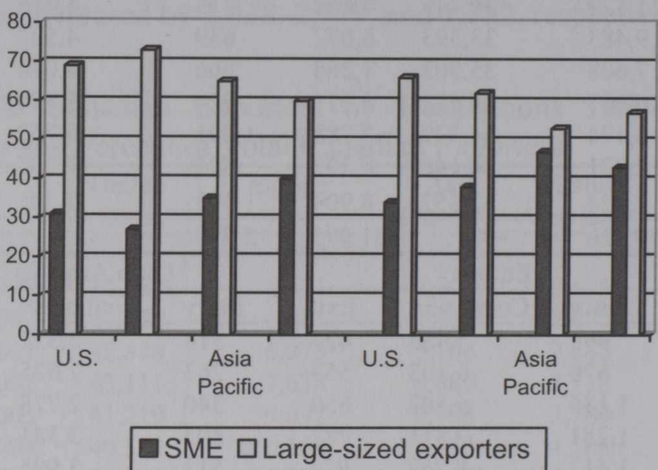
Year	United States			Asia Pacific		
	Entry	Continuers	Exit	Entry	Continuers	Exit
2000	11,129	30,449	4,668	715	4,016	327
2001	9,483	33,393	6,077	639	4,527	366
2002	7,608	35,503	7,268	866	5,014	523
2003	6,647	34,572	8,011	924	5,874	657
2004	6,174	34,379	7,788	1,091	6,762	745
2005	5,371	34,148	8,375	821	7,305	910
2006	2,924	33,352	8,904	503	7,281	1,239
Total	49,336		51,091	5,559		4,767
Year	Europe			Latin America		
	Entry	Continuers	Exit	Entry	Continuers	Exit
2000	966	5,485	427	318	2,357	162
2001	870	6,103	553	263	2,625	174
2002	1,136	6,502	650	340	2,778	233
2003	1,281	7,811	782	403	3,381	256
2004	1,417	8,752	*922*	513	3,995	285
2005	775	9,478	1,298	424	4,479	447
2006	598	8,954	1,590	236	4,434	595
Total	7,043		6,222	2,497		2,152

Source: Statistics Canada.

Over the same period, the number of continuing exporters to the United States remained stable. The number of continuing exporters to the U.S. market increased in the early 2000s, but declined after 2002 and levelled off at the 2001 level. This is not the case in the other three markets. Net increases in the number of continuing exporters were 3,265 in Asia, 3,469 in Europe, and 2,077 in Latin America. This indicates that new exporters to these latter markets were able to consolidate their initial footholds in the new markets. This is significant given the importance of continuing exporters to export sales.

The diversification of markets was led by small- and medium-sized exporters, both in terms of number of exporters and value of exports. The expansion in terms of values is especially remarkable in the Asian markets. In 1999, SME exporters accounted for 35 percent of total exports to Asia; in 2006, this share reached 47 percent—almost as much as the contribution of large-sized exporters (see Figure 1).

Figure 1. Small- and medium-sized exporters accounted for nearly half value of exports to Asia



The channels through which market diversification takes place depend in part on distance to market, significance of trade costs and size and productivity of the exporting firm. When trade costs (e.g., establishing own distribution networks) are high and potential markets are distant, less-productive exporters (mostly SMEs) go through intermediaries such as wholesalers and retailers to export. As such, the share of exports handled by wholesalers and retailers increases with the difficulty of accessing destination markets. As illustrated in Table 10, 70 percent of SMEs export sales to Asia and Latin America were via the wholesale and retail route in 2001. In more mature markets such as the United States and Europe, the share of SME exports via wholesale and retail networks was about 50 percent.

Table 10: Share of Export Sales by Size and by Market (%)

	United States		Asia	
	SME	Large	SME	Large
2001				
Agricultural & Commodities	8.5	6.7	13.1	6.6
Food & Beverages	5.1	4.9	4.7	5.5
Wood, Paper & Chemical	15.5	20.8	5	27.3
Other Manufacturing	20.8	55.4	7	21.7
Wholesale & Retail	49.6	12.2	70	39
2006				
Agricultural & Commodities	11.4	7.4	29.1	12
Food & Beverages	3.4	4.4	3	6.2
Wood & Paper & Chemical	14.1	22.9	4.1	22.9
Other Manufacturing	19.5	52.2	10.9	27.5
Wholesale & Retail	51	13.1	52.1	31.3
	Europe		Latin America	
	SME	Large	SME	Large
2001				
Agricultural & Commodities	12.7	12.6	6.9	3.8
Food & Beverages	5.6	2.4	5.2	5.3
Wood, Paper & Chemical	9.2	17.3	5.1	30.4
Other Manufacturing	25.3	56.6	11.7	33.4
Wholesale & Retail	46.8	9.8	70.8	27.1
2006				
Agricultural & Commodities	22.3	18.6	7.6	5.2
Food & Beverages	4.2	2.3	3.6	6.5
Wood & Paper & Chemical	6.6	13.7	8.3	28.1
Other Manufacturing	37.8	52.1	17.4	32.2
Wholesale & Retail	28.5	13.2	57.7	27.9

Source: Statistics Canada.

Of particular note is the decline of the importance of intermediaries in SME export sales to Asia and Latin America over the examined period. This share came down to around 50 percent in 2006 from 70 percent in 2001. This indicates once firms have established their potential for direct sales in foreign markets, the need for intermediaries diminishes.

4. Growth Decomposition

In this section, we show that the diversification of Canadian exports into non-U.S. markets has been mainly driven by changes at the extensive margin of trade. Entrant exporters are defined as the new exporters that did not export at time *t*–1 but enter into the export market at time *t*. Exiters are the exporters that had export sales at time *t*–1 but none at time *t*. Continuers are exporters that exported in both time periods.

Continuing exporters contribute most to annual export growth—typically, about 99 percent of the growth in exports from year to year is accounted for by continuing exporters. However, over longer periods of time, the number of firms that sustain their export market participation gradually declines, while the cumulative weight of exports accounted for by new exporters increases. Thus, comparing exports in 2000 and in 2006, the cumulative effects of entry and exit over the sample period can be seen to have been substantial. Note that, in this calculation, a continuing exporter is an exporter that exported in both 2000 and 2006. An entrant is defined as an exporter did not export in 2000, but did export in 2006. Similarly, an exiter in 2006 is defined as an exporter that exported in 2000 but did not export in 2006. This approach allows us to capture the cumulative effect of entry and exit over the sample period.

Table 11 shows that total export growth was 2.2 percent over the period 2000-2006. The continuing exporters (those that were exporters in both 2000 and 2006) contributed negatively to total export growth over that period, by -1.5 percentage points. The gross contribution of new entrants over the period amounted to 9.4 percentage points, while exiters subtracted 5.8 percentage points. Thus, the contribution to total export growth of net entry over the period was almost 4 percentage points. The entry and exit dynamics over the entire examined period indicates that the extensive margin was far more important in explaining the overall export growth than the year-to-year export growth. This is because firms that enter foreign markets and survive more than a year are typically able to export more.

Table 11: Growth Decomposition by Market (in percent)

		Contribution of:			
t=2006, t–1=2000	Export Growth	Continuing Exporters	Entrant Exporters	Exiting Exporters	Net Entry
Total	2.2	-1.4	9.4	-5.8	3.6
U.S.	–3.5	-5.6	7.6	-5.5	2.1
Asia	28.7	14.7	30.6	-16.7	13.9
Europe	33.5	21.9	24.4	-12.9	11.5
Latin America	23.2	5.4	33.1	-15.2	17.9

Source: Statistics Canada[7].

In the previous section, it was noted Canadian exporters increasingly shifted to non-U.S. markets over the period examined. Tables 11 also reports the decomposition of Canadian export growth by region: the United States, Asia Pacific, Europe and Latin America. Total Canadian exports to the U.S. market declined by 3.5 percentage points from 2000 to 2006. This reflected the fact that the positive contribution of new entrants of 7.6 percentage points was more than offset by the negative contribution due to a decline in export sales by continuing exporters of 5.6 percentage points together with the negative contribution of 5.5 percentage points from exiters. The decline in export sales by continuing exporters highlights the deterioration of the trading environment for Canadian firms in the U.S. market, inducing many exporting firms to exit the U.S. market, particularly those that were less competitive. At the same time, the role of new entrants in largely offsetting the deterioration of performance by existing exporters underscores the vital importance of continuing export promotion; in international trade, given firm-level dynamics, a country that depends on its existing export base will suffer a steady erosion of its export performance.

In Asia, total Canadian export growth was high, up by 28.7 percent from 2000 to 2006. Of this, 14.7 percentage points can be explained by the expansion of the existing trading relationships (i.e., growth at the intensive margin). New trading

[7] The detailed calculation is available upon request.

relationships (gross entries) contributed 30.6 percentage points, which is significantly higher than the expansion at the intensive margin of trade. Exiters contributed negatively, or by -16.7 percentages points, resulting in a contribution from net entry of 13.9 percentage points.

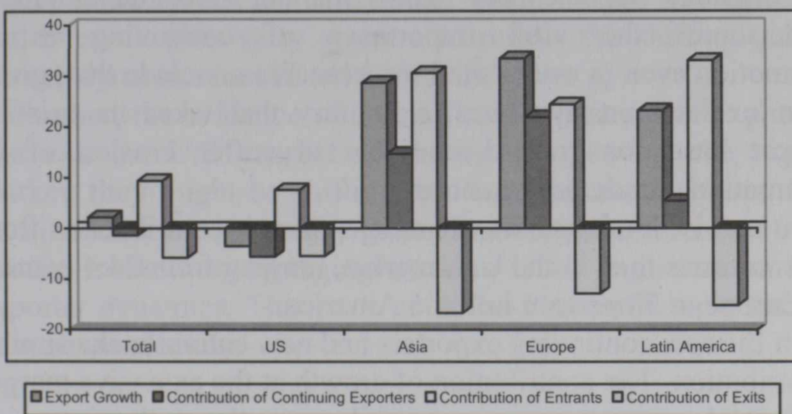
Total export growth to Latin America was 23.2 percent during the examined period. Growth at the intensive margin contributed 5.4 percentage points while gross entries contributed as much as 33.1 percentage points. The contribution of net entry was 17.9 percentage points. Clearly growth at the extensive margin overwhelmed the contribution at the intensive margin with respect to accounting for Canada's total export growth to Latin America.

Europe accounted for the highest export growth among all of Canada's destination regions, increasing by 33.5 percent. Of this, 21.9 percent could be accounted for by export sales of continuing exporters. This is consistent with the findings in the previous section that Europe had the greatest growth in the number of continuing exporters among all regions. The gross contribution of new exporters amounted to 24.4 percentage points. This was partially offset by the negative contribution of existers of -12.9 percentage points, resulting in a contribution from net entry of 11.5 percentage points.

In summary, the decomposition of export growth by region shows the endogenous response of Canadian exporters to changes in the trading environment facing them. Two factors in particular impacted on Canadian exporters in the first half of the 2000s—rising frictional costs of trade in the U.S. market and a steep appreciation in Canada's bilateral exchange rate vis-a-vis the U.S. dollar. Canadian exporters adapted by diversifying into non-U.S. markets. This diversification was mainly driven by changes in exports at the extensive margin of trade or by setting up the new trading relationships (See Figure 2).

This trend is particularly pronounced in new and emerging markets such as Asia and Latin America in which the expansion at the extensive margin of trade overwhelms the contribution of expansion at the intensive margin to total export growth. In more mature markets such as Europe, the intensive margin of trade remains a significant factor in explaining trade growth, although developments at the extensive margin accounted for a good share of export growth as well. Firms that exported to the European market were also more likely to be multi-product, multi-country exporters. They were more relied to a greater extent on direct sales rather than on wholesale and retail intermediaries.

Figure 2. Decomposition of Canadian Export Growth, 2000-06



5. Conclusions

In this paper, we have examined the dynamics of Canadian exporters and their responses to changes in the international trading environment. In particular, we have documented the firm-level dynamics of entry and exit into and out of Canada's major export markets that underpinned the remarkable shifts in Canada's global pattern of exports from the 1990s to the 2000s.

We highlight the important role of new entrants in sustaining Canada's overall export growth. Over the period between 2000 and 2006, the contribution of continuing exporters to total export growth was -1.4 percent, while the contribution of net entry was 3.6 percent.

We show that the diversification of Canada's trade was largely accomplished at the extensive margin as Canadian exporters exited the U.S. market and entered the Asian, European and Latin American markets.

In the U.S. market, total Canadian export growth to the U.S. in 2000-2006 was negative. The continuing exporters contributed -5.6 percent to total Canadian export growth to that market. Net entrants to the U.S. market contributed positively to total export growth to that market, but not enough to offset the negative contribution of continuing exporters. This highlights the role of new entrants in sustaining Canadian export performance in the key U.S. market; this development underscores the vital importance of continuing export promotion even in established markets. We conclude that, given firm-level export dynamics, a country that takes its existing export base for granted is liable to suffer erosion of its international trade performance.

In non-U.S. market, we see much stronger contributions from new entrants than in the U.S. market, ranging from 24.4 percent in Europe to 33 percent in Latin America.

In Europe, continuing exporters and new entrant make similar contribution. The contribution of growth at the extensive margin was 24.4 percentage points, while growth at the intensive margin contributed 21.9 percentage points.

In Asia, the contribution of new entrants (extensive margin) to total export growth to that region double that of continuing exporters. New entrants contributed 30.6 percentage points to total export growth to that region, compared to a contribution of 14.7 percentage points from expansion of sales by continuing exporters (intensive margin). In Latin America, contribution of new entrants far exceeds that of continuers. Growth at the extensive margin contributed 33.1 percentage points to total export growth, compared to only 5.4 percentage points from growth at the intensive margin. This is the only region outside of the U.S. where net entry exceeds continuers.

As more Canadian exporters entered the non-U.S. markets, the average number of export destinations served per firm and the proportion of multi-market exporters in the total Canadian exporter population increased. Small- and medium-sized exporters led the growth outside the U.S. market. In particular, in the Asian market, SMEs exported almost as much as large-sized exporters.

Given the factors shaping the diversification trends, we conclude that the diversification into Europe may have reflected the greater relative profitability of sales to Europe as compared to the United States due to the major exchange rate shifts. In Asia, the diversification was steadier and not obviously driven by exchange rate developments since the Canadian dollar appreciated against the Asian currencies in tandem with its appreciation against the U.S. dollar. Accordingly, this aspect of the diversification story appears to reflect the shifting global growth dynamics associated with Asia's rise.

Further, the evidence of diversification means that exporters that exit the U.S. market are necessarily leaving the export market; they might be shifting to other markets and becoming multi-market exporters. The gradual market diversification from mature markets to emerging markets is an important part of exporter dynamics. This issue could be a research topic for the next phase of study.

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Canada's Share of U.S. Product Markets: Dissecting the 1998-2006 Trends

Ram C. Acharya*

Abstract: The decade of the 2000s saw an erosion of Canada's position in the U.S. market. At the macroeconomic level, this was manifested in a three percentage point fall in Canada's share of total U.S. imports. At the firm level, this was reflected in exiting firms outnumbering new entrants, reducing the total number of Canadian exporters serving the U.S. market. This paper examines this development at the product level, evaluating Canada's market share in over 16,000 products imported by the United States (HS 10-digit level), classified by level of sophistication. Competitor countries are identified by product. The paper finds that Canada's market share decline reflected a fall in product penetration (the share of product categories in which Canada exports to the United States) from 73 to 70 percent; this reflected a failure of new product entries to offset product exits. Market share erosion was thus in good measure at the extensive margin and may reflect weak innovation performance. China's competitive pressure in the form of new product entries in a wide range of areas, including in knowledge-intensive sectors, implies that the observed structural shift of Canada's product palette towards higher-unit-value products was more due to product exit at the low end than to product up-grading. I conclude that the action was at the extensive margin but may shift to the intensive margin. The key issue for Canada is innovation to sustain competitive product entry.

Key words: Canada, trade, products, exit, entry, extensive margin
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1. Introduction

The United States is the world's single largest destination for global merchandise exports. Capturing and preserving U.S. market share is thus a priority for trade-dependent countries. This is especially true for Canada, which historically was the largest goods supplier to the U.S. market until being surpassed in 2007 by China. Does Canada's slide into second place amongst U.S. goods suppliers amount to no more than a loss of bragging rights? Or does it merit the concerns that have been expressed in policy circles and in some of the public policy commentaries?

Canada' share of U.S. imports has waxed and waned over the years, reflecting a wide range of developments. It rose in the 1990s helped by the preferential access gained in the U.S. market through the Canada-U.S. FTA and the extended period of low valuation of the Canadian dollar in the latter part of the 1990s and early 2000s. Canada's share fell back in the 2000s in a context of rising cross-border trade costs following 9/11 and the steep appreciation of the Canadian dollar post-2002.

Developments elsewhere also impacted on Canada's share of U.S. imports. Canada's preferences in the U.S. market were eroded by U.S. FTAs with third parties, the most notable being Mexico through the NAFTA. Mexico almost doubled its share of the U.S. import market from 5.8 percent in 1990 to 10.2 percent in 1998, although its share has stagnated since (rising marginally to 10.6 percent in 2007). And of course the massive expansion of China's exports that vaulted it into first place in goods exports globally in December 2009 had a pervasive effect on import market shares worldwide and most particularly in the United States where China's market share (which reached 17 percent in 2007) was almost double its global share (8.7 percent in 2007). The China factor is of course complicated. It reflects in part the expansion of China's exports of products typically supplied by low-income countries based on comparative advantage in the form of abundant cheap labour. In part it also reflects China's improved market access following its WTO accession in 2001, and the vast improvement in its trade infrastructure over the years. However, it also reflects China's role as final stage of assembly of technologically advanced products developed by multinational firms based in Japan, Europe and the United States[1].

Accordingly, it is not a straightforward matter to gauge the significance of the changes in Canada's share in the U.S. import market. To shed some light on this issue, this paper approaches it from the perspective of product dynamics—product penetration, product churning (replacement of old product lines with new over the product life cycle) and product overlap (which Canadian products compete with which other country's products?). This complements the firm-level analysis of the same issue by Chen and Yu (2010), providing additional insights into the role of trade dynamics at the extensive margin (in this case trade expansion due to introduction of new products or contraction due to exit of established products) versus the intensive margin (trade expansion—or decline—due to changes in the value of sales or market shares of established products). Dissecting the market share decline in this manner may yield insights of relevance to economic policy in Canada.

The rest of the paper is organized as follows. Section 2 briefly describes the data. Section 3 discusses the various methodological issues involved in measuring product dynamics. Section 4 examines product dynamics in terms of product penetration and product churning, using various alternative approaches to identifying the extent of head-to-head competition between Canada and other exporters to the U.S. market, including product overlap, export similarity indexes and various measures based on export unit values. Section 5 concludes.

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[1] An often-cited example is the iPod, which Apple assembles in China for its worldwide markets. As noted by Linden, Kraemer and Dedrick (2007; at p. 10), "trade statistics can mislead as much as inform. For every $300 iPod sold in the U.S., the politically volatile U.S. trade deficit with China increased by about $150 (the factory cost). Yet, the value added to the product through assembly in China is probably a few dollars at most." Accordingly, China's market share in terms of value added is substantially smaller than its share of gross value of traded products.

2. Overview of the data

To examine product dynamics in the U.S. import market, I draw on data on U.S. imports by country and industry at the Harmonized System (HS) 10-digit level[2] from the University of California Davis' Center for International Data directed by Robert Feenstra[3]. Just to provide some sense of how detailed the data are at this level of disaggregation, the dataset has six types of ladies' shawls, seven types of men's ties, 13 types of cheese, 11 types of air-conditioners, 12 types of mowers, six types of sewing machines, and seven types of bicycles. These data are thus at a sufficiently fine level of detail to make it reasonable to assume that they represent individual products.

Working at the 10-digit level minimizes the inevitable aggregation bias faced when dealing with higher orders of aggregation. This is especially important in comparing unit prices of products across countries as a means of assessing the level of sophistication of the products. Unit price comparisons at more aggregate levels can be completely misleading.

The 2002 revision of the Harmonized System (HS 2002), one of a regular series of updates to take into account changes in the composition of international trade due to the emergence of new products, creates an issue for this study since the original U.S. import data for 1998, the base year, were collected under the previous version of the code, HS 1996, while the 2006 data were collected under HS 2002 codes. To permit direct product line comparisons over time, the 1998 data are converted to HS 2002 definitions using the concordance developed by Pierce and Schott (2009). Some products have different HS 10-digit numbers in two years; these have to be concorded using family

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[2] The Harmonized System has 21 sections (1-digit), 96 chapters (two-digit), more than 1,200 headings (four-digit), over 5,000 subheadings (6-digit) and over 16,000 products at the 10-digit level. The World Customs Organization assigns 6-digit codes for general categories and countries adopting the system then define their own codes to capture commodities at more detailed levels.

[3] http://cid.econ.ucdavis.edu/

ID. Since a family ID could have more than one HS 10-digit product, the total number of products used for computing product exit and entry rates is lower than the total number of HS 10-digit products that serve as the basis for calculating initial penetration rates. For example, Canada exported 11,864 products to the United Sates in 1998; however, the count for the entry/exit figures is 8,983. Similarly, whereas Canada exported a total of 11,869 products to the United States in 2006, the count used for the entry/exit figures was 8,786. Similar proportions apply to the other U.S. trading partners.

The United States had imports in 16,326 product categories in 1998, a figure which rose to 16,968 products in 2006. The chemical industry had the highest product count in 2006, with 2,147 products or about 13 percent of the total, followed by the clothing industry which had 1,697 products or about 10 percent of the total. The number of products was slightly larger in most industries in 2006 compared to the situation in 1998, except for a slight fall in the mining and oil and gas industry and, surprisingly, in the computer and electronic industry as well[4].

For expositional purposes, some results are presented by industry for 14 industries, either individual North American Industrial Classification System (NAICS) merchandise industries at the 3-digit level, or aggregations of 3-digit NAICS industries[5]. Among the 14 industries, one is agriculture-related, one is mining-related and 12 are manufacturing industries. Among the 12 manufacturing industries, 6 are individual NAICS 3-digit industries while the other 6 are aggregations of the remaining 15 NAICS 3-digit manufacturing industries, with

[4] Note that product count changes is not identical to the net of new product introductions and old product disappearances since the HS codes updates involve some families of products expanding and others shrinking over time as the statistical agencies change the product definitions (see Pierce and Schott, 2009, on the growing and shrinking of product trees).

[5] Altogether there are 29 NAICS 3-digit merchandise industries: 8 in agriculture, fishing, forestry and mining and 21 in manufacturing.

the sorting based on similarity of production technology[6]. These industries are listed in Table 1. See Appendix 1 for details.

For analytical purposes, the 12 manufacturing industries are in turn grouped into two categories: five are considered to be medium-and high-technology industries (MHT) and seven are considered to be low-technology industries, along with agriculture-related and mining-related industries.

Table 1: Product sectors by Technology Level

Low-technology Sectors	**Medium- to High-Technology Sectors**
Agriculture, Forestry, Fishing and Hunting	Chemical
Mining and Oil and Gas Extraction	Machinery
Food; Beverage and Tobacco	Computer and Electronic Product
Textile; Clothing; Leather	Electrical Equipment, Appliance and Components
Wood; Paper; Printing	Transportation Equipment
Petroleum and Coal Products	
Plastics and Rubber; Non-metallic Mineral	
Metal products (primary and fabricated)	
Furniture and Related industries and Miscellaneous industries.	

Source: Aggregation by the author..

[6] Four of them combine two NAICS 3-digit industries each (respectively 311-312; 326-327; 331-332, and 337 and 339); one combines three NAICS 3-digit industries (321-323), and one combines four NAICS 3-digit industries (313-316). The relative individual importance of these combined industries in terms of export values is small. In 2007, among NAICS 311-312 group of industries, food (311) had a share of 1.9 percent and beverage and tobacco (312) had share of 0.9 percent. In the 313-316 group, textiles mills products (313) had a share of 0.5 percent, textile mills (314) had 0.7 percent, clothing (315) had 4.1 percent and leather and allied products (316) had 1.5 percent. Similarly, plastics and rubber (326) and non-metallic mineral (327) had shares of 1.8 percent and 1.1 percent respectively. In metal industries, primary metal (331) had a relatively large share of 4.6 percent, while fabricated metal products (332) had 2.6 percent. In the last category, 337 & 339, the share of furniture and related industry (337) was only 1.4 percent, while the miscellaneous category (339) accounted for 5.3 percent of which 4 percent was antique products.

Competitor countries are classified into three groups defined on the basis of per capita gross domestic product (GDP): these include 87 low income countries (LICs) with per capita GDP up to 40 percent of the 1987 global average; 68 medium income countries (MICs) with per capita GDP as high as 3 times the world average; and 31 high income countries (HICs). This approach sheds light on the extent to which observed changes in market share for Canada reflect the magnitude of competition that Canada is facing from low wage countries.

The major U.S. trading partners are broken out from these groups. These trading partners are: the EU15 and Japan from the HICs, Mexico from the MICs and China from the LICs. I also further subdivide for analytical purposes the HICs group into other East Asian countries (OEACs) and other high income countries (OHICs); and the MICs into oil exporter countries (OECs) and other middle income countries (OMICs); the LICs excluding China are labelled other low-income countries (OLICs). Hence, altogether there are nine competitors for Canada in the U.S. market: Japan, EU15, Mexico, China, OEACs, OHICs, OECs, OMICs and OLICs. The list of countries in each group and sub-group is given in Appendix 2.

The degree of competition in the U.S. import market is brought out by the fact that very few products have a sole supplier. For example, in 2006, Canada was sole supplier of only 1.8% of the products imported in the United States, and the value of imports in these categories constituted only 0.29 percent of total U.S. total imports from the world. Altogether only 6.6 percent of the products imported by the United States had a sole supplier; these accounted for only 0.34 percent of total U.S. imports.

3. Methodological issues: measuring product dynamics

Product dynamics are discussed in terms of three concepts: product penetration, which measures the breadth of a country's export palette; product churning, which decomposes changes in product penetration into the exit of previously exported products out of, and the entry of new products into, a given export market; and head-to-head competition in terms of three different measures, product overlap, which measures the degree to which trading partners of a given country are head-to-head competitors on a product-line basis in a given import market, unit export price comparisons, and export similarity indexes.

I compute the product penetration rate for each trading partner in the U.S. market for the 14 industry groups for 1998 and 2006. Denoting products by p, county/region by c, industry by i, *and* time period by t, the product penetration rate P_{cit} is computed as:

$$(1) \qquad P_{cit} = \frac{N_{cit}}{\sum_{c} N_{cit}} \times 100,$$

where N_{cit} is the number of products that the United States imports from country/region c in industry i at time period t.

Product churning decomposes the product penetration rate into the net of exit of previously supplied products and entry of new products. Arithmetically, the number of products exported by any country in two time periods (t and $t+1$) are related in following way (industry subscript is suppressed):

$$(2) \qquad N_{ct+1} = N_{ct} - D_{ct+1} + \mu_{ct+1},$$

where N_{ct+1} is the total number of products exported in year $t+1$ (2006 in our case); N_{ct} is the number of products exported in year t (1998); D_{ct+1} is the number of products that were exported in year t but were dropped in year $t+1$, and μ_{t+1} is the number of new products that were not exported in year t but were exported in year $t+1$. N_{ct} - D_{ct+1} gives the total number of continuing products in the sense that they were exported in both periods, t and $t+1$. Hence, equation (2) can be written as:

$$(3) \qquad N_{ct+1} = C_{ct+1} + \mu_{ct+1},$$

where C_{ct+1} is the number of continuing products. Dividing by the total number of products exported by each U.S. trading partner in 1998 gives the rate of survival of product lines for that partner in 2006 compared to 1998 and its rate of introduction of new products into the U.S. market.

Product overlap is simply the number of same products sold by two competitors and thus measures the extent to which two countries are direct competitors at the product line level. For a pair of countries *c* and *c'*, the product overlap of country *c'* with respect to exports of country *c* is defined as follows:

$$(4) \qquad O_{ct} = \frac{N_{pcc't}}{N_{pct}} \times 100$$

where O_{ct} is product overlap; $N_{pcc't}$ is the number of products that both countries *c* and *c'* sell in the target market, and N_{pct} is the total number of products sold by country *c* in the target market. Note that product overlap can be calculated from the perspective of country *c'* by making the denominator in the above expression the total number of products sold by country *c'* in the target market.

Another way to approach the issue of head-to-head competition between various trade partners in a given market is Finger and Kreinin's (1979) export similarity index (ESI). This index incorporates information about both market share and product penetration; in principle, it captures the effect of comparative advantage and has been widely used to assess the scope for trade diversion due to regional integration and industrial convergence[7].

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[7] Pomfret (1981) used it to test the similarity of export patterns of new entrants to the European Economic Community to those of established community members. In a similar application, Derado (2008) applied it to test the impact of EU expansion for Croatia. Pearson (1994) and Xu and Song (2000) applied the index to examine the patterns of industrialization of East Asian emerging economies. It has also been used by Schott (2006) to assess the implications of China's industrialization for U.S. product markets. Kellman and Schroder (1983) carried out basic tests on the index for aggregation bias (index values rise systematically with higher levels of aggregation) and structural stability on the index (generally found to be stable).

For any two U.S. trading partner countries, *c* and *c'*, in year *t*, Finger and Kreinin (1979) define the ESI as follows:

$$(5)\quad ESI_{cc't} = \sum_{p} \min\left(s_{pct}, s_{pc't}\right),$$

where s_{pct} is product *p*'s share in country *c*'s exports in year *t*. Similarly, $s_{pc't}$ is the corresponding share of country *c'*. Using this formula, we compute the *ESI* between each U.S. trading partner and each other U.S. trading partner. This bilateral measure is computed using all products and is bounded by zero and unity. If country *c* and *c'* have no products in common in year *t,* then $ESI_{cc't} = 0$. On the other hand, if their exports are distributed identically across products, then $ESI_{cc't} = 1$. To compute a region's *ESI*, we use regional total exports (across all countries in the region)[8]. Since we will be using most disaggregate product category (comparing more than 16,000 product shares for each pair of country/region), the results do not suffer from aggregation bias, a well-known problem with the ESI, and so provide a clear picture of the export similarity for each pair of competitors in the U.S. import market.

The measures we discuss so far look only at the U.S. import patterns in terms of number of products and market shares. Next, we develop measures that take into account the quality dimension using the unit values of the products that each of the major competitors commands in the U.S. market to see whether Canada's products tend to compete on price (lower unit values) or quality (higher unit values).

A number of cautions must be observed when using unit values as a proxy for product prices and differences in these proxy prices as an indicator of quality differences or product sophistication. As noted by Silver (2007), "Bias in unit value indices is mainly attributed to changes in the mix of the heterogeneous items recorded in customs documents, but may

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[8] This index can also be computed on an industry-specific basis. In either case, it is bounded by zero and unity. Here, we present results using all products and aggregating at one level only (industry-specific results are not presented).

also arise from the poor quality of recorded data on quantities. The former is particularly important given the increasing differentiation of products and turnover of differentiated products that is a feature of modern markets." Silver adds that "Significant unit value bias arises within strata defined at levels of detail well beyond that available in customs systems." Thus, if several firms in both countries sell a particular commodity such as flat panel monitors and the monitors vary in size, and therefore unit value, although not necessarily in quality, then differences in the mix of sizes between the two countries (or within a country's exports over time) result in changes in unit value that would be (incorrectly) interpreted as quality differentials.

The advantage of Feenstra's dataset is that it provides data collected by one customs agency at the most disaggregate level of the HS classification, which at least minimizes the biases to which the unit value measure is subject. Further, we use the unit value data in three ways and thus do not rely on one particular comparison based on this statistic. First, we compare Canada's unit values by product to other countries. For a particular product, the country with the higher unit value is deemed to have the superior product in terms of quality. Second, we compute the pair-wise unit value dissimilarity index. As far as we are aware, this measure is new to the literature; it has not been used before. Third, we examine the distribution of unit values for major U.S. trading partners.

The unit value is calculated as follows:

$$(6) \quad U_{pct} = V_{pct} / Q_{pct},$$

where V measures value and Q measures the quantity. For some countries and products the quantity data are not available and as a result the unit value cannot be computed. For our sample countries/regions, the unit value was computable for about 83 to 90 percent (depending on the country/region) of the products in both years (1998 and 2006)[9].

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[9] For Canada, we could calculate unit values for 89 percent of the products in both years; for China, 87 percent in 1998 and 90 percent

The first application we make of the unit value index is to calculate a product superiority measure. For any two countries/regions *c* and *c'*, the share of superior products of country *c* compared to the situation with country *c'* at time *t*, S_{ct}, is simply:

$$(7) \qquad S_{ct} = \frac{N^{higher}_{pct}}{N_{pcc't}} \times 100,$$

where N^{higher}_{pct} is the number of products for which country *c* has a higher unit value compared to country *c'* and $N_{pcc't}$ is the set of common products that are exported by *c* and *c'* for which we have information on both value and quantity. By construction, the superiority measure for country c' will be 100 minus the superiority measure of country c.

The product superiority index is limited in that it does not incorporate information on the size of the gap between the unit values being compared: a product with a small advantage in unit value contributes equally to the index as a product with a big advantage. To incorporate information on the gaps between unit values by country pair, we compute a unit-value dissimilarity index (UDI). For countries/regions *c* and *c'* that export to the United States, the UDI is computed as follows:

$$(8) \ UDI_{cc't} = \sum_p \left\{ \left[m_{pt} \right] \times \left[\frac{\max\left(U_{pct}, U_{pc't}\right) - \min\left(U_{pct}, U_{pc't}\right)}{\max\left(U_{pct}, U_{pc't}\right)} \right] \right\},$$

where U_{pct} is the unit value of product *p* in country *c* in period *t*; $U_{pc't}$ is the corresponding value for country *c'*; and, which is product *p*'s share in total U.S. imports, is given by:

$$m_{pt} = \sum_c M_{pct} \Big/ \sum_c \sum_p M_{pct},$$

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products in 2006; for the EU15, 90 percent for both years; for Mexico, 87 percent for both years and for the OEACs 88 percent for each year.

where $\sum_{c} M_{pct}$ represents U.S. imports of product p from the world (sum across all countries) in period t, and $\sum_{c}\sum_{p} M_{pct}$ is total U.S. imports (sum across all products and countries). The fraction m_{pt} is used to provide a set of weights to sum the UDI across products on a weighted basis.

The second component on the right-hand side needs some explanation. This fraction is the percentage difference in unit value of a given product between two countries evaluated from the perspective of the country with the higher unit value. The numerator of this term is the difference of unit value between two countries and the denominator normalizes it by the higher of the two unit values so that the outcome is a positive fraction, unless the two countries have the same unit value, in which case the result is zero. The larger the percentage differences between the unit values of the two countries, the larger the value of this term and the larger the implied quality differential. Once this fraction is computed for all common products between two countries, the UDI is obtained by summing across all products using the share of that product in US total imports as a weight[10]. To our knowledge this particular index has not been previously used in the literature.

Finally, we also consider a third alternative approach to identifying quality differentials across U.S. trading partners vis-à-vis Canada. First, we select the highest unit value (HUV) for each product p by comparing unit value of the product across all exporting countries to the United States: $U_{pt}^{\max}$. Second, for each product from each country, we compute the ratio of its unit value to HUV for that product. Based on that ratio, we break the total products of each country/region into five groups: less than

[10] This weighting scheme gives greater importance to price differences in products that are important to the United States but might represent only a small share of the export base of the two countries being considered. Alternative weighting schemes could be considered (e.g., simple averages or the weights derived from the combined exports of the two countries being compared).

10 percent of HUV, 10-25 percent of HUV, 25-75 percent of HUV, greater than 75 percent of but less than HUV, and HUV. This is described by equation (9):

$$(9) \qquad \frac{u_{pct}}{u_{pt}^{\max}} = \{< 0.1;\; 0.1 - 0.25; 0.25 - 0.75; 0.75 - 1; 1\}$$

In this scheme, a country which sells mainly low-end products in terms of unit value will have higher share of its product counts and revenue in the lower groups. By the same token, a country/region that sells more expensive products will have the larger share towards the last range of distribution.

4. Product Dynamics

Based on the methodology described above, we consider Canada's product dynamics in the U.S. import market in three ways. First we examine product penetration to gauge the extent of Canada's representation in individual U.S. product markets. Then we consider product churning, the rate at which Canadian products break through into new product categories versus the rate at which Canadian exports drop out of U.S. markets. Finally, we consider a range of measures that bear on the extent of head-to-head competition in U.S. product markets between Canada and other U.S. trading partners.

4.1 Product penetration

The aggregate levels of product penetration in the U.S. market for 1998 and 2006 are shown in Table 2. In both years, the EU15 had the highest penetration rates at 89 percent in 1998 and 87 percent in 2006. Canada had the second highest penetration in 1998 at 73 percent but in 2006 China claimed that position with a 77 percent rate, while Canada fell to third with a 70 percent rate. Over the period of eight years, China's penetration rate increased by 20 percentage points. In total product counts, China's exports increased from 9,249 in 1998 to 13,123 products in 2006. China's product counts were the largest of any single supplier country to the United States.

Table 2: Product penetration in the U.S. market by trading partner, 1998 and 2006, percent

	Percent of U.S. tariff lines in which imports were registered	
	1998	2006
Canada	73	70
China	57	77
EU15	89	87
Japan	60	59
Mexico	52	52
OEACs	63	64
OHICs	36	37
OMICs	69	75
OLICs	68	72

Source: Author's calculation based on Robert Feenstra's database, http://cid.econ.ucdavis.edu

Of the major U.S. trading partners, Canada experienced the largest (3 percentage points) drop in its product penetration rate. Japan and the EU15 saw lesser declines while other high income countries increased their penetration rates. The major gainers in terms of increased product penetration rates were the middle and low income countries.

From the perspective of product penetration, a decline for a higher income country is not actually unusual. A "stylized fact" of economic development is that countries first diversify their export product palette but, beyond a certain level of per capita GDP, tend to reduce the range of products they export. As Imbs and Wacziarg (2003) conclude: "Poor countries tend to diversify, and it is not until they have grown to relatively high levels of per capita income that incentives to specialize take over as the dominant economic force. This non-monotonicity is a very robust feature of the data". Thus, the decline in Canada's product penetration rate in the U.S. market is not *per se* a source of policy concern. Indeed, it is worth recalling in this context the finding of Trefler (2004) that free trade with the United States led to a considerable degree of narrowing of product lines at the firm level basis, which would be consistent with a narrowing on a product line basis, reflecting increased specialization and with it higher levels of productivity.

Table 3: Product penetration by industry, 1998/2006 (percent)

Industry	Canada	China	Mexico	Japan	EU15	OEACs	OLICs	OMICs
Agri., Forestry, Fishing & Hunting	72/69	30/44	41/37	23/21	54/48	29/27	52/49	61/64
Mining and Oil and Gas Extraction	71/70	36/56	40/43	26/23	66/67	29/23	50/58	65/62
Food; Beverage and Tobacco	67/62	27/41	34/36	23/23	70/68	32/33	50/57	62/70
Textile; Clothing; Leather	64/59	60/85	54/52	42/47	93/91	67/70	76/82	70/79
Wood; Paper; Printing	88/87	51/79	50/45	44/43	82/83	55/54	64/65	69/72
Petroleum and Coal Products	98/94	17/32	52/41	50/54	88/88	50/44	58/62	72/71
Chemical	56/55	49/77	38/37	70/65	95/90	41/47	61/68	54/61
Plastics and Rubber; Non-metallic Mineral	84/84	80/96	79/76	82/79	98/98	82/84	78/81	83/87
Primary Metal; Fabricated Metal	83/81	57/81	58/60	78/73	96/95	69/71	60/68	73/80
Machinery	86/87	56/82	53/57	87/86	98/98	77/81	68/72	71/80
Computer and Electronic Product	68/68	81/92	56/62	89/87	93/92	87/86	82/82	78/77
Electrical Equip., Appliance & Component	89/91	84/96	79/80	86/83	99/97	91/94	80/82	79/90
Transportation Equipment	91/86	51/67	64/60	69/68	90/92	63/66	52/56	65/73
Furniture; Miscellaneous; Antiques	84/79	83/90	71/68	73/71	95/94	87/87	84/86	86/89
Total	**73/70**	**57/77**	**52/52**	**60/59**	**89/87**	**63/64**	**68/72**	**69/75**

Source: Author's calculation based on Robert Feenstra's database, http://cid.econ.ucdavis.edu.

At the industry level, the fact that Canada improved or maintained its product penetration rate in machinery, computers and electronic products, and electrical machinery and equipment, three of the more knowledge-intensive sectors, also tends to mitigate concern about the overall slide in product penetration rates (see Table 3).

That being said, it is noteworthy that China not only increased its product penetration rates across the board but made vast strides in the knowledge-intensive sectors, including in transportation equipment, a sector in which Canada had a fairly steep decline in product penetration (from 91 to 86 percent) and in chemicals, a sector in which Canada had a minor decrease (from 56 to 55 percent). China's product penetration rates were more than 90 percent for the electrical equipment, appliances and component sector (96 percent) and computer and electronic products (92 percent). In three of the five industries that are considered relatively medium- and high-tech, the number of products that China exports to the United States surpassed that of Canada. In the remaining two (transportation equipment and machinery), the difference in the number of products supplied by Canada and China was reduced to minimal levels by 2006. While China's value-added may account for only a small part of the overall value of its exports, the competitive challenge to Canadian-based producers remains significant. What matters is the competitiveness of the global value chain that culminates in products assembled in China. If Canadian firms are not part of these chains, they compete with them.

4.2 Product churning

The changes in the overall product penetration rates for Canada and its competitors discussed above can be analyzed as the outcomes of each country's product churning in the U.S. market—its ability to sustain its presence in existing product lines and its ability to add new products to its export palette. Table 4 shows the continuity rate and adding rate for Canada's major competitors in the U.S. import market.

Table 4: Product churning, 2006 versus 1998 (percent)

	Canada	China	Mexico	Japan	EU15	OEACs
Initial Penetration	73	57	52	60	89	63
Exit rate	13	4	19	15	5	12
Adding rate	11	40	19	15	5	16

Source: Author's calculation based on Robert Feenstra's database, http://cid.econ.ucdavis.edu

As a general observation, it is important to note the very high negative correlation between the initial product penetration rate and the rate of product additions. If we exclude China as an interesting special case, the simple correlation coefficient between the initial product penetration rate (from line 1 in the table) and the rate of product adding by 2006 (line 3 in the table) is -0.99. For the EU15 which registered exports in 89 percent of the U.S. tariff lines, there is limited scope to add new product lines. The rate of innovation in Europe might still be high in that, for example, a French product might displace a German model, or a new German product might displace an existing German product in the same tariff line. In either case, the EU15 would not register a product introduction in this statistic.

The data show that, for Canada, 87 percent of the products that were exported to the United States in 1998 survived in 2006 while 13 percent were either driven out or became obsolete. By comparison to the competitors, the rate of continuation of products is not out of line—it is little different from the rates achieved by Japan and the other East Asian advanced economies. The EU15 and China, however, had significantly higher rates of product survival at 95 and 96 percent respectively, although given the different stages of development and the bases of competitiveness of these two economies, one would anticipate that these similar rates were achieved on the basis of rather different strengths.

The third observation on Table 4 is in respect of new product entry. In Canada's case, the rate of addition of new products to the export palette was only 11 percent, the second lowest in the group, significantly below the rates achieved by Japan and the other more advanced East Asian economies, and well below the rates achieved by Mexico and China. Canada did have a higher rate of product introductions than the EU15, although this edge must be qualified by consideration of the very high rate of product penetration that the EU15 had in the U.S. import market to start with—as noted, there are few manufactured products that the EU15 does not export to the United States and so adding new lines is rather difficult. So, at the aggregate level, the main takeaway point from the "product adding" data in Table 4 is the outlying nature of China's performance.

The fourth observation on these data concerns the difference between the dropping and adding rates by country. Whereas China and to a lesser extent the Other East Asian high income countries had higher rates of product addition than of product disappearance, and the others in the table broke even, Canada had a higher rate of product disappearance than introduction.

This last observation takes on more significance when we compare the remarkably high rate of product churning evidenced in these data. The way concepts like comparative advantage and competitive advantage manifest themselves in products bought and sold in the international market place is clearly fluid. This underscores the importance for an economy of maintaining innovative capacity to maintain a steady flow of product introductions to replace the products squeezed out by emerging competition or becoming technologically obsolete.

Table 5 provides the product churning comparisons at the industry level for Canada, China and Mexico. For some industries, Canada's product disappearance rate is in the 20 percent range (mining and oil and gas extraction and chemicals at 22 and 20 percent respectively). At the same time, product introduction rates are high as well in the same industries (25 and 19 percent respectively), pointing to a rapidly changing industrial product landscape.

Table 5: Product churning by industry, Canada, China and Mexico, 2006 versus 1998 (percent)

NAICS – industries	Canada		China		Mexico	
	Exit	Entry	Exit	Entry	Exit	Entry
Agriculture, Forestry, Fishing and Hunting	10	11	12	60	21	14
Mining and Oil and Gas Extraction	22	25	12	55	22	25
Food; Beverage and Tobacco	15	10	10	66	25	31
Textile; Clothing; Leather	19	13	2	51	22	20
Wood; Paper; Printing	4	8	1	46	20	20
Petroleum and Coal Products	2	16	27	127	26	30
Chemicals	20	19	6	59	27	24
Plastics and Rubber; Non-metallic Minerals	7	8	1	14	12	9
Primary Metal; Fabricated Metal Products	7	7	4	38	16	18
Machinery	7	7	5	46	18	24
Computer and Electronic Products	15	11	4	12	12	23
Electrical Equip., Appliance & Components	6	7	1	15	7	9
Transportation Equipment	8	5	4	26	18	12
Furniture and Related; Miscellaneous	11	6	3	9	15	12

Source: Author's calculation based on Robert Feenstra's database, http://cid.econ.ucdavis.edu

Two observations may be made on the data in this table. First, at the industry level, the rate of product turnover is very high, with China in particular registering phenomenal numbers in terms of product entry. Second, in the medium- and high-technology sector, Canada had a lower rate of product entry than exit in three of the industries, matched the exit rate in one and marginally exceeded the exit rate in one. Looked at through the prism of product churning, there is some evidence pointing to a weak Canadian innovation record in terms of Canadian higher technology sectors being unable to introduce new products into international trade at a sufficiently high rate to replace older products being driven out of the international market.

4.3 Product overlaps

We now consider the issue of product overlap – the extent to which Canada competes head-to-head with particular competitors in the U.S. import market. The results for the assessment are presented in Table 6.

Table 6: Product overlap in the U.S. import market, Canada and major competitors, 1998 and 2006, percent

	Canada	China	Mexico	Japan	EU15
					1998
Canada	100	80	87	81	75
China	62	100	72	70	61
Mexico	63	67	100	63	56
Japan	66	74	72	100	65
EU15	92	96	95	97	100
					2006
Canada	100	75	86	81	73
China	83	100	89	90	83
Mexico	64	60	100	65	56
Japan	67	68	73	100	65
EU15	91	93	95	97	100

Note: This table is computed using the full HS 10-digit product groups. For Canada, the total number of products exported in 2006 was 11,869; China exported 9,858; Mexico exported 7,586; Japan exported 8010, and EU15 exported 10821. In 1998, the total number of products that Canada exported was equal to 11,864.

Source: Author's calculation based on Robert Feenstra's database, http://cid.econ.ucdavis.edu

The economy with which Canada's exports in the U.S. market overlap to the greatest extent in this comparison is the EU15. Looking at the column "Canada", in 1998, the EU15 exported 92 percent of the product lines that Canada was exporting. At that time, China was selling to the United States products in 62 percent of the tariff lines in which Canada was selling. In 2006, the Canada-EU overlap was almost unchanged but China was selling in 83 percent of the individual product markets in which Canada was also active. The overlap with Mexico and Japan was lower and changed little between 1998 and 2006.

Accordingly, to the extent that tougher foreign competition explains Canada's revealed inability to introduce new, globally competitive products at a sufficient pace to maintain its overall market share in the all-important U.S. import market, that competition appears to have come predominantly from China, whether due to indigenous value-added activities or because of its role as the final stage of global supply chains that compete with Canadian domestic production.

4.4 *Export similarity index*

The export similarity index (ESI) results for Canada, China, Mexico, Japan, and the EU15 for the years 1998 and 2006 are given in Table 7. The table is to be read by column. The first two columns provide, for 1998 and 2006 respectively, Canada's ESI readings with respect to the U.S. trading partners listed in the row-headings. Similarly, the ESI readings for China for 1998 and 2006 are provided in the third and fourth columns[11].

Table 7: Export similarity index

Countries/ Regions	Canada		China		Mexico		Japan		EU15	
	1998	2006	1998	2006	1998	2006	1998	2006	1998	2006
China	0.12	0.14	-	-						
Mexico	0.31	0.33	0.20	0.22	-	-				
Japan	0.27	0.29	0.19	0.20	0.24	0.24	-	-		
EU15	0.30	0.29	0.17	0.19	0.25	0.25	0.34	0.34	-	-
OEACs	0.19	0.24	0.32	0.37	0.26	0.26	0.31	0.36	0.25	0.29
OHICs	0.20	0.25	0.08	0.08	0.14	0.20	0.12	0.10	0.20	0.21
OMICs	0.22	0.29	0.24	0.26	0.30	0.34	0.21	0.16	0.25	0.25
OLICs	0.16	0.20	0.25	0.21	0.23	0.19	0.17	0.12	0.23	0.20
OECs	0.09	0.13	0.03	0.02	0.06	0.06	0.03	0.01	0.07	0.08

Source: Author's calculation based on Robert Feenstra's database, http://cid.econ.ucdavis.edu

Note, this table was constructed using the full sample of un-concorded data for each of 1998 and 2006.

[11] Note that for each country pair, the ESI is symmetric; hence, we report only the figures below the diagonal.

Among the individual countries and regions considered in the table, the most similar country to Canada in terms of the range of exports to the United States is Mexico, with an ESI value of 0.33 in 2006, followed by Japan the EU15 and the OMICs, all with ESI readings of 0.29. The relation of Canada's exports to the US with those of OEACs and OHICs are not much different. At the other end of the spectrum, we find the oil exporters and China with ESI readings of 0.13 and 0.14 respectively in 2006.

Comparing the 2006 and 1998 readings, the similarity between Canada and other higher income countries/regions generally increased, including with Japan, the OHICs and the OEACs. The notable exception was the EU15 in which case the ESI reading edged down from 0.30 in 1998 to 0.29 in 2006. Strikingly, the greatest increase in similarity was with the other middle income countries, in which case the ESI rose from 0.22 to 0.29 to match the major high income countries/regions. The increase in similarity with Mexico is also noteworthy as is the fact that, from Mexico's point of view, Canada ranks amongst the most similar countries to it (slightly less than OMICs).

China's ESI rose with respect to developed countries and fell with respect to LICs and OECs. It rose with respect to Canada, Japan, the EU15, OEACs and OMICs. It remains the same with respect to OMICs. China's ESI is most similar with respect to OEACs at 0.37; moreover, the OEACs is the group with which China registered the greatest increase in similarity over the period studied, from 0.32 in 1998.

For Japan, the most similar trading bloc is the EU15 and for the EU15 it is Japan.

4.5 Unit value analysis

We now consider the quality dimension. Table 8 compares the unit values of the products exported by Canada, China, Mexico, Japan and the EU15 (column headings) with respect to each other and with the OEACs (row headings). Thus the entry of 71 in column "Canada" and row "China" means that in 1998, among the products that both Canada and China were exporting to the United States, Canada had a higher unit value than China—i.e., Canada's products are "vertically superior"— in 71 percent of the cases. Note that the data above the diagonal are symmetrically 100 less the data below the diagonal. For example, in column "China" and row "Canada", we have the entry 29, which is the share of products for which China has a higher unit value compared to Canada. Note that the number of products for which we could compute unit values varied by year and country pair. The bottom panel of Table 8 gives the number of products for which the calculation was possible for 2006. Thus, for example, in 2006, unit value comparisons for Canada and China were possible for 7,999 products.

Table 8: Share of higher unit value (superior) products (percent)

	Canada	China	Mexico	Japan	EU15
	1998 Superior Product Percentage				
Canada	-	29	35	61	60
China	71	-	59	81	80
Mexico	65	41	-	71	73
Japan	39	19	29	-	45
EU15	40	20	27	55	-
OEACs	66	38	52	77	76
	2006 Superior Product Percentage				
Canada	-	23	35	58	56
China	77	-	68	85	83
Mexico	65	32	-	72	70
Japan	42	15	28	-	45
EU15	44	17	30	55	-
OEACs	69	31	54	78	76
	2006 Number of common products				
China	7,999				
Mexico	6,086	6,257			
Japan	6,635	7,283	5,099		
EU15	9,073	10,283	6,848	8,060	
OEACs	7,077	8,268	5,749	6,692	8,704

Source: Author's calculation based on Robert Feenstra's database, http://cid.econ.ucdavis.edu

Canada had higher unit values for a majority of products compared to China, Mexico and the OEACs but for a minority of products compared to Japan and the EU15 in both years. Comparing the figures for 2006 versus 1998, Canada's relative position in terms of the share of products that command higher unit value strengthened in 2006 from the situation in 1998 with respect to all competitors, except for Mexico in which case the results did not change.

A particularly remarkable observation may be from Table 8 by comparing the entries for China for 2006 versus 1998. China had a lower percentage of products with higher unit value in 2006 compared to 1998 with respect to all trading partners. There are two interpretations, not mutually exclusive, that can be made of this development: first, that China's expansion at the extensive margin in terms of number of export products has been accomplished on the basis of lower prices, even though its expansion has been into higher technology sectors; second, the expansion of lower price goods has outpaced China's product upgrading of existing product lines to command higher unit values.

A further observation is that China's percentage of superior products with respect to Canada is higher than with respect to Japan and the EU15. For both years, Japan is the country that has the highest share of superior products with respect to all partners (reading down the "Japan" column, the entries are more than 50 percent in all rows). The EU15 ranks second in this regard with a higher share of superior products than every country/region except Japan. The inference from these data is that Canada is not as advanced in product quality as Japan and the EU and thus more exposed to competition from China.

To get some indication of the size of the unit value differences between the different country pairs, we turn to the unit-value dissimilarity index. Table 9 reports the values for this index for 1998 and 2006. The figures in this table have the straightforward interpretation of measuring the average percentage difference in unit value between the set of products exported to the United States by a country pair. Thus, a figure of 50 means the average unit value difference was 50 percent.

Table 9: Unit-value dissimilarity index

Countries/ Regions	Canada		China		Mexico		Japan		EU15	
	1998	2006	1998	2006	1998	2006	1998	2006	1998	2006
China	0.58	0.44	-	-	-	-	-	-	-	-
Mexico	0.45	0.38	0.47	0.40	-	-	-	-	-	-
Japan	0.62	0.50	0.59	0.60	0.50	0.54	-	-	-	-
EU15	0.44	0.50	0.57	0.47	0.47	0.43	0.42	0.42	-	-
OEACs	0.63	0.50	0.40	0.73	0.42	0.42	0.50	0.52	0.51	0.52

Source: Author's calculation based on Robert Feenstra's database, http://cid.econ.ucdavis.edu

Note: For computation of UDI, the products that have no unit value for either of the pair countries/regions above have been excluded. For the number of products used in computing this table see the bottom panel of Table 8.

The first thing to note in this table is that the average differences between unit values across countries are large; the range in this table is from 38 percent between Canada and Mexico in 2006 to 73 percent between China and the Other East Asian High Income Countries, also in 2006. The average difference across all the country pairs recorded in the table was 50 percent in 1998 and 49 percent in 2006.

Our second observation is that vis-à-vis the two trading partners that had a superior product quality mix according to the comparison made on the basis of the Product Superiority Index, the unit value wedge narrowed (quite sharply) against Japan but widened (to a lesser degree) against the EU15. Since Japan had a superior product mix to the EU15, there is no consistent way to interpret these changes over time in terms of a narrowing or widening of quality. This underscores the limitations of unit value indices as discussed earlier.

The third observation is that the greatest degree of narrowing was observed vis-à-vis China. Unfortunately, the gap between China and the other East Asian High Income Countries widened from 40 percent to 73 percent; given that the gap between Canada and this latter group narrowed, there is again no consistent reading of developments in terms of price/quality convergence that can square these various observations.

We next consider the distribution of total export value by product groups with unit values falling into different categories defined by the distance from HUV. The results are given in Table 10. Note that in this table row sums equal 100, save for rounding error.

Table 10: Share distribution of country/region's export value by unit value categories

	<10% of HUV	10-25% of HUV	25-75% of HUV	75-100% of HUV	HUV
			1998		
Canada	16	14	46	12	11
China	45	32	20	3	1
Mexico	19	30	40	9	2
Japan	20	16	40	14	11
EU15	17	14	34	16	19
OEACs	39	25	32	2	2
			2006		
Canada	10	10	52	18	10
China	43	34	20	2	1
Mexico	18	18	36	24	5
Japan	16	13	47	15	9
EU15	15	10	32	17	26
OEACs	24	32	33	10	2

Source: Author's calculation based on Robert Feenstra's database, http://cid.econ.ucdavis.edu

Note: For this table, products on which there is no information on unit value were dropped. For the number of products used in computing this table see the bottom panel of Table 8.

First, as a general observation, the most prominent feature in this table is European domination of the HUV category and China's of the low end. Europe had a wide margin of export revenues from HUV products over the next nearest in 1998 (Canada and Japan) and an even wider margin in 2006. China meanwhile had 77 percent of its export values derived from products in the lowest two categories, in both years.

The second observation is the relative evenness of the distribution of export values across categories for most countries. Countries tend to have products that successfully hold market share across a very wide range of relative unit values: for example, Europe generated almost as large a share of export values from product categories in which its products were at 25 percent or less of HUV as from products that were at HUV. This heterogeneity of implied product qualities by individual exporting country/region may be the result of the aggregation biases associated with unit values below even the finest level of disaggregation recorded by customs offices; however, it is consistent with the established fact that firms with widely ranging productivity levels co-exist in markets.

China is an exception in having generated virtually no export revenues from products in the upper two categories, in either year. Given the significant portion of China's exports that are generated by foreign multinationals using China as the final stage in the production chain, and given that China's share of U.S. imports in the medium- and high-technology product groups rose substantially between 1998 and 2006, this is at least somewhat surprising. However, it is not inconsistent with the idea that the products that multinationals tend to produce in China are those that have entered the commodity stage of the product life cycle and no longer command premium prices. China's most direct competitors would seem to be the OEACs which also derived their export revenues disproportionately from products in the last two value groups (64 percent in 1998 and 56 percent in 2006).

In terms of the inter-temporal pattern, most country/regions increased export revenue generation from products in the higher value groups (the last two groups). The biggest shifts were recorded by Mexico (from 11 to 29 percent), EU15 (from 35 to 43 percent), and the OEACs (from 4 to 12 percent). China again stands apart, with virtually no change in its distribution. This latter observation accords with intuition that countries that rely on low-prices are at risk from Chinese competition given that the results are consistent with China expanding its international market presence through lower-priced goods.

The Canadian results are consistent with these general features. In 1998, of Canada's total export earnings in the U.S.

market, 30 percent was obtained by products with unit value less than one-quarter of HUV, while 23 percent was generated from products in the upper two categories, including 11 percent from products commanding the HUV. Between 1998 and 2006, Canada's distribution of source of export earnings moved toward medium and higher unit value products, with the result that in 2006 Canada had the highest share of its export earnings coming from products in the upper three categories (80 percent) of any of the major competitors, including the EU15, which had a corresponding figure of 75 percent.

Another way to examine the distribution of export earnings by products with differing relative unit values is by industry group. For expositional tractability, I consider only two categories for unit values—more than half of HUV and 50 percent or less of HUV. Table 11 provides the share of export value contributed by products whose unit values were more than half of HUV by country/region and industry.

Canada does well in this particular comparison at the aggregate level with the highest share of exports (over 62 percent) accounted for by products with unit values more than half of HUV, although Japan (over 59 percent) and the EU15 (over 58 percent) are not far behind, and Mexico (48 percent) has a fairly high ratio as well. China again stands out: almost 95 percent of its export value is derived from products with unit values less than half of HUV.

Industry-wise, there is quite a bit of variation. Notably, in all five medium- and high technology (MHT) industries, Canada's ratio of export value derived from higher unit products is less than at the aggregate level and in two of these industries it is particularly low: the chemical industry at 28 percent, and electrical equipment at 32 percent. In these two sectors as well as in the transportation equipment industry (56 percent), the leading countries/regions are Japan and the EU15. In transportation equipment, Japan and the EU15 have very high ratios at 83 and 85 percent respectively. However, in machinery and computer and electronic product industries, it is Canada that has the highest share of export revenues contributed by higher value products evaluated across competing exporters[12].

Table 11: Export value share of products with unit value higher than half of HUV (percent)

NAICS Industries	Canada	China	Mexico	Japan	EU15
Agriculture, Forestry, Fishing and Hunting	79.1	43.8	49.2	89.2	49.4
Mining and Oil and Gas Extraction	98.5	75.4	99.1	37.0	97.7
Food; Beverage and Tobacco	34.3	32.5	48.5	77.3	64.5
Textile; Clothing; Leather	32.5	2.7	6.3	56.7	61.8
Wood; Paper; Printing	36.1	8.7	32.8	54.8	34.0
Petroleum and Coal Products	82.7	28.6	97.1	92.4	65.1
Chemical	28.3	14.5	28.4	45.3	53.4
Plastics and Rubber; Non-metallic Minerals	35.3	13.1	21.8	66.3	41.5
Primary Metal; Fabricated Metal Products	61.2	19.6	43.9	40.1	52.8
Machinery	50.0	3.0	33.6	40.5	41.0
Computer and Electronic Product s	61.9	1.2	36.5	19.9	24.0
Electrical Equip., Appliances & Components	32.4	5.3	9.1	12.2	39.6
Transportation Equipment	56.3	9.2	43.3	82.6	84.6
Furniture and Related; Miscellaneous	59.1	2.4	9.6	28.2	61.2
Total	**62.1**	**5.6**	**48.0**	**59.4**	**58.2**

Source: Author's calculation based on Robert Feenstra's database, http://cid.econ.ucdavis.edu.

It is also noteworthy that Canada tends to have higher unit values in some relatively low-tech industries, including mining,

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12 The same comparison done in terms of product counts rather than export revenues yields broadly similar results, although there are some noteworthy differences, which reflect differences in quantities shipped per product. Canada's shares of product counts and export value in 2006 were quite similar for high end products (unit value of over 75 percent of HUV, including products with HUV) at 32 and 28 percent respectively. For the intermediate group (25 to 75 percent of HUV), the value share (52 percent) was significantly higher than the product count (30 percent). For the lowest group (less than 25 percent of HUV), the reverse was true: value share (20 percent) was significantly lower than the product count (38 percent). The interpretation suggested by these figures is that, in Canada's case, the low end and high end products are sold in smaller quantities, as their product count shares are higher than their respective export value shares. On the other hand, middle range products are sold in larger quantities since their export value share is higher than their product count. In contrast to Canada, the export value share of high end products is higher than product counts for Japan and EU15. In China's case the export value share of high end products at 3 percent is lot smaller than the product count share of 22 percent.

oil and gas extraction (98.5 percent of products with unit values equal to more than half of HUV), petroleum and coal products (83 percent), and agriculture and related industries (79 percent).

China has a particularly high concentration of export earnings from lower unit value products in four industries: textile, clothing and leather; machinery; computer and electronic products; and furniture related and miscellaneous. In these sectors, over 95 percent of China's export value comes from products with unit values less than half of HUV.

5. Conclusions

This paper has examined Canada's trade performance in the U.S. market compared to that of China, Mexico, Japan, the EU15, and other groups of countries classified by income levels, through the lens of product dynamics—product penetration, product churning as evidenced by U.S. market entry and exit of products, and degree of head-to-head competition by product group between the various suppliers to the U.S. market.

Using Harmonized System (HS) 10-digit data, the most detailed (disaggregate) level of import data recorded by the U.S. customs service, the value, quantity and unit price of about 16,000 products imported by the United States in 1998 and 2006 from each of the countries/country groups was computed. This level of detail affords the closest possible correspondence between tariff line trade data and individual product data. Recognizing the various caveats, multiple approaches were used to triangulate on some conclusions that could be drawn with some semblance of confidence.

Our results suggest that the number of products that Canada sold in the U.S. market fell between 1998 and 2006. This is inferred from the fact that Canada's product penetration rate declined from 73 to 70 percent of U.S. import tariff lines.

At least some of the explanation for this decline can be attributed to the fact that product introductions lagged product exits. Put differently, Canada was either not able to keep its foothold in individual U.S. product markets to the same extent as competitors, in particular China, or was not able to introduce new products into that market at a sufficient pace to offset the loss of old product niches due to technological obsolescence or intensified global competition. Given that Canada exited 13 percent of the product lines in which it exports to the United States over a period of less than a decade while adding new product lines at the rate of 11 percent of the base year total indicates the importance of on-going export market product development. At the product level, comparative and competitive advantage change rapidly. Put another way, much of the action in trade market shares is at the extensive margin, in terms of product entry and exit.

Concern about the slide in Canada's U.S. market share is mitigated by three considerations. First, at the industry level, Canada improved or maintained its product penetration rate in three of the medium- and high-technology (MHT) sectors, namely machinery, computers and electronic products, and electrical machinery and equipment and lost little ground in a fourth MHT sector, chemicals. The biggest slide was in the transportation sector which is dominated by the troubled automotive industry. Second, Canada is at that stage of development where the normal tendency is to increase specialization and thus to reduce lines of export production. Third, since the observed rates of product introductions vary inversely with the product penetration rate, Canada's relatively high rate of product penetration in the base year may mask a stronger innovation dynamic at the firm level (with one firm's products displacing another's within the same tariff classification) than suggested by the data assessed here.

Given the fact that Canada did lose market share, the paper considered the following question: to which country market share was ceded? The greatest degree of product overlap between Canada and other U.S. trading partners is with the EU15, which ships products in over 90 percent of the tariff lines in which Canada ships. The greatest degree of increase in product overlap, however, came from China, which expanded its presence in product lines that Canada occupies from 62 percent in 1998 to 83 percent in 2006. Examining the same issue through the lens of the Export Similarity Index (ESI), which takes into account the distribution of market share as well as product overlap, it can be seen that, while the similarity between Canada's and China's export palettes did increase between 1998 and 2006, the increase was much more muted than suggested by the increase in product overlap. This suggests again that most of the action in that period was at the extensive margin—product entry and exit. It is important to note, however, that in due course increased initial penetration leads to increased action at the intensive margin—in terms of convergence of market shares by product, which would drive increases in the ESI between Canada and China. In this sense, the ESI can be interpreted as a lagging indicator of competitive pressure while changes in the product overlap measure are leading indicators of such competitive pressures. In other words, the greater impact of China's exports to the United States on Canadian products is yet to come.

The conventional wisdom that China competes on the basis of low price is supported strongly by unit value analysis. China's presence is overwhelmingly concentrated in products that have comparatively low unit values. Given the large number of new, and evidently low-unit-value product entries by China into the U.S. market, and the decline in Canadian product presence in low unit value products, the evidence suggests that the main source of new pressure on Canadian market share in the U.S. market is from China, and it is primarily felt in low-unit-value products. This suggests that the observed structural shift of Canada's product palette towards higher-unit-value products is due more to product exit at the low end than to product up-grading. Again, the action appears to be at the extensive margin.

The evidence amassed here is not conclusive, only suggestive. However, the cumulative weight of circumstantial evidence can be significant. At the product level, the bottom line is that Canada has not been able to introduce new products into the U.S. market at a sufficient rate to replace products that apparently are exiting the market. Given the rapid pace of product churn evident in the trade numbers, an important conclusion is that that Canada has to win market share *on an ongoing basis* through product innovation.

In conclusion, the evidence suggests that the important activity during the past decade has been at the extensive margin in terms of a changing mix of competitors in individual U.S. product markets; importantly, the most pervasive new presence is that of China, including in many knowledge-intensive sectors. This may be problematic for Canada. As noted by Dobson (2004), "Much of the Chinese competition is based on its position in the global value chains of foreign companies, very few of which are Canadian." Given the evidence that suggests exporters learn by exporting and thereby increase their productivity, the major action in the coming decade may be at the intensive margin—through the expansion of market share in product lines where beachheads were established in the recent past. If Canadian companies cannot perform relatively better than other competitors in product and process innovation, Canada's share in the U.S. market is at risk of continuing to fall.

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Appendix 1

Mapping NAICS industries to HS 10-digit products

	NAICS Industry description	Product Examples	Number of Products (1998 / 2006)
11	Agriculture, Forestry, Fishing and Hunting	Horses, live, purebred breeding, male; Roses, grafted or not; Octopus, live, fresh or chilled	1001/1050
21	Mining and Oil and Gas Extraction	Crude or unrefined sulfur; Pebbles and gravel, except limestone; Electrical energy	146/134
311	Food	Carcasses & half-carcasses of swine fresh, chilled; Bones, crude, steamed or ground	1359/1408
312	Beverage and Tobacco	Non-alcoholic beer; Smoking tobacco, ex/pipe tobacco, etc	113/111
313	Textile Mills	Sewing thread artificial filaments for retail sale; Rubber thread and cord; textile covered	1380/1486
314	Textile Product Mills	Textile carpeting, machine-knotted pile, cotton; Babies' diapers of cotton, not knit	377/380
315	Clothing Manufacturing	Women's or girls' vests of cotton, not knit; Men's shirts of cotton, knit	1618/1697
316	Leather and Allied Product Manufacturing	Handbags, of reptile leather; Backpacks, of man-made fiber	494/567
321	Wood Product Manufacturing	Wood in chips or particles; Insulation, coated or not coated, compressed cork	339/400
322	Paper Manufacturing	Coniferous paper, light-weight coated writing etc over 10% mech; Mechanical wood pulp	237/307
323	Printing and Related Support Activities	Dictionaries (including thesauruses); Notebooks, of paper or paperboard	68/68
324	Petroleum and Coal Products	Unleaded gasoline, reformulated; Petroleum jelly	61/79

325	Chemical	Chlorine; gold compounds	2083/2147
326	Plastics and Rubber	Floor coverings of other plastics; nursing nipples and pacifiers	278/301
327	Non-metallic Mineral	Roofing tiles, ceramic; Sinks and lavatories of porcelain or china	406/415
331	Primary Metal	Mineral tars, including reconstituted tars; Parts of axles for railway locos or rolling	1033/1060
332	Fabricated Metal Product	Caulking guns of iron or steel; Sinks and wash basins of stainless steel	704/728
333	Machinery	Poultry incubators and brooders; brewery machinery	1586/1592
334	Computer and Electronic Product	Keyboard units; Line telephone sets with cordless handsets	1289/1247
335	Electrical Equip., Appliance and Component	Electric toothbrushes; Food blenders, domestic	444/450
336	Transportation Equipment	Missile and rocket reaction engines; Motor vehicle horns	401/406
337	Furniture and Related	Seat parts of rubber or plastics; Furniture parts of wood	95/98
339	Miscellaneous	First-aid boxes and kits; Pencil sharpeners	821/843
Total			**16326/16968**

Appendix 2

Country Groups and sub-groups of countries

Low Income Countries
China
Other low wage countries: Afghanistan, Angola, Arab Emirates, Bahamas, Barbados, Benin, Bangladesh, Bolivia, Bosnia, Burkina, Burundi, Cambodia, Cameroon, Chad, Congo, Cuba, C. Africa, Djibouti, Egypt, Equatorial Guinea, Ethiopia, Falkland Islands, French Guiana, Gambia , Georgia , Ghana, Gibraltar, Greenland, Guadeloupe, Guatemala, Guinea , Guyana, Guinea-Bissau, Haiti, Honduras, India, Indonesia, Ivory Coast, Jordon, Kenya, Kiribati, Lao, Liberia, Macau, Madagascar, Malawi, Mali, Moldova, Mongolia, Morocco, Mozambique, Mauritius, Nepal, New Guinea, Nicaragua, Niger, Nigeria, Pakistan, Paraguay , Philippines, Qatar, Rwanda, Samoa, Senegal, Sierra Leone, Somalia, St. Pierre and Miquelon, Sri Lanka, Sudan, Switzerland, Syria, St. Helena, Tajikistan, Tanzania, Togo, Turkmenistan, Uganda, Uzbekistan, Vietnam, Yemen, Yugoslav, Zaire, Zambia, Zimbabwe
Middle Income Countries
Mexico
Other middle wage countries: Albania, Algeria, Angola, Argentina, Armenia, Azerbaijan, Belarus, Belize, Botswana, Brazil, Bulgaria, Burma (Myanmar), Chile, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Dominica Is, Dominican Rep, Ecuador, El Salvador, Estonia, Fiji, Gabon, Greenland, Grenada Is, Hungary, Iran, Iraq, Jamaica, Kazakhstan, Kosovo, Kyrgyzstan, Latvia, Lebanon, Libya, Lithuania, Macedonia, Malaysia, Malta, Mauritius, Montenegro, Namibia, New Caledonia, Oman, Palau, Panama, Peru, Poland, Romania, Russia, Saudi Arabia, Serbia, Seychelles, Slovakia, Slovenia, South Africa, Suriname, Thailand, Trinidad & Tobago, Tunisia, Ukraine, Uruguay, Venezuela, Bahrain, Israel, Turkey,
Oil Exporters: Qatar, Russia, Saudi Arabia, United Arab Emirates, Algeria
High Income Countries
Canada
Japan
EU15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom
Other east Asian countries: Hong Kong, South Korea, Singapore, Taiwan
Other high wage countries: Australia, Bermuda, Iceland, Kuwait, Netherlands Ant, New Zealand, Norway, San Marino, Switzerland

Canadian Inward and Outward Direct Investment: Assessing the Impacts

Someshwar Rao, Malick Souare and Weimin Wang ♦

Abstract: This paper reviews trends in inward foreign direct investment (FDI) and multinational production in Canada as well as Canada's direct investment abroad (CDIA), and provides an assessment of their impact on the Canadian economy. It pulls together a large body of existing empirical literature in Canada and other countries on the economic costs and benefits of FDI. The main conclusion of the paper is that both inward and outward FDI provide significant net long-term economic benefits to both home and host countries, provided they have competitive and dynamic product and factor markets as well as a good and competitive business climate. In addition, there is little evidence of hollowing-out of corporate Canada in terms of movement out of Canada of key corporate headquarter functions of multinational enterprises operating in Canada.

Key Words: Foreign Direct Investment, Multinationals, Economic Growth, Productivity, Hollowing-out

JEL No.: F21, F23, O40

♦ Economic Research and Policy Analysis Branch, Industry Canada. The views expressed in this paper are those of the authors and do not reflect in any way those of Foreign Affairs and International Trade Canada, Industry Canada or the Government of Canada. We would like to thank Jianmin Tang of Industry Canada, Wulong Gu of Statistics Canada and Shenji Chen of Foreign Affairs and International Trade Canada for their many useful comments and suggestions on an earlier draft of the paper.

1. Introduction

Thanks to multinational enterprises (MNEs), the world economy is much more integrated today than 20 years ago. A number of key global economic trends have facilitated as well as necessitated the organization of MNEs' economic activities on a global basis, with a view to minimising costs and improving the quality of their products and services. These include: steep reductions in transportation and communication costs; liberalization of trade and foreign investment regimes in both industrialised and developing economies; rapid improvements in production processes; intense global competition among countries and companies for markets, skilled personnel, capital and innovation activities; and the emergence of China and India as major economic players on the world stage.

Canada too has participated actively in the globalization process by increasing its foreign direct investment (FDI) links with other countries. Indeed, Canada's inward and outward FDI orientations are higher than in many OECD countries.

The main objective of this paper is to review the recent trends in Canada's inward and outward FDI, and the literature assessing their impact on the Canadian economy. The paper concludes that both inward and outward FDI provide significant net long-term economic benefits to both home and host countries, provided they have competitive and dynamic product and factor markets as well as a good and competitive business climate. Little evidence is found of hollowing-out of corporate Canada in terms of moving out of Canada key corporate headquarter functions of MNEs operating in Canada.

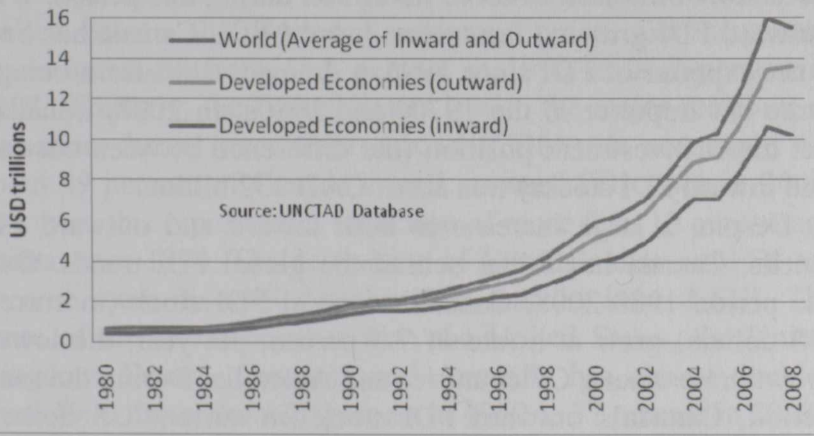
The paper is organized as follows. The next section describes recent trends in FDI and MNE activity, both globally and in Canada. Section 3 discusses the determinants of FDI and their impact on the amount and nature of direct investment in Canada. Section 4 discusses the impact of inward and outward FDI on the Canadian economy, including the issue of whether FDI trends have resulted in a "hollowing-out" of corporate Canada. Section 5 summarizes the main findings.

2. Trends in FDI, Globally and in Canada

2.1 Global Trends in FDI and MNE activity

Global FDI stocks (as measured by the average of reported inward and outward stocks) increased from just USD 0.63 trillion in 1980 to about USD 15.6 trillion in 2008, an average annual growth rate of 12.2 percent (see figure 1). Developed countries accounted for just under 70 percent of inward global FDI and about 88 percent of outward global FDI on average during this period. Nevertheless, the share of developing countries has been increasing. The rise in developing countries' share of inward global FDI steepened sharply in 2008 and in the early part of 2009 as the global financial crisis resulted in a steep decline in inward FDI into the developed world (UNCTAD, 2009).

Figure 1: Global FDI Stock, 1980-2008, USD trillions



The three types of FDI are: greenfield investments; mergers and acquisitions; and re-investment of retained earnings. In developed economies, mergers and acquisitions (M&As) have been the dominant drivers of FDI inflows. During 1987 to 2007, on average, M&As accounted for more than 70 percent of developed countries' FDI inflows. On the other hand, greenfield investment and retained earnings were the dominant sources of

FDI inflows in developing economies. In these countries, M&As accounted for less than one-third of total FDI inflows[1].

Currently there are over 82 thousand MNEs, with over 807 thousand foreign affiliates, operating all over the world – more than a four-fold increase since 1990 (UNCTAD, 2009). Mergers and acquisitions activity has been the preferred MNE strategy of gaining entry into foreign markets. In 2008, MNEs employed about 77 million people around the globe and accounted for over one-third of global trade, primarily through intra-company trade (UNCTAD, 2009). In addition, sales of foreign affiliates totalled USD 30 trillion in 2008 (UNCTAD, 2009).

2.2 FDI and Multinational Activities in Canada

Both Canada's inward and outward FDI stocks have increased steadily since 1980 (see figure 2). Canada's inward FDI stock increased from CAD 64.7 billion in 1980 to CAD 504.9 billion in 2008, while Canada's outward FDI stock increased from CAD 28.4 billion to CAD 637.3 billion during this period. With outward FDI growing faster than inward FDI, Canada has been a net exporter of FDI since 1996, a dramatic shift from being a large net importer in the 1970s and 1980s. In 2008, Canada's net direct investment position (the difference between outward and inward FDI stocks) was about CAD 132 billion.

Despite a large increase in both inward and outward FDI stocks, Canada has fallen behind the global FDI trends. Over the period 1980-2008, Canada's inward FDI stock (in current US dollars) grew at a rate of 7.5 percent per year, the lowest growth rate among G7 countries and Australia. During the same period, Canada's outward FDI stock (in current US dollars) grew at a rate of 11.7 percent per year, the third lowest rate among G7 countries and Australia.

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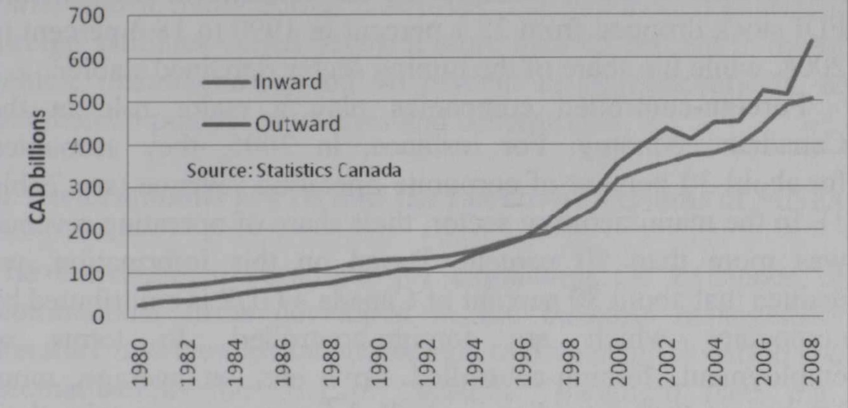
[1] The share of M&As in total FDI inflows into developing countries rose from virtually nil in the late 1980s to one-third of the total in the late 1990s, largely due to the wave of privatization of public assets, and particularly in Latin America. See Calderón, Loayza and Servén (2002) and World Bank (2001).

Figure 2: Canadian Inward and Outward Investment Stocks, 1980-2008, CAD billions



The geographic sources of Canada's inward FDI have became more diversified since 1990. The United States is still the dominant foreign investor in Canada; in 2008, it accounted for about 58 percent of Canada's inward FDI stock, compared to 64.2 percent in 1990. The share of all countries other than the United States, the United Kingdom, France, Germany, and Japan increased from 15.3 percent in 1990 to 24.7 percent in 2008. Similarly, the United States is also the major recipient of Canadian direct investment abroad (CDIA). It accounted for about 49 percent of Canada's total outward FDI stock in 2008; however, this represents a reduction of more than 10 percentage points since 1990. The destination of Canada's outward FDI has become more diversified since 1990 than its inward FDI. The share of all countries other than the United States, the United Kingdom, France, Germany and Australia has almost doubled since 1990, from about 20 percent in 1990 to 37 percent in 2008.

The manufacturing, mining, and finance and insurance sectors are the top three contributors to both inward and outward FDI in Canada. The manufacturing sector still receives the biggest share of Canada's inward FDI, but its share has been declining. In 2008, the manufacturing sector accounted for 34.6 percent of Canada's inward FDI stock, while it was 42.6 percent in 1999. On the other hand, the share of the mining sector has more than doubled since 1999, reaching 20 percent in 2008. The finance and insurance sector has the biggest share of CDIA. Its share increased to 40.3 percent in 2008 from 31.1 percent in 1990. In the meantime, the manufacturing sector share in the outward FDI stock dropped from 28.1 percent in 1990 to 18.3 percent in 2008, while the share of the mining sector remained stable.

Foreign-controlled companies play a major role in the Canadian economy. For instance, in 2005, they accounted for about 30 percent of corporate operating revenue (see Table 1). In the manufacturing sector, their share of operating revenue was more than 50 percent. Based on this information, we deduce that about 30 percent of Canada's GDP is contributed by companies which are foreign-controlled. In terms of employment, foreign-controlled firms are, on average, more productive than Canadian-controlled firms; consequently, their employment share would be somewhat lower than their GDP share. In 2004, foreign affiliates also accounted for over 35 percent of total Canadian business sector R&D spending.

Table 1: Foreign Affiliates' Activities in Canada

	1990	1995	2000	2005*
Manufacturing				
Production				
Level (CAD billions)	179.1	254.5	331.9	375.5
As percent of national total	47.1	51.2	49.9	51.2
Gross Operating Surplus				
Level (CAD billions)	9.3	19.2	29.3	25.3
As percent of national total	52.6	50.2	54.7	55.2
R&D spending				
Level (CAD billions)	1.6	1.8	2.6	2.9
As percent of national total	45.3	37.2	31.0	38.3
Total non-agricultural business				
Production				
Level (CAD billions)	318.9	447.6	694.5	851.3
As percent of national total	30.3	30.1	30.1	29.9
Gross Operating Surplus				
Level (CAD billions)	22.8	31.2	58.0	76.2
As percent of national total	30.0	26.7	30.2	30.5
R&D spending				
Level (CAD billions)	1.9	2.4	3.6	4.4
As percent of national total	37.1	29.7	29.3	34.9

Source: OECD. * Data for R&D spending are for 2004

The economic importance of foreign affiliates in Canada varies considerably across industries. The production shares of foreign affiliates varied between more than 85 percent in motor vehicle manufacturing and 76 percent in pharmaceuticals, to less than 16 percent in utilities and construction.

3. Determinants of FDI and the Location Decisions of MNEs

The conventional paradigm for explaining the existence of multinational firms developed in the business management literature involves advantages related to ownership, location and internalization—the OLI or "eclectic" paradigm (see, e.g., Dunning, 1977). Firm-specific intangible assets, such as unique technologies and superior managerial practices, enable foreign firms to succeed notwithstanding local firms' superior knowledge of the local domestic market (Hymer, 1960/1976)[2]. These intangible assets, which constitute the "ownership" element in this paradigm, can be used in multiple plants within a firm without being diminished (see Blonigen, 2005).

Furthermore, because of potential market failures[3], a firm may not be able to fully capture rents from these assets through

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[2] For a restatement of the ownership advantage in the framework of modern heterogeneous firm theory, see Helpman, Męlitz and Yeaple (2004). In their framework, low-productivity firms produce only for the domestic market; firms with higher productivity incur the fixed costs of entering export markets, while firms with the highest level of productivity incur the still higher fixed costs entailed in FDI. Dunning's "ownership advantage" is captured in the higher level of productivity of outward investing firms.

[3] A range of potential market imperfections or failures have been noted in the literature as possibly providing incentives for MNE formation. For example, in a seminal paper, Buckley and Casson (1976) argued that external markets for transactions in intermediate products that embody firm-specific intangible assets may be inefficient and costly or not even exist. Difficulty of ensuring firm reputation for quality may also dissuade a firm from licensing production to a foreign agent (Horstmann and Markusen, 1987). Preventing knowledge spillovers to potential rivals has also been widely recognized as an important consideration in motivating MNE formation and conditioning their behaviour.

other economic options such as exporting and licensing. Hence, it may be optimal for a firm to establish a presence abroad, thus "internalizing" its global economic transactions.

Historical evidence supporting the ownership and internalization aspects of this paradigm is abundant. For example, as regards the ownership advantage, Markusen (1995; p. 172) notes that industries in which multinationals are prevalent tend to feature firms with "high levels of R&D relative to sales; a large share of professional and technical workers in their workforces; products that are new and/or technically complex; and high levels of product differentiation and advertising." Consistent with this, multinationals tend to be firms whose intangible assets constitute a large share of their market value and, given the potential for spillovers to rival firms, seek to internalize these advantages by expanding their presence abroad through FDI rather than using market mechanisms (Morck & Yeung, 1991, 1992). At the same time, the recent explosive growth of outsourcing and offshoring at a time of growing importance of knowledge capital calls into question the relevance of ownership and internalization advantages; as noted by Doh (2005; p. 698): "By disintegrating production stages along the supply chain and transferring them to other geographic locations, firms may create conditions for the erosion of ownership and internalization advantages." Indeed, Lewin, Massini and Peeters (2008; p. 6) see offshoring as a competing paradigm: "offshoring can be seen as a new form of internationalization by which firms disaggregate their value chain across multiple locations, potentially externalizing portions of it to third party service providers."

FDI location decisions of MNEs, the third leg of the OLI paradigm, depend on country-specific factors such as the size of the economy, factor endowments, costs to trade and FDI, trade and investment barriers, taxes, exchange rates, and other considerations. Firms make location decisions by comparing costs and benefits of affiliates' production across various jurisdictions. Firms with different production structures may respond differently to country-specific factors. By itself, the OLI framework has provided few insights into the spatial patterns and trends of FDI (e.g., McCann and Mudambi, 2004; Bevan and Estrin, 2004). Accordingly, a range of hypotheses have been developed in the economics literature to help explain FDI developments.

Generally, the economics literature distinguishes between two types of multinational firms. A vertically integrated MNE locates its production in different countries based on differences in relative factor proportions across countries (see Helpman, 1984). This is consistent with the Heckscher-Ohlin model which predicts that FDI will flow from capital- or skills-rich countries to capital- or skills-poor countries. Vertically integrated MNEs usually increase host countries' imports of intermediate materials while raising exports of final products. Hence, economic activities of vertically integrated MNEs result in a complementary relationship between inward FDI and trade in host countries (see Johnson, 2005). By the same token, vertical FDI requires trade costs in host countries to be low and the savings from lower cost of production (net of extra trade costs) to be substantial.

On the other hand, a horizontally integrated MNE bases its production decisions on a tradeoff between geographic proximity to markets for its products and concentration of production to realize economies of scale; see Krugman (1983), Markusen (1984), Brainard (1993), and Horstmann and Markusen (1992). When the economic benefits of geographic proximity to markets are substantial, MNEs will split up their production across countries to serve local markets. The horizontal model of MNEs is motivated by large local markets, high trade costs, similar factor endowments across countries, low set-up costs and low plant-level economies of scale relative to firm-level economies of scale[4], whereby trade cost savings more than offset higher costs of foreign production.

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[4] Note: knowledge capital that can be deployed simultaneously in multiple plants is a source of firm-level economies of scale independently of the importance of plant-level economies of scale. On this point, see Chellaraj, Maskus and Mattoo (2009).

The knowledge capital model of FDI, first articulated by Markusen (1997), encompasses both horizontal and vertical motivations for FDI and provides testable predictions about firm choices between FDI and outsourcing based on the relative importance of knowledge capital to physical capital in their operations. The core idea of this model is that knowledge-intensive activities are intensive in skilled labour compared to factory-floor production and hence motivate the formation of vertical multinationals that invest abroad based on relative prices and availability of key factors of production. At the same time, knowledge-based assets (e.g., specific technologies) have a joint-input characteristic in that they can be used in multiple production facilities at relatively low cost, which facilitates the formation of horizontal multinationals that produce the same goods or services in multiple locations based on proximity to markets. Carr, Markusen and Maskus (2001) test this model on U.S. data and find that both vertical and horizontal investments are important and are related to country characteristics, as the model predicts. Testing this model on Singapore data, Chellaraj, Maskus and Mattoo (2009) demonstrate that, as Singapore built up the skill intensity of its workforce, its inward FDI shifted from a vertical orientation to a skill-seeking orientation, while its outward FDI shifted to horizontal types into developed countries and to vertical types into less-developed Asian neighbours.

Most empirical studies find that horizontal FDI dominates vertical FDI among developed countries; see Carr, Markusen and Maskus (2001), Markusen and Maskus (2002), and Gao (2003). But the Canadian evidence indicates that FDI in Canada is comprised more of the vertical type. Wang (2009) found that foreign multinational production in Canada fits well with the factor-proportions hypothesis—for example, foreign MNE production in Canada is increasing in the relative skills difference between investing countries and Canada and is decreasing in the trade costs in Canada.

Most empirical studies using data for developed countries find a positive link between GDP (a proxy for economic size) and inward FDI; see Ghosh, Syntetos and Wang (2007), Nicoletti et al. (2003) and Gao (2003) for OECD countries; and Carr, Markusen and Maskus (2001) and Markusen and Maskus (2002) for the United States. Canadian studies also come to similar conclusions (see Globerman and Shapiro, 1998; and Wang, 2009). This feature in the pattern of global FDI is consistent with the above-mentioned fact that FDI into developed countries is largely horizontal. For example, Markusen et al. (1996) and Markusen (1997) show that horizontal multinational activities increase with host country economic size while vertical multinational activities are not correlated with host country economic size.

The relationship between FDI and trade depends on the underlying motivations for FDI. FDI and trade are predicted to be substitutes under the proximity-concentration hypothesis and complements under the factor-proportions hypothesis. Some studies have found that they are substitutes, at least to some extent[5]; however, more studies report complementarity[6]. These two different relationships do not necessarily contradict each other, as explained by Head and Ries (2004), "studies with focus on narrow product lines can detect the substitutive relationship, while the complementarity can be found upstream

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[5] Head and Ries (2001), using a panel dataset on 932 Japanese manufacturing firms over 1965-1989, find a complementary relationship between direct investment abroad and exports for the full sample. However, firms that are unlikely to ship intermediate products to overseas production affiliates exhibit substitution. Belderbos and Sleuwaegen (1998) examining Japanese electronics firms exports to Europe found that 'tariff jumping' investment induced by EC anti-dumping measures substituted for exports from Japan but firms which invested in EC distribution activities, acquired EC firms, or produce components within a vertical Keiretsu, exported relatively more to Europe. Blonigen (2001), studying Japanese auto parts exports to the U.S. using product-level data, which more closely fits the assumption of a single-product firm that underpins the traditional theory of the MNE, also finds substantial evidence for both a substitution and a complementarity effect between Japanese affiliate production in the U.S. and exports to the U.S.

[6] See Head and Ries (2004) for Japan, Lipsey and Weiss (1981, 1984), Brainard (1997), Brainard and Riker (1997a) and Head, Ries and Spencer (2004) for the U.S., Blomström, Lipsey and Kulchycky (1988) for Sweden, and Fontagné and Pajot (2002) for France.

products of home countries are still attractive to their downstream affiliates abroad." In Canada, outward FDI and exports are found to be complements (see Hejazi and Safarian, 1999). Likewise, inward FDI and host country exports are more likely to be complements than substitutes as foreign affiliates add their production to host countries' exports. For Canadian evidence, see Hejazi and Safarian (1999), Cameron and Cross (1999), Cross (2002), Baldwin, Beckstead and Caves (2001), and Baldwin, Caves and Gu (2005).

The impact of trade costs and barriers on FDI depends on the production structure of MNEs. When trade costs are high, firms might choose FDI as a substitute for exports and become horizontal multinationals. In this case, trade costs have a positive impact on FDI. On the other hand, vertical FDI induces more imports of intermediate inputs and increases exports of final goods in host countries. Hence, high trade costs in host countries would discourage vertical FDI. The empirical evidence is mixed. A positive relationship is found in Ghosh, Syntetos and Wang (2008) and Nicoletti et al. (2003) for OECD countries, and in Markusen and Maskus (2002) for U.S. bilateral FDI, suggesting horizontal motivations for FDI. However, as noted above, a negative relationship is reported in Wang (2009) for Canada's inward FDI, suggesting vertical motivations.

Investment costs and barriers discourage inward FDI. Many factors impact on the cost of investing in a host country such as legal, legislative and regulatory frameworks, foreign ownership restrictions, bureaucracy, and infrastructure. Ghosh, Syntetos and Wang (2008) and Nicoletti et al. (2003) found that, in OECD countries, FDI restrictions reduce inward FDI dramatically while better infrastructure attracts more FDI. Wang (2009) found a negative relationship between the costs of undertaking foreign investment and inward FDI in Canada.

Theoretically, it is fair to say that high corporate taxes discourage inward FDI. However, there is limited empirical evidence in support of this prediction. For example, Ghosh, Syntetos and Wang (2008) found that corporate taxes have no significant negative impact on inward FDI in OECD countries.

However, the lack of empirical evidence on the impact of corporate taxes on FDI might be because the actual tax rates facing foreign affiliates are either not properly measured due to the complexity of tax treatment of these investments or because corporate tax rates do not vary much across OECD countries and over time. Becker, Egger and Merlo (2009) do find evidence of a negative relationship between business taxes (gewerbesteuer) levied at the municipal level and MNE headquarter locations in Germany.

Volatility as well as the level of exchange rates may also impact FDI. High volatility of a host country's currency means high market risk in respect of future returns to investment in that country and thus would discourage inward FDI. Amuedo-Dorantes and Pozo (2001) for U.S. inward FDI, Kiyota and Urata (2004) for Japanese inward FDI, and Nicoletti et al. (2003) for inward FDI in OECD countries provide empirical support for the negative relationship between inward FDI and exchange rate volatility in host countries. The level of the exchange rate might impact inward FDI through two channels: first, as emphasized in Froot and Stein (1991), capital market imperfections lead firms to invest more abroad when their home currency appreciates because their relative wealth increases and the internal cost of capital will be lower than borrowing; and second, currency movements will affect relative labour costs across countries. Both channels imply that a depreciation of a host country's currency encourages inward FDI, and vice versa. Froot and Stein (1991) and Klein and Rosengren (1994) found that US dollar depreciation increases U.S. inward FDI. The same conclusion was reached in Ghosh, Syntetos and Wang (2008) for OECD countries.

4. The Impact of FDI on the Canadian Economy

In this section we pull together the empirical findings on the impact of FDI on Canada's productivity performance and economic growth, as well as the implications for head office activity in Canada.

4.1 *FDI and Productivity*

There are three main channels through which inward FDI impacts a host country's productivity (see Lipsey, 2002).

First, because of superior technological know-how and management practices, foreign-controlled plants tend to have higher productivity levels than domestic firms in the host countries. As a result, the overall productivity level of host countries would tend to increase, the higher the share of foreign-controlled plants in the host economy. This represents a *direct* contribution to host economy productivity (Criscuolo, 2005). There is a large body of empirical literature comparing productivity levels of foreign-controlled and domestic firms. Most studies find evidence in support of this hypothesis; however, there is considerable variation from sector to sector and from country to country[7]. For Canada, higher productivity levels of foreign-controlled firms were reported by Globerman, Ries and Vertinsky (1994), Baldwin and Dhaliwal (2001), Rao and Tang (2005) and Baldwin and Gu (2005). For example, Rao and Tang (2005) found that foreign-controlled firms in Canada, on average, are about 20 percent more productive (in terms of multifactor productivity) than domestic firms.

By the same token, MNEs can contribute disproportionately to productivity growth. Corrado et al. (2009) report that, in the United States, MNEs (both U.S.-owned and foreign-owned) accounted for between 50 and 75 percent of productivity growth in the U.S. non-farm, non-financial corporate sector between 1977 and 2000, and *all* of the productivity growth in this sector in the late 1990s, despite accounting for only about 40 percent

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[7] For example, foreign affiliates in OECD countries have higher levels of productivity than domestic firms in manufacturing, but not always in services. Moreover, the productivity advantage of foreign affiliates in manufacturing ranges from very modest levels in some countries (e.g., Finland, France and the United States) to large levels in a wide range of countries (on the order of 50% to 100% higher) to very large levels in a few countries (on the order of 3 time greater in the United Kingdom and Hungary. See Criscuolo (2005), figures 3 and 4. The extent of dispersion of productivity differentials is very large; ibid, figures 5 and 6.

of the output of this sector. For Canada, Baldwin and Gu (2005) reported that there was a 1.7 percentage-point jump in labour productivity growth between the 1980s and the 1990s in the Canadian manufacturing sector, of which 1.1 percentage points were attributable to the activities of foreign MNEs in Canada.

Second, there could be intra-industry productivity spillovers from foreign-controlled firms to domestic firms—i.e., *indirect* contributions to host country productivity levels. MNEs in general tend to use more advanced technologies and have superior managerial practices, and these may impact on domestic firms within the same industry, resulting in (unintended) productivity spillovers in the industry. Canadian evidence again strongly supports this hypothesis. Gera, Gu and Lee (1999) found that inward FDI has a positive and significant impact on TFP growth in Canadian industries, mainly through reduction of production costs, technology transfer and international R&D spillovers. Baldwin and Gu (2005) and Rao and Tang (2005) also found that domestic firms in industries characterized by larger market shares of foreign producers or with higher FDI penetration tend to have better productivity performance, suggesting positive productivity spillovers from foreign-controlled firms to domestic firms within the same industry.

Third, foreign-controlled firms in one industry could also influence positively productivity performance of the supplier (upstream) and the user (downstream) industries in host countries via inter-industry linkages. As discussed in Gu and Wang (2006), domestic firms in the downstream industries could benefit from FDI via improvements in variety and quality of intermediate inputs, lower input costs and better customer service. Similarly, domestic firms in the upstream industries might receive management training and technical assistance from the foreign-controlled firms and also demand higher product quality from their suppliers. Blomström and Kokko (1998) note that productivity spillovers could also come from increased competition among local firms seeking to become suppliers to multinationals.

The empirical literature on spillovers is mixed: various studies utilizing different methods, examining different economies, and using data at different levels of industrial disaggregation find alternatively positive, nil and in some cases even negative spillovers[8]. Reflecting the mixed results found in the empirical literature, surveys of the literature by Hanson (2001) and Görg and Greenaway (2004) concluded that there is at best mixed evidence for such spillovers. Conversely, more recent studies based on micro data suggest that there are indeed spillovers. In some cases, these are found to be economically large, namely in sectors that are relatively high technology sectors but not in low technology sectors where FDI is seeking cheaper labour; see, Keller (2004) for a survey. Bitzer, Geishecker and Görg (2008) using industry-level data for 17 OECD countries find evidence for spillovers through vertical backward linkages (but not forward, downstream linkages) between multinationals and domestic firms for all countries, but that this effect is much higher for the Central and Eastern European Countries (CEECs) in this group than the other OECD countries. They also find some evidence for positive horizontal spillovers.

As regards the Canadian evidence, using data on Canadian manufacturing industries from 1973 to 1997, Gu and Wang (2008) reported strong and significant inter-industry productivity spillovers via both the forward (downstream) and the backward (upstream) production linkages. Lileeva (2006), meanwhile, reported significant productivity spillovers from FDI in the Canadian manufacturing sector because of strong forward linkages. In particular, the presence of foreign

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[8] A possible negative impact of inward FDI on the host country's productivity might come from the takeover of more efficient domestic firms by foreign MNEs and the increased demand for imported inputs, forcing domestic firms to move down the value chain. This issue is rarely explored empirically and there are no Canada-specific empirical studies. In an empirical study of the impact of FDI in Venezuela, Aitken and Harrison (1999) found that FDI impacted positively on smaller foreign-invested domestic firms but negatively on non-foreign-invested firms. On balance they found the impact on Venezuela to be negligible.

producers in supplier sectors was found to have a strong positive association with productivity growth in domestically-controlled plants in downstream sectors, with the effects being especially important for science-based manufacturing industries. At the same time, negative own-industry spillovers were observed, suggestive of market-stealing by foreign-controlled producers.

Overall, therefore, the empirical literature tends to support, on balance, that FDI spillovers are likely to increase productivity in host countries, although the scale of the impact depends on the industry and the economy and various factors that bear on the absorptive capacity of the economy (Durham, 2004).

As regards the channel through which FDI impacts on domestic productivity, De Mello (1999) concluded that the enhanced labour productivity growth in developed countries was generated through the TFP growth channel, while in developing countries it came via the capital deepening route.

As regards source countries, there has been little emphasis on whether there are differences in productivity impacts of inward FDI in host countries by country of origin. A recent Canadian study by Ng and Souare (2009) found that only U.S.-originated FDI had a significant positive impact on the TFP growth of Canadian industries. This is consistent with findings in previous studies for other countries that U.S.-owned firms or U.S. MNEs tend to outperform both domestically owned firms and non-U.S. MNEs. For example, Doms and Jensen (1998) for the United States and Criscuolo and Martin (2004) for the United Kingdom found that affiliates of U.S. MNEs tended to be more productive than those from other countries. See Ng and Souare (2009) for a brief review of this literature.

Home countries may also receive productivity benefits from outward FDI. MNEs could improve their overall productivity performance by their direct investment abroad from a more efficient allocation of their productive resources globally and their increased exposure to intense global competition. Baldwin and Gu (2005) found no significant difference in the productivity performance of Canadian MNEs and foreign

MNEs, indicating that Canadian firms with international orientation are as productive as foreign firms operating in Canada (this is consistent with earlier findings by Doms and Jensen, 1998, that the important factor underlying the productivity of a plant was not whether it was foreign-owned but whether it was part of multinational enterprise, domestic or foreign). The productivity advantage of home-based MNEs may spill over to domestic firms via the same channels of technology spillovers, business model copying, enhanced domestic competition and increased inter-industry linkages found to be important for foreign-owned MNEs. Empirical evidence on these issues is, however, scarce. Rao and Tang (2005) found that domestically oriented Canadian firms in a given industry do not get a productivity dividend advantage from Canada's outward FDI in that industry. Another channel through which the source economy could benefit from outward vertical FDI would be from the transfer of unskilled labour to the low-wage foreign host countries, which would in turn induce increased capital deepening and skills upgrading in the source economy. Again, however, no strong empirical evidence has been found in support of this argument.

4.2 FDI and Economic Growth

Inward FDI could also impact on the host country's economic growth through capital deepening and increased investments in R&D, intangibles and human capital. This might be reinforced by increased technology diffusion and acquisition of new skills and better management practices, which are conducive to growth (see, for example, De Mello, 1999, and Romer, 1993).

The impact of inward FDI on growth through its impact on domestic capital formation has been extensively studied at various levels and using various types of data—national balance of payments data, industry statistics and firm-level data. Inward FDI, especially "greenfield" investment, increases capital stock in the host countries to the extent that it does not crowd-out local investment on a one-for-one basis, thereby leading to higher output (Ries, 2002). Studies using national-level data arrive at differing conclusions, depending on the country and the type of data used. Hejazi and Pauly (2002) showed that, on average, a one dollar increase in inward FDI raises domestic capital formation in Canada by about 45 cents in non-services industries, but found no significant impact on domestic capital formation in services industries. On the other hand, using data from 22 OECD countries for the years 1975 to 1995, Lipsey (2000) found that the ratio of inward FDI flows to GDP is only significantly related to the next year's capital formation in eight countries, including Canada. In six other countries, the relationship was negative—that is to say, inward FDI crowds-out more domestic investment than its positive contribution to capital formation. Morley (2008) obtains a similar crowding out result for FDI into China.

Foreign MNEs play a major role in business R&D in many countries. For example, in 2005, 75 percent of Ireland's manufacturing business R&D was performed by foreign MNEs. In Canada, foreign affiliates accounted for about 38 percent of business R&D in the manufacturing sector and 35 percent in the total business sector in 2004 (see Table 1 above). Baldwin and Gu (2005) reported that foreign-controlled firms are more likely to perform R&D on an ongoing basis, to introduce product and process innovation, and to adopt new advanced technologies than domestic firms in Canada.

Inward FDI is also an important source of new technologies in host countries. Countries with higher inward FDI tend to have higher technology payments, pointing to intra-firm technology transfer from parent companies to their subsidiaries abroad. Baldwin and Sabourin (2001) found a positive relationship between technology payments and inward FDI stock across OECD countries, which is consistent with Canadian micro evidence showing that foreign-controlled manufacturing plants use more advanced technologies than Canadian-controlled plants.

Empirical studies done at the economy level generally suggest that inward FDI plays a positive role in stimulating host countries' economic growth; however, the size of the growth effect depends on host countries' trade and investment policies, human capital, general business climate and the state of financial markets. Bhagwati (1978) suggested that the growth effect of inward FDI is positively related to export promotion policies and negatively related to import substitution policies of host countries. This prediction is supported by the tests done by Balasubramanyam, Salisu and Sapsford (1996). Blomström, Lipsey, and Zejan (1994) reported that the growth effect of inward FDI is positive in developing countries with high per-capita income, but insignificant in countries with low per-capita income. Borensztein, De Gregorio, and Lee (1995) argued that the growth effect of FDI is positively related to the education level of host country workforce. Xu (2000) also found that the positive growth effect of FDI occurs only when the host country has a minimum threshold level of human capital. Alfaro et al. (2004), Durham (2004), and Hermes and Lensink (2003) reported that countries with well-developed financial markets gain significantly from FDI in terms of economic growth. On the other hand, Carkovic and Levine (2005) argue that many of these studies failed to control for, *inter alia*, simultaneity bias and country-specific effects, resulting in biased estimates of the impact of FDI on growth. Controlling for joint determination of FDI inflows and economic growth, they found that the exogenous component of FDI does not exert a robust positive influence on economic growth.

All studies mentioned above are mostly based on the experiences of developing countries. Studies explicitly based on the experiences of developed countries are rare. Using a panel data for 25 OECD countries over 1980-2004, Ghosh and Wang (2009) found that both inward and outward FDI are positively correlated with host and source country economic growth; however, the impact of FDI on economic growth is moderate, with an elasticity of GDP growth with respect to both inward and outward FDI in the host and source countries of only about 0.01.

Although there are a number of empirical studies on the impact of inward FDI on economic growth in host countries, empirical research on the impact of outward FDI on home country economic growth is scarce. Outward FDI may also impact positively economic growth by raising home countries' trend productivity growth. As noted above, Ghosh and Wang (2009) found a positive but very small growth impact of outward FDI in home countries, with the elasticity of growth to outward FDI being only 0.01.

4.3 Outward FDI and Home Country Employment

There seems to be no consensus among researchers about the impact of outward FDI on home country's factor demands, especially employment (see Baldwin, 1994). Some have argued that there will be a loss of either actual or potential jobs when firms invest abroad. Outward FDI may also influence home country factor demands and factor prices by allocating more labour-intensive production to affiliates in labour-abundant countries and concentrating more capital-intensive or skill-intensive operations at home. Lipsey (2002) argued that larger affiliate output relative to parent output should be associated with lower labour intensity in home production. Others, meanwhile, have argued that firms' investment decisions are based on the efficient use of factors of production globally and much of their investment abroad is induced by the growing competitiveness of foreign producers. Therefore, direct job losses in the activities moving offshore may not be avoided even if firms do not invest abroad. At the same time, outward FDI could increase home countries' exports of intermediate products and capital goods, as well as headquarter services, and thus stimulate job creation at home.

Empirical work bearing on this issue includes both studies assessing the substitutability of employees in MNEs' home countries and foreign workers; and whether outward FDI reduces investment and thus growth in the domestic economy.

Glickman and Woodward (1989) estimated the employment impacts of outward FDI in the United States and concluded that there was on average a net annual loss of 274,000 U.S. jobs (0.5 percent of U.S. jobs) between 1977 and 1986 as a result of U.S. investment abroad. Andersen and Hainaut (1998) investigated the relationship between outward FDI and home country employment using panel data on 21 countries over 1985-1995 as well as time series for the United States, Japan, Germany and the United Kingdom. They found only limited evidence in support of the notion that outward FDI leads to job losses in source countries. Brainard and Riker (1997) and Riker and Brainard (1997) also estimated substitution elasticities between employment in parent companies and their foreign affiliates, based on panel data for U.S. multinationals and their affiliates in 90 countries. They too discovered a very low degree of substitution between parent and affiliate employment. Using data on U.S. manufacturing multinationals in the 1980s, Slaughter (1995) reported that home and foreign production workers are at best weak substitutes and they might be complements. By contrast, Hatzius (1998) concluded there is qualified support for substitutability between foreign labour and home country employment of Swedish MNEs. Pain and Van Welsum (2004) meanwhile found that international production relocation in non-service sectors is more likely to provide a positive stimulus to services exports than is relocation in service sectors, which tends to reduce services exports. Taking these various findings into account, the generally weak degree of substitutability between employment in parent companies and their foreign affiliates in non-service sectors, together with the potential for gains in service sector exports, suggests that the displacement of home country workers via outward FDI in goods-producing industries is likely to be small. This conclusion may not apply to outward direct investment in services.

As regards the issue of outward FDI and domestic capital formation, a range of studies have arrived at different conclusions, depending on the empirical approach, and in particular on the level of aggregation of the data and the country studied. Desai et al. (2005), using national-level data, found that, for most OECD countries, high rates of outward FDI were associated with lower domestic investment, suggesting that outward FDI and domestic investment are substitutes. For the United States, however, they found that years in which American MNEs expanded investment abroad coincided with even greater domestic capital spending, suggesting a complementary relationship between outward FDI and domestic capital formation. In a follow-up study using firm-level data, Desai et al. (2008) confirmed a complementary relationship, finding that 10% greater foreign investment by U.S. MNEs was associated with 2.6% greater domestic investment by those MNEs, and 10% greater foreign employee compensation was associated with 3.7% greater domestic employee compensation.

As regards the hypothesis linking outward FDI to increased skill intensity in source countries, there is no strong empirical support. Kravis and Lipsey (1988) did not find a consistent positive correlation between affiliates output and skill intensity (measured by hourly wages) of employees of the U.S. MNEs at home. Using data on U.S. manufacturing industries, Slaughter (2000) also did not find a significant impact of affiliate activities on skills upgrading at home. Industry-level analysis by Head and Ries (2002) reached similar conclusions for Japan, but their firm-level analysis suggested that affiliate activities in low-wage countries tend to raise parent firms' demand at home for skilled workers relative to the demand for unskilled workers.

4.4 Is Corporate Canada Hollowing out?

"Hollowing out" refers to the move of head offices out of an economy. Head offices are important to an economy because of the concentration of key management functions and activities. These include: human resource planning; marketing; R&D; financial management; international operations; and information acquisition and filtering. Concentration of these activities could raise the overall skill levels and wages of employees at firm headquarters, resulting in productivity spillovers in home countries.

There has been a great deal of public discussion and debate in Canada over recent foreign takeovers of large and established Canadian companies, and their potential adverse impact on the Canadian economy. Therefore, empirical investigation of the hollowing-out of corporate Canada has important policy implications.

As noted in Acharya and Rao (2007), the positive effects of head offices are expected to stem largely from the concentration of R&D activities and skilled workers associated with the head office functions. R&D activities generate and accumulate knowledge capital that benefits the local economy through knowledge transfer and knowledge spillovers. Such activities also could attract other foreign firms to the country. Since the overall business climate is an important determinant of R&D activities of MNEs and since R&D and skills are complements, the availability of skilled workers and competitive market framework policies in host countries are crucial for attracting and retaining R&D activities of foreign as well as domestic MNEs.

To understand well the extent and nature of hollowing-out in corporate Canada, empirical attempts are needed to investigate the long-term trends and dynamics of head office activities and head office employment in Canada. A number of recent Statistics Canada studies shed light on this important policy issue.

Baldwin, Beckstead and Brown (2003) found little evidence that head office functions were being scaled down during the late 1990s and early 2000s. The authors actually reported that the number of head office units increased from 3,936 to 3,969 between 1999 and 2002, and employment in head offices during the same period increased at an annual rate of about 1 percent. Baldwin and Brown (2005) examined the long-run trends in head office employment in the Canadian manufacturing sector over the last three decades and again found little evidence of hollowing-out. A more recent paper by Beckstead and Brown (2006) also came to the conclusion that hollowing-out of corporate Canada is not happening. Instead, the authors reported that, over 1999-2005, both the number of head offices and head office employment in Canada grew at an annual rate 4.2 percent and 11 percent, respectively.

Another interesting question is whether management functions of Canadian firms that are taken over by foreign firms are moving abroad, resulting in the loss of head offices and head office employment. Beckstead and Brown (2006) investigated the dynamics of head offices in Canada and found that foreign-controlled firms were actually the main driving force behind the growth in the number of head offices and head office employment in Canada during 1999-2005, accounting for six out of ten new head-office jobs created during the period. In addition, over this period, the number of head offices of Canadian-controlled firms actually fell slightly, while counts of head offices in foreign-controlled firms rose; the head office employment of foreign-controlled firms increased by 21 percent, while the corresponding figure for Canadian-controlled firms grew by only 6 percent.

In short, the empirical evidence to date show that foreign takeovers have reduced neither the number of head offices nor the head-office employment in Canada. On the contrary, more new head offices were created than lost and the overall head office employment was just as high after the takeovers, if not higher, as before the takeovers.

Based on a detailed survey of senior managers of 62 MNEs operating in Canada during the post-NAFTA period, including foreign-owned as well as Canadian-owned firms, the Conference Board of Canada concluded that many foreign-owned subsidiaries in Canada have become strategic leaders in their company's global network (Hodgson, 2007). This result is contrary to the fear that foreign affiliates might move out of Canada and make Canada a "warehouse economy".

5. Conclusions

Canada has actively participated in the globalization process. Canada's inward and outward FDI stocks increased dramatically over the last three decades and Canada has been a net exporter of capital since 1996. Multinational production accounts for about 30 percent of total business output and more than 50 percent of total manufacturing production in Canada.

To understand better the impact of FDI on Canadian economy, this paper reviews available empirical evidence on the home and host country effects, with a focus on the Canadian experience.

The available empirical Canadian evidence suggests the following: inward FDI expands Canadian exports and the impact increases with reductions in trade and investment barriers worldwide; foreign-controlled firms, on average, have higher productivity levels than Canadian-owned firms, although this is mainly because of the difference in outward orientation (Canadian MNEs are as productive as their foreign-owned counterparts); intra- and inter-industry productivity spillovers from FDI are also significant; and inward FDI also raises economic growth in Canada through increased investments in physical and knowledge capital and skills upgrading, technology transfer and knowledge spillovers.

An important recent policy concern has been the hollowing-out of corporate Canada. A number of studies examined this issue and found no evidence in support of the hollowing-out of corporate headquarter functions. Instead, these studies showed that head office functions in Canada have actually increased in recent years.

On balance, all the empirical evidences indicate that FDI provides significant net economic benefits to Canada. The policy implication of these findings is that Canada would benefit further by liberalizing its regulatory regime relating to FDI and foreign ownership. For instance, research done at the OECD (Nicoletti et al. 2003) and Industry Canada (Ghosh, Syntetos and Wang, 2008) suggest that by reducing its FDI and foreign ownership restrictions to the low levels in the United Kingdom, Canada could increase its inward FDI stock by as much as 50 percent over a 5 to 10 year period and raise its aggregate total factor productivity by between 3 percent to 5 percent.

Although there is ample empirical research on the positive impact of inward FDI on trade, capital formation, R&D, productivity and economic growth in Canada, the evidence on the impact of outward FDI on the Canadian economy is very scarce, see Table 2. Future research efforts should concentrate in closing this important knowledge gap.

Table 2: A Summary of the Empirical Research

Variables	Inward FDI (host country impacts)	Outward FDI (home country impacts)
Trade (exports and imports)	(+)	(+)
Capital formation	(+)	?
R&D	(+)	?
Skills	(+)	?
Technology adoption	(+)	?
Productivity level	(+)	(+)
Intra-Industry productivity spillovers	(+)	?
Inter-Industry productivity spillovers	(+)	?
Economic growth	(+)	?

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