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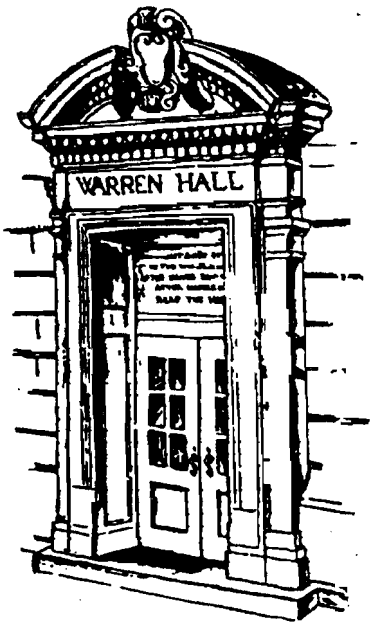

Staff Paper

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Regional Impact of Change in Dairy Trade Policies on the Northeast U.S. and Central Canada Dairy Sectors

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REGIONAL IMPACT OF CHANGE IN DAIRY TRADE POLICIES ON THE NORTHEAST U.S. AND CENTRAL CANADA DAIRY SECTORS

Maurice A. Doyon, James E. Pratt, and Andrew M. Novakovic*

Abstract

Quebec, Ontario and the Northeast U.S. are expected to be important players in Canada-U.S. dairy trade. This study explores two dairy trade scenarios between Quebec, Ontario and the Northeast U.S. In simulation I, the U.S. is allowed to unilaterally export yogurt and frozen desserts to Canada, and simulation II reflects a total free trade environment. In both trade simulations, the Canadian farm milk value decreases significantly.

The linear programing model described in this paper was run at the Cornell National Supercomputer Facility using OSL (3,L). The authors wish to acknowledge support for this project from The Dairy Program of the National Institute for Livestock and Dairy Policy (NILDP), La Fédération des producteurs de lait du Québec, and the Cornell National Supercomputing Facility (CNSF), a resource of the Cornell Theory Center, which is funded in part by the National Science Foundation, New York State, the IBM Corporation, and members of the Center's Corporate Research Institute.

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INTRODUCTION

The North American Free Trade Agreement (NAFTA), and the eighth round of the General Agreement on Trade and Tariffs (GATT) afford the Canadian and U.S. dairy sectors unprecedented opportunities for liberalized trade. The anticipation created by recent events has motivated a considerable amount of research to determine the effect of alternative trade policies on the dairy sector. Many of these studies have used mathematical programming models (FAPRI, 1992 and SWOPSIM, 1991), but have ignored the multiple component nature of raw milk. Such simplifications can lead to misrepresentations and inaccurate conclusions. In addition, the high level of aggregation typically found in mathematical models limits the usefulness of such studies for particular sectors of the dairy industry.

This paper explores two dairy trade scenarios between Quebec, Ontario and Northeast U.S., with more aggregated connections to the rest of the U.S. and Western Canada. In simulation I trade conditions allow the U.S. to unilaterally export yogurt and frozen desserts to Canada, and simulation II reflects a total free-trade environment. The model includes seven dairy products, 296 supply points, 184 consumption points and 307 processing points, and balances supply and demand using a multiple milk component scheme. Interplant transfers of milk components are a key feature of the model used for the analysis.

The paper begins with a presentation of the spatial trade model, followed by an explanation of the two scenarios. Finally, results of the two dairy trade liberalization scenarios are presented.

MODEL

To account for dairy products imports and exports to and from Quebec, Ontario and Northeast U.S., three external points were established. Edmonton was arbitrarily chosen to represent Canadian aggregated excess demand (CAED), and Chicago and Miami were arbitrarily chosen to represent aggregated excess supply (USAES) and aggregated excess demand (USAED), respectively. The Northeast U.S. consists of New York, Pennsylvania, New Jersey, Vermont, Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut , Delaware and Maryland.

Production data, processing data, consumption and transportation data were required for data inputs. The primary sources of data for Quebec were the Fédération des producteurs de lait du Quebec (FPLQ) and the Groupe de recherche en économie et politique agricole (GREPA) of Laval University. Data for Ontario were obtained from the Ontario Milk Marketing Board (OMMB). Data for the Northeast U.S. were obtained from Cornell University and the United States Department of Agriculture (USDA).

Table 1 Dairy Products Category Descriptions

Category	Description	Category	Description
Fluid	- all creams - all beverage milk	Butter	- butter
Frozen desserts	- ice cream - ice milk - sherbet - other frozen desserts	Yogurt	- yogurt
		Cheddar	- cheddar - processed cheese
Specialty cheese	- all type of cheese, including cottage, but excluding cheddar and processed cheese		
Dry & condensed	- condensed milk - all milk powders but whey powder		

Note: Cheddar and specialty cheese's SNF requirement has been adjusted to account for whey powder.

A competitive, static, partial equilibrium, multi-commodity and multi-region linear programming model was used to determine the effects of trade liberalization policies on Quebec, Ontario and Northeast U.S. dairy sectors. The model used a minimum-cost network flow solution algorithm developed by Pratt, *et al.* (1986) and Jensen (1985). Subsequent modifications were applied by Stephenson, *et al.* (1990), Novakovic and Pratt (1991), and Francis (1992). The current model extended previous work by adding Canadian variables, integrating milk components, introducing interplant movement of nonfat dry milk and adding new constraints to simulate the different scenarios of trade liberalization. The model was designed to derive a spatial equilibrium in which production and consumption components were balanced and allocated on the basis of assembly, processing and distribution costs.

From its inception, the model was developed to explore questions of market organization, not price equilibrium. Hence, the model requires point estimates of production and consumption, not supply and demand relationships. From estimates of production and consumption, optimal spatial transportation and processing patterns were obtained. Shadow

prices provided insights on the price implication of exogenous changes in supply, demand, or marketing parameters (Samuelson, 1952).

In this model, marketing cost effects were clearly identified because they were not masked by price responsiveness effects. The results were interpreted as intermediate term consequences of a direct shock. Shadow price and sensitivity analysis can be used to provide insights on potential long term effects.

The modeling framework was partitioned into three components. The first identified the physical and geographical market structure of feasible market activities. The second described the cost functions that affect economic activities in the physical market network. The third involved the set of constraints imposed on the model to simulate different scenarios of trade liberalization. Using matrix notation, the components were expressed as:

$$\min c'x$$
$$s.t.\ Ax \leq b$$

where c' was a 1 x n vector of cost coefficients, x was a n x 1 vector describing the physical network of activity flows or decision variables, A was a m x n matrix identifying technical coefficients associated with product transformations, policy requirements, and product flow accounting, and b was a m x 1 vector of right-hand side constraint values.

The complete mathematical model was detailed with a submatrix block structure. The first submatrix of the model described raw milk assembly. Quebec, Ontario and the Northeast U.S. were considered as one market area with 295 supply locations. The raw milk available from these supply locations was shipped to any of the 307 processing locations. Each region studied was assigned its own assembly cost function based on information on truck sizes and other factors known to affect cost. The second submatrix provided an accounting summary of component volumes received at each processing location. The set of activities in the third submatrix included interplant transfers of skim and 40% cream, a standard industry practice needed to balance component supply and utilization. Interplant transfers of nonfat dry milk to cheese plants were also allowed. Assembly cost functions were modified to model interplant transfer cost functions. The fourth submatrix provided an accounting summary of components processed at each of the 307 processing locations. Processing cost functions were constructed based on previous studies Stephenson, (1990) and Price Waterhouse (1991). The fifth submatrix of activities in the model was associated with the distribution of processed products to demand locations. Individual consumer

demand for each of the seven product types was aggregated to 184 city locations. The cost of moving finished product from processing locations to the consumption areas was defined by linear cost functions specific to each product and region

Scenarios

The results of policy changes on trade patterns were evaluated relative to a base simulation. The base scenario chosen for this study represented pre-NAFTA and pre-GATT trade conditions. Therefore, the Canadian regions were not allowed to export dairy products to the U.S., and the U.S. was not allowed to export dairy products to the Canadian regions. Scenario I models the possible result of a trade dispute between the U.S. and Canada on yogurt and frozen desserts, which arose during the Uruguay Round discussions. Scenario I favored the U.S., and allowed the U.S. to export yogurt and frozen dessert tariff-free to Canada. Canada was constrained to pay prohibitively high tariffs when exporting to the United States. For simulation II, all constraints on the movements of dairy products and raw milk between the U.S. and Canada were removed.

RESULTS

Three aggregated regions comprised of Northeast U.S. states were defined to simplify the results presentation. Northern New England (NNE) was comprised of Vermont, Maine and New Hampshire. Southern New England (SNE) was comprised of New Jersey, Rhode Island, Connecticut and Massachusetts. Maryland, Washington DC and Delaware formed the Middle Atlantic (MAT) region. New York and Pennsylvania were not aggregated.

To avoid any confusion in reporting the results, net exports or net imports for a region were expressed in terms of local production. Percentage point changes in local production were used to assess changes in trade flows for each scenario.

Shadow prices were generated by the model and indicated the amount by which the objective function was reduced if an additional unit of a milk component was available. The supply shadow price was associated with raw milk at the farm having a fixed ratio of butterfat to SNF. In contrast, the processing shadow price is comprised of two prices, one for butterfat and one for SNF.

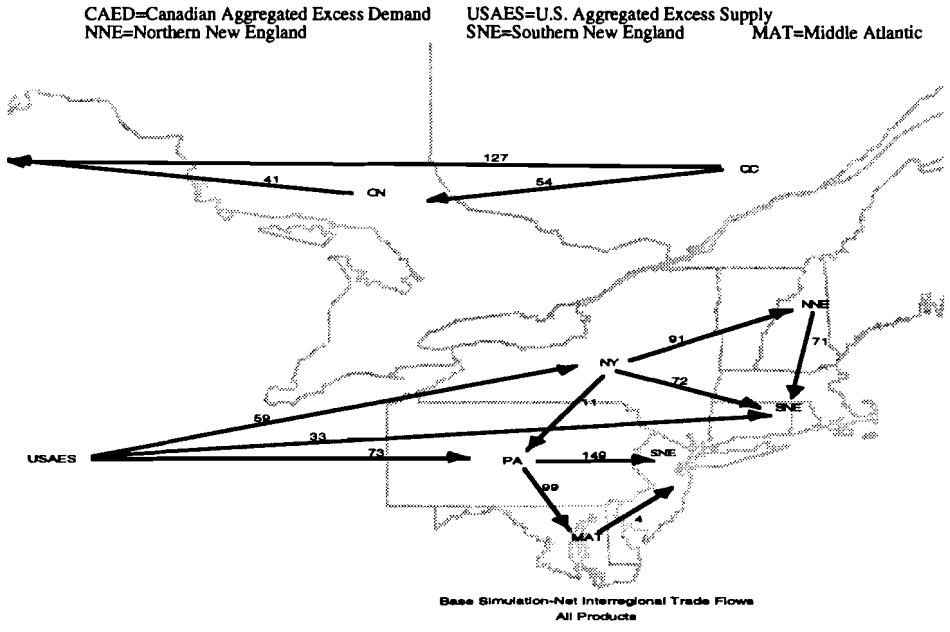
Base Simulation

In the base simulation, Quebec exported butter, cheddar cheese and nonfat dry plus condensed milk (NFDC) to Ontario and the CAED. Quebec also exported specialty cheese to the CAED, and imported yogurt and frozen dessert from Ontario. Ontario exported frozen

dessert and yogurt to the CAED and Quebec, and exported cheddar and specialty cheese to the CAED.

New York imported butter from Vermont, Pennsylvania and Maryland in the base simulation. However, New York exported frozen dessert and yogurt to Pennsylvania, and Maryland, and imported frozen dessert from Vermont. New York also exported cheddar cheese, NFDC milk and specialty cheese to SNE

Pennsylvania exported butter to Maryland, New York and New Jersey, while it imported yogurt from New York. Pennsylvania exported yogurt to the USAED, Maryland, DC, Delaware and New Jersey. Pennsylvania also exported cheddar cheese, NFDC milk and specialty cheese to New York city, SNE and MAT. Vermont exported butter and frozen dessert to New York, and frozen dessert to Maine. Vermont also exported cheddar cheese, specialty cheese and NFDC milk to New York, SNE and the other NNE regions. The USAES exported cheddar cheese to Western New York, Pennsylvania and SNE, while it exported NFDC milk to New York, Pennsylvania, SNE and MAT. A summary of the net interregional trade flows for all products is presented in Map 1.



Map 1 Net Interregional Trade Flows: Base Simulation-All Dairy Products

In Northeast U.S. the supply (farm value) shadow prices increased from the Northwest to the Southeast. In Quebec, shadow prices increased from East to West, but increased from West to East in Ontario. In general, supply shadow prices were higher in Canada than in the Northeast U.S.

In the Canadian regions, processing (plant value) shadow prices increased from East to West, and in Northeast U.S., they increased from Northwest to Southeast Processing shadow prices were much higher in Canada than in the U.S. regions, and milk was valued highest in Northeast Ontario.

Simulation I-Yogurt and Ice Cream

Although, the trading pattern of fluid milk, butter, cheddar cheese, specialty cheese, and NFDC milk were roughly the same as in the base simulation, changes in marketing patterns for yogurt and ice cream affected the quantities of traded products (Table 2).

Table 2 Changes In Percentage Point of Local Production for Net Imports and Net Exports: Simulations I and II Vs Base

		SNE		NNE		NY		ON		PA		QC		MAT	
		Exp	Imp	Exp	Imp	Exp	Imp	Exp	Imp	Exp	Imp	Exp	Imp	Exp	Imp
Simulation I	Fluid														
	Butter		-6		200				-19			-6			
	Ice cream					15		-8	265				5		
	Yogurt				13		-65	-30	35			-9	7		
	Cheddar cheese								-5		11	-3			
	Speciality cheese			5		-7		9	-1	3		-6			
	Dry & Condensed			-31			-283		-102			-4			
Simulation II	Fluid							3					4		
	Butter		1		-102		33		-17			-33			
	Ice cream			-1	17			3		-1		4	-2	2	
	Yogurt	1			111		-50	-30	16			-9	1		
	Cheddar cheese			-62	264	-2		5	-6		-25	14			
	Speciality cheese			12		-8			4	-4		-6			
	Dry & Condensed			18			-343		-117			-76	116		

SNE=Southern New England NNE=Northern New England MAT= Middle Atlantic

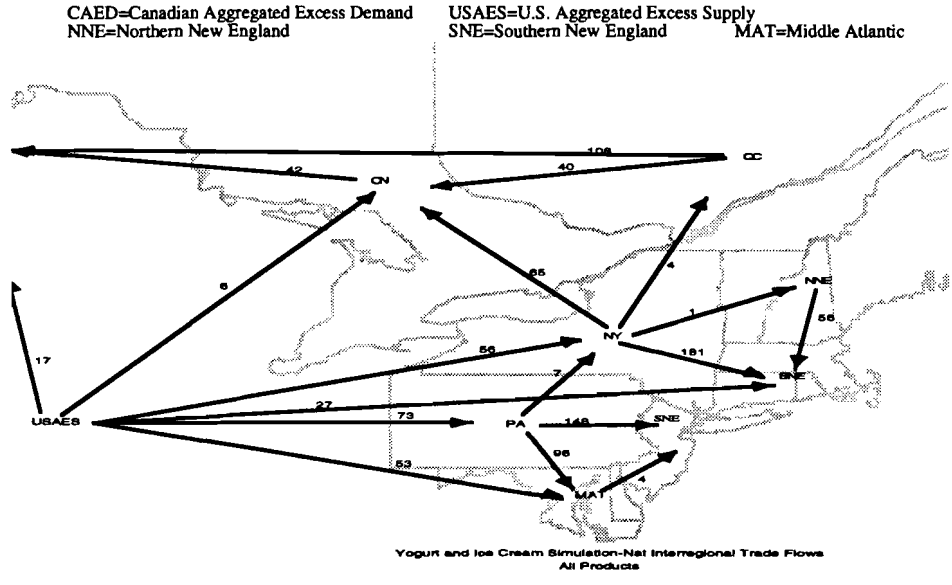
In simulation I, Quebec was adversely impacted in all categories of dairy product trade except fluid milk (Table 2). Butter net exports, cheddar cheese, specialty cheese and NFDC milk were reduced, while ice cream imports were slightly increased. Quebec's most affected product was yogurt; the region changed from a net exporter in the base to a net importer in simulation I. Quebec's processing shadow prices and farm milk values were greatly depressed in simulation I.

Ontario yogurt and ice cream sectors were greatly affected by simulation I. Ontario's CAED yogurt market was lost to USAES, and Ontario's Quebec ice cream market was lost to New York. New York and the USAES also penetrated Ontario's yogurt and ice cream

markets. More specifically, Ontario switched from a net exporter of yogurt and ice cream to a net importer of both products. Not surprisingly, Ontario reduced its net import position for all other dairy products. Imports of butter, cheddar cheese and NFDC milk decreased by 19, 5, and 102 percentage points, respectively. Furthermore, Ontario changed from a net importer of specialty cheese to a net exporter, but these gains did not compensate for the lost yogurt and ice cream markets. In addition, Ontario's farm milk value and the plant value of dairy components were significantly reduced .

New York increased ice cream exports by 15 percentage points and reduced its yogurt imports by 65 percentage points. New York also decreased net imports of NFDC milk by 283 percentage points (Table 2). New York net specialty cheese exports were slightly reduced in this simulation. Shadow prices in New York were minimally affected in simulation I.

Net imports of butter and yogurt by NNE increased by 200 and 13 percentage points respectively, while net exports of NFDC milk decreased by 31 percentage points. On the other hand, NNE slightly increased net exports of specialty cheese. Supply and processing shadow prices increased slightly for NNE in simulation I. Other Northeast locations were relatively unaffected by simulation I.



Map 2 Net Interregional Trade Flows: Simulation I-All Dairy Products

Simulation II-Free Trade for Dairy

The results indicated no movements of fluid milk between the U.S. regions and Canada, a consequence of the difference between the transportation cost of fluid milk and raw milk. Because raw milk is less costly to transport than fluid milk, it was no surprise to observe cross-border movements of raw milk to fluid milk plants rather than cross-border movements of fluid milk.

Under free trade conditions, Quebec relinquished market share for all dairy products except cheddar cheese and ice cream. Quebec significantly increased net exports of cheddar and shifted from a net importer of ice cream to a net exporter. Small losses for fluid milk and specialty cheese were also predicted. The loss of the CAED butter market and part of the Ontario butter market to USAES resulted in a 33 percentage point decrease in Quebec's net butter exports. The effect of the lost market share is somewhat mitigated by Quebec's butter exports to Maine, Vermont, and New York . Predicted exports of NFDC milk to Maine did not compensate for the loss of the CAED and Ontario NFDC markets to USAES. Moreover, Ontario, and to a lesser extent USAES, penetrated part of Quebec's domestic market for NFDC milk. As a result, Quebec was expected to lose 4 NFDC milk plants and shifted from net exporter to net importer of NFDC milk . Quebec also switched from a net exporter to a net importer of yogurt, but the imports were not as large as in simulation I, partially due to new exports to Maine and Northern New York .

Quebec significantly increased exports of cheddar cheese under simulation II trade conditions. Traditional East to West movements of cheese in Canada were replaced by North to South movements. Quebec lost its CAED and Ontario cheese market to USAES and New York, but exports to New England more than compensated for the lost market. However, Quebec's farm and plant values for milk components declined greatly in simulation II.

Ontario improved its trade position in simulation II for all dairy products except yogurt and specialty cheese. Net imports of specialty cheese slightly increased, and Ontario shifted from a net exporter of yogurt to a net importer and from a net importer of cheddar cheese to a net exporter.

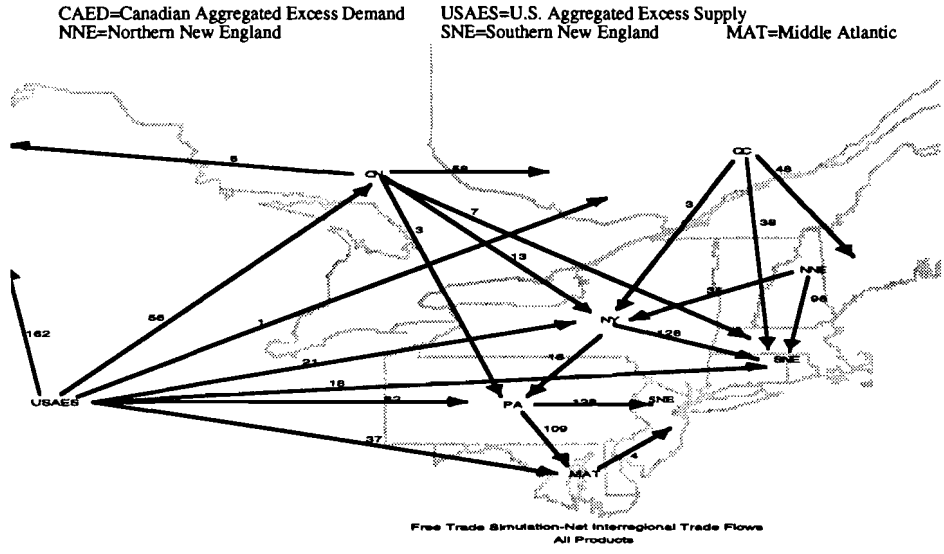
Compared to the results from simulation I, simulation II had little effect on Ontario ice cream trade, but a negative impact on yogurt trade persisted. Ontario's loss of the CAED cheddar cheese market to USAES was more than compensated by cheddar cheese exports to New York. Ontario also reduced net imports of butter and NFDC milk by 17 percentage points and 117 percentage points, respectively. The reduction in NFDC milk net imports was explained by new exports to Quebec, New York and SNE. As a result, the Western Ontario NFDC plant was replaced by a larger plant in Eastern Ontario. Significant decreases

in the value of Ontario farm and plant milk components were predicted under free trade conditions.

Simulation II was not as beneficial as simulation I in terms of trade position for New York. Imports of yogurt and NFDC milk decreased by 50 and 343 percentage points, respectively. Cheddar cheese exports decreased by 2 percentage points, and specialty cheese exports were reduced by 8 percentage points. However, the value of plant milk components and the farm milk value were greatly improved relative to the base.

By decreasing net imports of butter and increasing net exports of specialty cheese and NFDC milk, NNE gained trade in hard products. However, NNE significantly increased its net imports of yogurt and shifted from a net exporter of ice cream and cheddar cheese to a net importer of these two products. Although, NNE farm milk value and plant components value did not increase as much as for other Northeast states, they nonetheless increased significantly.

The trading patterns of other regions were relatively unaffected. All Northeast U.S. region supply and processing shadow price increased in simulation II. Interregional flows are summarized in map 3.



Map 3 Net Interregional Trade Flows: Simulation II-All Dairy Products

Based on relative marketing costs, some cross-border movements of raw milk were evident in simulation II. Raw milk moved from New York to Ontario and Quebec fluid milk plants and from Quebec to Vermont specialty cheese plants. Although a limited amount of raw milk moved from Canada to the U.S. and vice versa, in the short run more U.S. milk would be pulled North due to lower U.S. raw milk price. Factor price equalization would put that down toward the levels suggested by the model in the longer run.

Twelve simulations were run to determine the sensitivity of the analysis to small changes in the cost functions. The model does not appear to be sensitive to interplant transfer cost and to processing cost, but it is sensitive to distribution and assembly costs.

CONCLUSION

For many it may be tempting to assume that partial free trade is less disruptive and an easier intermediate step toward total free trade. However, when trade restrictions are lifted on the basis of product sector, new distortions are created which may be worse in the final analysis. From the base to the yogurt and ice cream simulation shadow prices for the Canadian regions decrease significantly while the Northeast ones are minimally affected. Quebec and Ontario lose more high value net exportation trade under simulation I than under simulation II. Simulation I results in greater trade in yogurt and ice cream than simulation II suggests is optimal.

One interesting finding is that fluid milk processing and distribution is minimally affected by either trade scenario. It appears that marketing costs alone are enough to insulate fluid milk from free trade. From the model results and cross-border purchase estimates (Dairy Farmers of Canada), 3% to 5% is probably the upper limit on Canadian fluid milk imports.

Another implication of the study is that the Canadian regions consistently fare well with regards to cheese when trade is allowed between U.S. and Canada. Quebec cheese processors have a competitive advantage and ship cheddar and specialty cheese to New England. Ontario cheese processors also have a competitive advantage and ship cheese to New York. These competitive advantages are robust and resistant to changes in marketing costs. On the other hand, the USAES has a clear competitive advantage for cheese in Western Canada. Despite the loss of the domestic market, Quebec and Ontario more than compensate with cheese exports to the Northeast U.S.

The results suggest that the current tariff of more than 300% is not necessary to protect the Canadian cheese industry. Papillon (1995) found that a tariff level of 30% to 40% would be as effective as a 300% tariff level.

The results indicate that geographic proximity is an important factor in determining trade impact on regions. Thus, Pennsylvania and the MAT states are not significant players in the model, and New York and NNE are the most active players. Similarly, the USAES and the CAED points, which are relatively close to each other, have a significant amount of interaction. Thus, free trade tends to alter somewhat the predominant flow of dairy products from east to west in Canada and west to east in the U.S by creating North-South trade.

Through shadow prices, the model confirms that any degree of trade liberalization will change the intrinsic value of raw milk, especially in Canada. Although the price effect on raw milk has not been directly estimated, changes in the supply shadow prices still allow for conclusions. Using the average net milk price at the farm for Quebec and New York in May 1995 and the predicted changes in supply shadow price from the base simulation to the two trade scenarios, a price effect can be estimated. In Quebec, dairy farmers received an average of $51.00 per hectoliter in May 1995. After simulation I, milk price would have been reduced to $42.00 per hectoliter and further reduced to $39.00 per hectoliter with the implementation of free trade conditions. New York dairy farmers received an average of $40.50 (Canadian) per hectoliter in May 1995 Simulation I results in a slight increase to $41.00 per hectoliter, and under free trade conditions, average price in New York for raw milk at the farm would rise to $46.00 per hectoliter. These price effects should be viewed as the first step in a price adjustment process following a shock to the market structure. The final equilibrium should imply a smaller price decrease for Quebec, and a small price increase for New York.

The model also suggests that consumers will be affected by trade liberalization in the dairy sector through consumer price changes. A look at the processing shadow price provides some instruction as to how the simulation might affect consumer prices of dairy products. Thus, Canadian consumers should realize significant price decreases in simulation I and II. In contrast, Northeast U.S. consumers should realize few changes in terms of dairy product prices in simulation I, but significant price increases in simulation II.

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