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Dairy Trade Liberalization Impacts in Canada

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Supply management in Canada is facing broad trade liberalization pressures. This paper uses a spatial equilibrium trade model to simulate the impacts of various trade liberalization scenarios in the Canadian dairy industry. The results critically hinge on the relationship between increased market access and the market sharing quota (MSQ) at the farm level. Two different MSQ decision rules are simulated: (i) global output at the farm level remains unchanged following liberalization; and (ii) the MSQ is reduced to support the unit production quota rent at its preliberalization level. The results show that if the MSQ is held constant following a potential compromise in the Doha Round, retail prices of fluid milk and cheese would decrease by about 5%. These price movements can be negated by a 1.4% cut in the global MSQ at the farm level. Net welfare gains in the Canadian dairy sector following market access reforms range between $48.2 and $64.2 million when evaluated at the 2003–04 world prices.
(OECD 2006). Some countries undertook important dairy policy reforms in the past (e.g., New Zealand, Australia), are in the process of implementing reforms (e.g., Switzerland) or have reduced to some extent their level of support in recent years (e.g., United States). No one can predict when (or even if) the current round of multilateral trade negotiations at the World Trade Organization (WTO) will be concluded. The negotiations resumed in March 2007 and the Chair of the agriculture negotiations released a draft agreement text on July 17, 2007 outlining potential compromise solutions. It calls for substantial reductions in tariffs even though countries could be allowed to identify between 4% and 6% of their tariff lines as “sensitive” (WTO 2007). Import tariffs for sensitive products could be lowered by one-third to two-thirds of the standard tariff cuts in return for improved market access through tariff-rate quotas (TRQs). It is fair to say that Canadian dairy farm representatives are not too thrilled about the prospects of implementing market access reforms.¹

The objective of the paper is to evaluate the market impacts of liberalizing trade in the Canadian dairy sector using a spatial equilibrium model introduced by Cox and Chavas (2001). Their spatial equilibrium model of the U.S. dairy industry involves classified pricing² but does not account for other specific features of the Canadian industry. Hence, we build upon their insights to model the particular structure of protection in the dairy sector (i.e., TRQs), farm-level production quotas, and administered prices for butter and skim milk powder.

Cox and Chavas’s approach to modeling dairy trade has sparked a small literature on the impacts of dairy trade liberalization (e.g., Bouamra-Mechemache et al 2002a, 2002b) but none of these studies to date have examined dairy trade liberalization impacts from the Canadian perspective. Past studies of the Canadian dairy industry have used nonspatial synthetic trade models. For example Meilke et al (1998) analyzed the potential increase in U.S.-Canada bilateral dairy trade flows following liberalization. They found that free trade of dairy products between the United States and Canada would result in consumer surplus increasing by 19.7% and 5.5% in the Canadian industrial and fluid milk markets, respectively. Conversely, Canadian dairy producers’ surplus could fall by close to 48%. Larivi`ere and Meilke (1999) also built a synthetic nonspatial dairy trade model, but used a more global approach than the former study. They analyzed dairy product trade for OECD countries and presented various liberalization scenarios. Using 1995 data to calibrate their model, they found that lowering bound import tariffs in Canada by 50% would have little or no effect on quantities and prices. Expanding market access had more significant impacts.

This analysis has many distinguishable features from the aforementioned studies. First, the theoretical model is calibrated with data from the 2003–04 dairy year. The model spatially links seven Canadian regions with the rest of the world, and thus offers a higher degree of disaggregation than previous studies. It considers administered prices for butter and skim milk powder and pooling of milk receipts at the farm level. It also investigates policy scenarios in the post-1994 Uruguay Round Agreement on Agriculture (URAA) era. The July 2004 WTO framework already established a few guidelines as to what a future trade agreement might look like in terms of export subsidy disciplines, market access reforms, and domestic support reductions. Of utmost importance for the Canadian dairy industry is the introduction of sensitive products. Designating dairy products as sensitive would allow the Canadian government to implement smaller cuts in tariffs in exchange
for improvements in market access commitments. Different liberalization scenarios are simulated in the current study to understand the implications of liberalization for the Canadian dairy processing and farm sectors.

Increased market access will generate downward pressures on prices. It is difficult to anticipate the impacts at the farm level due to the existence of supply management. Hence, we report the results of two different decision rules with regards to the level of the global MSQ at the farm level. First, output at the farm level remains unchanged following liberalization. The second scenario assumes cuts in the MSQ are made to preserve the unit production quota rent at its preliberalization level. The former scenario is consistent with a short-run dimension of liberalization because this places significant pressures on the price support scheme administered by the Canadian Dairy Commission (CDC 2006). The latter scenario may be more realistic in the long run because authorities are likely to need time implementing cuts in the MSQ. In what follows, we refer to the situation where there are no adjustments in the MSQ as the “short-run” scenario, while changes in the MSQ will be referred to as the “long-run” outcome. It is important to note that these labels are simply used to identify the different assumptions, and do not refer to any specific model dynamics.

Overall, we find that liberalization has some potentially important impacts for the industry, although tariff cuts need to be large for the industry to sustain significant negative impacts. The first two liberalization scenarios simulate large reductions in overquota tariffs. There are significant price and quantity impacts that threaten the existence of supply management because of important reductions in production quota values. A third scenario illustrates how smaller cuts in tariffs accompanied by an increase in the market access commitments for dairy products have less severe implications for the industry. Not surprisingly, it is the extent of the tariff cuts in overquota tariffs that drives the results. The more realistic Doha outcome generates small welfare implications. Sensitivity analyses with respect to the world price and the calibration of dairy producers’ marginal costs are also presented.

THEORETICAL MODEL

The spatial equilibrium model draws heavily from Cox and Chavas (2001) and Bouamra-Mechemache et al (2002a). Let capital letters $J$, $K$, and $S$ represent, respectively, the number of Canadian regions, the number of processed products and the number of milk components. The milk components are lipids, proteins, and carbohydrates ($S = 3$). There are eight dairy products consumed at the retail level (butter, cheese, fluid milk, concentrated milk, ice cream, yogurt, buttermilk powder, and powdered skim milk). We consider seven Canadian regions (Atlantic, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, and British Columbia) plus the rest of the world.

Let the variable $Q_i$ represent farm-level milk production in region $i$ and $MSQ_i$ be the market sharing production quota in region $i$, which is exogenous in the model. Marketing rules imply $MSQ_i \geq Q_i$. The variable $X_i$ measures milk purchases by processing firms in region $i$. Regulations prevent trading raw milk across provinces; hence $Q_i \geq X_i$. A Leontief production technology is assumed in the dairy processing sector. The quantity of component $s$ in raw milk used by processing firms must be greater than the quantity of the same component found in the production of all processed products (denoted $Y_{ik}$) in a given region; that is, $\sum_{k=1}^{K} Y_{ik} b_{iks} \leq X_i a_{is}$ where the coefficient $a_{is}$ measures the quantity
of component s per unit of raw milk in region i and \( h_{ik} \) denotes the quantity of component s per unit of product k in region i.

Consumption of dairy product k in region i is measured by \( Z_{ik} \). Consumption can be sourced from many different regions. The variable \( T_{ijk} \) measures sales of product k from i toward region j. TRQs regulate trade of dairy products in Canada. A TRQ is a two-tier tariff for which a first tariff (the in-quota tariff) is applied on quantities not exceeding a minimum access commitment (MAC), and a higher tariff (the overquota tariff) is applied for units exceeding the MAC. Let the in-quota and overquota tariffs applied on imports of product k be denoted by \( \tau_{IQ}^k \) and \( \tau_{OQ}^k \), respectively. The variable \( MAC_k \) denotes the MAC of product k. The variable \( \rho_{ik} \) is the proportion of import licenses held by firms in region i, and thus \( MAC_{ik} = \rho_{ik} MAC_k \).

Imports in a given region may not necessarily be consumed at the point of entry; thus \( TMAC_{ijk} \) is the quantity of imports in region i that is transferred to region j. There are no licenses required to import foreign products at the overquota tariff. Hence, once the minimum access for a product is filled, firms can import products at the overquota tariff. These imports are denoted by \( T_{OQ}^{Wk} \). Denote the world price of product k by \( p_{Wk} \), the unit transportation costs of k from the world market into region i by \( c_{Wik} \), and the unit transportation costs of k from i to j by \( c_{ijk} \).

The CDC establishes support prices for butter and skim milk powder to provide guidance for the price paid by processing firms to buy milk going into the production of the different processed products. The CDC commits to purchase and sell butter and skim milk powder at these support prices to balance seasonal fluctuations in supply and demand. It is not a pure price support scheme because output restrictions at the farm level are the main instrument to reach the target prices. Administered prices are rather signaling tools. Purchases of skim milk powder and butter cannot be sold at lower international prices for fear of exceeding Canada’s WTO commitment with regards to export subsidization. This tacks on additional difficulties from a theoretical perspective because we need to account for a dynamic mechanism that addresses temporary disequilibrium situations with a model that is essentially static.³

Figure 1 provides a simplified illustration of the economics of price support in the current model. The \( S \) and \( D \) segments on the left hand-side panel illustrate the domestic supply and demand schedules of one product (say butter). Domestic supply and demand yield an excess demand represented by the segment \( abj \) in the right hand-side panel of Figure 1. The government is committed to enforce an equilibrium solution around the support price \( p_G \). If there is excess demand at this price, the CDC will sell products into the domestic market to lower the market price whereas if there is excess supply at the support price, the CDC will be buying products on the domestic market. Hence, domestic production will not be lower than the quantity \( y(p_G) \), yielding the bold vertical segment, which can be interpreted as the effective supply function. The government’s demand is zero when the market price is higher than \( p_G \), and is perfectly elastic at price \( p_G \). The effective supply and demand schedules trace out a new excess demand function in the right hand-side panel (labeled \( ED \)) that is kinked at the support price. The world price is represented by \( p_W \).

The MAC is \( M_1 \). Above this level, imports are taxed at rate \( \tau_{OQ} \). For illustrative purposes, the initial domestic market equilibrium is exactly at the support price level in Figure 1, effectively not requiring any intervention by the government. The initial
overquota tariff is high enough that there are no imports above the MAC. Initially, the effective excess supply function of foreigners includes the segments united by points $dehhfg$. The domestic price is equal to the support price $p_1$ and imports are equal to $M_1$. Consumption is measured by $z_1$ and production is $y(p_G)$.

Suppose that the overquota tariff is lowered to $\tau_{2}^{OQ}$. The new excess supply function is $dehi$. The arbitrage condition implies that the domestic price is $p_W + \tau_{2}^{OQ}$ and consumption is measured by $z_2$. Although not evident from Figure 1, increased market access for other dairy products will potentially decrease the demand for milk at the farm level and thus lower the price paid to dairy producers. This will shift out the marginal cost function of processing firms selling butter to $S'$, which in turn shifts inward the excess demand function in the right hand-side panel, yielding the effective excess demand $ED'$. Note that there are no imports over the MAC in this example due to the decrease in processors’ marginal cost. From a theoretical perspective, production could now occur at point $B$ in the left hand-side panel of Figure 1 because the CDC's demand for butter is perfectly elastic at $p_G$. In reality, this equilibrium would not be sustainable in the long run because it would imply that the CDC is committed to buy all butter produced domestically.

In the long run, adjustments to the MSQ would need to be made if landed prices fall below support prices. This represents the main feature of the price support system that the theoretical model needs to capture. Hence, a constraint that the output of butter and skim milk powder following liberalization cannot exceed their preliberalization level is introduced. This constraint is tantamount to assuming that the level of support in the industry is capped at the preliberalization level. More importantly, it is consistent with some form of WTO discipline placed on Canadian domestic support because the difference between the administered price (i.e., the support price) and the world price (i.e., the reference price) multiplied by the units sold into the domestic market is recognized as trade-distorting domestic support. As such, it enters into the calculation of Canada’s WTO aggregate measure of support. When the landed price falls below the support price, the CDC purchases the product from processors at the support price and sells back its

Figure 1. Price support policy in the Canadian dairy industry
purchases to consumers at the landed price. This amounts to a deficiency payment made to processing firms to cover the difference between the support and landed prices. The decrease in the overquota tariff has created a permanent disequilibrium that only farm output restrictions (through production quotas) are able to correct. The domestic (landed) price is below the support price and thus nothing prevents domestic agents (consumers and retailers) from buying all the units that they desire at the current landed price. Hence, it is assumed in the theoretical model that all units bought by the CDC in the short run to support the price \( p_G \) are offered to consumers/retailers at the world price. As mentioned before, there are no dynamics in our spatial equilibrium model, and temporary disequilibrium situations are difficult to depict in that framework. In the long run, we assume that cuts in the MSQ are implemented to bring back the production quota rent at its preliberalization level, effectively shifting up the processing industry's supply schedule. The supply shift can entail going back to an equilibrium point on the new supply schedule (either to the left or to the right of \( S \)), but near the initial equilibrium point A.

Going back to the theoretical foundations of the spatial equilibrium model, the output of product \( k \) sold in region \( i \) to the CDC is denoted by \( TG_{ik} \), while the support price of product \( k \) is denoted by \( p_{Gk} \). The variable \( TX_{ik} \) measures exports of product \( k \) from region \( i \). Let \( p_i^k (Q_i) \) be the inverse supply of milk in region \( i \) with \( \partial p_i^k (Q_i)/\partial Q_i > 0 \). Furthermore, assume that it is linear. In a perfectly competitive setting, the farm production cost of milk in region \( i \) is \( S_i(Q_i) = \int_0^{Q_i} p_i^k(q) \, dq \). Let \( p_{ik}^k(Z_{ik}) = a_{ik}/b_{ik} - (1/b_{ik})Z_{ik} \) be the retail sector's inverse demand function for product \( k \) in \( i \) with \( a_{ik} \) and \( b_{ik} \) greater than zero. Buyer surplus in region \( i \) is defined as \( D_i(Z_{i1}, \ldots, Z_{iK}) = \int_0^{z_{i1}} \sum_{k=1}^K p_{ik}^k(qk) \, dq \).

Following Cox and Chavas (2001), the processing technology in each region is defined by the multioutput restricted cost function \( G_i(Y_{i1}, \ldots, Y_{iK}, X_i) \), which outlines the cost-minimizing use of other inputs (beside milk) given production levels \( Y_{ik} \). It is assumed that \( \partial G_i/\partial Y_{ik} > 0 \) and \( \partial G_i/\partial X_i < 0 \). The competitive resource allocation in the Canadian dairy industry can be determined by maximizing total surplus in the Canadian dairy industry subject to resource allocation constraints (Samuelson 1952; Takayama and Judge 1971). The objective function is

\[
\sum_{i=1}^J \left[ D_i(Z_{i1}, \ldots, Z_{iK}) - S_i(Q_i) - G_i(Y_{i1}, \ldots, Y_{iK}, X_i) \right] - \sum_{i=1}^J \sum_{j=1}^J \sum_{k=1}^K T_{ijk} c_{ijk} \\
- \sum_{i=1}^J \sum_{k=1}^K T_{MACijk} (p_{Wk} + c_{Wik} + \tau_{ik}^Q + c_{ijk}) \\
- \sum_{i=1}^J \sum_{k=1}^K T_{Wik}^O (p_{Wk} + c_{Wik} + \tau_{ik}^Q) + \sum_{i=1}^J \sum_{k=1}^K TX_{ik} (p_{Wk} - c_{Wik}) \\
+ \sum_{i=1}^J \sum_{k=1}^K TG_{ik} p_{Gk} - \sum_{i=1}^J \sum_{k=1}^K TC_{Gik} p_{Wk}
\]

The bracketed term in Equation (1) \( \sum_{i=1}^J \left[ D_i(z_{i1}, \ldots, z_{iK}) - S_i(Q_i) - G_i(Y_{i1}, \ldots, Y_{iK}, X_i) \right] \) sums up welfare in the industry and is by assumption continuous and twice-differentiable in \( (Q, X, Y, Z) \). It equals to buyers' total surplus minus production costs.
at the farm and processing levels. The other terms in Equation (1) represent payments made to foreigners, export revenues and transportation costs. The summation term \( \sum_{j=1}^{J} \sum_{j=1}^{J} \sum_{k=1}^{K} \tilde{T}_{ijk}c_{ijk} \) measures to inter-provincial trade costs at the processing level. The expression \( \sum_{j=1}^{J} \sum_{k=1}^{K} \sum_{j=1}^{J} T MAC_{ij}(p_{wk} + c_{wjk} + \epsilon_{ik}^{Q} + c_{ijk}) \) sums up import costs under the MAC, which includes the world price, in-quota tariff and transportation cost. Similarly, the expression \( \sum_{j=1}^{J} \sum_{k=1}^{K} T Q_{i}^{Q}(p_{wk} + c_{wjk} + \epsilon_{ik}^{Q}) \) represents the overquota total import costs. The summation \( \sum_{j=1}^{J} \sum_{k=1}^{K} T G_{ik}P_{qk} \) measures the payments made under the price support program while \( \sum_{j=1}^{J} \sum_{k=1}^{K} T C_{Gk}P_{wk} \) are purchases of government stocks by consumers/retailers as explained in Figure 1. The terms \( \sum_{j=1}^{J} \sum_{k=1}^{K} T X_{wjk}(p_{wk} - c_{wjk}) \) measure export revenues.

There are two constraints specifically associated with the price support scheme in the model: (i) consumers/retailers’ purchases from the CDC \( (\sum_{j=1}^{J} T C_{Gk}) \) cannot exceed the output of product \( k \) made available by the CDC (\( Y_{Gk} \)), that is, \( Y_{Gk} \geq \sum_{j=1}^{J} T C_{Gk} \); (ii) sales of product \( k \) to the CDC must be lower or equal to the preliberalization output level \( \bar{Y}_{Gk} \), that is, \( \sum_{j=1}^{J} T G_{ik} \leq \bar{Y}_{Gk} \). The variable \( Y_{Gk} \) in the first constraint is determined by an iteration procedure such that \( \sum_{j=1}^{J} T G_{ik} = Y_{Gk} \). The second constraint effectively limits the level of trade-distorting support at the preliberalization level.

The remaining constraints of the optimization problem are the market clearing conditions and import license allocation methods. Output of product \( k \) in a given region must not be lower than total sales; i.e., \( Y_{ik} \geq \sum_{j=1}^{J} T_{ijk} + T X_{wjk} + T G_{ik} \). Moreover, the local demand in each region must not be lower than total shipments to that region (including imports); that is, \( \sum_{j=1}^{J} T_{ijk} + \sum_{j=1}^{J} T MAC_{ijk} + T C_{Gik} + t_{ik}OC \geq Z_{ik} \). The MAC allocated to one region must be greater than the total shipments of in-quota imports originating from that region; hence \( \rho_{ik} MAC_{k} \geq \sum_{j=1}^{J} T MAC_{ijk} \).

The final detail of the model is the inclusion of classified pricing (price discrimination) in the currently competitive model. Cox and Chavas (2001) introduced the concept of price discrimination into a competitive model by adding the terms \( \sum_{j=1}^{J} PW_{ik}X_{i} - \sum_{i=1}^{J} \sum_{k=1}^{K} PW_{ik} Y_{ik} \) to the objective function in Equation (1). The term \( PW_{ik} Y_{ik} \) is the revenue associated with the price wedge (PW) induced by price discrimination in downstream market \( k \). These revenues generated by price discrimination are transferred from processing firms to producers. These additional producers’ revenues (compared to the baseline payments accruing to producers under perfect competition) are measured by the \( PW_{i} \). In summary, classified pricing in the model is accounted by introducing a distortion (PW) under the constraints that all gains from price discrimination are transferred to producers:

\[
\sum_{i=1}^{J} PW_{i}X_{i} - \sum_{i=1}^{J} \sum_{k=1}^{K} PW_{ik} Y_{ik} = 0
\]  

(2)

In what follows, the PW in each region is set equal to a common value; that is, \( PW_{i} = PW \), \( \forall i \). Since the condition in Equation (2) involves exogenous variables for given values of \( X_{i} \) and \( Y_{ik} \), there are no guarantees that Equation (2) will hold. The algorithm proposed by Cox and Chavas (2001) is to first select PWs in the downstream market that are based on educated guesses about the elasticity of the processing firms’ demand and/or market power in the downstream market. Production and consumption decisions in the industry are carried out given \( PW_{ik} \) and \( PW \) and the endogenous values are solved...
by the constrained optimization problem. The output values are then used to verify whether the condition in Equation (2) is verified. If the constraint does not hold, a new guess estimate of $PW$ is supplied to the programing model to generate new output and consumption equilibrium variables. This procedure is repeated until the classified pricing scheme replicates the baseline solution.

The maximization problem is formed by writing out the Lagrangean defined by the objective function in Equation (1) under the classified pricing distortion Equation (2) and the resource allocation constraints. The Kuhn-Tucker conditions are supplied in the appendix. A few interesting insights can be obtained by analyzing these conditions assuming away corner solutions. In each region, the shadow price of milk at the farm level is equal to producers marginal cost plus the production quota’s unit rent. Let $\lambda_{ik}$ be the Lagrange multiplier associated with the constraint on component usage $\sum_{k=1}^{K} Y_{ik} b_{iks} \leq X_i a_{is}$. At the optimal solution, milk components are allocated across products according to the rule $p_i = -\partial G_i / \partial X_i + \sum_{s=1}^{S} \lambda_{ik} a_{iks} + PW$, which states that the farm-gate price of milk equals the marginal value of all components ($-\partial G_i / \partial X_i + \sum_{s=1}^{S} \lambda_{ik} a_{iks}$) plus the $(PW)$. Another allocation rule is that the market price of product $k$ in region $i$ equals the sum of the processed product’s marginal cost ($\partial G_i / \partial Y_{ik}$), the marginal product value of the components ($\sum_{s=1}^{S} \lambda_{ik} b_{iks}$), the $PW$ and transportation cost ($c_{iik}$); thus $p_{ik} = \partial G_i / \partial Y_{ik} + \sum_{s=1}^{S} \lambda_{ik} b_{iks} + PW_{ik} + c_{iik}$.

Another arbitrage condition defines the price relationship $p_{ik} = p_{Wk} + c_{iWk} + \tau_{k}^{IQ} + \eta_{iik}$, which implies that the market price of product $k$ in $i$ equals the sum of the world price ($p_{Wk}$), transportation cost ($c_{iWk}$) to get the product from the world market to region $i$, the in-quota tariff ($\tau_{k}^{IQ}$) and the import license rent ($\eta_{iik}$). If imports above the MAC are positive, it must be that product $k$’s market price equals the world price plus the transportation cost and the overquota tariff ($p_{ik} = p_{Wk} + c_{iWk} + \tau_{iik}^{OQ}$). The two arbitrage conditions define the unit rent associated with the first MAC imports in region $i$ ($\eta_{iik} = \tau_{iik}^{OQ} - \tau_{iik}^{IQ}$).

Finally, when price support is effective, the difference between the support price and the price processors could receive from the market is positive, and it is shown in the appendix that this difference ($\theta_{iik}$) equals

$$\theta_{iik} = p_{Gk} - (\chi_{iik} - c_{iik}) = \beta_{iik} + \mu_{k} - \chi_{iik} + c_{iik} > 0$$

(3)

where $\beta_{iik}$ is the Lagrange multiplier associated with the constraint $Y_{ik} \geq \sum_{j=1}^{J} T_{ijk} + TX_{ijWk} + TG_{ikGk}, \mu_{k}$ the Lagrange multiplier associated with the constraint $\sum_{i=1}^{I} TG_{ikGk} \leq \bar{Y}_{ikGk}$ and $\chi_{iik}$ is the Lagrange multiplier associated with the constraint $\sum_{j=1}^{J} T_{jik} + \sum_{j=1}^{J} T MAC_{jik} + TC_{Gik} + T_{Wk}^{OC} \geq Z_{ik}$. The multipliers $\beta_{iik}$ and $\chi_{iik}$ measure respectively the industry’s marginal cost and the implicit market price of consumers, respectively, while $\mu_{k}$ measures the difference between the support price $p_{Gk}$ and the industry’s marginal cost $\beta_{iik}$.

DATA AND CALIBRATION

The calibration exercise requires a few assumptions. It is assumed that the multi-output cost function in the dairy industry is linear in all its arguments, and thus $G_i(Y_{i1}, \ldots, Y_{ik}, X_i) = g_i X_i + \sum_{k=1}^{K} g_{ik} Y_{ik}$ with $g_i$ being the unit cost of processing $X_i$, ...
and $g_{ik}$ being the unit cost associated with producing $Y_{ik}$. The latter costs include packaging, administration, etc. Linear consumer demand schedules are constructed using elasticities reported in the literature. Moschini and Moro (1993) estimated the retail demand elasticity of fluid milk to be $-0.34$. The retail demand elasticity of butter was set to $-0.78$ as reported in Goddard and Amuah (1989). The demand model of Veeman and Peng (1997) suggest setting the retail demand elasticities of yogurt, cheese, and ice cream at $-0.81$, $-0.66$, and $-0.68$, respectively. Finally, the retail demand elasticity of powdered products (buttermilk and skim milk) and concentrated milk was set to $-1$ (Moschini and Moro 1993). The retail demand functions are then adjusted to retrieve the demand schedules at the wholesale level.

Wholesale and retail price data in accordance with the product classification in this study are difficult to obtain. In some instances, prices are only available for one or a few regions, and thus many prices needed to be imputed. The 2004 retail price data come from the Canadian Dairy Information Center (CDIC) except in the case of ice cream, yogurt, concentrated milk, and butter where the 2001 unit value of the Food consumers’ survey (Statistics Canada) was used to impute a 2004 value. The butter, cheese, powdered buttermilk, and skim milk powder wholesale prices in the province of Quebec were obtained from CDIC. Statistics Canada publishes a dairy price index at the wholesale level, but it is only available at the national level. Regional heterogeneity in wholesale prices was thus introduced in the model by using the consumer price index for dairy products.

An average retail-to-wholesale margin (in percentage terms) was computed using the products for which retail and wholesale prices were available. This average margin was subsequently used to compute wholesale prices in the few cases where only retail prices were available. The demand schedules of retailers (i.e., the demand faced by processing firms) were obtained by subtracting the average margin from the retail price and assuming that the mark up between the wholesale and retail levels is independent of output levels. This method yields demand schedules at the wholesale level that are parallel to retail demand schedules. Consumption levels were recovered using per capita consumption at the national level available from the CDIC and population estimates in each region.

Due to production controls at the farm level, it is not possible to directly observe the supply response of Canadian dairy farmers. The farm supply elasticity was set to one as in Meilke et al (1998). Farm milk production, production quota prices, and milk prices in each region were obtained from the CDIC. The production quota discount rate was set to 10% based on the average of the estimates reported in Doyon et al (2006). The previous assumptions yield a marginal cost estimate (when evaluated at the 2003–04 production level) of $31$ per hl in Quebec and Ontario while other regions’ cost estimates are a little higher (e.g., Alberta producers’ marginal cost is $39$ per hl). These estimates are in line with previously reported estimates of average variable costs (e.g., Levallois and Perrier 2001). Because the positioning of the marginal cost function has potentially important welfare implications in the trade liberalization simulations, a sensitivity analysis will be proposed in the next section.

The processing firms’ marginal cost is calibrated using the first-order conditions of the theoretical model. The marginal production cost of good $k$ in region $i$ is determined by the condition $-\partial G_i/\partial y_{ik} - PW_{ik} - \sum_{s=1}^{S} \lambda_{is} b_{iks} + p_{ik} = 0$, which implies under the assumption of linearity that
\begin{equation}
\begin{aligned}
g_{ik} = p_{ik} - PW_{ik} - \sum_{s=1}^{S} \lambda_{is} b_{iks} \\
\end{aligned}
\tag{4}
\end{equation}

where $\lambda_{is}$ is the implicit price of component $s$ in region $i$. The implicit price and the true PW are not directly observable. We use the actual prices of components (reported by the CDIC) to define $\sum_{s=1}^{S} \lambda'_{iks} b_{iks} \equiv \sum_{s=1}^{S} \lambda_{is} b_{iks} + PW_{ik}$ and readily calibrate the processors' marginal cost based on the relationship between output price and the price of components defined by the first-order condition in Equation (4). Data on the protein, lipid, and carbohydrate components were borrowed from CDC and CIQUAL (2002).

The world prices of butter, cheese and skim milk powder are the annual average of the Oceania export prices in 2004 (CDIC). The fluid milk export price is the 2003 U.S. wholesale price for fluid milk (U.S. GAO 2004) converted back into Canadian dollars using the 2003 annual exchange rate between the Canadian and U.S. currencies. Transportation costs between regions are based on the estimates of US$0.35 per cwt per 100 miles for dairy product transportation costs in the United States as reported in Cox and Chavas (2001). This 1995 value was converted to 2003 Canadian dollars using the average exchange rate and Statistics Canada transportation cost index. Distances between regions were taken from Furtan and van Melle (2004) who used a weighted average of the latitudes and longitudes of the three most populous cities of each region (the great circle method) to create a unique economic center in each region. Within region transportation costs were borrowed from Helliwell and Verdier (2001). The transportation cost between the world market and the Canadian border is computed as the difference between import unit values and export prices.

Table 1 presents the TRQ specifications of each product. All tariffs are the most-favored nation tariffs. However, certain countries enjoy duty-free access within the MAC. For example, New Zealand, Australia, and the United States all have some free access

<table>
<thead>
<tr>
<th>Product</th>
<th>MAC (MT)</th>
<th>In-quota tariff (%)</th>
<th>Overquota tariff (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid milk</td>
<td>64,500</td>
<td>7.5</td>
<td>241.0</td>
</tr>
<tr>
<td>Yogurt</td>
<td>332</td>
<td>6.5</td>
<td>237.5</td>
</tr>
<tr>
<td>Powdered buttermilk</td>
<td>980</td>
<td>1.5$^a$</td>
<td>208.0</td>
</tr>
<tr>
<td>Butter</td>
<td>3,274</td>
<td>6.5$^b$</td>
<td>298.5</td>
</tr>
<tr>
<td>Cheese</td>
<td>20,412</td>
<td>1.0$^c$</td>
<td>245.5</td>
</tr>
<tr>
<td>Ice cream</td>
<td>347</td>
<td>6.5</td>
<td>277.1</td>
</tr>
<tr>
<td>Concentrated milk</td>
<td>12</td>
<td>1.6$^d$</td>
<td>243.0</td>
</tr>
<tr>
<td>Skim milk powder</td>
<td>4,345</td>
<td>6.5</td>
<td>270.1</td>
</tr>
</tbody>
</table>

Source: APEC Tariff database (www.apectariff.org).

$^a$The specific tariff for powdered buttermilk is 3.32 ckg (cents per kg).

$^b$The specific tariff for butter is 11.38 ckg.

$^c$The specific tariff for cheese is 3.32 ckg.

$^d$The specific tariff for concentrated milk is 2.84 ckg.
within the MACs.\(^8\) If a tariff is expressed in cents per kilogram, an ad-valorem equivalent is computed using world prices. Market access commitments were taken in Canada’s commitment schedule in the URAA. Finally, there are no official data on the share of import licenses within the MAC held in each region. Hence, the initial share of a given product’s MAC in a region is set equal to its share of total Canadian dairy imports.

Once all the data are supplied to the model, preliminary runs were used to compute PWs following the methodology described in Cox and Chavas (2001). The calibration exercise produced output levels in the baseline scenario that all come within a reasonable margin of the 2003–04 data. A total of 40,000 tons of skim milk powder was exported in 2003. Hence, we set the wholesale price of powdered skim milk at the export price adjusted for transportation costs, which implied that the domestic price is below the official support price of $5.40 per kg. In the case of butter, the model was calibrated with a wholesale price of $6.13 per kg, which is a little lower than the actual support price of $6.30 per kg in 2003–04. All other prices are near observed prices with the greatest margin of error between calibrated and actual prices being 1.2% (fluid milk).

**POLICY SIMULATIONS**

A number of liberalization scenarios are simulated. No one can predict at this time when, or even if, the Doha Round will be concluded. There are still many unknowns related to the extent of tariff cuts, the increase in minimum access, the number of tariff lines that will be excluded from general tariff cutting formulas and the potential compensation associated with these exclusions, the cuts in trade distorting support and the pace at which export subsidies will be eliminated. Yet, the market access scenarios below are based on the July 2004 framework and the draft agreement proposed by the Chair of the WTO agriculture negotiations (WTO 2007). The latter can be regarded as a starting point toward a compromise that would bridge the differences among WTO members regarding market access.

*Baseline solution:* As mentioned before, the model is calibrated using 2003–04 data.

*Scenario 1—Aggressive tariff cuts with no change in MAC:* This scenario corresponds to a strong liberalization outcome for the Doha Round in which there are no products that are recognized as sensitive. Bound tariffs are cut by 50% and in-quota tariffs are simply eliminated.

*Scenario 2—Aggressive tariff cuts with small increase in MAC:* This scenario is identical to the first scenario but also looks at the implications of enlarging the MAC by 50%. Import tariffs cuts are identical to scenario 1.

*Scenario 3—Moderate tariff cuts with small increase in MAC:* This scenario corresponds to a potential “compromise” outcome for the Doha Round. Dairy products are recognized as sensitive and MAC levels are increased by 50%. Bound tariffs are cut by only 25%.

*Scenario 4—Moderate tariff cuts, small increase in MAC and increase in world prices:* This scenario is identical to scenario 3 plus a simulated increase in world dairy prices following the elimination of export subsidies and the reduction of worldwide domestic support. World prices are increased at their 2005 level. Although this scenario intends to capture the potential impact of export subsidy and domestic support reductions on world prices, it can also be associated with a number of different factors in the
international market such as a depreciation of the Canadian currency, strengthening of the world demand for dairy products due to income growth in developing economies, etc.

One important unknown factor in these simulations is how global output at the farm level will be adjusted following liberalization. It is difficult to endogenize the regulator’s reaction function in the current framework because the model relies on the assumption of perfectly competitive behavior. However, it is unrealistic to assume that large cuts in tariffs or a significant increase in market access will not be accompanied by proportional changes in the MSQ. Given the unknown reaction function, we provide two different sets of results for all scenarios that are at the opposite end of the spectrum in terms of possible reactions. First, we do not change global farm output and let prices bear the blunt of the adjustment. We label this case the short-run scenario. In the second case (labeled long run), a cut in the production quota is implemented such that unit production quota rents equal their preliberalization levels.

Table 2 presents the trade liberalization impacts of the four scenarios on dairy product output in Canada and wholesale prices in Quebec. The results for fluid milk, butter, cheese, skim milk powder, and yogurt are reported. The first scenario involves liberalizing trade through aggressive tariff cuts. The simulated tariff cuts (50%) are important enough to trigger imports of cheese and butter over the MAC. Quite naturally, the wholesale price of these two commodities decreases as indicated in Table 2. Cheese output decreases while the existence of the price support system leaves domestic production of butter unchanged. The decrease in cheese production results in a relatively more important decrease in the demand for lipids than for the protein component of milk due to the technological composition of cheese. The lower demand for milk at the farm level and the resulting decrease in the price of milk imply a fall in the marginal cost of processors. In some instances, output at the wholesale level increases (e.g., fluid milk and yogurt). This supply shift at the processing level results in lower prices at the wholesale and retail levels. Hence, despite the fact that there are no additional imports of yogurt and fluid milk, substitution possibilities in processing result in lower prices for consumers. It is interesting to note that output of skim milk powder decreased because the price of the protein component increased (due to the outward shift in the demand for proteins following the larger output of fluid milk and yogurt).

Table 3 reports the welfare implications of trade liberalization at the farm level. Unit production quota values decrease by 74% and 77% in Quebec and Ontario while the decrease in percentage terms is stronger in Alberta (96%). The significant reductions in quota prices are consistent with the significant decline in cheese and skim milk powder production. The production quota in some regions is not binding, and production quota rents in these regions fall to zero. With the decrease in farm prices larger than 30% and the loss in-quota rent values, it follows that the 50% cut in import tariffs would seriously jeopardize the future of supply management. Assuming that supply management is preserved, it is difficult to anticipate with precision what would happen with the level of the MSQ. The domestic market price of butter is well below the support price in the short-run equilibrium. The price support system no longer constitutes a seasonal equilibrium mechanism, and rather acts as a pure price support system. As indicated in Table 3, the MSQ needs to be cut by about 35% in the long run to preserve the rent
Table 2. Impacts of trade liberalization scenarios on Canadian output and Quebec wholesale prices

<table>
<thead>
<tr>
<th>Production (baseline, 000 MT)</th>
<th>Fluid milk (baseline, 000 MT)</th>
<th>Butter (baseline, $/kg)</th>
<th>Cheese (baseline, $/kg)</th>
<th>Skim milk powder (baseline, $/kg)</th>
<th>Yogurt (baseline, $/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1 – SR (% change)</td>
<td>2.3</td>
<td>0.0</td>
<td>−2.6</td>
<td>−3.1</td>
<td>1.6</td>
</tr>
<tr>
<td>Scenario 1 – LR</td>
<td>1.2</td>
<td>0.0</td>
<td>−73.7</td>
<td>−26.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Scenario 2 – SR</td>
<td>1.0</td>
<td>0.0</td>
<td>−2.1</td>
<td>−1.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Scenario 2 – LR</td>
<td>−0.1</td>
<td>0.0</td>
<td>−74.0</td>
<td>−25.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Scenario 3 – SR</td>
<td>−0.1</td>
<td>0.0</td>
<td>−0.6</td>
<td>0.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Scenario 3 – LR</td>
<td>−1.2</td>
<td>−0.4</td>
<td>−2.1</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Scenario 4 – SR</td>
<td>−0.1</td>
<td>0.0</td>
<td>−0.1</td>
<td>0.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Scenario 4 – LR</td>
<td>−1.2</td>
<td>−0.4</td>
<td>−2.1</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Wholesale prices (baseline, $/kg)</td>
<td>1.17</td>
<td>6.13</td>
<td>8.59</td>
<td>2.71</td>
<td>3.72</td>
</tr>
<tr>
<td>Scenario 1 – SR (% change)</td>
<td>−9.5</td>
<td>−19.3</td>
<td>−17.3</td>
<td>0.0</td>
<td>−2.8</td>
</tr>
<tr>
<td>Scenario 1 – LR</td>
<td>−6.1</td>
<td>−19.3</td>
<td>−14.8</td>
<td>0.0</td>
<td>−2.0</td>
</tr>
<tr>
<td>Scenario 2 – SR</td>
<td>−9.5</td>
<td>−19.3</td>
<td>−17.3</td>
<td>0.0</td>
<td>−2.8</td>
</tr>
<tr>
<td>Scenario 2 – LR</td>
<td>−6.2</td>
<td>−19.3</td>
<td>−14.8</td>
<td>0.0</td>
<td>−2.0</td>
</tr>
<tr>
<td>Scenario 3 – SR</td>
<td>−5.0</td>
<td>−2.7</td>
<td>−4.7</td>
<td>0.0</td>
<td>−2.1</td>
</tr>
<tr>
<td>Scenario 3 – LR</td>
<td>−0.4</td>
<td>−2.1</td>
<td>−0.3</td>
<td>0.0</td>
<td>−0.2</td>
</tr>
<tr>
<td>Scenario 4 – SR</td>
<td>−5.0</td>
<td>−2.7</td>
<td>−4.7</td>
<td>24.7</td>
<td>−2.1</td>
</tr>
<tr>
<td>Scenario 4 – LR</td>
<td>−0.4</td>
<td>−2.1</td>
<td>−0.3</td>
<td>24.7</td>
<td>−0.2</td>
</tr>
</tbody>
</table>

Note: SR and LR denote, respectively, the short-run and long-run scenarios with respect to changes in the MSQ.
### Table 3. Impacts of trade liberalization at the farm level

<table>
<thead>
<tr>
<th></th>
<th>Alberta</th>
<th>Ontario</th>
<th>Quebec</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Production unit quota values</strong> ($/hl)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline scenario</td>
<td>19.30</td>
<td>24.90</td>
<td>24.10</td>
</tr>
<tr>
<td>Scenario 1 – SR (% change)</td>
<td>−95.9</td>
<td>−74.3</td>
<td>−76.7</td>
</tr>
<tr>
<td>Scenario 2 – SR</td>
<td>−96.1</td>
<td>−74.5</td>
<td>−76.9</td>
</tr>
<tr>
<td>Scenario 3 – SR</td>
<td>−30.0</td>
<td>−23.3</td>
<td>−23.7</td>
</tr>
<tr>
<td>Scenario 4 – SR</td>
<td>−29.5</td>
<td>−22.9</td>
<td>−23.7</td>
</tr>
<tr>
<td><strong>Farm price</strong> ($/hl)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline scenario</td>
<td>58.1</td>
<td>56.1</td>
<td>55.2</td>
</tr>
<tr>
<td>Scenario 1 – SR (% change)</td>
<td>−31.8</td>
<td>−33.0</td>
<td>−33.5</td>
</tr>
<tr>
<td>Scenario 2 – LR</td>
<td>−11.9</td>
<td>−19.3</td>
<td>−19.6</td>
</tr>
<tr>
<td>Scenario 2 – SR</td>
<td>−32.0</td>
<td>−33.2</td>
<td>−33.5</td>
</tr>
<tr>
<td>Scenario 2 – LR</td>
<td>−12.4</td>
<td>−19.6</td>
<td>−19.9</td>
</tr>
<tr>
<td>Scenario 3 – SR</td>
<td>−10.0</td>
<td>−10.3</td>
<td>−10.3</td>
</tr>
<tr>
<td>Scenario 3 – LR</td>
<td>−0.7</td>
<td>−0.9</td>
<td>−0.7</td>
</tr>
<tr>
<td>Scenario 4 – SR</td>
<td>−9.8</td>
<td>−10.2</td>
<td>−10.3</td>
</tr>
<tr>
<td>Scenario 4 – LR</td>
<td>−0.9</td>
<td>−0.9</td>
<td>−0.7</td>
</tr>
<tr>
<td><strong>Farm output (000 MT)</strong></td>
<td>616.7</td>
<td>2,440.1</td>
<td>2,765.9</td>
</tr>
<tr>
<td>Scenario 1 – LR (% change)</td>
<td>−34.8</td>
<td>−34.8</td>
<td>−34.8</td>
</tr>
<tr>
<td>Scenario 2 – LR</td>
<td>−35.2</td>
<td>−35.2</td>
<td>−35.2</td>
</tr>
<tr>
<td>Scenario 3 – LR</td>
<td>−1.4</td>
<td>−1.4</td>
<td>−1.4</td>
</tr>
<tr>
<td>Scenario 4 – LR</td>
<td>−1.4</td>
<td>−1.4</td>
<td>−1.4</td>
</tr>
</tbody>
</table>

Note: SR denotes the short-run scenario, which entails no changes in the MSQ. By assumption, the farm price and production quota values return at their preliberalization levels in the long-run scenario and are thus not reported.

of production quotas at the preliberalization level. Cheese output decreases by more than 73% while there is a small increase in the percentage of fluid milk and yogurt production.

Table 4 reports the welfare impacts of liberalizing trade for buyers and producers, as well as the overall impact on the industry. Buyers’ surplus is based on the demand faced by dairy processing firms; thus it measures surplus of consumers and retailers. The producers’ surplus measure is further decomposed into total production quota rents and the standard triangle measure of surplus. Total welfare is the sum of buyers’ surplus, producers’ surplus, processing firms’ surplus, government transfers, import rents, and export revenues. In the long run, buyers stand to gain from liberalization as prices decrease. Buyers’ surplus increases by 9.4% and 7.3% in the short and long run, respectively. Producers’ surplus decreases by more than 57% in the long run. Even though the MSQ is fixed in the short run, producers’ surplus decreases because production quotas are not binding in small dairy producing regions. Total surplus increases in the short run but is lower in the long run compared to the baseline solution. The latter result can be explained by the very large reductions in domestic production at the farm level, as well as the reductions in import
Table 4. Welfare impacts of trade liberalization scenarios

<table>
<thead>
<tr>
<th></th>
<th>Producers’ welfare</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Buyers’ surplus</td>
<td>Quota values</td>
<td>Surplus</td>
<td>Total welfare</td>
</tr>
<tr>
<td>Value (000,000$)</td>
<td>12,666.2</td>
<td>1,683.5</td>
<td>1,211.9</td>
<td>16,062.2</td>
</tr>
<tr>
<td>Baseline scenario</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scenario 1 – SR (% change)</td>
<td>9.4</td>
<td>−79.9</td>
<td>−1.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Scenario 1 – LR</td>
<td>7.3</td>
<td>−31.1</td>
<td>−57.5</td>
<td>−1.0</td>
</tr>
<tr>
<td>Scenario 2 – SR</td>
<td>9.4</td>
<td>−80.1</td>
<td>−1.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Scenario 2 – LR</td>
<td>7.4</td>
<td>−31.7</td>
<td>−90.0</td>
<td>−0.7</td>
</tr>
<tr>
<td>Scenario 3 – SR</td>
<td>3.0</td>
<td>−25.2</td>
<td>0.0</td>
<td>0.4</td>
</tr>
<tr>
<td>Scenario 3 – LR</td>
<td>0.3</td>
<td>−1.3</td>
<td>−2.8</td>
<td>0.3</td>
</tr>
<tr>
<td>Scenario 4 – SR</td>
<td>2.7</td>
<td>−25.0</td>
<td>0.0</td>
<td>−0.3</td>
</tr>
<tr>
<td>Scenario 4 – LR</td>
<td>0.0</td>
<td>−1.3</td>
<td>−2.8</td>
<td>−0.5</td>
</tr>
</tbody>
</table>

Note: SR and LR denote the short-run and long-run scenarios, respectively.

rents under the MAC. In other words, it becomes very costly for the society to preserve the supply management system.

The second scenario involves the same cuts in the overquota tariffs as in the first scenario accompanied by an increase of 50% in the MACs in Table 1. The results are very similar to the first scenario, but increased market access at the in-quota tariffs (zero) has different impacts on output of fluid milk and yogurt compared to scenario 1. The difference in impacts on wholesale prices is negligible between the two scenarios. Table 4 reports that liberalization induces a decrease of 32% and 90% in long-run quota values and producers’ surplus, respectively. The overall welfare impact of this scenario is quite similar to the first scenario in that the extent of the cuts in the MSQ are so large that liberalization generates a negative welfare variation in the long run. As before, it could be argued that the 35% cut in the MSQ is so large that it would jeopardize the future of supply management. The results in the first two scenarios illustrate why dairy lobbies wish to have dairy products identified as sensitive in the next WTO trade agreement so they can be exempted from tariff reductions.

The third scenario involves liberalizing trade based on what a potential compromise in the WTO Doha Round could look like. Based on the draft agreement released by the Chair of the agriculture negotiations, overquota tariffs are cut by a smaller fraction than in the previous scenarios because Canada could possibly identify all dairy products as sensitive. In return for a lower cut in overquota tariffs, additional market access must be offered to Canada’s trading partners. These features are captured by an increase of 50% in the MAC levels and a decrease of 25% in overquota tariffs. The most important result is that the 25% reduction in overquota tariffs does not trigger imports above the MAC. The only additional imports under the “compromise outcome” are the ones that enter through the increase in MAC at the in-quota tariffs. Increased imports lower output of dairy products in both the short and long run, as reported in Table 2. The only exception is for yogurt because the decrease in the demand for milk at the farm level lowers the milk price paid by processors. The cost reduction outweighs the negative impact of the
lower domestic price for yogurt. In the long run, the positive impact for processors linked to a lower farm price disappears because of the decrease in the MSQ. The differences in output impacts between the long-run and short-run scenarios are due to the decrease in the level of the MSQ (a cut of 1.4%). In the short run, consumers/retailers see benefits as prices of butter, fluid milk, cheese and yogurt are all lower. In the long run, the cut in domestic production reduces gains of consumers/retailers.

The farm-level implications of trade liberalization under scenario 3 are more manageable for dairy producers than in scenarios 1 and 2. Table 3 reports that the farm price decreases by about 10% in the short run. Unit quota values decrease by 30% in Alberta while the decrease in Ontario and Quebec is less important (23%). Table 4 reports that buyers’ surplus increases by 3% and 0.3% in the short and long run, respectively. Even though unit quota values are back at their preliberalization level in the long run, it must be noted that domestic output is lower and thus producers are worse off as illustrated by variations in total quota values and producers’ surplus. Producers’ surplus declines by about 3% in the long run. Producers stand to lose between $55.7 and $424.2 million in surplus under the “compromise outcome” depending on what happens to output at the farm level. Buyers’ surplus is predicted to increase between $38 and $380 million compared to the baseline solution. The overall welfare implications of increasing market access under scenario 3 are positive and range between $48.2 and $64.2 million.

The fourth liberalization scenario investigates the additional impacts (with respect to scenario 3) of strengthened world prices due to policy active countries implementing stricter disciplines on domestic support and eliminating export subsidies. Obviously, one important impact is that import rents under the MAC decrease. Buyers even experience a decrease in their surplus when the level of the MSQ is cut to preserve the unit quota rent at the farm level. Hence, total welfare in Table 4 decreases in both the short and long run. Overall, the implications of liberalization on output and prices are nevertheless similar to scenario 3 as indicated in Table 2. Because there are positive exports of skim milk powder in the baseline scenario, the increase in the world price raises the retail price on the domestic market (due to the arbitrage condition) and domestic output is reallocated toward the export market.

As mentioned before, some assumptions in the calibration exercise may have important welfare implications when evaluating trade liberalization scenarios. For example, the positioning of the dairy producers’ marginal cost function is critical when measuring welfare implications. Hence, Table 5 compares the trade liberalization impacts of scenario 3 under two different assumptions with respect to the supply elasticity (i.e., the slope of the marginal cost function) at the farm level. In the baseline solution, marginal cost is calibrated assuming that the supply elasticity is one, while the sensitivity analysis assumes that the supply elasticity is 0.5. The differences between the baseline estimates of buyers’ surplus and quota values are relatively small. However, the baseline estimate of producers’ surplus is larger when the slope of marginal cost is steeper. It follows that a similar percentage impact on producers’ surplus following liberalization implies that producers’ losses under scenario 3 are higher when marginal cost is steeper (a difference between the two scenarios of $29.1 million). Otherwise, the qualitative differences between the two scenarios are pretty small.
Table 5. Sensitivity analysis for the trade liberalization scenario 3

<table>
<thead>
<tr>
<th></th>
<th>Fluid milk</th>
<th>Butter</th>
<th>Cheese</th>
<th>Skim milk powder</th>
<th>Yogurt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production (baseline, 000 MT)</td>
<td>2,520.5</td>
<td>86.1</td>
<td>441.3</td>
<td>101.9</td>
<td>167.1</td>
</tr>
<tr>
<td>Supply elasticity -&gt; 1 – SR (% change)</td>
<td>-0.1</td>
<td>0.0</td>
<td>-0.6</td>
<td>0.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Supply elasticity -&gt; 0.5 – SR</td>
<td>-0.1</td>
<td>0.0</td>
<td>-0.6</td>
<td>0.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Supply elasticity -&gt; 1 – LR</td>
<td>-1.2</td>
<td>-0.4</td>
<td>-2.1</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Supply elasticity -&gt; 0.5 – LR</td>
<td>-1.1</td>
<td>-0.4</td>
<td>-2.0</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Wholesale prices (baseline, $ / kg)</td>
<td>1.17</td>
<td>6.13</td>
<td>8.59</td>
<td>2.71</td>
<td>3.72</td>
</tr>
<tr>
<td>Supply elasticity -&gt; 1 – SR (% change)</td>
<td>-5.0</td>
<td>-2.7</td>
<td>-4.7</td>
<td>0.0</td>
<td>-2.1</td>
</tr>
<tr>
<td>Supply elasticity -&gt; 0.5 – SR</td>
<td>-5.0</td>
<td>-2.2</td>
<td>-4.8</td>
<td>0.0</td>
<td>-2.1</td>
</tr>
<tr>
<td>Supply elasticity -&gt; 1 – LR</td>
<td>-0.4</td>
<td>-2.1</td>
<td>-0.3</td>
<td>0.0</td>
<td>-0.2</td>
</tr>
<tr>
<td>Supply elasticity -&gt; 0.5 – LR</td>
<td>-0.8</td>
<td>-1.7</td>
<td>-0.7</td>
<td>0.0</td>
<td>-0.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Welfare-supply elasticity -&gt; 1</th>
<th>Buyers’ surplus</th>
<th>Quota values</th>
<th>Producers’ surplus</th>
<th>Total welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (000,000$)</td>
<td>12,666.2</td>
<td>1,683.5</td>
<td>1,211.9</td>
<td>16,062.2</td>
</tr>
<tr>
<td>Scenario 3 SR (% change)</td>
<td>-25.2</td>
<td>0.0</td>
<td>-2.8</td>
<td>-2.1</td>
</tr>
<tr>
<td>Scenario 3 LR (% change)</td>
<td>-25.2</td>
<td>0.0</td>
<td>-2.8</td>
<td>-2.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Welfare-supply elasticity -&gt; 0.5</th>
<th>Buyers’ surplus</th>
<th>Quota values</th>
<th>Producers’ surplus</th>
<th>Total welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (000,000$)</td>
<td>12,683.7</td>
<td>1668.8</td>
<td>2,423.9</td>
<td>17,274.2</td>
</tr>
<tr>
<td>Scenario 3 SR (% change)</td>
<td>-25.6</td>
<td>0.0</td>
<td>-2.6</td>
<td>-2.1</td>
</tr>
<tr>
<td>Scenario 3 LR (% change)</td>
<td>-25.6</td>
<td>0.0</td>
<td>-2.6</td>
<td>-2.1</td>
</tr>
</tbody>
</table>

Note: SR and LR denote the short-run and long-run scenarios, respectively.
CONCLUDING REMARKS

Dairy marketing institutions in Canada are facing broad globalization pressures. Supply management has always been a cornerstone of Canadian agricultural policy. While the outcome of the Doha Round of multilateral trade negotiations is still uncertain, it is possible that it will entail important market access reforms, and thus impact the ability of supply management to support farm-level prices. The impacts of liberalizing trade in the Canadian dairy industry are estimated using the spatial equilibrium developed by Cox and Chavas (2001). Their approach is extended to account for dairy trade policies and administered prices in Canada. The quadratic programming model spatially links seven Canadian regions with the rest of the world and is calibrated using 2003–04 data. Three broad liberalization scenarios are considered to simulate the impacts of moderate or aggressive increases in market access commitments and reductions in import tariffs. A sensitivity analysis is also discussed.

Increased market access will automatically put downward pressures on prices and it is difficult to anticipate the reaction of authorities with respect to farm output planning. To account for this uncertainty, a first simulation assumes that the MSQ at the farm level remains unchanged following liberalization. The second simulation assumes cuts in the MSQ are made to bring back the value of production quotas at their preliberalization level. The latter simulation is labeled a “long-run” scenario, while the former is labeled “short run.”

When significant cuts in import tariffs are implemented, output of cheese and skim milk powder in the long run falls by 74% and 27%, respectively. Wholesale prices of cheese, fluid milk, and butter decrease by 15%, 6%, and 19%, respectively. Prices are even lower in the short run because the MSQ level is unchanged following liberalization. The large tariff cuts have important welfare implications at the farm level because quota values fall significantly under liberalization. In some instances, it is preferable for small producing regions not to produce all milk allowed by the MSQ. In the “WTO compromise” liberalization scenario, output of fluid milk and butter decreases by less than 2% in the long run while cheese output falls by 2.1%. Movements in prices are more significant in the short run and quota values decrease by more than 25% in Quebec and Ontario. Not surprisingly, the extent of the tariff cuts has a major impact on the results. This explains why dairy producers are vigorously lobbying the Canadian government to negotiate an agreement that allows identifying all dairy products as sensitive.

There are no doubts that trade liberalization has the potential to significantly impact supply management policy in Canada. Contrary to what the popular press reports (and the emphasis of this paper as well), there are issues other than market access that threaten the supply management policy. WTO members already agreed to eliminate (almost) all forms of export subsidies before the end of 2013. This implies that pricing industrial milk at different levels depending on whether products are sold domestically or exported will not be possible. Since Canadian exports are generally not competitive at world prices, this means lower output at the farm level at current domestic prices. Moreover, there is a strong possibility that disciplines on domestic support involves a cap on product-specific support. This would significantly limit the ability of the CDC to increase support prices for butter and skim milk powder in the future. These trade liberalization pressures combined...
with domestic issues, such as high production quota values, will make it difficult for Canadian dairy producers to compete in a more open environment if adjustment policies and reforms are not implemented prior to liberalization. Further research efforts should be directed at identifying structural changes in the dairy industry following liberalization in terms of production scale effects at the farm level and entry/exit decisions of dairy producers in a more open environment. These factors were ignored in the current study, but are undoubtedly important determinants of welfare under trade liberalization.

NOTES

1 For example, the spokesperson of the GO5 coalition (a Quebec-based coalition that defends supply management) stated following the suspension of the WTO negotiations in July 2006: “An agreement (…) would have been devastating for agricultural producers both in Canada and in developing countries. The proposed tariff cuts would have left farmers open to unfair competition from heavily subsidized foreign products.” Available at: www.go5quebec.ca/en/communiques_280706.php. Accessed September 5, 2006.

2 Classified pricing is the exercise of price discrimination. It represents a structure of prices that differ according to category of use.

3 Bouamra-Mechemache et al (2002) modeled the EU price support system. The difference is that the European policy clearly acts as a price support system in that government purchases can be sold into the international markets at lower prices than in the domestic market. In our case, government purchases must be mostly stored until eventually sold to domestic agents. The difficulty arises because a policy inherently dynamic needs to be included in a static setting.

4 The most recent notification to the WTO made by the Canadian government is for the year 2001. Total support in the dairy industry (computed as the difference between the administered and reference prices) amounted to Can$453.9 million and represented 11.7% of the value of butter and skim milk production sold domestically.

5 Another option would be to restore the farm price at its preliberalization level. However, given the existence of decreasing returns to scale at the farm level, the reduction in the production quota would have had to be extremely (and unrealistically) large in the empirical simulations of the next section.

6 The government cannot sell back on the market a quantity that is larger than what it purchases in the current period; hence we assume away initial inventories. The constraint \( \sum_{i=1}^{J} TG_{ijGk} \leq Y_{Gk} \) is not introduced in the baseline solution because it will be satisfied by construction.

7 Referring back to Figure 1, \( \mu_k \) is equal to the segment \( AC \).

8 This duty-free access is inconsequential in the simulations below.

9 Because there are no differences between the price of milk used to produce skim milk powder for the domestic and export markets in our model, exports are not considered as subsidized.

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The authors would like to thank Hartley Furtan for providing his estimates of distances between Canadian provinces. Part of this project was realized with the financial support of the Fonds de développement de la transformation alimentaire (FDTA). The views expressed in the paper should not be attributed in any way to this funding agency. Finally, we would like to thank two reviewers for providing helpful suggestions. Of course, remaining errors are the authors’ sole responsibility.
REFERENCES


The objective function is defined in Equation (1). The Lagrangean ($\Upsilon$) of the problem is

$$\Upsilon = \sum_{i=1}^{J} \left[ D_i (Z_{i1}, \ldots, Z_{ik}) - S_i (Q_i) - G_i (Y_{i1}, \ldots, Y_{iK}, X_i) \right] - \sum_{i=1}^{J} \sum_{j=1}^{J} \sum_{k=1}^{K} T_{ijk} c_{ijk}$$

$$- \sum_{i=1}^{J} \sum_{k=1}^{K} T_{MAC_{ijk}} (p_{Wk} + c_{Wk} + \tau_k^{IQ} + c_{ijk})$$

$$- \sum_{i=1}^{J} \sum_{k=1}^{K} T_{W_{ik}} (p_{Wk} + c_{Wk} + \tau_k^{IQ})$$

$$+ \sum_{i=1}^{J} \sum_{k=1}^{K} T_{X_{ik}} (p_{Wk} - c_{Wk}) + \sum_{i=1}^{J} \sum_{k=1}^{K} T_{G_{ik}} p_{Gk}$$

$$- \sum_{i=1}^{J} \sum_{k=1}^{K} T_{C_{ik}} p_{Wk} + \sum_{i=1}^{J} PW_{x_i}$$

$$- \sum_{i=1}^{J} \sum_{k=1}^{K} PW_{ik} Y_{ik} + \sum_{i=1}^{J} \sum_{s=1}^{S} \lambda_{is} \left( X_i a_{is} - \sum_{k=1}^{K} Y_{ik} b_{iks} \right) + \sum_{i=1}^{J} \alpha_i (Q_i - X_i)$$

$$+ \sum_{i=1}^{J} \sum_{k=1}^{K} \beta_{ik} \left( Y_{ik} - \sum_{j=1}^{J} T_{ijk} - T_{G_{ik}} - T_{X_{ik}} \right)$$

$$+ \sum_{i=1}^{J} \sum_{k=1}^{K} \eta_{ik} \left( \rho_{ik} MAC_{ik} - \sum_{j=1}^{J} T_{MAC_{ij}} \right)$$

$$+ \sum_{i=1}^{J} \sum_{k=1}^{K} \chi_{ik} \left( \sum_{j=1}^{J} T_{ijk} + T_{C_{ik}} + \sum_{j=1}^{J} T_{MAC_{ij}} + T_{W_{ik}}^{OQ} - Z_{ik} \right)$$

$$+ \sum_{i=1}^{J} \delta_i (MSQ_i - Q_i) + \sum_{k=1}^{K} \gamma_k \left( Y_{Gk} - \sum_{i=1}^{J} T_{G_{ik}} \right) + \sum_{k=1}^{K} \mu_k \left( \bar{Y}_{Gk} - \sum_{i=1}^{J} T_{G_{ik}} \right)$$

where $\lambda_{is}$ is the Lagrange multiplier associated with the components allocation constraint in each region, $\alpha_i$ is the multiplier associated with the MSQ and is equal to the implicit price of milk in each region, $\beta_{ik}$ is the multiplier associated with the constraint on shipments with respect to production in each region and represents the marginal value of output, $\chi_{ik}$ is the multiplier associated with the constraint on shipments with respect to consumption in each region and represents the implicit market price of product $k$ in region $i$, $\delta_i$ is the unit value of the production quota at the farm level, $\eta_{ik}$ is the implicit price of the import license for product $k$, $\gamma_{ik}$ comes from the constraint on domestic sales made by the CDC and is the implicit consumer rent resulting from the support price scheme and $\mu_{ik}$ is the multiplier associated with the constraint on the CDC purchases.
The Kuhn-Tucker conditions are

\[
\frac{\partial L}{\partial Q_i} = -\frac{\partial S_i}{\partial Q_i} + \alpha_i - \delta_i \leq 0 \quad \text{with strict equality if} \quad Q_i > 0 \tag{A1}
\]

\[
\frac{\partial L}{\partial X_i} = PW - \frac{\partial G_i}{\partial X_i} + \sum_{s=1}^{S} \lambda_{is} a_{is} - \alpha_i \leq 0 \quad \text{with strict equality if} \quad X_i > 0 \tag{A2}
\]

\[
\frac{\partial L}{\partial Y_{ik}} = -\frac{\partial G_i}{\partial Y_{ik}} - PW_{ik} - \sum_{s=1}^{S} \lambda_{is} b_{iks} + \beta_{ik} \leq 0 \quad \text{with strict equality if} \quad Y_{ik} > 0 \tag{A3}
\]

\[
\frac{\partial L}{\partial Z_{ik}} = \frac{\partial D_i}{\partial Z_{ik}} - \chi_{ik} \leq 0 \quad \text{with strict equality if} \quad Z_{ik} > 0 \tag{A4}
\]

\[
\frac{\partial L}{\partial T_{ijk}} = -c_{ijk} - \beta_{ik} + \chi_{jk} \leq 0 \quad \text{with strict equality if} \quad T_{ijk} > 0 \tag{A5}
\]

\[
\frac{\partial L}{\partial T_{MAC_{ijk}}} = -p_{Wk} - c_{iWk} - \tau_{k}^{OQ} - c_{ijk} + \chi_{jk} - \eta_{ik} \leq 0 \quad \text{with strict equality if} \quad T_{MAC_{ijk}} > 0 \tag{A6}
\]

\[
\frac{\partial L}{\partial T_{Wk}} = -p_{Wk} - c_{iWk} - \tau_{k}^{OQ} + \chi_{ik} \leq 0 \quad \text{with strict equality if} \quad T_{Wk} > 0 \tag{A7}
\]

\[
\frac{\partial L}{\partial T_{Xiwk}} = p_{Wk} - \beta_{ik} \leq 0 \quad \text{with strict equality if} \quad T_{Xiwk} > 0 \tag{A8}
\]

\[
\frac{\partial L}{\partial T_{Gik}} = p_{Gk} - \beta_{ik} - \mu_k \leq 0 \quad \text{with strict equality if} \quad T_{Gik} > 0 \tag{A9}
\]

\[
\frac{\partial L}{\partial T_{C_{Gik}}} = -p_{Wk} - \gamma_{ik} + \chi_{ik} \leq 0 \quad \text{with strict equality if} \quad T_{C_{Gik}} > 0 \tag{A10}
\]

\[
\frac{\partial L}{\partial \lambda_{is}} = X_i a_{is} - \sum_{k=1}^{K} Y_{ik} b_{iks} \leq 0 \quad \text{with strict equality if} \quad \lambda_{is} > 0 \tag{A11}
\]

\[
\frac{\partial L}{\partial \alpha_i} = Q_i - X_i \leq 0 \quad \text{with strict equality if} \quad \alpha_i > 0 \tag{A12}
\]

\[
\frac{\partial L}{\partial \beta_{ik}} = Y_{ik} - \sum_{j=1}^{J} T_{ijk} - T_{Gik} - T_{Xiwk} \leq 0 \quad \text{with strict equality if} \quad \beta_{ik} > 0 \tag{A13}
\]
\[
\frac{\partial L}{\partial \chi_{ik}} = \sum_{j=1}^{J} T_{ijk} + TC_{Gik} + \sum_{j=1}^{J} TMAC_{ijk} + T_{Wik}^O - Z_{ik} \leq 0
\]
with strict equality if \( \chi_{ik} > 0 \)

(A14)

\[
\frac{\partial L}{\partial \delta_i} = MSQ_i - Q_i \leq 0 \quad \text{with strict equality if } \delta_i > 0
\]

(A15)

\[
\frac{\partial L}{\partial \eta_{ik}} = \rho_{ik} MAC_k - \sum_{j=1}^{J} T MAC_{ijk} \leq 0 \quad \text{with strict equality if } \eta_{ik} > 0
\]

(A16)

\[
\frac{\partial L}{\partial \gamma_k} = Y_{Gk} - \sum_{i=1}^{I} TC_{Gik} \leq 0 \quad \text{with strict equality if } \gamma_k > 0
\]

(A17)

\[
\frac{\partial L}{\partial \mu_k} = Y_{Gk} - \sum_{i=1}^{I} TG_{iGk} \leq 0 \quad \text{with strict equality if } \mu_k > 0
\]

(A18)

It is worthwhile to discuss the role of the support price policy in the context of the programming model because of the discrepancies between the objective of the price support system (which is an instrument to balance temporary deviations from an equilibrium path) and the static nature of the programming model. From the system of equations above, it is relatively easy to show that for butter and skim milk powder: (i) when the support price in region \( i \) is not effective, we have \( TG_{iGk} = 0 \) and \( TC_{Gik} = 0 \); (ii) when the support price is effective, we have \( TG_{iGk} > 0 \) and \( TC_{Gik} > 0 \), which imply the arbitrage conditions \( p_{Gk} - \beta_{ik} - \mu_k = 0 \) and \( p_{Wk} + \gamma_{ik} - \chi_{ik} = 0 \), as well as a positive price difference between the support and market prices \( \theta_{ik} = p_{Gk} - (\chi_{ik} - c_{ik}) = \beta_{ik} + \mu_k - \chi_{ik} + c_{ik} > 0 \). Government purchases are positive and thus marginal cost (\( \beta_{ik} \)) is equal to the support price less \( \mu_k \). Government purchases need to be sold on the domestic market (\( TC_{Gik} \)) or exported. The price paid by domestic consumers (\( \chi_{ik} \)) is equal to \( p_{Wk} + \gamma_{ik} \). From a mathematical standpoint, domestic production is bought by the CDC and sold back to domestic consumers at world price. In reality, the transactions of the CDC are minimal and it only intervenes when the market price momentarily falls below the support price. This situation is temporary as any recurrent excess supply that would cause a market price to be permanently below the level of the support price would have to be addressed through changes in the global production quota. This motivates our long-run scenario.