Exports and Productivity in Canadian Food Manufacturing

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Abstract:

This paper examines the relationship between productivity and export market participation of Canadian food processing plants using a plant-level panel dataset. We find that exporters are more productive than non-exporters, and have higher productivity growth prior to entering export markets. However, we find that plants do not experience higher productivity growth after entering export markets. The results have implications for policies targeted at enhancing R&D and innovation policy and lessening border restrictions, and the role of international trade openness.

Acknowledegment:

JEL Codes: D24, D22

#1663

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Increased integration of the world economy over the past two and a half decades has led to substantial increases in international trade. Particularly, with the rise of emerging economies as major players in the global marketplace (e.g., BRICS), and free trade agreements such as the North American Free Trade Agreement (NAFTA), the Canada-Korea Free Trade Agreement (CKFTA), the Transpacific Partnership (TPP), and the Canada-EU Comprehensive Economic Trade Agreement (CETA). Meanwhile, in recent years, anti-trade sentiments, often fueled by the idea that international trade has created more losers than winners, have become increasingly common in trade policy. This is exemplified by Britain's vote to exit the European Union (Brexit), opposition by the U.S. to the Trans-Pacific Partnership (TPP), and the ongoing renegotiation of the North-American Free Trade Agreement (NAFTA). These issues suggest that the debate among economists regarding the link and causality between trade openness and economic growth is still open. Our paper is related to the on-going debate on trade and productivity growth; and we contribute to the microeconomics of trade and within-plant productivity growth.

In the most influential empirical studies, Bernard and Jensen (1995; 1999) find that firm and plant heterogeneity is systematically related to export market participation. Exporting firms outperform their non-exporting counterparts - i.e., exporting firms are larger, have higher productivity, are more capital intensive, more skilled-labour intensive, and they pay a higher wage within the same industry prior to their entry into international markets [1]. The theory of international trade with heterogeneous firms explains the empirical findings using a model of industry equilibrium with heterogeneous firm productivity (Melitz, 2003). In the Canadian data for instance, only 10 percent of small and medium-sized Canadian firms were exporters in 2011, where exports accounted for only 4 percent of the total revenue of small and medium firms (Industry Canada 2017). In the U.S., in 2000, only 4 percent of firms were exporters, where the top 10 percent accounted for 96 percent of the total U.S. exports. Between 2012 and 2015, 94 percent of Canadian exports of processed foods were to the United States. Meanwhile, Canada was the largest destination for U.S. agricultural products in 2015 (USDA).

The finding that exporting firms and plants are more productive than their non-exporting counterparts raises a question of causality between exports and productivity. Does high productivity encourage firms to self-select into export markets or does exporting improve productivity growth through learning by exporting? The learning-by-exporting model suggests productivity improvements following export market entry (Van Biesebroeck 2005; de Loecker 2007), whereas the self-selection model suggests that it is the most productive firms that become exporters as they are the only ones able to overcome the transportation and sunk-costs associated with exporting (Melitz 2003). Although most studies find evidence consistent with self-selection, there is less evidence of learning-by-exporting, particularly in developed countries [2].

In Canada however, the reduction in tariffs as a result of NAFTA and the Canada-U.S. Free Trade Agreement, led to increased export intensity as it allowed more

[1] see for example: Bernard and Jensen (1999); Bernard, Jensen and Lawrence (1995); Biesebroeck (2005); Clerides, Lach and Tybout (1998); De Loecker (2007)

[2] See for example: Baldwin and Yan (2012, 2015); Baldwin and Gu (2005); Biesebroeck (2005); Delgado, Fariñas and Ruano (2001); Greenaway and Kneller (2007); Wagner (2007))

productive plants to expand and the least productive ones to exit the market (Baldwin and Yan, 2015). In fact, Baldwin and Yan (2012) find that the productivity growth of Canadian manufacturing plants that entered new markets, either domestic or international, was superior to the productivity performance of those that maintained the status quo. Liveeva and Trefler (2010) find that the eliminations of the U.S. tariff induced Canadian firms to start exporting or to export more, leading to increased labor productivity, more product innovation, and higher adoption rates for advanced manufacturing technologies. In the post 2000 period, however, the sharp decline in productivity for manufacturers was mainly driven by exporters (Baldwin, Gu and Yan, 2013). Exporters experienced large declines in both MFP and labour productivity as a result of excess capacity "arising from lower demand in the export markets" (Baldwin, Gu and Yan, 2013).

In this paper, we examine the relationship between exporting behaviour and productivity growth in Canadian food manufacturing. We use plant-level microdata from the Annual Survey of Manufacturers and Loggers and the General Index of Financial Information from 2000 to 2011 for manufacturing and food manufacturing. We estimate both labour productivity and multifactor productivity. To estimate multifactor productivity, we use the estimation approach proposed by Olley and Pakes (1996) and Levinsohn and Petrin (2003), which addresses the possibility of sample selection and simultaneity problems in estimating a production function using panel data. The relationship between export market participation and productivity is examined by exploring (1) the export premia, (2) the self-selection hypothesis and (3) the learning-by-exporting hypothesis. In the empirical literature, the causality between exporting behaviour and within-plant productivity growth is still an open research question. Our paper is related to the on-going debate on trade and productivity growth; and we contribute to the microeconomics of trade and within-plant productivity growth.

To our knowledge, no other micro-level studies have looked at the relationship between food manufacturing productivity and export orientation. Food manufacturing differs substantially from other sectors of the economy for a number of reasons. For instance, consumption of food is more inelastic than that other manufactured goods, which makes the industry more resilient and less prone to recessionary pressures. For example, food manufacturing was the only Canadian manufacturing industry that experienced positive revenue growth with low variability during the recession of 2008-2009. Food manufacturing is the second largest manufacturing industry, with a revenue of 88 billion Canadian dollars in 2011 (Sparling and Cheney, 2014, p. 2). In addition, employment in food processing consists of 15% of all people employed in the country, making it the largest employer in manufacturing. However, the industry has been facing challenges that raise questions about its ability to remain competitive in the long-run. For example, the industry is facing low investment in research and development, a diminishing trade balance, squeezed margins, and a skilled labour crisis. Importantly, the current NAFTA renegotiations pose an important challenge for food processors as the United States is the main trading partner; over 80% of Canadian food processing exports are to the United States.

First, we find substantial heterogeneity in productivity (dispersion) even within narrowly-defined subindustries. For the food manufacturing industry and its subindustries, the top 10 percent plant is over 3 times more productive than the bottom 10 percent. Second, the results suggest that exporting plants have higher levels of productivity than non-exporting plants. Multifactor productivity for exporters is higher than non-exporters by 4.62 percent, whereas labour productivity is higher by 22.26 percent. Third, the relationship between entering export markets and productivity growth is more ambiguous in a sense that we find more productive plants self-select into export markets, but there is no evidence of learning-by-exporting. The evidence to support the self-section hypothesis suggests that future entrants into export markets experience a higher rate of productivity growth prior to becoming exporters compared to plants that do not enter export markets. The lack of evidence to support the learning by exporting hypothesis suggests that entering export markets does not necessarily lead to higher productivity growth once in international markets in the short run. The findings may suggest that policy should encourage the productivity growth of domestic plants as they get ready to enter export markets, rather than promoting the growth of plants already in export markets. The signing of new free trade agreements such as the TPP has the potential to encourage Canadian food manufacturers to become more productive as they will experience greater foreign competition and have access to new more diverse markets.

The implication of the model of self-selection is that trade liberalization or free trade agreements such as CETA/TPP/CKFTA lead to the shrinkage or exit of low-productivity firms and the expansion or entry of high-productivity firms. The reallocation of resources from low-productivity firms to high-productivity firms then raises industry productivity and welfare (e.g., Baldwin and Gu 2004). For example, the Canada-United States Free Trade Agreement (CUSFTA) raised overall Canadian manufacturing productivity by 13.8 percent over the 1988 to 1996 period (Trefler 2004, Lileeva and Trefler 2010 and Melitz and Trefler 2012). For food manufacturing, CUSFTA raised labour productivity by about 6 percent overall (Trefler 2004). De Hoyos and Iacovone (2013) show that NAFTA stimulated the productivity of Mexican plants through an increase in import competition and access to imported intermediate inputs. Our empirical work highlights the important role of within-plant productivity heterogeneity in explaining exporting behaviour for Canadian food manufacturing plants

Our paper is closely related to a recent and growing empirical literature that adopts the heterogeneous firms trade model (Baldwin and Gu, 2005; Baldwin and Yan, 2012; Baldwin and Yan, 2015; Baldwin, Gu, and Yan, 2013; Wagner, 2007; Delgado, Farias, and Ruano, 2001; Biesebroeck, 2005; Clerides, Lach, and Tybout, 1998; and Greenaway and Kneller, 2007). There are no other studies as far as we know that have examined the learning-by-exporting hypothesis and the self-selection hypothesis for food processing sector. The finding that food processing plants increase their productivity growth prior to entering export markets, but productivity does not increase further after becoming exporters, is consistent with most studies in manufacturing industries in developed countries.

Next, we describe the data used for the study. In the second section, we describe the estimation strategies. In sections three and four, we describe and discuss the main findings of this research. Finally, in the last section, we provide concluding remark.

I. Data

We use plant-level data from from the Annual Survey of Manufacturers and Loggers (ASML) and the General Index of Financial Information (GIFI) from 2000 to 2011 for manufacturing and food manufacturing. The ASML is a plant-level dataset "intended to cover all establishments primarily engaged in manufacturing and logging activities", which contains detailed information on value added, shipments, inventories, employment, heat and power costs, total material costs, ownership status, and age of plants (Statistics Canada, 2015). The ASML does not provide data on capital. Capital stock obtained from the GIFI, which is "a report that Canadian corporations must include along with their T2 tax returns that provides information reflecting the contents of their financial statements" (Moussaly and Wang, 2014, p. 14).

Plants with negative or zero output or inputs were excluded from the study as well as those with imputed observations, this leads to an exclusion of approximately 20% of observations[3]. All prices are deflated using price indices from the Industry KLEMS Productivity Program, which develops an industry productivity database that includes indexes of output, capital, labour, energy, and material inputs at various levels of industry aggregation. All values are deflated using 3-digit and 4-digit NAICS industry level price deflators.

To estimate productivity, we use information on output, labour, capital, energy, and materials. Output was measured as gross output, as opposed to value added [4]. The literature suggest using gross output at the establishment level because there are no intra-industry sales and gross output equals the theoretical output measure (Baily, 1986, p. 191). In reality, a production function based on value added is unobservable, where it is more natural to regard production as function of labour, capital, energy, and materials (OECD, 2008, p. 18).

Following Baldwin and Gu (2005), Baldwin, Gu and Yan (2013) and Baldwin and Yan (2012), we use total number of employees as the measure for labour [5]. Energy is measured as cost of purchased fuel and electricity. Materials are measured as cost of materials and supplies. Finally, capital is measured as capital stock. The main variable of interest is export status. An exporter is defined as a plant that exports to a foreign destination in a given year. The control variables consist of the following: 1) size, measured as the ratio of sales by a plant in a given year to total sales by the plants in the sample in the same year; 2) ownership, a dummy variable if the plant is Canadian owned; 3) Ontario, a dummy variable reflecting whether a plant is located in Ontario; 4) age, is a measure the age of plant from 1990 or later year of birth; 5) recession, a dummy variable for period 2008 to 2009; 6) trend, is a trend variable starting in 2000.

[3]Imputing of the data refers to “when non-response occurs, when respondents do not completely answer the questionnaire, or when reported data are considered incorrect during the error detection steps, imputation is used to fill in the missing information and modify the incorrect information” (Statistics Canada, 2015).

[4]Value added was also used to estimate productivity for robustness check

[5]To check the robustness of the result, we compared the choice measure of labour input as the number of employees to wages and salaries

The next section provides a description of the methods used to analyze the relationship between exports and plant level productivity. Estimates for labour and multifactor productivity are first obtained. Following Bernard and Jensen (1999); Bernard, Jensen and Lawrence (1995), these estimates are used to determine the impact of exports on the productivity of Canadian food processing plants.

II. Estimation Strategies

The first step of the study is to estimate productivity. We use two both labour productivity and multifactor productivity measures.: Multifactor productivty (MFP) refers to the changes in output that cannot be explained by changes in inputs. Labour productivity is the ratio of output to labour input. There are several methods that can be used to measure MFP with a plant level data set. The Olley and Pakes (1996) and Levinsohn and Petrin (2003) production function (and their extensions) has often been used because of the ability to deal with simultaneity problems that may arise when dealing with input choice and unobserved firm-specific productivity. A key challenge for identification arises because a firms productivity shock transmits to the firm's optimal input choice (Levinsohn and Petrin, 2003, p. 317), leading to the endogeneity problem often referred to as "transmission bias"Marschak and Andrews (1944).

While OLS fails to account for the potential endogeneity problems,"by using only the within-firm variation in the sample, fixed effects estimators overcome the simultaneity bias" (Van Beveren, 2012, p.14). In practice, however, fixed effects estimators lead to downward biased capital coefficients. "Olley and Pakes (1996) perform fixed effects on a balanced and an unbalanced sample and find large differences between the two sets of coefficients, suggesting the assumptions underlying the model are invalid" (p. 13). In order to address this issue, Olley and Pakes (1996) and Levinsohn and Petrin (2003) developed two semi-parametric proxy variable production function approaches. Levinsohn and Petrin (2003) use intermediate inputs as a proxy, while Olley and Pakes (1992) use investment. Both methods have received significant attention in the literature, but the Levinsohn and Petrin approach is often preferred to Olley and Pakes because with investment often many observations are zero, and intermediate inputs are often treated as flexible and thus not subjected to adjustment costs (Del Gatto, Di Liberto, and Petraglia, 2011, p. 987). Following Levinsohn and Petrin (2003), the Cobb-Douglas production function is specified as:

$$y_{ist} = \beta_0 + \beta_l l_{ist} + \beta_k k_{ist} + \beta_m m_{ist} + \omega_{ist} + \epsilon_{ist} \tag{1}$$

where y_{ist} denotes output of plant i in industry s at time t; l_{ist}, k_{ist}, m_{ist}, and e_{ist} denote labour, capital, materials, and energy, respectively. Finally, the β's represent the parameters to be estimated. All the variables are expressed in natural logarithm. ω_{ist} reflects the productivity shocks, which may be observed by the firm and impact its input choices. ϵ_{ist} is uncorrelated with input choices, and therefore exogenous. ϵ_{ist} can also represent (potentially serially correlated) measurement error in the output variable" (Ackerberg et al., pg. 2414, 2015).

To deal with the empirical issue, Levinsohn and Petrin (2003) assume that the demand for the intermediate input depends on the state variables, k_{ist} and ω_{ist}, such that:

$$m_{ist} = m_{ist}(k_{ist}, \omega_{ist}) \tag{2}$$

Levinsohn and Petrin (2003) and Olley and Pakes (1992) assume that equation 2 is monotonically increasing in k_{ist} and ω_{ist}, and therefore can be inverted to obtain:

$$\omega_{ist} = \omega_{ist}(m_{ist}, k_{ist}) \tag{3}$$

The production function can be written as:

$$y_{ist} = \beta_l l_{ist} + \phi(m_{ist}, k_{ist}) + \epsilon_{ist} \tag{4}$$

Such that:

$$\phi(m_{ist}, k_{ist}) = \beta_0 + \beta_k k_{ist} + \beta_m m_{ist} + \omega_{ist}(m_{ist}, k_{ist}) \tag{5}$$

Levinsohn and Petrin (2003) suggest that in order to obtain a consistent estimator of β_l, first, take the expectation of equation (4) conditional on m_{ist} and k_{ist} or use another non-parametric estimator such as a polynomial [6]. This expectation is then subtracted from equation 4 to obtain a consistent estimator of β_l:

$$y_{ist} - E[y/m_{ist}, k_{ist}] = \beta_l[l - E[l/m_{ist}, k_{ist}]] + \epsilon_{ist} \tag{6}$$

To obtain a consistent estimator of β_k, Olley and Pakes (1992) assume ω_{ist} follows a first-order Markov process. Additionally, "capital does not immediately respond to the innovations in productivity over last period's expectation" given by: (Levinsohn and Petrin, 2003, p. 321).

$$\xi_{ist} = \omega_{ist} - E[\omega_{ist}/\omega_{it-1}] \tag{7}$$

[6] Levinsohn and Petrin (2003) use a third order polynomial in m_{ist} and k_{ist}.

Levinsohn and Petrin (2003) define output net of labour's contribution as:

(8) $$y^*_{ist} = \beta_0 + \beta_k k_{ist} + \beta_m m_{ist} + E[\omega_{ist}/\omega_{it-1}] + \epsilon^*_{ist}$$

Where $\epsilon^*_{ist} = \xi_{ist} + \epsilon_{ist}$. This last step yields consistent estimates for the remaining $\beta's$. Then, productivity is estimated by:

(9) $$\hat{\omega}_{ist} = y_{ist} - (\hat{\beta}_0 + \hat{\beta}_1 l_{ist} + \hat{\beta}_2 k_{ist} + \hat{\beta}_3 m_{ist} + \hat{\epsilon}_{ist})$$

(10) $$MFP_{ist} = \exp(\hat{\omega}_{ist})$$

The parameter estimates of the production functions and the estimate of the productivity were obtained using Levinsohn and Petrin's STATA's algorithm, which uses a third order polynomial in m_{ist} and k_{ist} to estimate the non-parametric component.

A. *Exports and Productivity*

The next step is to assess the impact of export status on productivity levels and growth. This section first describes how the exporter premia is estimated, and the last two sections describe how the self-selection and learning-by-exporting hypotheses are tested. For all three regressions, it is important to control for industry specific fixed effects, otherwise it is possible that differences in productivity may reflect concentration of exporters in more productive industries (Baldwin and Gu, 2005).

Export Premium

In order to estimate the exporter premium, the percentage difference in productivity between exporters and non-exporters first we regress the productivity estimates obtained in the previous section on export status:

$$\hat{\omega}_{ist} = \beta_0 + \alpha_s + \beta Export_{ist} + \gamma Control_{ist} + \epsilon_{ist} \tag{11}$$

where $\hat{\omega}_{its}$ represents the log of multifactor productivity in industry s, $Export_{ist}$ is a dummy variable for the current export status (i.e., 1 if plant i is an exporter, 0 otherwise), $Control_{ist}$ is a vector of plant-specific controls (i.e., size, age, ownership, province), and α_s is the industry specific fixed effect [7]. β is the parameter of interest.

The export premium is then calculated as:

$$\textit{Export Premium} = 100\%(e^{\hat{\beta}} - 1) \tag{12}$$

B. Self-Selection Hypothesis

To test the empirical validity of the self-selection hypothesis, the data was separated into two periods; period one from 2000 to 2005 and period two from 2006 to 2011. The following fixed effects regression was estimated to determine the pre-entry differences in productivity of future exporters:

$$\hat{\omega}_{2005is} - \hat{\omega}_{2003is} = \delta_0 + \delta_s + \delta_2 Export_{2006is} + \xi Control_{is0} + \epsilon_{ist} \tag{13}$$

Following Wagner (2007), we are interested in estimating productivity growth differences prior to plants entering export markets. The growth rate in productivity between 2003 and 2005 was regressed on export status, where $Export_{ist} = 1$ for plants that do not export between 2003 and 2005, but do export in 2006. Similarly, $Export_{ist} = 0$ for plants that do not export between 2003 and 2006. δ_s represents the

[7] the export premium equation is analogous with labour productivity

industry fixed effect. If plants increase their productivity growth prior to entering the export markets, then we should expect $\delta_2 > 0$.

C. Learning-By-Exporting

To test the learning by exporting hypothesis, we are interested in the post entry differences in productivity growth between export starters and non-exporters. The following fixed effect regressions were estimated for labour and multifactor productivity:

$$\begin{aligned} \hat{\omega}_{is1} - \hat{\omega}_{is0} &= \gamma_0 + \gamma_s + \gamma_1 start_{ist} + \gamma_2 continue_{ist} \\ &+ \gamma_3 stop_{ist} + \phi Control_{is0} + \epsilon_{ist} \end{aligned} \tag{14}$$

The regression coefficients γ_1, γ_2, and γ_3 are estimates of growth in productivity rates for export starters, exporters in both periods, and export stoppers relative to non-exporters in both periods (Wagner, 2007; Bernard and Jensen, 1999). $Control_{ist}$ controls for plant characteristics. We are interested in γ_2 to compare export starters relative to non-exporters. Given a lack of guidance in the literature as to how to define exporters, to ensure robustness of the results, table 1 presents various definitions of export status:

Table 1—: Various Definitions of Exporters in the First and Second Period

Model	Export_{is1}	Export_{is2}
Model 1	Last two years of period 1	Last two years of period 2
Model 2	Last three years of period 1	Last three years of period 2
Model 3	Last five years of period 1	Last five years of period 2

III. Results

A. Summary Statistics

Table A1 in the appendix shows that the number of plants in food manufacturing declined by 31% from 4255 in 2000 to 2927 in 2011. From 2000 to 2011, total exports increased from $8.25 billion in 2000 to $9.57 billion in 2011. However, both the percentage of exporting plants and export intensity[8] declined during the study period. In 2000, 57.45% of food manufacturing plants were exporters and 19.20% of their sales were exports. In 2011, however, only 37.07% were exporters and 11.06% of sales were exports. This suggests that sales increased faster domestically than abroad. During this period, the percentage of exports to the U.S. increased from 88.58% to 92.45%, making the U.S. Canada's largest trading partner. Changes in the U.S. economy were closely tracked by the percentage of Canadian exports to the U.S. For instance, from 2003 to 2006 when the Canadian dollar rapidly appreciated, food manufacturing's percentage of exports to the U.S. declined from declined from 94.3% to 87.25%. During the recession of 2008-2009, the percentage of food manufacturing exports to the U.S. decreased from 93.87% to 88.61%.

[Table A1 Here]

Food manufacturing's gross output grew at an average annual rate of 5.25%, compared to 4.16% for manufacturing from 2000 to 2011. During the recession of 2008-2009, output grew at a rate 8%, whereas manufacturing's output declined by 4.9% . Seven out of nine subindustries in food processing experienced a positive revenue growth during the recession. However, average input growth was faster for food processing and its subindustries, suggesting a decline in MFP growth. The next section describes the

[8]Export intensity= $\frac{Exports_{ist}}{Sales_{ist}}$

results for the Levinsohn and Petrin production production and productivity

B. Productivity Estimates

Table A3 presents the Levinsohn and Petrin estimates for a Cobb-Douglas production function, and Tables A4 and A5 show the results using OLS and Fixed effects estimators. The Levinsohn and Petrin estimates show that all output elasticities are positive. Output elasticities of labour and energy are positive and statistically significant for manufacturing, food manufacturing, and its nine subindustries. While the elasticities for capital and materials are positive for all industries, they are not always statistically significant. For example, neither capital or materials have a significant effect on output for sugar.

[Table A3 Here]

While the Levinsohn and Petrin capital coefficient ranges from 0.0295 in sugar and confectionary to 0.398 in seafood processing,in the OLS case, the highest capital coefficient is 0.0491 in other food processing, and for fixed effects it is 0.0230 in bakery. These results are consistent with Van Beveren (2012) as the estimates fixed effects estimates for capital are lower than in the OLS regression. In fact, the capital coefficient is negative for food manufacturing and for 5 out of 9 food manufacturing subindustries. These results suggest that the capital is downward biased in the OLS and fixed effects regressions. Levinsohn and Petrin (2003) suggest that when variable inputs are more highly correlated with unobserved productivity shocks than capital is, capital tends to be downward biased in OLS (p. 333).

[Table A4 Here]

[Table A5 Here]

Aggregate productivity estimates were obtained through a weighed average of productivity across plants using equations 15 and 16 for multifactor and labour productivity. Figures A1 and A2 illustrate the changes in MFP and labour productivity over the study period for manufacturing and food manufacturing. Food manufacturing experienced a continuous slowdown at an average annual rate of-3.49%, whereas manufacturing's productivity was more volatile.

$$MFP_t = \sum_{i=1}^{i=I} \left(\frac{revenue_{it}}{\sum_{i=1}^{i=I} revenue_{it}} \times M\hat{F}P_{it} \right) \tag{15}$$

$$LP_t = \sum_{i=1}^{i=I} \left(\frac{revenue_{it}}{\sum_{i=1}^{i=I} revenue_{it}} \times L\hat{P}_{it} \right) \tag{16}$$

Manufacturing's labour productivity closely tracks changes in the sector's MFP, which is consistent with de Avillez (2011) who found that between 1997 and 2007, MFP change accounted for 25.5% of the changes in labour productivity in Canada's manufacturing sector. Overall, food processing's labour productivity grew at an average annual rate of 4.01% compared to 2.90% in manufacturing. This is consistent with Ross (2011) who found that between 2000 and 2007, food manufacturing experienced a growth rate faster than manufacturing. In fact, Ross (2011) found that food manufacturing outperformed 16 out of 20 other manufacturing industries.

[Figure A1 Here]

[Figure A2 Here]

Following Syverson (2011), we examine the productivity dispersion among food processing plants. Table A2 displays the dispersion of productivity for manufacturing, food manufacturing, and food manufacturing's subindustries. Column 2 shows how much more productive a plant in the 90th percentile of the productivity distribution is than one in the bottom 10th percentile. The results suggest that in Canadian manufacturing and food manufacturing, the top 10% is over 3 times more productive than the bottom 10%. this is consistent with a body of literature that finds that even within narrowly defined industries there are high levels of productivity dispersion.

C. Exports and Productivity

In order to answer the research questions regarding the relationship between productivity and export orientation, this section looks at 1) the export premium; 2) the self-selection hypothesis; and 3) the learning-by-exporting hypothesis.

EXPORT PREMIUM

Table A6 shows the estimation results from equation 11. We find that food processing exporters are more productive than non-exporters. This implies that a reduction in trade barriers leads to an increase in productivity, which is consistent with the Melitz model predictions. Using equation 12, we find that for MFP, exporters are 4.64% more productive and in terms of labour productivity, they are 22.26% more productive than non exporters. Baldwin and Gu (2005) suggest this may occur when exporters are more capital intensive than non-exporters.

[Table A6 Here]

Table A6 shows that on average, as plants get older, their MFP decreases for manufacturing, while it is not statistically different from zero for food manufacturing. Conversely, as plants get older, labour productivity increases. This could be the result of older plants being bigger and more capital intensive, which would increase their labour productivity. The impact of size and size squared suggest that MFP increases until plants reach a maximum size, and then the marginal effect becomes negative. However, for the labour productivity case, neither size or size squared have a significant impact on productivity.

SELF-SELECTION HYPOTHESIS

Table A7 provides results for the relationship between pre-entry productivity growth for future exporters and future non-exporters. The results indicate that future exporters experience higher levels of productivity growth prior to entering exporting markets than future non-exporters, which is consistent with the self-selection hypothesis. However, for food manufacturing, it cannot be rejected that the difference in MFP growth is equal to zero between future export market entrants and non-entrants.

[Table A7 Here]

Table A8 illustrates the percentage differences in multifactor and labour productivity growth between exporters and non-exporters, Canadian owned plants and foreign owned, and plants located in Ontario versus plants in the rest of Canada. The results indicate that food manufacturers that enter exporting markets have productivity growth rates that are 3.86% and 17.7% higher than non-exporters for multifactor and labour productivity, respectively. “The difference between labour productivity and MFP growth suggests that plants that begin to export increase their capital accumulation relative to non-entrants” (Baldwin and Yan, 2015, p. 8). Ontario has a lower productivity growth than the rest of Canada during the study period, but this difference is less pronounced for food manufacturing, which could be due to the industry having different technology. Finally, Canadian owned plants experienced higher levels of productivity growth for food manufacturing during the study period, which suggests could be the result of foreign owned plants being more export oriented than domestic plants in a time of low demand for Canadian products.

[Table A8 Here]

The impact on short-term productivity growth of entering exporting markets in manufacturing and food manufacturing is presented in tables A9 and A10 . On average, food processing plants that begin exporting do not experience higher levels of productivity growth relative to non-exporters. This suggests that there is no evidence of learning-by-exporting in the short run. The results for manufacturing on table A10 suggest that in terms of multifactor productivity growth, manufacturing plants that enter exporting markets do experience higher levels of productivity growth than non-exporters. In terms of labour productivity growth, however, export market entrants do not experience higher levels of productivity growth.

[Table A9 Here]

[Table A10 Here]

The lack of evidence of learning by exporting in manufacturing's labour productivity growth is consistent with Baldwin, Gu, and Yan (2013) who find that in the post-2000 period starting to export has no impact on labour productivity growth relative to non-exporters. Since the coefficient for $start_{ist}$ is positive and significant for multifactor productivity growth and insignificant for labour productivity, it suggests that plants that enter export markets have better production technology than non-exporters.

D. Robustness Checks

In order to test the robustness of the Levinsohn and Petrin production function estimates, two robustness checks were performed: 1) the Levinsohn and Petrin production function was estimated using a value added rather than revenue approach; 2) the Levinsohn and Petrin production function was estimated using a balanced panel;

that is, plants that responded to the survey every year from 2000 to 2011[9]. These results are presented in tables A11 and A12, respectively.

[Table A11 Here]

[Table A12 Here]

The estimates for the balanced panel scenario are fairly similar to those with an unbalanced panel. For instance, the output elasticities for labour range from 0.12% to 0.32%, for capital from 0% to 0.84%, compared to 0.19% to 0.33% for labour in the unbalanced panel case and from 0% to 0.917% for capital. On the other hand, the output elasticities in the value added case are different from the gross revenue case; labour ranges from 0.48% for fruits and vegetables to 0.68% in meat and poultry processing. The output elasticity for capital ranges from 0% in sugar and confectionary processing to 0.11% in other food processing. According to Cobbold (2003), differences between value added and gross output are to be expected since they are measuring two different things. Gross output is intended to measure technical change, and value added "reflects an industry's capacity to translate technical change into income and into a contribution to final demand" (p. 23).

Despite the differences in the production function estimates, the productivity estimates for food processing are highly correlated to one another. Table A13 shows the spearman correlation among the various productivity estimates. There is an 87% correlation between the balanced and unbalanced panel estimates, which indicates that entry and exit from the market by plants does not have a big impact on average productivity. Similarly, there is a 77% correlation between the value added scenario and the gross revenue case. Therefore, the gross revenue unbalanced panel results are consistent to using value added or a balanced panel.

[9]The standard errors were bootstrapped 200 times for value added and balanced panel.

[Table A13 Here]

To check the robustness of the findings that indicate that there is evidence of self-selection for manufacturing and food manufacturing, a sensitivity analysis was performed. While it is commonplace in the literature to use three years before the first period ends to test whether self-selection into exporting markets is present, there is no guidance as to why this interval is chosen. To compare the results, the same regressions were estimated by taking all plants that did not export between 2000 and 2005 in order to estimate the differences in productivity growth between plants that began exporting in 2006 and those that did not. The results of these regressions can be found in table A14, which shows that being an exporter has a positive and statistically significant effect on for labour productivity and is marginally significant for MFP. The results are robust to different specifications of what it means to be a non-exporter, and it can be concluded that future exporters experience higher levels of productivity growth than future non-exporters.

IV. Discussion

Canada's food manufacturing industry is a valuable part of the Canadian economy and the manufacturing sector due to its size and resilience. The post-2000 period, however, has marked a challenging period for the industry, characterized by an ongoing change in the market conditions faced by the industry and a change in the industry's structure. The changing structure is reflected by a large number of closures and mergers, as well as the relocation of plants to cheaper jurisdictions. The movement towards greater automation also resulted in a skilled employee deficit where there are not enough people with the skills necessary to fulfill the job vacancies in food manufacturing. Changes in the trade environment such as an appreciated Canadian dollar, a natural resource boom, and increased border effects after 9/11, also created unfavourable conditions for Canadian processors.

The main findings of this research suggest that between 2000 to 2011, food manufacturing MFP was on a constant downward trend, while labour productivity grew at an average annual rate of 4%. Some factors that could explain the decline in MFP include low investment in research and development in the industry, appreciation of the Canadian dollar, excess capacity, and a declining demand for Canadian exports. These factors indicate that there are few incentives for plants to engage in technological improvements. Low demand for Canadian products and a declining trade balance suggest that even if plants innovate, output might not grow sufficiently to spread out the costs of the innovation and thus average costs increase, and productivity declines.

The trading environment was significantly different in the 1990s and the 2000s. As mentioned in the literature review, during the 1990s there was the implementation of NAFTA and the Canada-U.S. free trade agreement, leading to tariff reductions and increased trade. It would be interesting for future research to analyze the impact of such free trade agreements on the productivity of Canada's food manufacturing sector. Future researchers could also repeat this analysis with data until 2015 to determine whether the impact of export orientation and the pattern of productivity change differed in the recovery period from the 2000s. For this study, these comparisons were not possible as ASML data on exports is not consistent prior to the year 2000 and it only goes up to 2011. Additionally, to determine the relative competitiveness with other countries, it is important to compare studies across countries, but to our knowledge no other study has looked at the plant level relationship between productivity and exports for food manufacturing.

When analyzing the relationship between productivity growth and export orientation, we find that exporters have higher levels of productivity than non-exporters. Exporters are 4.62% more productive than non-exporters in terms of MFP and 22.26%

in terms of labour productivity. This is consistent with Baldwin and Gu (2005); Baldwin, Gu and Yan (2013); Bernard and Jensen (1999); Bernard, Jensen and Lawrence (1995); Clerides, Lach and Tybout (1998), who found that exporters have higher levels of productivity. The relationship between entering export markets and productivity growth is more ambiguous, future entrants into exporting markets experience higher levels of productivity growth prior to becoming exporters compared to plants that do not enter exporting markets. The results for the learning-by-exporting hypothesis suggest that they do not experience further increases in productivity growth after entering the market for either MFP or labour productivity growth. Contrary to economic theory, entering exporting markets does not necessarily lead to higher productivity growth once in international markets in the short run. The finding that food processing plants increase their productivity growth prior to entering exporting markets, but productivity does not increase further after becoming exporters, is consistent with most studies in manufacturing industries in developed countries. Some of these studies include Baldwin and Gu (2005); Baldwin and Yan (2012); Baldwin and Yan (2015); Baldwin, Gu and Yan (2013); Wagner (2007); Delgado, Fariñas and Ruano (2001), Biesebroeck (2005); Clerides, Lach and Tybout (1998); and Greenaway and Kneller (2007).

When evaluating the learning by exporting hypothesis it is possible that plants might not accrue the benefits of entering export markets right away as was assumed in this study. The transfer of information and technology could take various years to develop and to overcome the learning effects. Further research could look at whether there is evidence of learning by exporting several years after plants begin to export, as well as whether there is a threshold of export intensity after which plants exhibit increases in productivity.

The average decline in multifactor productivity suggests that policy should be geared towards increasing productivity and productivity growth. The finding that smaller firms experience higher levels of productivity, suggests that policy should focus on promoting the growth of small and medium enterprises. While larger plants might have the financial means to enhance technical change through investment in R&D and other forms of innovation, smaller plants are more financially constrained. It could be beneficial to promote cooperation between universities and businesses, particularly small businesses that might not have the funds to fund research (Damijan and Kostevc, 2010). While smaller plants might not have the scale necessary to spread out investments in research and development, an alternative would be promoting the adoption of best practice technologies by helping plants obtain the necessary funding to do so.

Finally, evidence of self-selection suggests that policy should focus on supporting less productive plants to increase their productivity prior to entering international markets. The signing of new free trade agreements such as CETA and TPP, have the potential to encourage Canadian food manufacturers to become more productive as they will experience greater foreign competition and have have access to new, more diverse markets.

V. Conclussion

The proliferation of new free trade agreements, such as the Transpacific Partnership, Canada - European Union: Comprehensive Economic and Trade Agreement, and the Canada-Korea free trade agreement, among others, reflect the reduction of trade barriers with some of Canada's main trading partners. Exploring the nexus between trade and productivity provides valuable lessons as to how trade impacts the food manufacturing industry and how to help processors succeed in a more globalized economy.

Various conclusions can be drawn from this analysis. First, we found that Canadian food manufacturing plants have experienced a decline in multifactor productivity and an increase in labour productivity. The findings of a decline in MFP in food manufacturing are consistent with Lai (2015) who found that between 1990 and 2014, food manufacturing saw an average yearly decline in MFP growth of 0.9%.

There is a general consensus in the literature that exporters are different from non-exporters; exporters have higher wages, sell more, have larger scale, invest more, and are more capital intensive (see Bernard and Jensen (1999); Biesebroeck (2005); Clerides, Lach and Tybout (1998); De Loecker (2007)). The first research question sought to determine whether this was the case for Canada's food manufacturing industry. The findings are in line with the broader literature as food manufacturing exporters have higher productivity than non-exporters and are more capital intensive. Plants located in Ontario have higher levels of productivity, which could be a result of higher competition within the province.

The second research question sought to determine whether food manufacturing plants experience higher levels of productivity growth prior to entering export markets, and/or after becoming exporters. The findings suggest that food manufacturing plants increase their productivity growth and capital intensity prior to becoming exporters. Once in the exporter market, however, their productivity growth is not different from that of non-exporters in the short-run. These results are in line with Baldwin and Yan (2015); Baldwin, Gu and Yan (2013); Wagner (2007); Delgado, Fariñas and Ruano (2001), and Clerides, Lach and Tybout (1998), who all found evidence of more productive plants self-selecting into export markets, but no evidence of learning-by-exporting.

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TABLES

Table A1—: Summary Statistics

	Manufacturing		**Food Manufacturing**	
	2000	2011	2000	2011
Plants in the Industry	42,185	29,038	4,355	2,927
Plants that reported whether they exported or not	24,738	29,038	2,115	2,927
Exporters (%)	66.89%	49.04%	57.45%	37.03%
Export (billions)	$183	$140	$8.25	$9.57
Export Intensity (%)	22.22%	20.70%	19.20%	11.67%
Exports to the U.S (%)	95.38%	91.57%	88.58%	92.45&

Table A2—: MFP Dispersion

Industry	**90-10 percentile range**
Manufacturing - 31	3.341
Food Manufacturing- 311	3.361
Animal Food-3111	3.573
Grain and oilseeds milling -3112	2.758
Sugar- 3113	3.617
Fruits and Vegetables- 3114	3.198
Dairy- 3115	1.682
Meat- 3116	3.298
Seafood- 3117	1.221
Bakery - 3118	3.377
Other- 3119	3.344

Table A3—: Levinsohn and Petrin Production Function

Industry	**Labour**	**Energy**	**Capital**	**Materials**
Manufacturing - 31	0.332*** (163.44)	0.141*** (110.27)	0.194*** (47.34)	0.116*** (13.88)
Food Manufacturing- 311	0.186*** (30.33)	0.237*** (32.1)	0.0882*** (4.51)	0.434*** (13.13)
Animal Food-3111	0.155*** (9.02)	0.228*** (15.41)	0.267*** (12.77)	3.99E-38 0
Grain and oilseeds milling -3112	0.246*** (15.3)	0.167*** (3.54)	0.0660** (2.38)	0.783*** (4.2)
Sugar- 3113	0.238*** (10.1)	0.133*** (5.74)	0.0295 (0.55)	0.245 (1.12)
Fruits and Vegetables- 3114	0.246*** (11.92)	0.295*** (10.76)	0.0303 (0.53)	0.426*** (5.98)
Dairy- 3115	0.128*** (7.7)	0.237*** (35.82)	0.194 (1.4)	0.917*** (5.95)
Meat- 3116	0.254*** (9.31)	0.156*** (16.84)	0.105*** (3.01)	0.426* (1.93)
Seafood- 3117	0.148*** (10.72)	0.279*** (24.22)	0.380*** -4.25)	0.528*** (6.74)
Bakery - 3118	0.174*** (14.7)	0.279*** (13.16)	0.165*** (7.32)	0.270*** (8.68)
Other- 3119	0.262*** (8.77)	0.157*** (6.95)	0.197*** (4.13)	0.209** (2.11)

t statistics in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Based on bootstrapped standard errors

Observations by NAIC Code: 31- n= 408898, 311-n= 40235, 3111-n= 1331, 3112-n= 4690, 3113- n= 1538, 3114-n= 2972, 3115- n= 2972, 3116- n= 6159, 3117-n= 5123, 3118- n= 10893, 3119- n= 4354.

Table A4—: OLS Production Function

Industry	**Labour**	**Energy**	**Capital**	**Materials**	**Trend**	**Constant**
Manufacturing - 31	0.358*** (251.82)	0.151*** (145.26)	0.0321*** (70.09)	0.488*** (296.05)	-0.0109*** (-63.38)	4.924*** (343.31)
Food Manufacturing- 311	0.216*** (64.39)	0.264*** (50.81)	0.0331*** (23.82)	0.516*** (90.48)	-0.0146*** (-25.28)	3.568*** 97.51
Animal Food-3111	0.173*** (13.43)	0.277*** (15.71)	0.0321*** (9.29)	0.552*** (25.45)	-0.0313*** (-17.93)	3.117*** (19.59)
Grain and oilseeds milling -3112	0.243*** (9.46)	0.173*** (6.23)	0.00882* (1.65)	0.644*** (15.92)	-0.00532** (-2.32)	2.988*** (11.37)
Sugar- 3113	0.285*** (14.3)	0.176*** (6.65)	0.0300*** (4.41)	0.550*** (13.19)	0.00202 (0.96)	3.894*** (14.03)
Fruits and Vegetables- 3114	0.268*** (15.21)	0.350*** (18.09)	0.00831 (1.63)	0.404*** (19.38)	-0.0166*** (-6.92)	4.352*** 24.53
Dairy- 3115	0.199*** (11.89)	0.253*** (11.41)	0.0402*** (7.75)	0.535*** (19.44)	-0.0174*** (-7.22)	3.400*** 18.78
Meat- 3116	0.313*** (16.88)	0.171*** (14.67)	0.0196*** (7.4)	0.536*** (34.07)	-0.0085*** (-6.41)	4.203*** (22.11)
Seafood- 3117	0.197*** (13.79)	0.279*** (18.65)	0.0158*** (4.21)	0.498*** (28.11)	-0.0227*** (-11.66)	3.912*** 23.61
Bakery - 3118	0.207*** (33.19)	0.329*** 30.42	0.0418*** (14.45)	0.439*** (41.44)	-0.007*** (-6.77)	3.748*** 56.76
Other- 3119	0.296*** (20.06)	0.190*** (15.42)	0.0491*** (10.28)	0.509*** (25.81)	-0.0159*** (-10.06)	4.083*** (24.02)

t statistics in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Observations by NAIC Code: 31- n= 408898, 311-n= 40235, 3111-n= 1331, 3112-n= 4690, 3113- n= 1538, 3114-n= 2972, 3115- n= 2972, 3116- n= 6159, 3117-n= 5123, 3118- n= 10893, 3119- n= 4354.

Table A5—: Fixed Effect Production Function

Industry	**Labour**	**Energy**	**Capital**	**Materials**	**Constant**
Manufacturing - 31	0.349*** (142.8)	0.155*** (72.86)	0.00617*** (6.08)	0.392*** (129.03)	6.501*** (140.69)
Food Manufacturing- 311	0.227*** (36.87)	0.228*** (30.02)	-0.000733 (-0.28)	0.379*** (38.07)	6.275*** (42.75)
Animal Food-3111	0.189*** (8.86)	0.256*** (9.52)	-0.0194*** (-3.05)	0.400*** (10.48)	6.187*** (12.54)
Grain and oilseeds milling -3112	0.241*** (7.32)	0.167*** (4.78)	-0.000915 (-0.10)	0.479*** (6.77)	5.730*** (7.14)
Sugar- 3113	0.252*** (9.73)	0.189*** (6.25)	0.00881 (1)	0.381*** (8.14)	6.559*** (11.59)
Fruits and Vegetables- 3114	0.232*** (11.55)	0.274*** (11.6)	-0.0196** (-2.29)	0.342*** (10.17)	6.551*** (14.16)
Dairy- 3115	0.184*** (7.15)	0.223*** (8.13)	-0.00782 (-1.09)	0.418*** (10.02)	6.103*** (10.06)
Meat- 3116	0.298*** (14.93)	0.140*** (8.53)	0.00595 (1.37)	0.415*** (14.85)	6.586*** (15.25)
Seafood- 3117	0.234*** (11.21)	0.261*** (11.48)	-0.00542 (-0.56)	0.382*** (13.83)	5.822*** (15.29)
Bakery - 3118	0.180*** (20.73)	0.260*** (15.34)	0.0230*** (3.26)	0.317*** (20.79)	6.330*** (22.08)
Other- 3119	0.293*** (16.22)	0.190*** (9.73)	0.00313 (0.22)	0.382*** (14.45)	6.439*** (16.62)

t statistics in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Observations by NAIC Code: 31- n= 408898, 311-n= 40235, 3111-n= 1331, 3112-n= 4690, 3113- n= 1538, 3114-n= 2972, 3115- n= 2972, 3116- n= 6159, 3117-n= 5123, 3118- n= 10893, 3119- n= 4354.

Table A6—: Export Premium for Manufacturing and Food Manufacturing from 2000 to 2011

	Multifactor Productivity		*Labour Productivity*	
Variables	***Manufacturing***	***Food Manufacturing***	***Manufacturing***	***Food Manufacturing***
Exporter	0.116*** (10.96)	0.0452** (2.13)	0.110*** (9.45)	0.201*** (4.98)
Ownership	0.0744*** (4.86)	0.00261 (0.12)	-0.528*** (-34.02)	-0.424*** (-9.07)
Age	-0.00200*** (-4.15)	-0.000949 (-1.13)	0.00218*** (3.93)	0.0123*** (6.93)
Size	3994.0*** (21.44)	221.6*** (13.22)	-138.9 (1.57)	16.78 (0.61)
Size squared	-924425.4*** (-9.94)	-23607.7*** (-5.79)	138830.3*** (4.66)	-2605.2 (0.66)
Trend	-0.0159*** (-7.52)	-0.0180*** (-4.98)	-0.00648*** (-2.66)	-0.0164** (-2.25)
Ontario	0.0806*** (14.18)	0.0812*** (8.31)	0.105*** (15.97)	0.197*** (9.76)
Constant	7.989*** (321.98)	4.320*** (129.34)	12.82*** (492.77)	13.40*** (181.48)
Recession	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes

Dependent Variable: Productivity

t statistics in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust Standard errors

Table A7—: Self Selection for Food Manufacturing and Manufacturing Between 2000-2011

Variables	*Multifactor Productivity* ***Manufacturing***	***Food Manufacturing***	*Labour Productivity* ***Manufacturing***	***Food Manufacturing***
Exporter	0.0191***	0.0379	0.0434***	0.163***
	(2.7)	(1.4)	(4.25)	(3.23)
Canadian ownership	-0.0399***	-0.0755*	0.100***	0.297***
	(-2.79)	(-1.74)	(6.56)	(4.17)
Age	-0.00153**	-0.000095	-0.00217***	-0.00395
	(-2.51)	(-0.05)	(-2.78)	(-1.09)
Ontario	-0.0302***	0.00318	-0.0198***	0.00401
	(-5.57)	(0.19)	(-2.80)	(0.12)
Size	6.486	-10.14	302.8***	23.72
	(0.11)	(-0.51)	(5.56)	(0.75)
Size squared	720	2826.6	-41407.8***	-1440.2
	(0.09)	(1.02)	(-4.56)	(-0.52)
Constant	-0.0509***	-0.0891***	0.0891***	-0.294***
	(-2.62)	(-3.69)	(3.69)	(-3.24)
Industry fixed effects	Yes	Yes	Yes	Yes

t statistics in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors

Dependent Variables: Productivity growth between 2003 and 2005

Table A8—: Differences (%) in Productivity Growth Rates.

Variables	*Multifactor Productivity* ***Manufacturing***	***Food Manufacturing***	*Labour Productivity* ***Manufacturing***	***Food Manufacturing***
Exporter	1.93%	3.86%	4.44%	17.70%
Canadian Owned	-3.91%	7.84%	10.52%	34.58%
Ontario	-2.97%	-0.32%	-1.96%	0.40%

Note: Productivity growth differences= $100(e^{\beta} - 1)$

Table A9—: Food Manufacturing Learning-by-Exporting

	Multifactor Productivity Growth			***Labour Productivity Growth***		
Variables	*Model 1*	*Model 2*	*Model 3*	*Model 1*	*Model 2*	*Model 3*
Start	-0.012 (-0.62)	-0.002 (-0.09)	-0.029 (-1.07)	-0.018 (-0.40)	-0.025 (-0.51)	0.0009 (0.02)
Stop	-0.008 (-0.35)	0.0099 (0.31)	-0.004 (-0.09)	0.018 (0.42)	0.044 (0.72)	0.106 (1.58)
Continue	-0.023 (-1.22)	0.025 (1.07)	0.008 (0.27)	-0.001 (-0.03)	0.021 (0.66)	-0.01 (0.31)
Age	-0.003** (-2.21)	-0.005*** (-3.09)	-0.005** (-2.15)	-0.003 (-0.96)	-0.005 (-1.22)	0.0002 (0.04)
Size	24.12** (2.33)	-11.82 (-0.74)	-39.59** (-2.11)	70.16*** (3.95)	88.86*** (3.6)	60.41*** (2.68)
Size squared	-2959.8*** (-5.82)	-3896.3*** (-2.90)	-319 (-0.14)	-3630.1*** (-3.25)	-8088.2*** (-2.59)	-4428.0** (-2.41)
Canadian Ownership	Yes	Yes	Yes	Yes	Yes	Yes
Naics 4 fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.071** (-2.51)	-181.4 (-0.14)	0.005 -0.12	-0.071 (-1.11)	-0.0395 (-0.69)	-0.064 (-0.77)

Dependent variable: productivity growth

t-statistics in parenthesis. *p <0.1, **p <0.05, ***p <0.01. Robust standard errors

Table A10—: Manufacturing Learning by Exporting

	Multifactor Productivity Growth			***Labour Productivity Growth***		
Variables	*Model 1*	*Model 2*	*Model 3*	*Model 1*	*Model 2*	*Model 3*
Start	0.0173**	0.0281***	0.0144*	0.008	-0.002	-0.005
	(2.41)	(3.95)	(1.91)	(0.79)	(-0.16)	(-0.48)
Stop	-0.0171**	-0.000673	-0.0113	-0.0205*	0.000265	0.00637
	(-2.18)	(-0.07)	(-0.79)	(-1.95)	(0.02)	(0.38)
Continue	0.00252	0.0173**	0.0293***	0.00422	0.0153*	0.0181*
	(0.4)	(2.41)	(3.14)	(0.59)	(1.85)	(1.8)
Age	-0.0022***	-0.0025***	-0.0028***	118.2***	-0.002**	-0.001
	(-4.52)	(-4.11)	(-3.51)	(3.68)	(-2.06)	(-0.81)
Size	-88.12*	-104.7*	-87.68	-15337***	88.33***	52.03
	(-1.92)	(-1.89)	(-1.50)	(-3.42)	(2.69)	(1.58)
Size squared	9447.1*	12598.8*	421.4	-0.002**	-14401***	-7739.3*
	(1.92)	(1.89)	(0.05)	(-2.48)	(-2.87)	(-1.94)
Canadian Ownership	Yes	Yes	Yes	Yes	Yes	Yes
Naics 3 fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.113***	-0.147***	-0.154***	-0.121***	-0.0608***	-0.112***
	(-7.02)	(-7.80)	(-7.31)	(-6.18)	(-6.29)	(-5.84)

t-statistics in parenthesis. *p <0.1, **p <0.05, ***p <0.01. Robust standard errors

Table A11—: Value Added Levinsohn and Petrin Production Function

Industry	Labour	Capital
Manufacturing - 31	0.652*** (235.57)	0.0749*** (20.88)
Food Manufacturing- 311	0.585*** (77.41)	0.0533*** (5.44)
Animal Food-3111	0.594*** (21.57)	0.0320** (2.38)
Grain and oilseeds milling -3112	0.642*** (21.57)	0.00761 (0.33)
Sugar- 3113	0.607*** (11.59)	-0.00755 (-0.23)
Fruits and Vegetables- 3114	0.481*** (17.28)	0.0642 (1.02)
Dairy- 3115	0.570*** (14.41)	0.00506 (0.09)
Meat- 3116	0.684*** (28.53)	0.0225 (1.25)
Seafood- 3117	0.526*** (17.52)	0.0738 (1.56)
Bakery - 3118	0.571*** (43.48)	0.0221 (0.98)
Other- 3119	0.625*** (20.81)	0.112*** (3.38)

t statistics in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Observations by NAIC-code 31- n= 408898, 311-n= 40235, 3111-n= 4690,
3112-n= 1331, 3113-n= 1538 ,3114-n= 2972, 3115-n= 3175 ,
3116-n= 6159 , 3117-n= 5123 , 3118-n= 10893 , 3119-n= 4354.

Table A12—: Levinsohn and Petrin Production Function: Balanced Panel

Industry	**Labour**	**Energy**	**Capital**	**Materials**
Manufacturing - 31	0.319*** (82.91)	0.106*** (32.57)	0.0969*** (9.99)	0.404*** (19)
Food Manufacturing- 311	0.200*** (17.68)	0.133*** (9.03)	0.149*** (3.43)	0.399*** (4.84)
Animal Food-3111	0.179*** (4.81)	0.180*** (3.67)	0.211*** (3.96)	1.88E-35 0
Grain and oilseeds milling -3112	0.267*** (5.71)	0.0987* (1.92)	7.65E-13 0	0.384 (1.35))
Sugar- 3113	0.300*** (6.92)	-0.0245 (-0.29)	0.0843 (3.89)	0.665** (2.24)
Fruits and Vegetables- 3114	0.217*** (10.47)	0.149*** (3.88)	0.183* (4.03)	0.269 (1.24)
Dairy- 3115	0.173*** (6.01)	0.114*** (4.34)	1.80E-25 0	0.730*** (3.51)
Meat- 3116	0.214*** (6.03)	0.0664*** (3.04)	0.820*** (3.89)	0.546*** (2.82)
Seafood- 3117	0.124*** (2.71)	0.207*** (5.94)	0.846*** (4.03)	0.247* (1.75)
Bakery - 3118	0.196*** (11.01)	0.116*** (4.66)	0.0598 (1.26)	0.258* (1.76)
Other- 3119	0.290*** (9.71)	0.0342* (1.79)	0.780*** (3.61)	0.300** (1.97))

t statistics in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Observations by NAIC-code 31- n= 87101, 311-n= 8280, 3111-n= 361, 3112-n= 1071, 3113-n= 365 , 3114-n= 658, 3115-n= 751 , 3116-n= 1301 , 3117-n= 802 , 3118-n= 1920 , 3119-n= 1051.

Table A13—: Spearman Rank Correlation Food Manufacturing

	Unbalanced panel MFP	Balanced panel MFP	Value Added MFP	Labour Productivity
Unbalanced panel MFP	1	0	0	0
Balanced panel MFP	0.9424	1	0	0
Value Added MFP	0.6286	0.7144	1	
Labour Productivity	0.5499	0.5576	0.6364	1

Table A14—: Self Selection Hypothesis for Multifactor Productivity Growth and Labour Productivity Growth

Variables	*Multifactor Productivity* ***Manufacturing***	***Food Manufacturing***	*Multifactor Productivity* ***Manufacturing***	***Food Manufacturing***
Exporter	0.0218** (2.38)	0.0603* (1.65)	0.0478*** (3.86)	0.226*** (3.8)
Canadian ownership	0.0229 (1.25)	0.00377 (0.07)	0.147*** (7.02)	0.309*** (3.55)
Age	-0.00567*** (-5.76)	-0.00229 (-0.64)	-0.0018 (-1.42)	-0.0171*** (-2.91)
Ontario	-0.0716*** (-9.61)	-0.236*** (-8.14)	-0.0943*** (-9.83)	-0.526*** (-10.66)
Size	-155.5*** (-2.65)	-40.21 (-1.37)	287.6*** (4.73)	130.5*** (2.81)
Size squared	19804.1** (2.35)	9002.4*** (3.27)	-41951.8*** (-3.35)	-14511.5*** (-2.76)
Constant	0.00756 (0.3)	-0.117* (1.67)	0.0537 (1.61)	0.326*** (2.82)
Industry fixed Effects	Yes	Yes	Yes	Yes

t statistics in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Dependent Variables: Productivity growth between 2000 and 2005

FIGURES

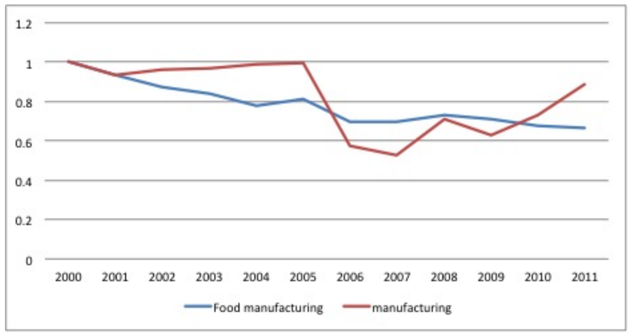

Figure A1. : Aggregate Multifactor Productivity for Manufacturing and Food Manufacturing from 2000 to 2011.

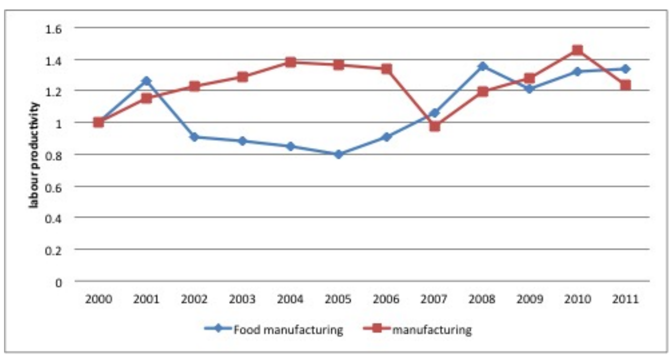

Figure A2. : Aggregate Labour Productivity for Manufacturing and Food Manufacturing from 2000 to 2011.