Trade Liberalization, Selection, and Productivity in a Supply Managed Economy

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Abstract

In this paper I use farm-level data from the Quebec dairy industry to estimate the relationship between productivity and participation in the Commercial Export Milk (CEM) program (2000-2003). Under the CEM program farmers could sell milk without production quota and faced a farm price that was approximately half of the domestic price under supply management. I find a positive correlation between participation in the CEM program and farm-level total factor productivity (TFP). I then use a difference-in-difference research design with inverse propensity weights to test for causality in the relationship between participation in the CEM program and TFP. I find evidence of a positive and statistically significant effect in two of four regression specifications. A number of economists have argued that the Canadian dairy industry could benefit from trade liberalization through export market growth and returns to scale in production. My results suggest that trade liberalization would also lead to additional productivity and welfare gains from farm-level selection and the direct effects from exposure to a competitive pricing environment.

JEL classification: D24, F14, Q18
Keywords: Firm heterogeneity, Trade liberalization, Productivity, Agriculture, Supply Management

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1 Introduction

This paper focuses on the productivity effects of the Commercial Export Milk (CEM) Program (2000-2003) in the Canadian dairy sector. Under this program farmers could sell milk destined for export directly to Canadian processors. The empirical trade literature has established that export participation is positively correlated with firm-level productivity. However, whether or not exposure to trade *causes* productivity enhancement is an open question, (Bernard et al., 2011). The farm-level data used in this paper provides a unique opportunity to study the heterogeneous effects of export participation in a supply managed economy. This paper is also relevant to the ongoing negotiations of the Trans-Pacific Partnership (TPP). The TPP negotiations have increased the likelihood of liberalization of the supply managed industries in Canadian agriculture. It is difficult to predict how these industries will be impacted by trade liberalization since farmers' responses to competitive price movements are unobserved under supply management. Under the CEM program the farm price of milk was approximately half of the administered supply managed price. Therefore, studying the CEM program provides insight into the potential effects of trade liberalization and competitive pricing in Canada's supply managed agricultural industries.

In 1999 the WTO Dispute Settlement Body ruled that Canada must reform its dairy export mechanism. Canada responded by introducing the CEM program and a number of other new export policies for the Canadian dairy industry. The CEM permitted farmers to sell milk directly to Canadian processors provided that the final goods were destined for export. Importantly, farmers did not require production quotas for milk sold through the CEM program. Participation in the program was voluntary, and the farm price of milk was negotiated directly between farmer and processor. The CEM created a dual marketing stream for raw milk that circumvented the highly regulated system of marketing under supply management. Therefore, farmers who participated in the program effectively faced a competitive marketing environment. The CEM program was cancelled in 2003 after a 2002 WTO ruling concluded that the CEM constituted an export subsidy for Canadian dairy processors.

The data for this paper comes from the Canadian Census of Agriculture (1996, 2001, 2006) and the Quebec Federation of Management Clubs' Agritel database (1993-2006). I begin by estimating farm-level total factor productivity (TFP) using the fixed effects and Olley and Pakes (1996) methodologies. I then estimate the 'export premia' regressions that are routinely reported in the empirical trade literature following the methodology of Bernard and Jensen (1999). These regressions show a positive correlation between farm-level TFP and participation in the CEM program. This positive correlation persists when the sample is restricted to observations in the pre-policy period, which provides evidence of the self-selection of highly productive farms into the CEM program. To test if participation in the CEM program increased farm-level TFP I use difference-in-difference methodology and inverse propensity weighting following the approach of Hirano et al. (2003). I find that the CEM had a positive and statistically significant effect on farm-level productivity in two of four empirical specifications.

This paper contributes to the empirical trade literature on firm heterogeneity and export participation. While there is a large literature documenting the correlation between export participation and firm-level productivity, relatively few papers have tested for causality in this relationship. Examples include: Clerides et al. (1998), Bernard and Jensen (1999), Van Biesebroeck (2005), and De Loecker (2007). The majority of papers in this literature focus on a single sector: manufacturing. To my knowledge, this is the first paper to test for causation between trade participation and productivity using farm-level data in the agriculture sector. Understanding this relationship is important as tariff rates in agriculture are notoriously high in comparison with other industrial goods. By focussing on the Canadian dairy industry, this paper provides insight into the gains from trade in the agricultural sector where a great deal of trade liberalization has yet to occur. The results of this paper also inform policy discussions surrounding the ongoing negotiations of the TPP. Earlier papers to examining the CEM program include Doyon et al. (2006) and Turvey et al. (2003). However, these papers focus primarily on domestic production quota pricing, and neither use farm-level data or consider the effect of CEM participation on farm-level productivity. More recently, Barichello et al. (2014) argues that the Canadian dairy industry stands to benefit from trade liberalization by showing that the potential gains from export opportunities in emerging markets outweigh the losses associated with eliminating supply management. However Barichello et al.'s (2014) analysis does not account for the added welfare gains from trade liberalization that arise from farm-level heterogeneity. My results suggest that Barichello et al.'s (2014) estimates are a lower bound on the gains from liberalization as increases in farm-level productivity resulting from trade exposure would further increase aggregate welfare.

The remainder of this paper is organized as follows: Section 2 describes the data, Section 3 reports the farm-level TFP estimates, Section 4 presents the research design and main results of the paper, and Section 5 concludes.

2 Data

The main source of data for this paper is the Agritel panel database, which is generated from a farm-level survey completed annually by the Federation of Management Clubs in the province of Quebec. In Section 3 I describe the variables from the Agritel database that will be used to estimate the farm-level production function and TFP. In this Section I focus on describing the variables that relate to the CEM program. My previous research indicates that the Agritel database is not representative of the population of dairy farms in Quebec. Over the period 1993-2011, the average revenue of farms in the Agritel database was 42 percent higher than for the population of dairy farms in Quebec, (Chernoff, 2015). To correct for the unrepresentative nature of the sample I construct sample weights using farm-level data from the Canadian Census of Agriculture for the years 1996, 2001, 2006.[1]

Table 1 reports summary statistics on farmers' participation in the CEM program between 2000 and 2003. The second column in Table 1 shows the total number of farmers in the Agritel Survey during each of the four years of the program. The third column shows the weighted percentage[2] of these farmers who participated in the CEM program, and thus provides an estimate of the percentage of Quebec farmers participating in the program. In the years 2001 and 2002, participation in the program peaked at 38.3 and 32.3 percent respectively. Whereas few papers have documented farm-level participation in export markets for agricultural industries, it useful to compare the statistics in Table 1 with firm-level export data for the manufacturing sector during the same era. Bernard et al. (2007) find that 18 percent of U.S. manufacturing firms participated in export markets in 2002. By this comparison, farm-level participation in the CEM at the extensive

[1] The weights are constructed using the following procedure: In each Census year a tabulation of frequencies of the number of cows per farm is calculated from the Census farm-level data. That is, I count the number of farms with herd sizes within discrete intervals (the classes are: 1-10 cows per farm, 11-20 cows per farm, etc). I then calculate the average of the frequencies in each discrete interval over the three Census years (1996, 2001, 2006). Next I make a corresponding tabulation of frequencies for each year over the period 1996-2006 using the Agritel data. I then calculate the average of the frequencies in the Agritel data over the period 1996-2006. For each interval, the sample weight is calculated to equate the frequency counts from the Agritel tabulation with the Census tabulation.

[2] Henceforth all averages are weighted by the Census population weights unless otherwise noted.

margin was relatively high.

Column four indicates that milk marketed through the CEM program accounted for only a small percentage of output (output is measured in hectolitres (hl) of milk). At the height of the program in 2001, the average output marketed through the CEM was only 2.57 percent. Bernard et al. (2007) estimate that mean exports accounted for approximately 14 percent of output in the U.S. manufacturing sector in 2002. Therefore farm-level participation in the CEM program at the intensive margin of trade was relatively low. The next two columns compare the CEM price, P_{CEM}, with the price farmers receive under supply management, P_{SM}. A comparison of these prices illustrates that the average CEM price was 51 percent lower than the supply managed price during the four years of the program. While farmers received a much lower price for their milk under the CEM marketing scheme, they avoided the costs associated with purchasing production quotas.

Table 1: Quebec Farm Participation in the Commercial Export Program

Year	Sample	CEM Participants	$\frac{\text{Exports}}{\text{Output}}$	P_{CEM}	P_{SM}	CEM Fees	SM Fees	CEM Costs	Sample Costs
2000	1,317	9.51%	0.38%	\$27.40	\$56.55	\$1.25	\$3.17	\$37.16	\$37.57
2001	1,293	38.3%	2.57%	\$29.54	\$57.43	\$2.16	\$3.49	\$38.38	\$39.00
2002	1,222	32.3%	2.28%	\$32.16	\$58.53	\$2.13	\$3.77	\$39.09	\$40.24
2003	1,171	7.49%	0.28%	\$24.16	\$60.34	\$1.76	\$3.88	\$37.99	\$39.39

Values are in Canadian dollars per hectolitre (hl). Column six is the monthly reference price sourced from the Fédération des Producteurs de Lait du Québec. Columns three to five, and seven to ten are weighted sample averages using the Agritel database and the sample weights constructed from the Canadian Census of Agriculture. Column two is the Agritel sample size; column three is the percentage of farmers in the sample that participated in the CEM program; column four is the average percentage of firm output marketed through the CEM; column five is the average price farmers received for milk sold through the CEM program; columns seven and eight are the average milk marketing fees associated with the CEM program and supply management respectively; and columns nine and ten are the average variable costs of farmers participating in the CEM and for the entire sample respectively.

In sum, the data in Table 1 indicate that a large fraction of farmers used the CEM program, however the average quantity of milk farmers sold through the program was relatively low. The final columns of Table 1 help to explain these stylized facts. Column seven presents the average marketing fees paid by farmers participating in the CEM program, and column eight presents the average marketing fees associated with marketing milk through supply management. Marketing fees under the CEM program were 49 percent below the marketing fees farmers paid to market their milk through supply management. In the Melitz (2003) model firm-level participation in trade is mediated by the fixed costs of trade which results in only the most productive firms entering into export markets. The evidence in Table 1 suggests that this fixed cost was relatively low for the CEM program. This may explain why farm-level participation at the extensive margin was high relative to Bernard et al.'s (2007) estimates for the U.S. manufacturing sector during the same era. Turvey et al. (2003) find that processor demand for milk through the CEM far exceeded supply, which indicates that farmers did not need to incur additional search costs to sell their milk through the CEM program. The final two columns give the average variable cost (per hectolitre) of producing milk for the farmers participating in the CEM and for the entire sample. The average variable cost of producing milk was well above the CEM price and this explains why so little milk was marketed through the CEM program. The average variable costs of farmers participating in the CEM program were below the average for the entire sample, which suggests that farmers' participating in the CEM were more productive. In the next section I estimate farm-level total factor productivity in order to test this hypothesis explicitly.

3 Total Factor Productivity Estimation

In this section I describe the production technology, TFP estimation methodology, and results. I assume that farmers produce milk using a Cobb-Douglas production function. The natural logarithmic representation of the production technology is given by the following equation:

$$Output_{i,t} = \beta_0 + \beta_1 Labor_{i,t} + \beta_2 Concentrates_{i,t} + \beta_3 Forages_{i,t} + \beta_4 Cereals_{i,t} + \beta_5 Cows_{i,t} \quad (1)$$

$$+\beta_6 Capital_{i,t} + \beta_7 Time + u_{i,t}, \quad u_{i,t} = \Omega_{i,t} + \eta_{i,t}$$

Output and all inputs in equation (1) are expressed in logarithmic form. The variable $Output_{i,t}$ is the hectolitres of milk produced by farmer i in year t. The production function inputs include labour and three additional variable production inputs, $Concentrates_{i,t}$, $Forages_{i,t}$, and $Cereals_{i,t}$. These three production inputs are the largest variable inputs in production as measured by their value share in the average variable cost of production during the observation period, 1993-2006. Labour is measured in physical units using the standardized method employed in the Agritel survey. The other three variable inputs are measured in nominal values. The herd size, $Cows_{i,t}$, is measured by the number of dairy cows used by farmer i in year t. Physical capital, $Capital_{i,t}$, is measured by the nominal value of machinery, equipment, and buildings (construction value) on farm i in year t. A time trend, $Time$, is included to capture industry-wide technological progress.

Following Olley and Pakes (1996) I assume the error term, $u_{i,t}$, is composed of two additive components, $\Omega_{i,t}$ and $\eta_{i,t}$. The first term, $\Omega_{i,t}$ is a productivity shock that is observed by the farmer but not the econometrician. The second, term $\eta_{i,t}$, is a second productivity shock that is unobserved by both the farmer and econometrician. After observing $\Omega_{i,t}$ the farmer is assumed to simultaneously choose the level of output and variable inputs to maximize profits. The simultaneity of this decision results in an upward bias on the variable input coefficient estimates. If the productivity shock $\Omega_{i,t}$ is assumed constant over time, then fixed effects estimation can be used to account for unobserved farm-level heterogeneity. Under the more realistic assumption that farmers' productivity varies over time, Olley and Pakes (1996) estimation can be used to account for the simultaneity in input and output decisions. This approach involves using investment as a proxy for farm-level productivity shocks. Farmer-exit is a second potential source of bias in estimating equation (1). Olley and Pakes (1996) show that if exit is unaccounted for, then the coefficient estimates for fixed inputs will be biased downward.

For the purposes of Olley and Pakes (1996) estimation, $Labor_{i,t}$, $Concentrates_{i,t}$, $Forages_{i.t}$, and $Cereals_{i,t}$ are specified as variable inputs while $Cows_{i,t}$ and $Capital_{i,t}$ are specified as fixed in any given year. I follow Olley and Pakes (1996) in using investment as a proxy for productivity. The investment variable is specified in logarithmic form and therefore all farmers with zero investment are not used in the Olley and Pakes (1996) estimation procedure. This can result in sample selection bias if a large number of farmers have zero investment. In my sample 94.7 percent of observations had non-zero levels of investment, and therefore any effect of sample selection bias is expected to be small. To account for exit I create an exit variable that takes a value of 1 if a farmer exits the survey and never re-appears in any future year. In creating this variable I use data extending up to 2011, which extends five years beyond the final year in my observation period, 1996-2006.

I estimate equation (1) by fixed effects and Olley and Pakes's (1996) methodology and report the results in Table 2. The magnitude of the estimated coefficients is similar across the two specifications. The two sets of results in Table 2 are used to estimate farm-level TFP. The correlation coefficient between the Olley and Pakes (1996) and fixed effects TFP estimates is 0.92, which in-

Table 2: Total Factor Productivity Estimation Results

	Fixed Effects	Olley & Pakes
Labour	0.0612***	0.0448***
	(0.0137)	(0.00653)
Concentrates	0.160***	0.151***
	(0.0318)	(0.00374)
Forages	0.0125	0.0601***
	(0.0132)	(0.00679)
Cereals	0.0139***	0.0369***
	(0.00206)	(0.00191)
Cows	0.623***	0.550***
	(0.0478)	0.00891
Capital	0.0188*	0.106***
	(0.00994)	0.006912
Time Trend	0.0111***	0.00539***
	(0.00151)	(0.000464)
Observations	14,182	13,317
R-squared	0.848	

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable and all explanatory variables except the time trend are expressed in natural logarithm form. Estimates use sample weights constructed from the Canadian Census of Agriculture.

dicates that there is little variation in the results between the two methodologies. The Olley and Pakes (1996) estimates are deemed the preferred estimates since the estimator is robust to bias arising from simultaneity and farmer exit. In general, the results in the remainder of this paper are robust to either specification. In the interest of being concise, in Section 4.1 I only use the Olley and Pakes (1996) TFP estimates in the analysis as the qualitative results are robust to either specification. In Section 4.3 I present both specifications as the results differ slightly depending on whether the fixed effects or Olley and Pakes (1996) TFP estimates are used.

4 CEM Participation and TFP

4.1 Export Premia Regressions

In this section I present the export premia regressions that are commonly reported in the empirical trade literature following the methodology of Bernard and Jensen (1999). The export premia regression takes the following form:

$$TFP_{i,t} = \beta_0 + \beta_1 Xstatus_i + Z_{i,t}\delta + u_{i,t} \quad (2)$$

The dependent variable, $TFP_{i,t}$, is the natural logarithm of TFP estimated by the Olley and Pakes (1996) method. The vector $Z_{i,t}$ contains variables that control for year fixed effects. In some specifications I also include the natural logarithm of output to control for economies of scale. The variable of interest is the dummy variable indicating farmers' participation status in the CEM program. I consider two different specifications of the CEM participation variable. In the first specification the variable X_1 takes a value of one if the farmer marketed milk through the CEM program *once* during the period 2000-2003. In the second specification the variable X_2 takes a value of one if the farmer marketed milk through the program *more than once* during the period 2000-2003. The coefficient on the CEM participation variable, β_1, is the key coefficient of interest. This coefficient is referred to as the export premia and measures the correlation between CEM participation and TFP, holding constant the other control variables.

The results of the export premia regressions for the observation period 1993-2006 are reported in Table 3. In three of the four specifications the regression output show a positive relationship between CEM participation and TFP, as the export premia coefficient is statistically significant at the 1 percent level. The results also show a positive and highly significant relationship between firm size and TFP. This is consistent with prior research indicating that there are increasing returns to scale in dairy farming.[3]

The theoretical trade literature has offered a number of explanations for the positive correlation between trade participation and productivity. In Melitz (2003) firms must pay a fixed cost to enter export markets which leads to selection of the most productive firms into trade. To test if selection factors in the positive correlation between CEM participation and productivity, I re-estimate the export premia regressions for the period *before* the CEM policy was implemented, 1993-1999. The results are reported in Table 4. In all four regressions the export premia coefficient is positive and statistically significant (in three of four regressions the coefficient is statistically significant at the 1 percent level, and statistically significant at the 10 percent level in the fourth case). This

[3]For example, Mosheim and Lovell (2009) find evidence of increasing returns to scale in US dairy farming. Similarly, Moschini (1988) finds that there are increasing returns to scale in dairy farming in Ontario.

Table 3: Export Premia Regressions - 1993-2006

Dependent Variable	TFP_{OP}	TFP_{OP}	TFP_{OP}	TFP_{OP}
X_1	0.00286	0.0125***		
	(0.00429)	(0.00325)		
X_2			0.0145***	0.00805***
			(0.00347)	(0.00260)
Output		0.170***		0.170***
		(0.0110)		(0.0109)
Observations	13,317	13,317	13,317	13,317
R-squared	0.025	0.357	0.027	0.357

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Each regression model includes dummy variables for year fixed effects. Estimates use sample weights constructed from the Canadian Census of Agriculture. The CEM participation variables are dummy variables defined as follows: $X_1 \equiv 1$ if farmer participated in CEM once during 2000-2003; $X_2 \equiv 1$ if farmer participated in CEM more than once during 2000-2003.

provides strong evidence that selection at least partially explains the positive correlation between CEM participation and farm-level productivity over the period 1993-1999.

Table 4: Export Premia Regressions - 1993-1999

Dependent Variable	TFP_{OP}	TFP_{OP}	TFP_{OP}	TFP_{OP}
X_1	0.0195***	0.0162***		
	(0.00521)	(0.00435)		
X_2			0.0205***	0.00639*
			(0.00514)	(0.00363)
Output		0.182***		0.181***
		(0.0218)		(0.0218)
Observations	7,268	7,268	7,268	7,268
R-squared	0.036	0.367	0.037	0.366

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Each regression model includes dummy variables for year fixed effects. Estimates use sample weights constructed from the Canadian Census of Agriculture. The CEM participation variables are dummy variables defined as follows: $X_1 \equiv 1$ if farmer participated in CEM once during 2000-2003; $X_2 \equiv 1$ if farmer participated in CEM more than once during 2000-2003.

It is useful to benchmark the estimated export premia for the Canadian dairy farming industry to that of the U.S. manufacturing sector during the same era. Bernard et al. (2007) reports that the TFP export premia for the U.S. manufacturing sector ranged from 0.02 to 0.05 which is higher than the export premia reported for the Canadian dairy sector in Tables 3 and 4. The summary statistics presented in Table 1 may help to explain this result. In section 2 I noted that the marketing fees for the CEM program were low relative to the marketing fees incurred from selling milk domestically through supply management. Interpreted in the context of the Melitz (2003) model, the magnitude of the selection effect may have been relatively small for the CEM program since the costs of participating in the program was low.

4.2 Identification

In this section I turn to the question of whether or not participation in the CEM program enhanced farm-level productivity. A naive approach to addressing this question would be to use a standard difference-in-difference research design. This would involve supplementing the export premia regression model with interaction terms as follows:

$$TFP_{i,t} = \beta_0 + \beta_1 Xstatus_i + \beta_2 During_t + \beta_3 Xstatus_i \; x \; During_t \tag{3}$$

$$+\beta_4 After_t + \beta_5 Xstatus_i \; x \; After_t + Z_{i,t}\delta + u_{i,t},$$

where $Before$, $During$ and $After$ are dummy variables that take a value of one if the period is 1993-1999, 2000-2003, and 2004-2006 respectively.

The problem with a standard difference-in-difference research design is that the treatment (participation in the CEM program) is not randomly assigned. The results in Table 4 indicate that there were ex-ante differences between the farmers who did and did not participate in the CEM program. In particular, the results in the previous section indicate that the control group (farmers who did not participate in the CEM program) had lower TFP on average. Fortunately inverse propensity weighting can be used to improve the research design by increasing the ex-ante similarity between the treatment and control group. After the inverse propensity weights have been applied, the weighted average observable characteristics of the two groups are near identical for the period before the CEM program. Then when the difference-in-difference regression is estimated the coefficient of interest, β_3, captures the treatment effect resulting from farm participation in the CEM program.

To calculate the inverse propensity weights I follow the procedure introduced by Hirano et al. (2003). First I estimate the probability $\hat{P}_{i,t}$, which is the probability that farmer i in period t belonged to the treatment group conditional on the farmer's observable characteristics. The observable characteristics include the farmer's TFP, herd size, and age. The probability $\hat{P}_{i,t}$ is estimated from the following probit regression, which is estimated for period *before* the CEM program was implemented (1993-1999):

$$Xstatus_i = \gamma_0 + \gamma_1 TFP_{i,t} + \gamma_2 cows_{i,t} + \gamma_3 age_{i,t} + u_{i,t} \quad (4)$$

Next I calculate the inverse propensity weights using the following equation:

$$w_{it} = \frac{Xstatus_i}{\hat{P}_{i,t}} + \frac{1 - Xstatus_i}{1 - \hat{P}_{i,t}} \quad (5)$$

Finally I create a new set of regression weights by multiplying the inverse propensity weights in equation (5) by the sample weights created from the Census of Agriculture. These new weights are used in estimating the difference-in-difference regression equation (3).

4.3 Difference-in-Difference Results

Table 5 presents the results from estimating equation (3) by OLS with the weights defined in the previous section. To preserve the comparison between the control and treatment groups the sample is restricted to the balanced panel of observations over the period 1993-2006. The regression is run with both the fixed effects and Olley and Pakes (1996) TFP estimates. I also include two specifications of the CEM participation dummy variable, $XStatus_i$ following the same specifications as described in section 4.1.

The key parameter of interests is the coefficient for the interaction variable $Xstatus_i\ x\ During_t$. This parameter captures the effect of the CEM participation on farm-level productivity. The results indicate that this parameter is positive and statistically significant at the 10 percent level in two of the four specifications. In the final column this parameter is *almost* significant at the 5 percent level as the t-statistic is 1.9 with a p-value of 0.57. Interpreting the parameter of interest in the cases where it is statistically significant implies that CEM participation resulted in an increase in farm-level TFP of approximately 3 percent. It is possible that the CEM program increased farm-level productivity by providing a more flexible marketing arrangement for farmers. It has already been noted that the marketing costs of the program were relatively low. Furthermore, farmers did not need to acquire production quotas in order to participate in the program. Therefore, the

Table 5: CEM Participation and TFP Regression Results

Dependent Variable	TFP_{FE}	TFP_{FE}	TFP_{OP}	TFP_{OP}
Xstatus Specification	X_1	X_2	X_1	X_2
Xstatus	0.0356***	-0.00847	0.0207**	0.00598
	(0.00924)	(0.00880)	(0.00993)	(0.0100)
During	-0.0584***	-0.0317**	-0.0288**	-0.0411***
	(0.0147)	(0.0148)	(0.0139)	(0.0137)
After	-0.112***	-0.0654***	-0.0810***	-0.0574***
	(0.0156)	(0.0148)	(0.0208)	(0.0152)
Xstatus x During	0.0304*	0.0208	0.0238	0.0319*
	(0.0172)	(0.0149)	(0.0165)	(0.0168)
Xstatus x After	0.00357	0.00736	0.00179	0.0184
	(0.0172)	(0.0179)	(0.0196)	(0.0204)
Output	0.207***	0.175***	0.141***	0.119***
	(0.00827)	(0.00927)	(0.00993)	(0.00867)
Observations	1,836	1,836	1,836	1,836
R-squared	0.544	0.479	0.334	0.313

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Estimates use inverse propensity weights combined with sample weights constructed from the Canadian Census of Agriculture. Each regression model includes dummy variables for year fixed effects.

CEM program may have increased farm-level productivity by enabling farmers to quickly respond during periods of high productivity by selling milk in a flexible marketing alternative to supply management.

It is also interesting to note that the coefficient on the interaction term, $Xstatus_i\ x\ After_t$, is *not* statistically significant under any of the specifications. This implies that any positive effects that resulted from farm-level participation in the CEM did not persist after the program was cancelled.

5 Conclusion

Carter and Mérel (2014) and Barichello et al. (2014) have argued that farmers in Canadian supply managed industries could potentially benefit from trade liberalization. Under full trade liberalization Barichello et al. (2014) predict that the Canadian dairy industry could achieve a cumulative growth rate of 5.8 percent annually. Under this scenario the authors predict that by 2022 the annual net aggregate welfare gains to producers and consumers would be approximately 1.23 billion, with

85 percent of this gain coming from increases in producer surplus. This scenario assumes a farm price of \$0.45 per litre, which is 39 percent below the 2013 average reference price of the Canadian Dairy Commission (\$0.74 per litre).[4] In Barichello et al.'s (2014) analysis, the gains in producer surplus are limited to those associated with scale economies and market expansion. My results indicate that when Canadian dairy farmers face lower prices there are additional productivity gains at the farm-level from selection and the direct effects of participating in competitive markets. This suggests that Barichello et al.'s (2014) estimates are a lower bound on the potential gains from trade liberalization in the Canadian dairy industry.

[4]The Canadian Dairy Commission average reference price was sourced from the website of the Fédération des Producteurs de Lait du Québec.

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