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Trade Liberalization: Export-market Participation, Productivity Growth and Innovation

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Abstract

The paper examines how Canadian manufacturing plants have responded to reductions in tariff barriers between Canada and the rest of world over the past two decades. Three main conclusions emerge from the analysis. First, trade liberalization was a significant factor behind the strong export growth of the Canadian manufacturing sector. As trade barriers fell, more Canadian plants entered the export market and existing exporters increased their share of shipments sold abroad. Second, export-market participation was associated with increases in a plant's productivity growth. Third, our analysis identified the presence of three main mechanisms through which export-market participation raises productivity growth among plants: learning by exporting; exposure to international competition; and increases in product specialization that allowed for exploitation of scale economies. Our evidence also shows that plants that move into export markets increase investments in R&D and training to develop capacities for absorbing foreign technologies and international best practices. Finally, entering export markets leads to increases in the number of advanced technologies being used, increases in foreign sourcing for advanced technologies and improvements in the information available to firms about advanced technologies. It is also associated with improvements in the novelty of the innovations that are introduced.

Keywords: tariff reduction, export participation, productivity growth and innovation

Executive summary

Two themes have dominated policy discussions in Canada and the OECD during the past two decades. The first is trade liberalization. The second is the benefits that an economy receives from innovation. Economists have long touted the benefits of trade liberalization. And during the period of the post 1973 slowdown in productivity growth, they turned increasingly to innovation for a cure to the slow technological changes that seemed to be taking place in North America. Rarely are trade liberalization and innovation empirically linked. In this paper, we do so by examining the implications of export growth for innovation and productivity growth.

We link the two by investigating two sets of events surrounding the Free Trade Agreement (FTA) between Canada and the United States. In the first instance, we investigate the nature of the firms that turn from purely domestic activities to export markets and whether the transition to export markets increases productivity.

We find that exporters in Canada have superior performance when it comes to labour productivity growth, output growth and wage growth. After controlling for other plant characteristics and industry and period fixed effects, annual labour productivity growth in exporters is 0.6 percentage points higher, shipment growth is 0.3 percentage points higher, and average wage growth is 0.6 percentage points higher. In contrast, employment growth is lower in exporters. Plants that become exporters not only increased their market share, they increased value added while decreasing their labour inputs all the while increasing their average wage rate. This suggests a transition to a higher skilled labour force, a plant that is less labour intensive and one that requires fewer supervisory personnel.

The results for Canada stand in sharp contrast to those for the United States. At the time of the North American Free Trade Agreement (NAFTA), exporters in the United States did not experience superior labour productivity, output or wage growth. We conclude that the benefits of trade liberalization are more evident in the smaller partner to a free trade agreement.

In the second instance, we ask whether the producers that enter export markets develop innovative capabilities that might explain increases in productivity. Evidence is presented of the presence of four mechanisms that raise productivity growth—increases in plant specialization, learning by exporting, exposure to international competition, and increased innovation.

The evidence shows that export-market participation was linked to increases in plant specialization. Operating behind tariff barriers and limited market size, Canadian plants have often been seen to have production runs that were too short to exploit economies of large-scale production. Trade liberalization and access to a much larger U.S. market were intended to allow Canadian plants to reduce product diversification and improve the length of their production runs. Our findings corroborate the existence of these effects. Plants that began to export after the FTA increased their product specialization (and therefore their production-run length) relative to those that did not export.

Three pieces of evidence support the view that exporting facilitates the transfer of knowledge across countries and enhances the innovation process in the Canadian economy. First, exporting was linked to an increase in the use of foreign technology at plants. Second, it was connected to an increase in the incidence of R&D collaboration agreements with foreign buyers. Third, exporting improved the flow of information about foreign technologies to Canadian plants.

Productivity gains from export-market participation do not materialize from thin air. Exporters tend to be the more innovative firms, both before and after they enter export markets. But becoming exporters did lead to changes in the nature of innovation. It was associated with the greater use of advanced technologies, thereby increasing the intensity of process innovation. In order to accomplish this, exporters acquired more foreign technologies and developed enhanced absorptive capacities that allowed them to ingest new knowledge. Exporters invested more in R&D and staff training thereby developing a greater capacity for absorbing foreign technologies. Innovators thereby improved the nature of their process innovation and tended to produce world-first innovations or Canada-first innovations more frequently.

All of this suggests that policy recommendations in the area of trade liberalization and innovation policy need not be treated separately as they normally are. The Canadian experience with trade integration into a larger North American market shows that some of the benefits come from standard sources—the exploitation of economies of scale. But there is evidence that trade liberalization was also associated with improvements in the innovation capabilities of firms that moved into export markets.

1. Introduction

Two themes have dominated policy discussions in Canada and the OECD during the past two decades. The first is trade liberalization. The second is the benefits that an economy receives from innovation. Economists have long touted the benefits of trade liberalization. And during the period of the post 1973 slowdown in productivity growth, they turned increasingly to innovation for a cure to the slow technological changes that seemed to be taking place in North America. Rarely are trade liberalization and innovation empirically linked. In this paper, we do so by examining the implications of export growth for innovation and productivity growth.

To condition our analysis, we approach the world as one inhabited by heterogeneous agents, each of whom learns about their own capabilities and what is required to succeed in a constantly changing world. In this world, firms develop capabilities that are then rewarded or penalized by market forces. Producers experiment with new activities, technologies or new markets and benefit or fail as a consequence.

Classic policy recommendations regarding trade liberalization make use of static frameworks where technology and production functions are taken as exogenous. Despite the usefulness of this framework, an alternative model provides additional insights on other effects that might be expected to flow from trade liberalization. Trade liberalization changes the set of opportunities over which firms search. It enables firms to investigate new options in terms of markets and to learn from their experiences in these markets. Learning culminates in the adoption of new technologies or other innovations.

This paper examines the extent to which innovation capabilities were enhanced as Canadian firms entered export markets after the formation of a North American free trade area. To do so, we use microeconomic databases that track the performance and innovative activities of firms. We examine the nature of the firms that turn from purely domestic activities to export markets, show that entry to export markets is associated with an increase in productivity and demonstrate that these gains are closely related to the development of innovative capabilities.

For our investigation, we make use of Canadian microeconomic data on manufacturing firms and their innovative capacity. This has two advantages. It allows us to study a country that has recently gone through a dramatic change in its trading relationships with a much larger neighbour—the United States. The two countries entered into a Free Trade Agreement (FTA) in 1989 that would gradually eliminate all manufacturing tariffs between them. Since the Canadian economy is only about one-tenth the size of the U.S. economy, a study of the effects of trade liberalization provides us with an understanding of the benefits that small countries gain when joining larger trading blocks.

A study of Canada benefits from the nature of the data available from Statistics Canada—one of the world's foremost statistical agencies. It uses one of the first longitudinal databases of establishments in manufacturing that was created for studies of industrial dynamics—a database

that permits entry, exit, growth and export activity to be tracked quite precisely.[1] Statistics Canada has also pioneered technology and innovation surveys[2] that can be linked to the manufacturing database so that we can observe how changes in export activity are related to a plant's activities in this area.

2. Background

A number of models have examined the link between tariff reductions and a plant's participation in the export-market (Bernard et al. 2003b, Melitz, 2003). In these models, only the most productive plants enter the export market to overcome trade barriers. As trade barriers fall, exporters increase their sales abroad and the most productive among the non-exporters start to sell in export markets. In the first part of this paper, we examine the relationship between tariff reductions and the decision to enter the export market using a longitudinal sample of manufacturing plants in Canada. In the second part, we ask how this export decision was related to productivity growth and innovation.

To examine the implications of export-market participation for innovation and productivity growth, we depart from previous studies that just examine the impact of exporting on productivity growth. We also examine a variety of mechanisms through which exporting raises productivity growth. These include learning-by-exporting, exposure to international competition, the exploitation of scale economies via increased product specialization, increased technology use and innovation.

Previous studies have argued that trade facilitates the transfer of knowledge and ideas across countries (Grossman and Helpman, 1991). In particular, participation in export markets brings firms into contact with international best practices and fosters learning and productivity growth (World Bank, 1997). Following the seminal piece on international R&D spillovers by Coe and Helpman (1995), a number of other studies investigated simple macro relationships in an attempt to ascertain whether imports acted as a conduit for knowledge transfer across countries. Eaton and Kortum (2001) and Gera, Gu and Lee (1999) demonstrate that access to foreign intermediate inputs and capital goods through imports is associated with higher productivity growth. However, most of these studies focus on imports and use the black-box approach that relies on aggregate industry-level data. They provide us with little evidence on changes in the actual technologies, or practices of producers. By contrast, we use plant-level data to examine the role that exporting plays in international technology transfers.

The rest of the paper is organized as follows. In the following section, we examine the link between trade liberalization and rising export-market participation of Canadian manufacturing plants. In Section 4, we present evidence that exporting is linked to higher productivity growth. To compare our results for Canada with those for the United States, we will use an empirical specification that is similar to the one in Bernard and Jensen (1999). In Section 5, we examine the mechanisms that lead to higher productivity in exporters. In Section 6, we conclude.

1. For more information, see Baldwin (1995) and Baldwin, Beckstead and Girard (2002).
2. See Baldwin and Hanel (2003).

3. The link between trade liberalization and export-market participation

Trade liberalization between Canada and the United States has been associated with a substantial increase in the percentage of plants that export (Baldwin and Gu, 2003). In a world where firms are heterogeneous entities, the reaction of enterprises to new opportunities or constraints is expected to differ. How their characteristics condition the response to lower tariffs is the subject of this section.[3] In this respect, a key question revolves around the productivity of firms that enter the export market. We ask whether firms that enter the export market tend to have higher productivity before they make that decision—both because we want to know whether there is something special about their production process and because we want to condition subsequent values of productivity on initial conditions. Simply finding higher productivity levels in exporters than in non-exporters tells us little about the impact of exporting on productivity if exporters were already more productive before the export decision.

The probability that a non-exporter becomes an exporter over a period is estimated as a function of plant labour productivity, the change in U.S. tariff rates applied to Canadian exports, the change in Canadian tariff rates applied to U.S. exports, and the interactions of tariff changes and plant labour productivity from a sample of non-exporters. The probit model is given by

$$(1) \qquad \text{Prob}(E_{pt} = 1) = \Phi\left[a_t + b_i + d_1 RP_{pt} + d_2 \Delta t_{it} + d_3 RP_{pt} \Delta t_{it} + g Z_{pt} \right]$$

where E_{pt} is a binary variable which takes a value of one if a non-exporting plant p becomes an exporter in period t and zero otherwise, RP_{pt} is the labour productivity of the plant relative to that of the mean plant in the same SIC 4-digit industry at the start of period t, Δt_{it} is the annual average change in industry tariff rates during period t, Z_{pt} is a set of plant characteristics that include plant size, plant ownership (foreign vs. domestic), and plant age at the start of the period. Industry fixed-effects b_i are included to control for differences in export-market participation rates between industries. Time fixed-effects a_t are included to allow for differences in export-market participation over time, which arise from events such as movements in foreign exchange rates and changes in the macro performance of the export market.[4]

3. Bernard, Jensen and Schott (2003a) have examined the link between changes in industry trade costs and plants' participation in the export market in a sample of plants for the United States.
4. The production data come from the Canadian Census of Manufactures and tariff data for Canada and the United States—more than 80 percent of Canadian exports go to the United States. The data are discussed at greater length in the Appendix.

Table 1. Summary statistics for the sample used for examining tariff cuts and exporting

	Panel of continuing plants	
	1984-1990	1990-1996
Number of plants	10,106	9,036
Annual average changes in Canadian tariff rates against the U.S. (%)	-0.36	-0.75
Annual average changes in U.S. tariff rates against Canada (%)	-0.22	-0.36
Share of exporters at the start of a period (%)	37	53
Share of non-exporters that become exporters (%)	38	38
Share of exporters that become more export-intensive (%)	48	58

Canadian tariffs against the United States are intended to capture the extent of import competition of Canadian plants. Caves (1990, 1991) traced a sequence whereby trade cost reductions in the 1970s lowered Canadian domestic prices but raised capital expenditures, induced productivity-enhancing reorganizations, and ultimately caused Canadian plants that faced import competition to become exporters. Canadian tariff rates on U.S imports also affect production costs of Canadian manufacturing plants. Manufacturing industries in Canada and the United States are highly integrated. Canadian producers purchase a large portion of intermediate inputs and investment goods from the United States. As Canadian tariffs against the United States fall, the costs of Canadian production decline. Declines in Canadian tariffs are therefore expected to increase the export-market participation rates of Canadian manufacturing plants.

To estimate equation (1) for export-market participation, we pool two panels of continuing plants, one over the period 1984-1990 and the other 1990-1996. As shown in Table 1, we have a total of 10,106 plants for the period 1984-1990 and 9,036 plants for the period 1990-1996. The final sample for the estimation consists of two panels of "long form" continuing plants that are non-exporters at the start of each period.[5]

The two panels cover the period both prior to and after the FTA between Canada and the United States. Tariff rates fall in both periods, but reductions became larger in the latter period, following the Canada-U.S. FTA. Over time, more plants in the Canadian manufacturing sector enter the export market and exporters become more export-intensive. The proportion of plants that export rose from 37 to 53 percent between the 1980's and 1990's (Table 1) and 48 percent of exporters increased their export/shipment ratios. That share increased to 58 percent for the period 1990-1996.

5. We cannot reject the hypothesis that error terms are independent among plants within 4-digit SIC industries using a likelihood ratio test. As such, we do not account for clustering in our estimation (Moulton, 1990).

Table 2. Probability of entering the export market

	(1)	(2)	(3)
Tariff changes	--	--	-1.9993
			(-2.01)
Canadian tariff changes	-2.9985	-3.2180	--
	(-2.19)	(-2.33)	
U.S. tariff changes	4.0713	2.1754	--
	(1.53)	(0.81)	
Relative labour productivity	0.0386	0.0417	0.0284
	(4.52)	(4.73)	(2.39)
Relative labour productivity × tariff changes			-1.7204
			(-1.74)
Foreign-controlled plants		-0.0188	-0.0186
		(-1.26)	(-1.25)
Plant size		0.0954	0.0960
		(18.08)	(18.20)
Young plants		0.0629	0.0630
		(4.69)	(4.70)
Dummy for period 1990-1996	0.0346	0.0358	0.0354
	(2.88)	(2.96)	(2.92)
Observations	10,523	10,523	10,523
Log likelihood	-6,188.75	-6,018.62	-6,018.24

Note: Numbers in parentheses are robust t-statistics. The coefficients are marginal changes. Regressions cover two panels 1984-1990 and 1990-1996. All specifications include fixed effects for 4-digit industries.

Canadian tariff reductions have a positive effect on the decision of Canadian plants to enter the export market. The results reported in Table 2 imply that the 4.5 percentage point decline in Canadian tariffs in the period 1990-1996 is associated with a 24 percentage-point increase in the probability that an average plant will enter the export market in the period.[6] This represents a 63 percent increase in the probability that a plant enters the export market.[7] This finding is consistent with the argument that import competition induced Canadian manufacturing plants to expand into the international market. It is also consistent with the view that the reduction in production costs due to cheaper imports and lower tariffs improved the competitive position of Canadian manufacturing plants and facilitated an increase in exports.

When included alongside Canadian tariff cuts, the decline in U.S. tariffs is not significantly related to the decision of Canadian plants to enter the export market. However, when the Canadian tariff variable is dropped and the U.S. tariff variable is introduced separately, the coefficient is negative and statistically significant. The political-economy considerations that determined tariff cuts in the two countries were sufficiently similar that it is difficult to separate the effect of Canadian from U.S. tariff cuts.

6. The calculation is based on the coefficient estimate in Specification (2) in the table.
7. The probability that a plant becomes an exporter in the sample is 38 percent. The estimated effect of tariff changes is large. This may suggest that the parameter is also picking up the effect of reductions in non-tariff trade barriers such as improvements in transportation and communication. Head and Ries (1999) show that changes in tariff barriers and overall trade barriers are highly correlated across industries.

Baldwin and Caves (1998) argue that import competition and export opportunities both matter since most manufacturing plants in Canada sell outputs and purchase inputs in the U.S. What matters is the overall effect of Canadian and U.S. tariffs on their competitive position in the world market. When we include the sum of the two tariff changes as an independent variable (Specification 3 of Table 2),[8] its coefficient has the expected sign and is statistically significant at the 5 percent level.[9] The interaction term between plant productivity and tariff changes has the expected sign and is statistically significant at the 10 percent level. It is the more productive non-exporters that enter the export market when tariff barriers fall.[10]

Larger, younger and more productive plants are more likely to enter the export market. The difference in the export participation between foreign- and domestic-controlled plants is not statistically significant after controlling for plant size, age and plant productivity.

The coefficient on the fixed effect for the period from 1990-1996 is positive and significant at the 5 percent level. This may have occurred because the FTA between Canada and the United States provided a trade dispute mechanism that increased the degree of certainty that producers faced with regard to a reversal of the liberalization process. But the positive fixed effect in the 1990s could also be the result of the weak Canadian dollar and the strong U.S. economic performance in the 1990s.

Export to GDP ratios improved both because of entry to export markets and because existing exporters increased their export intensity. To investigate the plant characteristics associated with changes in the latter, we estimated a probit model for the increase in export/shipment ratios from two panels of exporters over the 1984-1990 and 1990-1996 periods (Table 3). The decline in Canadian tariff rates is linked to an increase in export/shipment ratios for current exporters. The coefficient on the decline in U.S. tariff rates is not statistically significant. When the sum of the two tariff changes is included, the coefficient on the variable has the expected sign and is significant at the 10 percent level. The size of the coefficient implies that the 1.01 percentage points decline in the sum of U.S. and Canadian tariffs in the period 1990-1996 is associated with a 13 percentage-point increase in the probability of exporters becoming more export intensive.[11] Larger plants tended to increase their export intensity more than smaller plants, which is consistent with the argument that scale economies are important. But productivity in the initial period was not related to subsequent success. And there was no difference in the tendency of foreign plants to increase their export intensity than domestic plants, once controls were entered for plant size and age.

8. The exact weights given to two tariff rates in measuring the overall effect of tariff cuts should depend on the relative importance of imports and exports for individual plants. Due to a lack of information in this area, we assign equal weight to the two tariff rates.
9. The coefficients on two tariff variables are sensitive to the choice of industry fixed effects, but the coefficient on overall tariff changes is not. When we include a set of 2-digit industry fixed effects, we find that the coefficient on U.S. tariff rates has the expected sign and is statistically significant, and the coefficient on Canadian tariff rates is not significant.
10. To examine the difference in the impact of tariff changes on a plant's decision to export between periods 1984-1990 and 1990-1996, we have included the interaction of tariff changes and the dummy for period 1990-1996. The coefficient on the interaction term is negative and significant at the 5 percent level. This suggests that plants are more responsive to tariff changes in the FTA period 1990-1996 when tariff reductions became larger.
11. The average export/shipment ratio for exporters was 28 percent in 1990.

Table 3. Probability of increasing export/shipment ratios

	(1)	(2)	(3)
Tariff changes	--	--	-2.1924
			(-1.72)
Canadian tariff changes	-3.8055	-4.0229	–
	(-2.09)	(-2.21)	
U.S. tariff changes	1.6072	1.7868	–
	(0.50)	(0.55)	
Foreign-controlled plants		-0.0050	-0.0049
		(-0.36)	(-0.35)
Plant size		0.0428	0.0428
		(7.46)	(7.45)
Young plants		-0.0269	-0.0265
		(-1.61)	(-1.59)
Dummy for period 1990-1996	0.1050	0.1088	0.1086
	(8.63)	(9.89)	(8.88)
Observations	8,503	8,503	8,503
Log likelihood	-5,566.27	-5,530.28	-5,531.17

Note: Numbers in parentheses are robust t-statistics. The coefficients are marginal changes. Regressions cover two panels 1984-1990 and 1990-1996. All specifications include fixed effects for 4-digit industries.

4. Does exporting raise labour productivity growth?

Trade liberalization then was strongly associated with a redirection of economic activity. In industries where Canadian and U.S. tariffs fell, plants entered export markets and increased their export intensity. At issue is whether this led to major changes in industrial structure—outside of the reallocation of resources from import competing to export industries. A growing number of studies have approached this issue by asking whether firms that moved into the export market had higher productivity growth. Bernard and Jensen (1999, 2001) who examine the performance of U.S. manufacturing plants find no evidence that exporting raises plant productivity growth. In contrast, Baldwin and Gu (2003) find strong and robust evidence that export-market participation is linked to higher productivity growth for Canada. Entrants have faster labour productivity growth prior to entry than non-entrants and becoming exporters then increases their productivity growth relative to non-entrants.

In this section, we examine the evidence that export-market participation is linked to higher productivity growth among Canadian manufacturing plants. We follow the methodology of Bernard and Jensen (1999),[12] who compared productivity growth between exporters and non-exporters using the specification.

$$(2) \qquad \Delta \ln(LP_{pt}) = a_t + b_i + d\,EX_{pt} + g\,Z_{pt} + e_{pt}$$

12. In Baldwin and Gu (2003), we follow a slightly different strategy and ask whether exporting leads to increases in the rate of productivity growth.

where $\Delta \ln(LP_{pt})$ is the average annual log growth of labour productivity[13] for plant p during period t, EX_{pt} is the export status of plant p at the start of the period, Z_{pt} is a set of plant characteristics that include employment, average wage, and the share of non-production workers at the start of the period.[14] Period fixed-effects a_t and 4-digit SIC industry fixed-effects b_i are included. The coefficient d provides an estimate of the difference in labour productivity growth between exporters and non-exporters within industries in the same period.

As Table 4 shows, exporters have faster labour productivity growth than non-exporters. The results are robust to various alternative specifications. During the periods 1984-1990 and 1990-1996, annual labour productivity growth for exporters is half a percentage point higher than for non-exporters. Large plants, foreign-controlled plants, and plants with a larger share of skilled or non-production workers had faster productivity growth. The coefficient on average wage, after controlling for the share of skilled workers, is negative and statistically significant at the 5 percent level. This is consistent with the view that unionized plants tend to have slower productivity growth, since these plants tend to have higher average wages (Kuhn, 1998).

Table 4. Annual labour productivity growth of exporters vs. non-exporters

	(1)	(2)	(3)
Exporters	0.0045	0.0056	0.0053
	(2.25)	(2.82)	(2.62)
Initial employment level		0.0109	0.0102
		(4.00)	(3.80)
Average wage		-0.0014	-0.0014
		(-11.36)	(-11.68)
Share of non-production workers		0.0206	0.0202
		(3.02)	(2.97)
Foreign-controlled plants			0.0061
			(2.72)
Young plants			-0.0020
			(-0.84)
Dummy for period 1990-1996	0.0052	0.0148	0.0152
	(3.04)	(7.71)	(7.92)
Observations	18,871	18,871	18,871
R squared	0.0685	0.0757	0.0762

Note: Numbers in parentheses are robust t-statistics. Regressions cover two panels 1984-1990 and 1990-1996. All specifications include fixed effects for 4-digit industries.

Adaptation to trade liberalization saw plants entering export markets and increasing their labour productivity. The increase in labour productivity could simply have arisen because export activity required greater capital intensity, or as a result of shifts in the technological production frontier or other organizational changes.

13. Labour productivity growth comes from a large number of sources—technology, organizational change, exploitation of scale economies, and increases in capital intensity.
14. Initial employment and average wage are expressed in thousands.

Table 5. Performance of exporters vs. non-exporters (annual growth rates)

	Canada		United States	
	Without controls	With controls	Without controls	With controls
Growth of value-added per worker	0.0045	0.0056	-0.0084	-0.0050
	(2.25)	(2.82)	(-3.72)	(-3.13)
Shipment growth	0.0030	0.0028	-0.0096	0.0022
	(2.71)	(2.52)	(-6.61)	(1.50)
Employment growth	-0.0085	-0.0065	-0.0036	0.0040
	(-5.04)	(-3.78)	(-2.95)	(3.31)
Changes in the share of non-production workers	-0.0005	-0.0003	-0.0016	0.0002
	(-1.26)	(-0.70)	(-5.14)	(0.70)
Growth in average wage	0.0026	0.0049	-0.0059	-0.0004
	(3.68)	(7.49)	(-10.84)	(-0.87)
Growth in average wage of production workers	0.0026	0.0040	-0.0072	-0.0019
	(3.69)	(5.86)	(-11.03)	(-2.99)
Growth in average wage of non-production workers	0.0010	0.0048	0.0016	0.0016
	(0.78)	(3.91)	(1.58)	(1.60)

Note: Numbers in parentheses are robust t-statistics. Regressions cover two panels: 1984-1990 and 1990-1996. Specification without controls includes time fixed-effect and fixed effects for 4-digit SIC industries. Specification with controls also includes employment, average wage, and the share of non-production workers. The results for the U.S. are from Table 6 of Bernard and Jensen (1999) for the period 1984-1993.

To investigate other changes that were occurring simultaneously, we examine differences in several other plant characteristics between exporters and non-exporters. These include growth in shipments, output, and average wage as well as the share of non-production workers. We have also included in Table 5 similar results for the United States taken from Bernard and Jensen (1999). The results for the two countries were derived in a similar fashion—both were obtained by using a similar specification and covered a similar period.[15] The specification without controls includes period fixed effects and 4-digit SIC industry fixed effects. The specification with controls includes initial employment, average wage, and the share of non-production workers.

Exporters in Canada have superior performance when it comes to labour productivity growth, output growth and wage growth. After controlling for other plant characteristics and industry and period fixed effects, annual labour productivity growth in exporters is 0.6 percentage points higher, shipment growth 0.3 percentage points higher, and average wage growth 0.6 percentage points higher. In contrast, employment growth is lower. Plants that become exporters not only increased their market share, they increased value added while decreasing their labour inputs all the while increasing their average wage rate. This suggests a transition to a higher skilled labour force, a plant that is less labour intensive and one that requires fewer supervisory personnel.

The results for Canada stand in sharp contrast to those for the United States. Exporters in the U.S. did not experience superior labour productivity, output or wage growth. With controls, Bernard and Jensen (1999) find that exporters had lower labour productivity growth. Output

15. The one difference in the specifications is that Bernard and Jensen (1999) include region fixed-effects and we do not. We cover the period 1984-1996 and Bernard and Jensen (1999) the period 1984-1993.

growth and wage growth is similar between exporters and non-exporters. The growth in production worker wages is slower in U.S. exporters. Employment growth is higher, after controls are used.

The finding that exporters have lower labour productivity growth than non-exporters for the U.S. has been interpreted as evidence that exporting does not raise labour productivity growth (Bernard and Jensen, 1999, 2001). However, the finding that exporters have faster productivity growth by itself does not constitute conclusive evidence that exporting increases productivity growth, since exporters may already have had faster productivity growth prior to entry into the export market. A stronger test for export-led productivity growth is provided by a comparison of post-entry changes in productivity growth between entrants and non-entrants. Finding that entrants to the export market have a post-entry increase in productivity growth relative to non-entrants provides more powerful evidence that exporting raises productivity growth.

Baldwin and Gu (2003) employ such a test and report that Canadian entrants to the export market had faster labour productivity growth prior to entry than non-entrants. As shown in Table 6, plants with faster growth in labour productivity and total factor productivity (TFP) during the 1990-1993 period were found to be more likely to become exporters during the subsequent period 1993-1996. But as a result of entry, they experienced an acceleration in both their labour and TFP growth relative to non-entrants in the latter period. These results support the view that export-market participation increased labour productivity growth in Canada as the result of trade liberalization in the both the 1980s and 1990s.

Table 6. Productivity growth differences between entrants and non-entrants to the export market

	Labour productivity growth (% per year)	TFP growth (% per year)
Productivity growth difference prior to entry into export markets (1990-1993)	3.4*	-0.1
Productivity growth difference after entry into export markets (1993-1996)	5.5*	1.7*
Changes in productivity growth following entry	2.1*	1.8*

Note: One asterisk denotes statistical significance at the 5 percent level. Productivity growth differences control for size and industry effects. TFP growth differentials also control for capital/labour ratios.

Source: Baldwin and Gu (2003), Table 7.

5. What are the mechanisms of export-led productivity growth?

The use of micro data on plant performance allows us to sharpen our focus on whether a plant's transition from a purely domestic focus to being an exporter results in a substantial change in its performance. But it does not explain the source of those changes. Changes in productivity may come from straightforward industrial adaptation. Firms in small countries may suffer from small plants with short production runs that do not allow for exploitation of scale economies. Adaptation to larger markets may simply involve exploitation of these economies. To do so, firms would be expected to become larger and more specialized.

But implicit in the literature are less mundane effects that presume imperfect knowledge and heterogeneous firms. It is hypothesized that trade allows for learning—learning about superior technologies, different products, and new forms of organization. Exposure to this knowledge leads firms to experiment with new strategies and to reap the benefits thereof. And in a world where a lack of competition engenders complacency and results in high levels of x-inefficiency in an industrial population, trade has the additional salutary effect of increasing competitive pressures.[16]

We now focus on four mechanisms through which export-market participation might have affected productivity growth: changes in product diversification, learning-by-exporting, exposure to international competition, and innovation and technology use.

5.1 Data sources and empirical approach

To investigate the sources of productivity growth, we make use of two sets of linked plant-level micro data. The first is the 1993 Survey of Innovation and Advanced Technologies (SIAT). The second is the Annual Surveys of Manufactures (ASM) file that was used in the two previous sections. The SIAT provides us with information on the activities of manufacturing producers in the area of R&D activity, innovation, and technology use during the period 1989-1991.[17] These data allow us to ask how exporters differ from non-exporters with respect to the development of R&D facilities or the use of advanced technologies and to infer differences in activities related to export-market participation.

Ideally, we would like to use a difference-in-differences approach as we did (Baldwin and Gu, 2003) in determining whether entry to export markets led to changes in innovation activities. For example, when we examine the effect of export-market participation on the use of foreign technologies, we would like to calculate the post-entry change in the use of foreign technologies for the plants that enter the export market and then compare it to the same change for non-entrants. The difference in this post-entry change in the use of foreign technologies between entrants and non-entrants would then be attributed to the effect of export-market participation.[18]

16. See Caves (1992) for empirical evidence on the relationship between X-inefficiency and competition from trade.
17. For details regarding the survey, see the appendix of Baldwin and Hanel, (2003).
18. This is the difference-in-differences approach commonly used to identify the causal effect of a specific intervention such as policy changes (see, e.g., Meyer, 1995).

To implement this difference-in-differences approach, we need two linked innovation surveys. But we do not have panel data on the innovative characteristics of the manufacturing producers. We only have observations on the activities at a point in time (1993).

Instead, we will use an empirical approach similar in spirit to the double-difference approach. We first compare the difference in technology use in 1993 between exporters and non-exporters. We call this the post-entry difference. We then calculate the difference in technology use for two groups of non-exporters as of 1993—those who will enter the export market by 1996 and those who continue to be non-exporters over the period. This is defined as the pre-entry difference. We attribute the difference between the post-entry and pre-entry differences to exporting. There is a shortcoming of this approach. Unlike the difference-in-differences approach discussed above, the sample of plants for calculating the post-entry difference is not the same as the one used for calculating the pre-entry difference. To overcome this, we will control for a set of plant characteristics in calculating these differences.[19]

5.2 Is exporting related to a decline in product diversification?

Perhaps the most obvious link between export-market participation and increases in productivity is the possibility that free trade permitted exporters to take advantage of scale economies associated with accessing the large U.S. market. Earlier studies by Daly et al. (1968) and Caves (1975) focused on the argument that Canadian plants suffered from excessive levels of diversity. Operating behind high tariff barriers, Canadian plants were described as having production runs that were too short to exploit the economies of large-scale production.

Shorter production runs can arise either from suboptimal plant size or excessive product line diversity. A number of Canadian studies have attributed lower productivity to shorter production runs. For example, Safarian's survey on the relative costs of foreign multinationals operating in Canada (1966, ch. 7) reported that most foreign affiliates had higher unit costs than parent companies' plants located in the U.S. These were attributed by the firms to a variety of sources; but shorter production runs was the most common response. In the same vein, a study by Scherer et al. (1975) reported that Canadian textile makers claimed that their unit costs on style-sensitive dress goods and decorative fabrics were 20 to 30 percent higher than the costs of comparable U.S. manufacturers, primarily because of a ten-fold difference in market size and the attenuated but still substantial differences in lot sizes. Paint manufacturers reported that average batch sizes in Canada were one-fifth to one-half those experienced in the United States.

Both the Economic Council of Canada (1967, 1975) and the Royal Commission on Corporate Concentration (1978) predicted that the lowering of Canadian tariff barriers would increase Canadian average plant size and that it would reduce product diversity at the plant level and

19. To evaluate this alternative approach, we have applied it and re-estimated the post- and pre-difference reported in Table 6. The post-entry difference is calculated as the difference in labour productivity growth over the 1990-1993 period between exporters and non-exporters in the SIAT survey as of 1990. It is estimated to be 2.6 percent per year and is significant at the 5 percent level. The pre-entry difference is calculated as the difference in productivity growth over the 1990-1993 period between two groups of non-exporters as of 1993 in the SIAT survey—those who enter the export market by 1996 and those who do not. It is not significant with a t ratio of -0.63. These estimates are in line with the results reported in Table 6.

improve the length of production runs. While little has been found following the FTA in the way of increases in plant size (Head and Ries, 1999), several papers (Baldwin, Beckstead, and Caves, 2002; Baldwin, Caves and Gu, 2005, forthcoming) show that plant specialization in Canadian manufacturing changed dramatically. Commodity specialization increased substantially around the time of the implementation of the Free Trade Agreement between Canada and the United States.

To examine whether exporting is linked to a decline in product diversification, we have constructed an entropy index of diversification for the outputs for each individual plant. The index takes on a value of zero for plants with a single product and increases with product diversity.[20]

The difference in product diversification between exporters and non-exporters is estimated from a Tobit regression that relates the product diversification of a plant in 1990 to its export status in 1990, a set of plant characteristics and SIC 4-digit fixed effects.[21] The pre-entry difference is estimated from a Tobit regression that relates the product diversification of a plant in 1990 and a binary variable indicating whether the plant enters the export market in the period 1990-1993. A Tobit regression is used in both cases because a large number of plants produce a single product and thus have a product diversification index of zero.[22]

Table 7. Product diversification of exporters versus non-exporters

	Differentials for exporters		Pre-entry diff. for entrants to export market	
	(1)	(2)	(3)	(4)
Exporters	-0.0306	-0.0298	0.0014	0.0049
	(-5.00)	(-4.88)	(0.12)	(0.40)
Plant size	0.0900	0.0852	0.0859	0.0839
	(41.39)	(35.77)	(17.9)	(16.47)
Average wage		0.0000		-0.0005
		(0.11)		(-0.77)
Share of non-production workers		0.1729		0.1891
		(10.95)		(6.06)
Foreign-controlled plants		0.0013		-0.0123
		(0.17)		(-0.82)
Young plants		-0.0619		-0.0488
		(-9.14)		(-3.68)
Observations	18,372	18,372	4,930	4,930
Log likelihood	-8,795.54	-8,691.48	-2,112.58	-2,087.08

Note: Numbers in parentheses are robust t-statistics. All specifications include fixed effects for 4-digit SIC industries.

20. For details on the construction of the index, see, Baldwin, Beckstead and Caves, 2002.

21. The sample consists of plants that provide information on commo dity details of their shipments. These are plants that are given a long-form questionnaire.

22. As an alternative, we have also calculated the post-entry difference as the one between exporters and non-exporters in 1993 and the pre-entry difference as the one between entrants and non-entrants to the export market in the period 1993-1996. The results are similar. The positive effect of exporting on product specialization is confirmed in Baldwin and Gu (2005). They find that new and existing exporters increase product specialization and improve production-run lengths relative to non-exporters.

The results in Table 7 demonstrate that exporters were more specialized than non-exporters.[23] However, prior to entry into the export market, product diversification in the two groups was the same. As plants move into export markets, they reduce their product diversification. Since product specialization is linked to faster productivity growth (e.g., Gollop, 1997; Baldwin and Gu, 2005), we conclude that the increase in plant specialization provides an important mechanism behind export-induced productivity growth.

5.3 Do exporters learn from international best practices?

Increases in productivity associated with industrial restructuring fall within the standard ambit of trade theorists. A little less standard is the notion that trade itself can change knowledge and therefore the production process. Embedded in this view of the world is that learning is enhanced by experience and that producers that move into world markets will learn about new ways to improve their capabilities. To examine whether exporters learn to change their behaviour, we ask three questions. First, is exporting linked to an increase in the use of foreign technologies? Second, is exporting related to an increase in the incidence of R&D collaboration with foreign buyers? Third, does export-market participation improve the flow of information about foreign technologies?

For this purpose, we make use of responses to three different questions in the SIAT. In the first, respondents indicated the prime source of advanced technology used in the plant—as foreign or Canadian. The answers to this question allow us to ascertain whether exporters are more likely to learn the advantages of foreign sources of technology than just those available to them in domestic markets and to adopt them. The second question asks whether firms collaborated on R&D with other firms and the countries in which this occurred—Canada or foreign countries. The answer to this question allows us to ascertain whether exporters find new sources of information for innovative activity outside of Canada. The third question requested a ranking of the factors that had particular significance to the producer in terms of providing an impediment to technology acquisition. Here we make use of two categories—lack of information on foreign technology and lack of information on domestic technology. The answer to this question allows us to investigate whether exporters indicated that they were less likely to find information on foreign technologies an impediment to their adoption of advanced technologies.

We use the first two questions to infer that exporters learned that certain capabilities were important for their survival and growth. The third question approaches the issue of information directly—by asking whether exporters indicated that their information flows on a particular input (foreign technology) were superior.

23. See also Baldwin, Caves and Gu (2005).

Table 8. Do exporters learn from international best practices?

	Differentials for exporters		Pre-entry diff. for entrants to export market	
	Without controls	With controls	Without controls	With controls
Acquisition of:				
Foreign technology	0.0801	0.0732	0.0096	-0.0157
	(2.52)	(2.30)	(0.14)	(-0.24)
Canadian technology	0.1209	0.0534	0.1063	0.0640
	(4.40)	(1.92)	(2.54)	(1.67)
R&D collaboration with:				
Foreign buyers	0.0336	0.0275	0.0268	0.0053
	(2.65)	(2.16)	(0.69)	(0.16)
Domestic buyers	0.0115	0.0184	-0.0258	-0.0373
	(0.62)	(1.18)	(-0.49)	(-1.12)
Lack of information as impediments to acquisition of:				
Foreign technology	-0.0107	-0.0181	0.0031	0.0003
	(-1.01)	(-1.70)	(0.21)	(0.02)
Canadian technology	-0.0327	-0.0121	-0.0484	-0.0174
	(-1.57)	(-0.72)	(-1.44)	(-0.58)

Note: Numbers in parentheses are robust t-statistics. Specification without controls includes fixed effects for 2-digit industries. Specification with controls also includes employment, average wage, the share of non-production workers, plant ownership, and plant age. Note the difference between this table and table 10 on tech use. This table focuses on the four functional groups in Q6.1, while table 10 relates to all six functional group. See sample means for the difference.

The sample for estimating the post-entry difference consists of plants in 1990 that answered the 1993 SIAT. There are 1,430 such plants, of which 775 are exporters and 655 are non-exporters. The sample for estimating the pre-entry difference consists of entrants and non-entrants to the export market during the period 1993-1996 that answered the 1993 SIAT. We have 493 such plants, of which 150 become exporters and 343 remain non-exporters. To estimate these differences, we use a probit model that controls for 2-digit industry fixed effects and plant characteristics including employment, average wage, the share of non-production workers, plant ownership, and plant age. The results are presented in Table 8.[24] The probability that an exporter uses foreign technologies is 7 percentage points or 37 percent higher than that of non-exporters.[25] On the other hand, the probability of using foreign technologies is similar between exporters and non-exporters prior to entry into the export market. Export-market participation is linked to an increase in the use of foreign technologies.

24. All regressions are weighted by the sample weights derived from the survey. The coefficients in the table represent marginal changes in the probability of technology use, evaluated at the sample mean of the control variables.

25. For the rest of the discussion, we will focus on the results from the specifications with controls. For all regressions, the results from specifications with and without controls are similar.

While exporting matters for the use of foreign technologies, we should not expect that it matters for the use of Canadian technologies. Both exporters and non-exporters should have the same exposure to these before and after plants enter the export market. Our results are consistent with this view. Export-market participation is not related to changes in the use of Canadian technologies. Exporters are more likely to use them both before and after they enter the export market.

Export-market participation is related to an increase in the likelihood of R&D collaborative agreements with foreign buyers. This is consistent with the view that the interaction with foreign clients is an important source of benefits from exporting. While our data allows us to examine one particular type of interaction (R&D collaborative agreements), there are other types (not investigated here) that also benefit exporters. For example, many ideas for innovations come from customers (Baldwin and Hanel, 2003) and foreign buyers of exports often provide product designs and offer technical assistance to improve process technologies in the context of sourcing technologies (Evenson and Westphal, 1995).

Finally, the results in Table 8 show that participation in the export market improves a plant's information about foreign technologies. Exporters are much less likely to view the lack of information on foreign technologies as a significant impediment to their use; while before entering the export market, these plants are as likely to view the lack of information as a significant impediment. As expected, exporting does not improve a plant's information about Canadian technologies.

In sum, our evidence provides empirical support for the view that exporters learn from international best practices.

5.4 Do exporters face more intense international competition?

Participation in export markets not only provides the advantage of improved information flows, it may also provide more incentive to improve efficiency because of the intensity of competition. As competition is related to high innovation and fast productivity growth (Nickell, 1996), foreign competition provides an important mechanism through which exporting raises productivity growth. The Canadian domestic market is generally characterized by high levels of concentration—much higher than those in U.S. markets (Baldwin, Gorecki and McVey, 1986). We might therefore expect that an exporter faces more intense competition.

To test this hypothesis, we made use of a question in the SIAT that asked producers to rank the level of competition that they faced from foreign and domestic sources on a Likert scale from 1 to 5. We define a respondent who faces strong competition as one who responded to this question with either a 4 or 5.

Table 9. Do exporters face fiercer competition from abroad?

	Differentials for exporters		Pre-entry diff. for entrants to export market	
	Without controls	With controls	Without controls	With controls
Significant competition from abroad	0.1218	0.0726	0.0884	0.0595
	(3.38)	(1.92)	(1.55)	(1.06)
Significant competition from Canada	-0.0157	-0.0442	0.0609	0.0294
	(-0.39)	(-1.06)	(0.81)	(0.38)

Note: Numbers in parentheses are robust t-statistics. Specification without controls includes fixed effects for 2-digit industries. Specification with controls also includes employment, average wage, the share of non-production workers, plant ownership, and plant age.

There is strong evidence that export-market participation is linked to an increase in foreign competition, as shown in Table 9. Before plants enter the export market, firms did not rank the international competition facing them as much more intense. After entering, exporters indicated that they faced much more significant competition from abroad than non-exporters. The probability that an exporter ranked foreign competition very significant or extremely significant was 7 percentage points higher than for a non-exporter. As expected, there is not much difference in the intensity of domestic competition facing exporters and non-exporters both before and after entry into the export market.

5.5 Is exporting linked to investment in absorptive capacity?

Studies on the process of technological change point to the critical role of R&D investment and training that firms undertake in order to absorb, assimilate, and manage foreign technologies (Cohen and Levinthal, 1989, 1990). Productivity growth will be larger in exporters if they develop the absorptive capacities that allow them to take advantage of the productivity gains associated with innovation—in particular, process innovations that incorporate foreign technologies.

Here we make use of information from the SIAT on whether a producer conducted R&D activity on an ongoing basis.[26] The evidence in Table 10 shows that export-market participation is linked to an increase in R&D activity. The likelihood that R&D is performed on an ongoing basis is 10 percentage points higher in exporters than in non-exporters, and there is no such difference before plants enter the export market.

26. Baldwin and Hanel (2003) find that firms that engaged in ongoing R&D activity had a 32% probability of introducing an innovation, while those with no R&D facilities only had a 1% chance of doing so.

Table 10. Difference between exporters and non-exporters in R&D and training

	Differentials for exporters		Pre-entry diff. for entrants to export market	
	Without controls	With controls	Without controls	With controls
R&D performer	0.1214	0.0960	0.0727	0.0550
	(3.43)	(2.59)	(1.23)	(0.90)
Training crucial in firm's general development strategy	0.0423	0.0240	0.0269	0.0241
	(1.72)	(0.96)	(0.67)	(0.60)

Note: Numbers in parentheses are robust t-statistics. Specification without controls includes fixed effects for 2-digit industries. Specification with controls also includes employment, average wage, the share of non-production workers, plant ownership, and plant age.

This evidence is consistent with the view that exporters invest in R&D to develop absorptive capacity in order to benefit from foreign ideas and technologies. Previous studies find that own R&D and foreign technology use are complements (Globerman, 2000; Cohen and Levinthal, 1989, 1990). In a small open economy such as Canada's, foreign technologies and R&D provide an important source of productivity growth. R&D develops the absorptive capacity that allows firms to ingest new ideas (Mowery and Rosenberg, 1989).

We also ask whether exporters are more likely to develop staff competencies through training. Innovation depends not only on R&D but also on human capital in the firm. Here we make use of a question in the SIAT on the importance given to continuous staff training as part of the general development strategy in the firm. This question is ranked on a 5-point Likert scale and we define firms that emphasize training as those with extreme scores of 4 or 5.

The results depend on whether controls are entered for plant size. The results from a specification without controls show exporters tend to give more importance to staff training than non-exporters. As there is no difference between exporters and non-exporters prior to entry to the export market, we interpret this as evidence that staff training becomes more important after plants enter. However, after controlling for plant characteristics (plant size being the most significant variable), exporters and non-exporters attach similar importance to staff training both before and after entry into the international market. Thus, it is the larger plants that become exporters who increase their emphasis on training as a general strategy.[27]

5.6 Is exporting linked to an increase in innovation and technology use?

Exporting leads to improved information on foreign technologies, greater use of foreign technologies, more R&D activity and a greater emphasis on human capital development through continuous staff training. How does it affect innovation rates?

27. This accords with the findings reported in Baldwin and Gellatly (2003) that large firms generally give more emphasis to staff training than small firms.

To answer this, we make use of a question on the SIAT asking manufactures whether they had introduced either a product or a process innovation in the previous three years, and a question on the number of advanced manufacturing technologies being used. The latter was derived from a list of 22 technologies that a panel of experts had identified as state of the art. The results showing the differences for exporters and non-exporters both before and after entry to export markets are reported in Table 11. Export-market participation is not related to the change in innovation rates. Nor is it related to the change in process and product innovations. Exporters are more innovative than non-exporters both before and after they entered the export market. The rate of introducing any innovation, product or process, is about 8 percentage points higher in exporters. A similar difference is found between them prior to entry. As innovation is linked to faster productivity growth (Baldwin and Gu, 2004), the finding that entrants are more innovative than non-entrants prior to entry is consistent with entrants having a faster productivity growth prior to entry. The plants that eventually become exporters are better plants. They are more innovative, more productive and tend to have faster productivity growth before they begin to export. That is, better plants self select into the export market, a robust finding from almost all previous studies in different countries.

Table 11. Difference between exporters and non-exporters in innovation and technology use

	Differentials for exporters		Pre-entry diff. for entrants to export market	
	Without controls	With controls	Without controls	With controls
Innovation	0.1239	0.0780	0.1827	0.1283
	(3.74)	(2.25)	(2.96)	(1.99)
Process innovation	0.1200	0.0769	0.1689	0.1041
	(3.86)	(2.36)	(2.96)	(1.81)
Product innovation	0.1142	0.0824	0.1340	0.0962
	(3.68)	(2.58)	(2.29)	(1.60)
World-first innovation	0.0277	0.0203	0.0002	-0.0040
	(2.12)	(1.59)	(0.01)	(-0.34)
Canada-first innovation	0.0390	0.0248	0.0132	0.0140
	(1.62)	(1.01)	(0.28)	(-0.31)
Number of technologies	2.5664	1.5629	0.8398	0.4695
	(8.33)	(5.51)	(2.03)	(1.18)

Note: Numbers in parentheses are robust t-statistics. Specification without controls includes fixed effects for 2-digit industries. Specification with controls also includes employment, average wage, the share of non-production workers, plant ownership, and plant age.

We also investigate whether the quality of innovation increased by examining whether the innovation was more likely to be a world-first or a Canada-first. Only a small proportion of innovations are world-firsts. A slightly larger proportion is Canada-first.[28] Nevertheless, we found weak evidence that, after entry to the export market, producers were more likely to produce a world-first innovation or a Canada-first (Table 10), thereby lending additional credence to the contention that entry to export markets led to increases in the quality or novelty of innovation.

The SIAT surveyed 22 advanced technologies identified as important for the manufacturing sector. These are generally associated with the use of computers and information technology to design, develop and control manufacturing production (Baldwin and Sabourin, 2002). We use the number of technologies that a plant adopts to measure the intensity of technology. We recognize that the count measure is less than ideal. Nevertheless, previous studies find that the number of technologies adopted is useful to show how advanced the technology in a plant is (McGuckin, et al. 1998).

Exporting is linked to an increase in the intensity of technology use (Table 11). The number of technologies adopted is larger in exporters than in non-exporters; prior to entry, there is no difference. This indicates that plants become more intense users of advanced technologies in order to remain competitive in export markets. It is also a key explanation behind the relatively higher productivity growth in exporters. Using panel data from two different technology surveys in the 1990s, Baldwin and Sabourin (2004) show that increases in advanced technologies are closely related to productivity growth in the 1990s.

In conclusion, firms that are innovators are more likely to enter export markets. This process develops their innovative capacity. It leads to the creation of R&D units and to greater R&D collaboration with foreign partners, improves information flows on technology, leads to more foreign sourcing of technology and increases the number of advanced technologies that are being used by Canadian producers. While the rate at which innovations are being introduced does not increase, the quality of the innovation does. Process innovations for example involve the introduction of new technologies. Our evidence shows that by entering export markets, Canadian producers increase both the number of advanced technologies and potentially their quality (from foreign sources), thereby changing the quality and probably the effectiveness of their process innovations.

5.7 What explains the difference in results between Canada and the United States?

Our findings on the existence of export-led productivity growth for Canada stand in marked contrast to the results for the United States. The results in this paper and Baldwin and Gu (2003) show that exporting is associated with increases in productivity growth in manufacturing plants for Canada. In contrast, Bernard and Jensen (1999, 2001) find that there is no evidence that exporting increases plant productivity growth for the United States. Our analysis of the underlying causes behind this export-led productivity growth helps to explain why these differences have been found. This study has uncovered a number of mechanisms—learning-by-

28. See Baldwin and Hanel (2003) for a discussion of the importance of different types of innovations.

exporting, exposure to international competition, and increased plant specialization, through which exporting raises productivity growth. Most of these mechanisms would not be expected to apply in the United States.

Consider first the issue of foreign technologies. In Canada, both foreign sourcing and improvements in information regarding foreign technologies occurred after producers entered export markets. For the United States, domestic technologies are more important than foreign technologies (Keller, 2002; Eaton and Kortum, 1999; Gera, Gu and Lee, 1999). This suggests that while learning from international best practices was important for productivity growth for Canadian plants, it is less likely to be important for U.S. plants. Plants in the U.S. are often world technology leaders. For these plants, the more important source of productivity growth is technologies developed within the U.S.

Second, Canadian plants often face limited competition due to the smaller market size in Canada. For Canadian plants, exposure to international competition provides an additional incentive to become more productive and more competitive. For U.S. plants, competition in the domestic U.S. market has been described as being more intense than competition in other markets (Martin and Porter, 2001). Exposure to international competition is therefore less likely to provide additional pressures for these plants to become more productive and more competitive.

Third, while Canadian plants before the Free Trade Agreement with the United States may have had too many product lines and short production runs due to the limited Canadian market size, this is less of an issue for U.S. plants due to the much larger domestic market in the U.S. Access to the larger U.S. export market has allowed Canadian plants to increase product specialization and increase the length of production runs. The expansion of the market available to U.S. producers through exporting should have less of an impact on plant diversification than in Canada.

Our findings on the mechanisms of export-led productivity growth suggest that exporting should raise productivity growth in European countries. Challenges and opportunities facing European manufacturing exporters are similar to those for Canadian exporters: learning from international best practices, exposure to international competition, and opportunities to increase product specialization that larger export markets afford. Indeed, Girma, Greenaway and Kneller (2004) find such evidence for the U.K.

Our results also show that the benefits from export-market participation are not automatic. To learn from foreign buyers and to benefit from foreign technologies, plants need to invest in R&D and training to develop the absorptive capacity for developing new technologies. This may explain why export-market participation raises productivity growth for some developing countries, but not others. For example, Aw, Chung, and Roberts (2000) have reported evidence supporting the existence of learning-by-exporting in Taiwan, but not in South Korea.

6. Conclusion

Trade barriers between Canada and the rest of the world have been steadily declining over the last two decades, first with the Kennedy Round in the 1970s and then with the Tokyo Round in the 1980s. Starting in 1989, two major changes occurred in the trading environment facing Canadian manufacturers that led to deep cuts in trade barriers. First, the Canada-United States Free Trade Agreement (FTA) committed the two countries to gradually eliminate all manufacturing trade barriers. Second, the North American Free Trade Agreement (NAFTA) brought together Canada, Mexico and the United States. Enumerating the benefits that accrued to Canadian manufacturing producers as they adjusted to trade liberalization provides valuable lessons for other countries as they contemplate wider trade partnerships.

Several conclusions emerge from the analysis in this paper. First, trade liberalization was a key factor behind the strong export growth of the Canadian manufacturing sector. As trade barriers fell, more Canadian plants entered the export market and exporters increased the share of shipments sold abroad. Second, export-market participation was associated with higher labour productivity growth. Third, evidence is presented of the presence of three mechanisms that raise productivity growth—increases in plant specialization, learning by exporting, exposure to international competition. The evidence shows that export-market participation was linked to increases in plant specialization. Operating behind tariff barriers and limited market size, Canadian plants have often been seen to have production runs that were too short to exploit economies of large-scale production. Trade liberalization and access to a much larger U.S. market were intended to allow Canadian plants to reduce product diversification and improve the length of their production runs. Our findings corroborate the existence of these effects. Plants that began to export increased their product specialization (and therefore their production-run length) relative to those that did not export.

Three pieces of evidence support the view that exporting facilitates the transfer of knowledge across countries and enhances the innovation process in the Canadian economy. First, exporting was linked to an increase in the use of foreign technology at plants. Second, it was connected to an increase in the incidence of R&D collaboration agreements with foreign buyers. Third, exporting improved the flow of information about foreign technologies to Canadian plants.

Productivity gains from export-market participation do not materialize from thin air. Exporters tend to be the more innovative firms, both before and after they enter export markets. But becoming exporters did lead to changes in the nature of innovation. It was associated with the greater use of advanced technologies, thereby increasing the intensity of process innovation. In order to accomplish this, exporters acquired more foreign technologies and developed enhanced absorptive capacities that allowed them to ingest new knowledge. Exporters invested more in R&D and staff training thereby developing a greater capacity for absorbing foreign technologies. Innovators thereby improved the nature of their process innovation and tended to produce world-first innovations or Canada-first innovations more frequently.

All of this suggests that policy recommendations in the area of trade liberalization and innovation policy need not be treated separately as they normally are. The Canadian experience with trade integration into a larger North American market shows that some of the benefits come from standard sources—the exploitation of economies of scale. But there is evidence that trade liberalization was also associated with improvements in the innovation capabilities of firms that moved into the export market.

Appendix: Data sources

The data for our analysis come from a longitudinal file developed from the Annual Surveys of Manufactures (ASM). The ASM covers the entire Canadian manufacturing sector, using survey data for the larger plants (accounting for over 95% of shipments) and administrative data from tax records for the remainder. It collects information on shipments, value added, and employment. The plants in the ASM are classified into 236 manufacturing industries at the 4 digit 1980 SIC (Standard Industrial Classification, 1980) level.

The data on exports are only available for the plants that received detailed "long form" questionnaires. These are the larger plants. No information on exports is collected for small plants that received a "short-form" questionnaire. For the purpose of this paper, we use the sample of "long-form" plants from the ASM.

The Canadian tariff rates against U.S. imports are based on duties paid that are collected by commodity. These commodities are assigned to industries based on the primary industry of production. Average industry tariffs are then calculated using import values as weights. U.S tariff rates against Canadian imports are once again based on import duties by commodity, which are assigned to an industry using the same Canadian concordance table used for Canadian commodity duties, and then aggregated to industries based on U.S. import weights.[29]

We have U.S. and Canadian tariff rates at the 4-digit level for the period 1980-1996. Over that period, plant-level export data are available for the years 1984, 1990, 1993 and 1996.

The 1993 Survey of Innovation and Advanced Technology was designed to randomly sample all plants in the manufacturing sector and their parent firms and to provide a coefficient of variation of around 5%. The sampling procedure was two-stage—focusing separately on larger and smaller plants and providing stratification at the 2-digit industry level. There were 1,954 plants of larger firms sampled and 2,180 small firms sampled in the SIAT. Of the 1,954 large plants, 1,467 were matched with the longitudinal file of manufacturing plants. These matched plants are given the long-form questionnaire in the ASM. Therefore, information on exports is available for these plants. For plants that belong to multi-plant firms, questions on innovation and R&D were sent to their head offices, and only questions on technology use were addressed to plant managers. As such, innovation and R&D activities for these plants represent those of their parent firms.

29. We are grateful to Professor Dan Trefler for providing us with Canadian and U.S. tariff rates (for details on the sources and construction of the tariff data, see the Appendix in Trefler, 2004).

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30. Statistics Canada research papers can be downloaded from http://www.statcan.ca/english/studies/eaupdate.

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