Applied Economic Perspectives and Policy (2019) volume 0, number 0, pp. 1–17.
doi:10.1093/aepp/ppy038

Submitted Article

Reforming Canada's Dairy Sector: USMCA and the Issue of Compensation

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Submitted 26 October 2018; editorial decision 28 November 2019.

Abstract *Supply management (SM) in Canada's dairy sector was an obstacle to the successful renegotiation of the North American Free Trade Agreement. Reform of agricultural SM regimes in sugar, peanuts, tobacco, and dairy in various jurisdictions are reviewed, and an analytic framework is developed to investigate how Canada might eliminate its dairy quota regime while not overcompensating producers. Compensation based on quota values amount to $5.9 billion if untargeted, but only $2.9 billion if targeted; in contrast, theoretically correct estimates of the loss that dairy producers would face range from $0.2 to $1.9 billion. Such costs are low enough not to impede the elimination of supply management.*

Key words: Supply management, international trade, compensation and welfare measurement.

JEL codes: F13, Q13, Q17.

When conclusion of the World Trade Organization's (WTO) Doha Round appeared imminent, agricultural economists asked whether Canada's supply-managed dairy sector "should be realigned to be consistent with the new trade rules [that had yet to be determined], or if more fundamental changes should be undertaken to better position the industry for the future," (Barichello, Cranfield, and Meilke 2009). The Doha multi-lateral trade negotiations have not yet concluded and attention has shifted to regional trade negotiations. Canada settled a Comprehensive Economic and Trade Agreement (CETA) with Europe and signed the Comprehensive and Progressive Agreement related to the Trans-Pacific Partnership (without the United States and thus referred to as TPP-11). More recently, United States–Canada trade negotiations cleared the way for a United States–Mexico–Canada Agreement (USMCA) that replaces the North American Free Trade Agreement (NAFTA). In trade negotiations, the United States had particularly targeted Canada's dairy sector (CBC 2018):

> *"One issue on which currently there is little clarity is that of supply management. Both the US and New Zealand pressed Canada for more access to its closed dairy market, and the US continue[d] to do so in the context of NAFTA. In the original TPP, Canada agreed to open 3.25 percent of its market to dairy imports from TPP countries. Even this limited and long overdue reform came with a hefty price tag as the then-Conservative government promised over Cdn$4 billion in compensation to Canada's 12,000 dairy farmers (plus chicken and egg producers) to offset this minimal opening. The Trudeau government, like all previous governments, has signed on publicly to the myth that supply management is good for the Canadian economy. More realistically, it does not want to pay the political or financial price for opposing this powerful lobby,"* Stephens (2017).

Despite these trade agreements, pressure for Canada to reform its dairy sector will not easily go away as the supply management (SM) regime remains in place. The potential benefits to Canadian consumers of reform are obvious, but there are also benefits to producers as they could then take advantage of economies of scale and gain access to international markets, especially markets in rapidly developing countries whose citizens prefer products from rich countries because of food safety concerns, (Grant et al. 2014; Carter and Mérel 2016).

Canada maintains a stronghold on its supply-managed dairy sector, despite a spate of studies demonstrating its adverse economic and income distributional impacts (e.g., Veeman 1982, 1997; van Kooten 1988). The main factor accounting for the survival of SM is rent seeking by dairy producers, with the industry arguing that since it only serves the domestic market, it should not be considered in trade negotiations. In 2005, for example, the House of Commons unanimously passed a motion asking the government not to give up any protection for the SM sectors in international trade negotiations; this was re-affirmed in the Government's 2011 Speech from the Throne (Busby and Schwanen 2013). Yet, under CETA, the industry gave up 2% of its domestic market, followed by another 3.25% under TPP-11. In response to the U.S. position that Canada's average dairy tariffs of more than 250% are unacceptable and its dairy markets must be opened to trade, producers lobbied the Prime Minister with all parties in Parliament again resolving to protect SM. Clearly, rent seeking by farmers and acquiescence by politicians characterize SM and its continuance.

In this study, I examine the prospects for liberalizing Canada's dairy sector, as well as the potential need to compensate dairy producers. Background information on supply management and recent trade agreements is provided in the next section, followed by the development of a theoretical framework for potentially effectuating reform of Canada's dairy sector. In the subsequent section, I use data on milk sales, prices, quota levels and the value of quota, and assumptions about supply and demand elasticities to estimate the costs of compensating dairy producers under various assumptions. A concluding discussion ensues. The main conclusion is that the level of compensation that the government might provide Canadian dairy producers to abandon supply management is not particularly large compared to the benefits.

Background to Supply Management in Canada

Supply management in Canadian dairy began with the establishment of the Canadian Dairy Commission (CDC) in 1966. This was followed in 1970 by a National Milk Marketing Plan to control supply, with the federal government, Quebec, and Ontario as the original participants. The enabling

legislation for SM was not passed until two years later, with the *Farm Products Agency Act* (1972), which led to the establishment of SM boards in eggs (1973), turkey (1974), chicken (1978), and chicken hatching eggs (1986). The original quota owners did not pay for quota and captured the initial windfall. Then, as the demand for milk increased, any producers who were provided increased quota at no extra cost also reaped a windfall. Finally, buyers of quota benefitted from quota rents once their quota assets were fully depreciated. By 1974, all provinces except Newfoundland had signed on, with each province having its own dairy SM board.

The dairy system works as follows: Each year the Canadian Milk Supply Management Committee (CMSMC) sets a quota on industrial milk based on expected sales and wholesale prices, allocating this quota (measured in kilograms of butterfat) to provinces on the basis of historical market shares (Nogueira et al. 2012). Provincial boards use their industrial milk allocation and expectations about local sales of fresh milk to determine how much individual quota holders can produce, with farmers able to purchase or sell quota at monthly auctions (see below). Meanwhile, the federal government abrogated its responsibility over trade in dairy by suppressing interprovincial trade and permitting provinces to ban exports of dairy products (Busby and Schwanen 2013). Under the guise that the dairy system was set up to serve the domestic market, exports were banned entirely and Canada could not take advantage of rapid growth in demand by emerging countries. However, since supply of the fat component of milk is controlled, the high-protein, non-fat component of milk often exceeded domestic requirements and was exported as skim milk powder (SMP). Although such exports will be prohibited under international rules after 2020, they were an irritant to Canada's trading partners.

Since the mid 1970s, the price of milk in Canada has been determined as follows: The CDC (which acts as secretariat to the CMSMC) coordinates with the provinces to maintain a farm-gate *target price* that is based on a survey of production costs. Based on this information, the CDC calculates annual *support prices* for butter fat and SMP, and agrees to purchase any surplus butter and milk powder at those prices. In practice, farmers sell milk to their provincial marketing board and receive a price that is a blend of the butter fat and SMP prices. The provincial boards establish prices for the various milk classes so that the weighted average price is close to the blended target price. While the top 25% of producers account for about half of the country's milk production, the other half is produced by medium- to low-efficiency farmers whose costs essentially drive the target price.

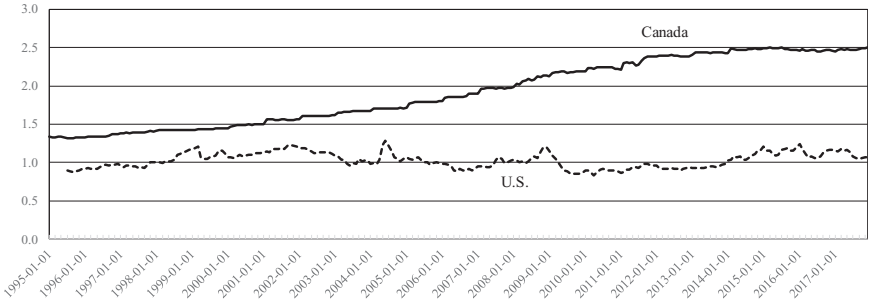
Currently, under WTO rules, Canada's tariff-rate quota (TRQ) on all dairy imports is 20,412 metric tons (t). Recent trade agreements increase TRQs in various ways, thereby negatively impacting the price Canadian farmers receive. Under CETA (which came into force September 2017), the TRQ on cheese and industrial cheese for European Union (EU) countries is to increase from 745.3t in 2017 to 16,000t in 2022 and onwards (although 800t is a transfer of WTO quota). Under TPP-11 (signed March 2018), increases in TRQs for various dairy products are to be phased in over a period of 19 years, rising from a total of 20,100t (1,933t of cheese) in the first year of the agreement to 110,700t (13,202t) in year 19 (Global Affairs Canada 2018).

Under USMCA (signed September 30, 2018), Canada agreed to provide the United States with tariff-free access to 3.59% of its dairy market. By the

Figure 1 Whole milk retail price, 1995–2017, $CDN/liter

Note: Data are in Canadian dollars per liter; U.S. data are converted from USD per gallon using a conversion of 3.78 liters per U.S. gallon and the monthly exchange rate.

Source: Canadian data from Statistics Canada, Table 326-0012, Average retail prices for food and other selected items, monthly; U.S. data from Agricultural Marketing Services, U.S. Department of Agriculture at https://www.ams.usda.gov/market-news/dairy.



sixth year of the agreement, the United States will be given *additional* quota as follows: fluid milk, 50,000t; cheese, 12,500t; cream, 10,500t; SMP, 7,500t; butter and cream powder, 4,500t; yogurt and buttermilk, 4,135t; concentrated and condensed milk, 1,380t; and other dairy products, 4,660t (Nudds 2018). Tonnage is to increase at a rate of 1% annually for 13 years thereafter.

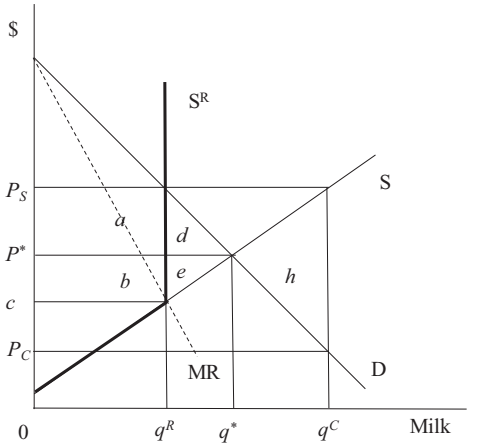
Finally, tariffs on milk protein concentrate, SMP, and infant formula (Canadian milk classes 6 and 7) are to be eliminated, which satisfied a major U.S. demand that Canada remove its impediments to imports of milk protein isolates. This should drive Canada's domestic SMP price toward the world price, thereby reducing what farmers receive for milk as their price is a blend of the SMP and butter fat target prices. Yet, despite opening up its dairy markets to the world's four largest dairy exporting regions—the EU, the United States, New Zealand, and Australia—Canada remains committed to supply management.

The impact of SM on consumers is important because high prices hurt the least well off more than middle- and upper-class citizens. As shown in figure 1, the retail price of whole milk in Canada diverged significantly from that in the United States beginning around 2001; therefore, farm-level prices of milk in Canada are almost double those in other countries (Barichello et al. 2011; see also Cardwell, Lawley, and Xiang 2015). Dairy price supports cost Canadian households an average of $276 per year, while providing an annual benefit of some $200,000 to an average dairy farm (Grant et al. 2014). Further, SM has prevented Canadian dairy producers from achieving economies of scale with respect to herd size, although other factors also play a role in determining economies of scale (Grant et al. 2014). Yet, it is likely that Canadian dairy farmers could compete effectively with those in other countries if they were able to expand their herds and participate in global markets.

Economics of Supply Management

By restricting supply, no cost is imposed on the public treasury, except perhaps expenses related to the implementation and governance of a quota scheme—setting production levels, import quotas (if any) and rules for

Figure 2 Welfare impacts of restricting supply



transferring quota, allocating output across producers, and monitoring compliance. A quota scheme transfers income from consumers to producers. The economic implications of a quota system can be demonstrated with the aid of figure 2.

By restricting the supply of milk to q^R, the relevant supply curve becomes vertical as indicated by the dark curve S^R—producers are allocated a production quota to prevent output from exceeding q^R. In figure 2, q^R is chosen so that the profit to the producers as a group is maximized, which occurs where the marginal cost function, represented by the sector supply curve S, intersects the marginal revenue (MR) function. With less output entering the market, producers receive P_S, which is also the price consumers pay, but the producers' supply cost is only c. The deadweight loss is $d + e < h$, where h measures the deadweight loss associated with a support program that sets the producer price at P_S but allows the market to clear at (q^C, P_C), and the cost to the treasury is given by the large rectangle $(P_S - P_C) \times q^C$.

In going from free trade, given by (q^*, P^*) to restricted trade (q^R, P_S) in figure 2, consumers lose surplus rectangle a, which constitutes an income transfer to producers, plus triangle d, which constitutes a deadweight loss. Producers gain area a but lose triangle e, which constitutes the second component of the deadweight loss. The wedge between price (P_S) and the marginal cost to producers (c) results in a policy-induced scarcity rent equal to area $a + b$, which is known as the quota rent. The right-to-produce now has value and is determined as follows: The annual quota rent R_A is given by producer's quota q multiplied by the difference between the market price and the marginal cost of production, $R_A = q \times (P_s - c)$. However, R_A is not the gain to producers from the establishment of a quota regime. Compared to the free trade situation, producers gain area ($a - e$) and, as argued below, compensation if any should be based on ($a - e$) as opposed to R_A.

If a quota scheme is assumed to continue into perpetuity, the value of quota would, as shown by Nogueira et al. (2012), equal $QV = R_A\ (1 - \lambda)/(i + \lambda - g)$, where i is the real economy-wide interest rate, λ is the risk of the eventual demise of the quota scheme, and g denotes the possible annual capital gain to quota. The interest rate i is likely less than 4% and buyers of quota likely consider g to equal zero (see below). The value of λ is bound to vary

from one producer to another as it is based on perception. For simplicity, in the remaining analysis the policy risk and economy-wide interest rate are taken together in the discount rate (denoted r), where $r = (i + \lambda - g)/(1 - \lambda)$.

During the early 1990s, the discount rate employed by farmers in valuing quota averaged between 20% and 49% (Chen and Meilke 1998), suggesting that they perceived a high risk that the quota system might be reformed. When the Uruguay Round of the GATT was completed in 1994, the value of this quota rose dramatically, indicating that the perceived risk factor declined accordingly (Barichello, Cranfield, and Meilke 2009). With NAFTA negotiation, the risk factor is probably quite high again, although it will be influenced by the prospects of compensation.

If the authority agrees to modify or eliminate SM as part of international free trade negotiations, as happened when Canada negotiated CETA and TPP-11, dairy producers may need to be compensated because they experience what might be considered a regulatory taking. Those who recently purchased quota are potentially able to identify their loss, but it would be difficult for those who have fully depreciated their quota investment to argue for compensation.

On fairness or equity grounds, and certainly for political reasons, the government might decide to buy back quota, which requires a determination of a fair buy-back price. If a market for quota exists, quota values can be used as a basis for determining compensation, although such values overestimate the actual compensation that should be paid. If data on quota values are not available, it is necessary to determine the quota value based on estimates of areas *a*, *b*, and *e* in figure 2. To do so requires estimates of demand and supply elasticities, and information from farm management studies or cost of production surveys that enable one to identify the gap between the known selling price and marginal cost.

Reforming Supply Management

Grant et al. (2014) reviewed earlier studies that examined how Canada might reform its dairy sector, although their primary focus was on the costs of a buyout. One study worth highlighting is by Barichello, Cranfield, and Meilke (2009), who argue that dairy producers should be compensated, but not for the full market value of the quota held (= quota allocation × price in quota market), which runs some $25 to $30 billion depending upon the year. Rather, these authors recommend a compensation package similar to that used in Australia, which targeted needy producers and poorer regions. Apart from the theoretical argument against compensating according to quota value, Barichello, Cranfield, and Meilke (2009) believe growth in quota value during the 1990s and early millennium had been the result of an asset price bubble and that speculation should not be compensated.

Grant et al. (2014) provide their own estimates of the cost of a potential buyout. These authors argue that quota acquired through purchases on provincial exchanges or through business consolidation would be depreciated over ten years, while intra-family transfers should be adjusted to reflect the pre-transfer vintage of the quota. If they use only total, non-depreciated value and exchange-traded information, they estimate that a buyout program would cost $5.6 billion; if they use the price at the time of purchase ("book value") and depreciate this value over 10 years, the required compensation would amount to $2.6 billion. However, the authors report that

off-exchange, intra-family transfers accounted for 80% of quota transfers trades in Ontario, 60% in Quebec, 51% in Alberta, and 59% in British Columbia in the dairy year 2011–2012.[1] Assuming that these represent between some 40% to 80% of the total exchange transfers, the authors calculated that a buyout would cost between $3.6 and $4.7 billion.

A lack of data on intra-family transfers is particularly problematic. Suppose a family farm is transferred to an heir. How much of the value of the enterprise constitutes a bequest, and how much does the heir pay for the various farm assets? Is a separate payment made for quota assets that had been fully depreciated by the original owner? Are the transfer and payment documented? Should the heir be compensated for any lost quota value in the event of reform to the SM regime? From the perspective of a buyout program, there are only two ways to deal with this issue: employ the pre-transfer vintage of the quota value, or require that the quota in question be auctioned, with the heir able to match any offer.

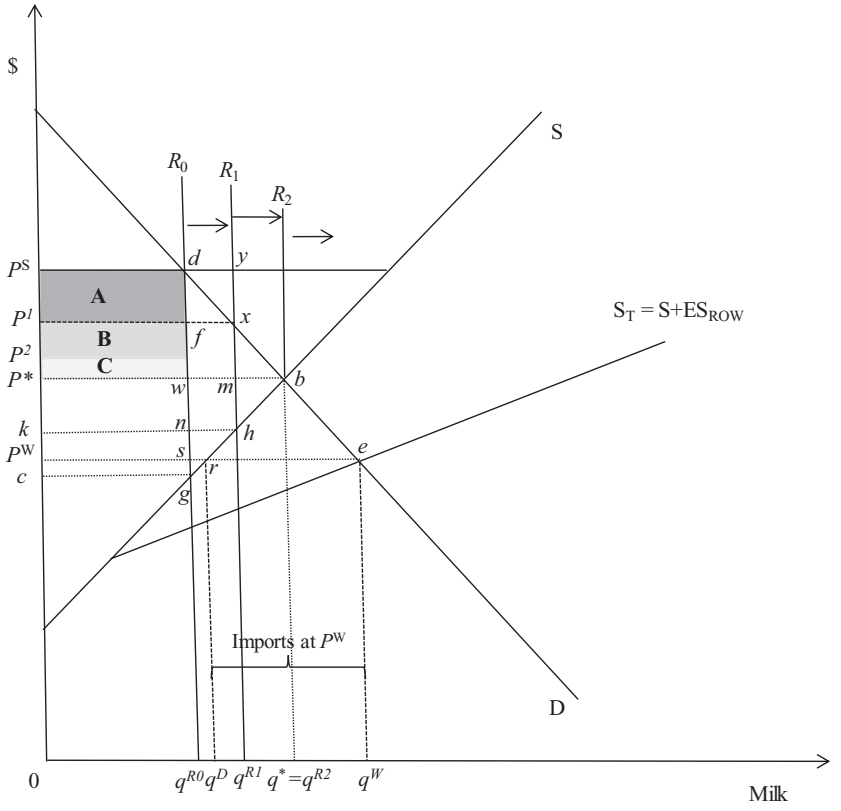
Few studies have employed an applied welfare economics framework to analyzing how a quota scheme might be dismantled and compensation paid to producers. Exceptions are economic analyses of the tobacco buyouts in the United States and Ontario, and a peanut buyout program in the United States (Schmitz and Schmitz 2010; Schmitz et al. 2016a, 2016b). The U.S. peanut buyout program cost the government $264 million while benefitting society by less than $40 million. U.S. tobacco producers were compensated $9.6 billion spread over ten equal annual payments. The tobacco buyback program in Ontario based payments on a producer's basic production quota rather than total marketing quota (actual production), where the latter was significantly lower than the former. Almost all farmers participated in the voluntary buyout, receiving $275,000 each and costing the government $286 million. However, the enabling legislation did not prevent tobacco farming and so production increased after the buyout. In effect, producers were highly overcompensated in at least two of the three programs. The U.S. tobacco buyback program was relatively successful, but its peanut program overcompensated producers, while the Ontario tobacco program not only overcompensated farmers but failed to reduce tobacco production.

Reforming Dairy Supply Management in Canada

To examine dairy-sector reform in Canada, a stylized compensation mechanism is developed in figure 3, where S and D are the domestic supply and demand functions, respectively. With trade, total supply is S_T, which consists of the horizontal sum of domestic supply S and the excess supply from the rest of the world (ES_{ROW}). Under autarky, price and quantity are given by (P^*, q^*), but under free trade Canadians would consume q^W at price P^W. Supply management imposes a supply restriction at R_0 ($=q^{R0}$) at the support price P^S; to maintain this price, imports need to be restricted. To keep the analysis simple, I assume that the tariff (some 270%) is sufficient to block all imports. The (annual) quota rent is given by area ($P^S dgc$), where c is the marginal cost of production. The total value of the quota asset then equals the capitalized value of the quota rent.

[1] *As a portion of total transfers, the figures reported here are considered high as they were based on guesstimates from a single source (Richard Barichello, personal correspondence, June 19, 2018).*

Figure 3 Reforming Canada's dairy supply management sector



Suppose the authority wishes to reform or eliminate the quota regime while providing dairy producers with compensation. A stylized description of how this might be done begins by increasing the quota beyond that needed to maintain price at P^S. Suppose the quota is initially increased to R_1 from R_0, which causes the domestic price to fall to P^1. Denoting the original quota amount as the reference quantity, the authority compensates producers for the price reduction up to the reference quantity. That is, producers receive $(P^S - P^1) \times q^{R0}$ as compensation, which is equivalent to the dark shaded area denoted **A**. Not only do producers receive **A** as compensation, they also gain (*ghn*) as quasi-rent, so dairy producers are overcompensated for their loss in quota value. Overcompensation can be dealt with by reducing the difference $(P^S - P^1)$, or can be dealt with in the next step.

In the second step, the dairy quota is increased to q^{R2} $(=R_2)$, which also happens (for convenience) to equal q^* as drawn here. This time the dairy producers are not compensated the full amount of the price decline from P^1 to P^*, but rather only for part of the difference, namely, $(P^1 - P^2)$. The total compensation for this increase in quota would amount to only the medium shaded area denoted **B**, but farmers would gain (*hmb*) as quasi-rent. Whether they are over or under compensated will depend on whether the lightest shaded area, denoted **C**, is smaller (overcompensation) or larger (undercompensation) than (*gwb*).

Any number of further steps are required to reduce the price to the world level P^W. Each step consists of some compensation at the discretion of the

policymaker. The policy maker must determine how much of the drop in price to compensate at each step—the price premium (using an EU term) to be provided, if any. However, when a free market equilibrium is reached and assuming the underlying fundamentals of the market in figure 3 remain unchanged, Canadian producers will only increase output from q^{R0} to q^{D} (where D refers to domestic), with an amount $q^{W} - q^{D}$ imported from other countries. Producers gain (gsr) but lose ($P^{S}P^{W}sd$).

Notice the caveat that the fundamentals of the market structure in figure 3 are unchanged. This is highly unlikely to be the case. Rather, the supply curve is likely to shift downwards as some dairy producers increase their cow herds to achieve economies of scale, while others leave the industry (which is why compensation is required from a political perspective). Unless dairy farms in Canada expand their dairy herds to benefit from economies of scale, Canada will be unable to compete internationally and require continued tariff protection. Milk prices will remain higher than those in other countries, with the least well-off citizens bearing the burden of SM.

It is often assumed that Canada might be a net importer of dairy products if trade is liberalized. To determine if this is the case, it would be necessary to compare the ratio of the autarkic price to the world price, and compare these across countries. The problem is that SM obscures the autarkic price in Canada. However, using economic theory, available data and assumptions on supply and demand elasticities, Carter and Mérel (2016) make the case that Canadian dairy producers may actually have a comparative advantage over countries that currently dominate dairy export markets; this is supported by evidence of per cow productivity (figure 3). Thus, by liberalizing trade, Canadian dairy producers would benefit, although there would likely be an exit of high- and medium-cost producers.

In an earlier study, Vercammen and Schmitz (1992) demonstrated that,

"[i]f producers under SM were forced to choose between offering import concessions and abandoning SM, they will, in specific circumstances [e.g., very inelastic demand], choose the former. The main reason for this is that SM may result in relatively large rent transfers from consumers to producers, implying that considerable import concessions could occur before the 'excessive' producer rents are eroded away."

If this is the case, although the authors do not consider this possible in the dairy sector (while it could be in chicken), policymakers might wish to begin dairy reform by providing greater import concessions during trade negotiations. As indicted earlier, this has been done despite the objections of the dairy lobby.

Calculating the Cost of Potential Reform

While the previous section described a mechanism for dismantling a quota regime, in this section two methods are used to calculate the potential compensation that the authority might pay to dairy producers to eliminate SM. The first assumes that broad-based compensation is required—that all producers would need to be compensated on the basis of their quota holdings—and employs applied welfare economic theory to derive estimates of the potential buyout costs. The second approach estimates compensation paid on the basis of its book value (vintage of the quota), with farmers who have depreciated the quota asset no longer eligible for compensation.

Broad-based Compensation

A theoretical estimate of potential compensation levels is presented in figures 2 and 3. Information on supply and demand functions is used to calculate the annual quota rent as a loss that is set against the gain in producer surplus; in essence, the net loss to producers is measured by the lost rent (area *a* in figure 2) minus the gain in producer surplus or quasi-rent (area *e*). The data required to calculate the welfare areas are found in table 1. The table provides the support prices, supply prices (marginal costs of production), and the levels of milk output for the years 2010 through 2016. The price wedge is calculated simply as the difference between the support price and the marginal cost of production.

To determine the potential levels of compensation, I employ information about the elasticities of supply and demand from Carter and Mérel (2016). These authors use a derived demand elasticity for milk in Canada of –0.47 and an elasticity of supply of 1.0, although they also consider supply elasticities of 5 and 10. I construct a Monte Carlo simulation model that randomly selects elasticity values for derived demand from a uniform distribution between -0.4 and -0.6, and elasticity of supply values from a triangular distribution with a minimum value of 0.8, a mode of 1.0, and a maximum value of 10. Based on the data for each year found in table 1 and 10,000 different demand and supply elasticity combinations, I calculate the producers' welfare gains and losses in moving from SM to a free market. These are provided in table 2, where each year represents an alternative compensation scenario for the wedge between price and marginal cost.

In table 2, all values have been adjusted for inflation. The respective table columns represent the annual quota rent (essentially area $a+b$ in figure 2) and, when eliminating dairy quota in favor of free trade, the average (over 10,000 iterations) of the annual quota rent that producers lose (area *a*, which is the transfer from producers to consumers in moving from SM to a free market), the producer quasi-rent gained (area *e*), and the net loss (area *a*–*e*). The quota rent is simply the product of the last two columns in table 1, while the average net loss (lost rent plus the gain in quasi-rent) represents the potential compensable annual loss. Finally, the average values in the bottom row of table 2 represent the average of the welfare measures across the seven years.

Compensation schemes are generally based on the value of the quota. To determine the value of quota, it is necessary to discount the future stream of annual quota rents. As discussed earlier, farmers know there is a risk to buying quota and discount future quota rents at rates of 20% to 49% (Chen and Meilke 1998). Grant et al. (2014) indicate that quota purchases are depreciated within a decade. I employ two scenarios: one where welfare measures accruing to quota are depreciated over a decade, the other where they are depreciated over 15 years. Compensation measures using these two methods are compared in table 3, where annual monetary values (from table 2) are divided by the risk-adjusted discount rate and then adjusted for inflation so that values are in real 2018 Canadian dollars.

The theoretically correct measure of compensation is based on the producer loss, which is the lost quota rent minus the gain in producer surplus. The net producer loss is of most interest because this is the theoretically correct measure of the loss to producers in moving from a quota regime to free trade. The average net loss in surplus ranges from $754 million to $1.3

Table 1 Estimated Support Prices, Marginal Costs of Production, Quota Rent, and Milk Production, 2010 Through 2016

	Support price	Marginal cost	Price wedge	Production
Year		$/litre		million liters
2010	0.80665	0.52900	0.27765	7,652.49
2011	0.81825	0.54670	0.27155	7,754.69
2012	0.86866	0.57070	0.29796	7,957.57
2013	0.87636	0.63320	0.24316	7,797.67
2014	0.88850	0.64060	0.24790	7,802.88
2015	0.87574	0.62950	0.24624	8,155.38
2016	0.72817	0.62100	0.10717	8,448.85

Source: Author's calculations using data from CDC and CIDC. Support prices are from http://www.cdc-ccl.gc.ca/CDC/index-eng.php? id=3809; marginal cost data (including information on butter fat and solid non-fat component) from annual Cost of Production surveys at http://www.cdc-ccl.gc.ca/CDC/index-eng.php? link=209; and sales data from http://aimis-simia-cdic-ccil.agr.gc.ca/rp/index-eng.cfm? action=pR&pdctc=&r=235 (accessed 22 June 2018). No data are available for other years.

Table 2 Average Annual Loss in Quota Rent, Gain in Quasi-rent and Net Loss with Elimination of Supply Management in Dairy Annual Quota Rent and Losses, Gains and Net Loss with Elimination of Quota Regime, Various Scenarios (2018 millions of dollars)

Year	Quota rent	Rent lost	Surplus gain	Net loss[a]
2010	2,421.99	373.45	18.65	354.80
2011	2,332.35	346.38	17.41	328.97
2012	2,587.29	398.04	19.73	378.31
2013	2,050.49	252.61	13.59	239.02
2014	2,051.75	253.98	13.64	240.34
2015	2,106.53	263.15	14.03	249.12
2016	936.49	59.99	3.70	56.29
Average	2,069.56	278.23	14.40	263.84

Note: Author's calculations based on 10,000 iterations for each year.
[a]Based on 70,000 simulations, the maximum net loss was $457.92 million using 2012 data; the minimum loss was $32.38 million for 2016.

billion, with the largest compensable loss estimated to be $1.9 billion (2012). This contrasts with average losses in quota value that range between $5.9 billion and $10.3 billion, with a maximum potential loss of $12.9 billion (2012).

As noted in the discussion concerning figure 2, dairy producers would recover a large portion of the quota rent as quasi-rent (producer surplus) when output expands and prices fall. Indeed, based on our simulations, on average more than 85% of the quota rent is recovered through increased producer surplus. In terms of figure 2, this implies that area *a* is quite a bit smaller than area *b*. Further, producers would gain area *e*, which not surprisingly is quite small in comparison to the other areas, averaging only $14.4 million. While estimates of compensation using this approach are sensitive

Table 3 Potential Compensation from Elimination of Supply Management in Dairy, Canada, 10- and 15-year Depreciation Scenarios (2018 millions of dollars)

	Based on quota rent		Based on producer loss	
Year	**15 years**	**10 years**	**15 years**	**10 years**
2010	12,109.96	6,919.98	1,773.98	1,013.71
2011	11,661.73	6,663.85	1,644.86	939.92
2012	12,936.47	7,392.27	1,891.54	1,080.88
2013	10,252.43	5,858.53	1,195.10	682.91
2014	10,258.77	5,862.15	1,201.69	686.68
2015	10,532.64	6,018.65	1,245.62	711.78
2016	4,682.46	2,675.69	281.45	160.83
Average	10,347.78	5,913.02	1,319.18	753.82

Note: Author's calculations based on table 2, with annual values converted to total discounted values by dividing by discount rates of 20% and 35% for the 15- and 10-year depreciation scenarios.

to supply and demand elasticities (especially the latter) the range of elasticities employed are based on best available data.

The conclusion from this analysis is that if the authority wishes to compensate dairy producers for potentially reforming the dairy SM system, compensation should be based on the net loss in table 3. If the situation representing 2012 is expected to continue in the future, the level of compensation should be around $1.9 billion, but, based on average conditions over the period 2010–2016, the level of compensation should be $1.3 billion.

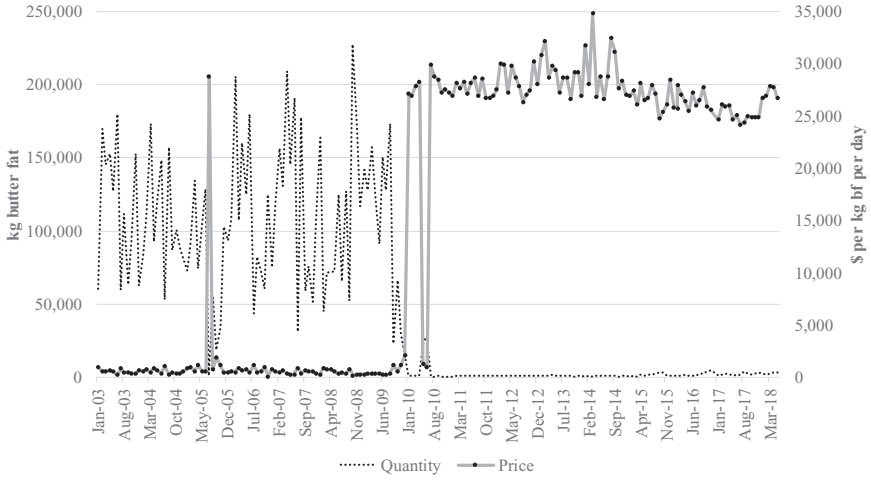
There is one caveat, however. The calculations in table 3 ignore the impact of trade—the potential of Canadian producers to lose market share to foreign competitors. This was illustrated in figure 3 where it is assumed that, after removal of supply management, the world price would be much lower than the Canadian domestic autarkic price. If this is true, then the gain in producer surplus (quasi-rent) is given by area (*gsr*) and not the larger area (*gwb*), and the measures of compensation in table 3 are too low. However, as argued by Carter and Mérel (2016), there is no reason why Canada could not be a net exporter of dairy products once SM is eliminated.

Targeted Compensation

An alternative approach to that above has been employed by Grant et al. (2014), Barichello, Cranfield, and Meilke (2009) and others. This approach uses data on quota trades to estimate the cost of a buyout (as discussed above). In this subsection, I use this "book-value" approach and quota trade data to estimate the potential cost of a quota buyout in the dairy sector. In particular, I look back at the past 185 months of available provincial trade data. I assume that those who purchased quota prior to 2003 would have more than recovered their investment. Farmers who purchased milk quota during 2003 would have collected quota rents for some 15 years, so I assume they have paid off their original investment in the quota asset. A more recent investor in quota might have received an associated rent for only a few years, while those with quota assets of an earlier vintage would have collected rents for any number of years. Further, dairy producers will be able

Figure 4 Dairy quota trading (kg bf per day) and prices ($/kg bf), monthly Canada-wide average, January 2003 to May 2018

Source: CDIC (2018).



to collect quota rents from the time a decision to dismantle SM is taken until its final implementation. All in all, limiting the quota trade data to the past 15 years seems reasonable.

Quota values in Ontario, Quebec, New Brunswick, Nova Scotia, and PEI (denoted by the CDC as P5) are currently capped at $24,000/kg of butter fat (bf) per day; in May 2018 in the four western provinces (WMP), dairy quota traded for $29,950/kg bf per day in Manitoba, $32,200 in Saskatchewan, $40,375 in Alberta, and $38,500 in British Columbia (Canadian Dairy Information Centre 2018; CDIC). Because the WMP prices are not capped but are an outcome of actual trades, they are more reflective of the true value of quota. The problem with a price cap is that farmers are reluctant to sell quota that is more valuable to them than the capped price. This in turn prevents potential buyers from expanding their operations to take advantage of economies of scale.

Even so, it is unlikely that country-wide free trade in quota could be a first step towards major reform for several reasons. First, if producers who intend to buy quota consider this to be a first step to further reform, they will delay purchasing quota in anticipation of lower prices in the future. Second, the question of compensation (or buyout) shifts from those who have long owned quota to new quota holders who purchased quota in a country-wide market and may require a higher level of compensation since they have not yet paid off the quota asset.

The prices at which quota trade in a free market are a factor in determining the compensation that dairy producers might require for them to acquiesce to sectoral reform. The monthly milk quota traded in Canada for the 15 years (185 months) from January 2003 through May 2018 is plotted in figure 4, as is the weighted average of the provincial prices for each of those months. Between the beginning of the series and the end of 2009, the price of quota exceeded $1,000/kg bf per day only nine times and only once did it spike above $20,000 (July 2005). In 2010, quota traded above $20,000 and continued to do so until the present, with the exception of two months (May

and June 2010), averaging $27,028/kg bf for the period 2010 through May 2018. In the meantime, trade averaged 106,400 kg bf per month for the first 84 months of data (2003–2009), but only 1,987 kg bf per month thereafter—the sharp break in figure 4 is indicative of this.

A closer look at provincial trading indicates the reason for the break in 2010. Prior to 2010, prices at which quota traded in the WMP exceeded those in the rest of Canada by a factor of 100. Then, for some inexplicable reason other than market forces or a change in preceptions regarding the future of the SM regime, prices in the western provinces spiked. Prior to September 2009, Alberta milk quota traded at an average weighted monthly price of $68/kg bf with monthly purchases of 49,347/kg bf; the price in Alberta jumped from $89 to over $33,215/kg bf between August and September 2009, with purchases falling from over 127,000 kg bf to only 124 kg bf. Simiarly, in BC, quota traded at a weighted average price of $88/kg bf prior to July 2010, with 50,100 kg bf traded monthly; then, over the period July 2010 through May 2018, quota traded at an average price exceeding $41,500/kg bf with only 132 kg bf traded monthly (the same was true in Saskatchewan and Manitoba). Prior to 2010, WMP markets were rather robust, but after 2010 markets tended to be rather thin. Finally, from mid-August 2008 to May 2018 milk quota rose from about 650 million liters to around 850 million liters (Canadian Dairy Commission 2018; CDC).

The simple sum of quota sales during the period 2003 through mid-2018 turns out to be $8.725 billion, which might represent an upper limit on the compensation that should be paid to dairy producers for loss of their quota benefits. To take into account the number of periods that a farmer could collect quota rent before SM reform, I first converted the nominal monthly payments for quota into real 2018 dollars. Then, I determined the number of months that a purchaser of quota would be able to collect quota rent, and subtracted the potential quota benefits from the book value of the quota (i.e., the original purchase price). In doing so, a discount rate of 20% was employed to reflect the risk that dairy producers face when they buy quota; this is a conservative rate given the range identified by Chen and Meilke (1998), and emulates a 15-year depreciation period (as $1 received after 15 years is worth only 6.5¢).

The results are provided in table 4. The total compensation package for eliminating the SM regime in dairy would amount to about $3.0 billion, representing an estimate that takes into account the risk that supply management regime may face major reform in the not-too-distant future; this is a risk that farmers knowingly undertake. Compensation is greatest for Quebec dairy producers ($1.1 billion), followed by those in Ontario ($0.9 billion), with all other producers receiving about the same ($0.9 billion).

My estimates of a buyout using exchange-traded values are similar to those of Grant et al. (2014). These authors estimate that a buyout based on total exchange-traded data for ten years would cost $5.6 billion, while I provide an estimate of $5.9 billion (table 3). Using book value and 10-year depreciation, Grant et al. estimate real 2018 buyout costs of $0.852 billion ($0.805 billion in 2014) for Ontario and $2.754 billion ($2.603 billion) for all of Canada, compared to my estimates of $0.882 billion for Ontario and $2.952 billion for Canada (table 4). The main difference is that quota prices are higher in the later years for which I have data. However, none of these measures is theoretically correct. The theoretically correct measures are

Table 4 Estimates of Annual and Total Compensation Required to Buyback Dairy Quota in Canada and Four Provinces, Risk Discount Rate of 20% (2018 millions of dollars)

Year	Canada	Ontario	Quebec	BC	Alberta	ROC[a]
2003	49.349	22.088	17.548	1.995	3.322	4.396
2004	56.190	26.127	21.099	4.080	3.052	1.831
2005	68.345	31.188	27.511	6.175	0.764	2.707
2006	93.712	38.968	36.746	8.630	3.873	5.495
2007	88.071	31.197	39.318	8.847	5.607	3.102
2008	85.769	28.239	36.330	9.453	6.535	5.211
2009	98.458	29.372	38.072	9.896	15.276	5.842
2010	74.369	15.878	21.610	3.764	16.298	16.819
2011	99.542	24.759	32.635	7.805	11.004	23.340
2012	135.658	40.559	36.137	16.157	21.518	21.287
2013	166.824	42.062	52.730	18.157	31.709	22.167
2014	179.860	54.671	38.309	36.376	25.753	24.750
2015	337.870	99.625	146.820	30.637	25.668	35.120
2016	472.937	163.174	165.360	46.043	46.018	52.341
2017	577.654	154.732	310.212	21.099	34.362	57.249
2018	367.416	79.415	128.442	86.585	21.461	0.000
Total	2,952.022	882.053	1,148.880	315.700	272.219	281.657

Source: Author's calculations.
[a]*Rest of Canada.*

found in the last two columns of table 3, and these indicate that compensation should fall between $0.754 and $1.319 billion.

Discussion and Conclusions

Supply management has been the norm in Canada's dairy sector for some 35 years. As an agricultural support mechanism, SM has been successful in stabilizing prices and supporting farm incomes at little cost to the Treasury. It has been less successful in providing low-cost food to citizens, earning foreign exchange and/or economic surplus, or driving economic growth, innovation, and employment. It has also been an obstacle in international trade negotiations and a source of economic distortion in the domestic economy. While other states that adopted SM have subsequently found it wanting and abandoned it, Canada has steadfastly supported its quota regimes. However, if SM were to be abandoned in the future, dairy producers would likely be covered under Canada's existing business risk management programs, helping them manage risks in the same way that farmers do in other sectors. Nonetheless, to facilitate a transition away from supply management, it may be necessary to provide dairy farmers with compensation.

With the exception of a few dairy producers who have benefitted from rising quota values, even farmers themselves are harmed by a dairy quota regime because they may carry unnecessary debt, have difficulty expanding output to take advantage of economies of scale, and are unable to take advantage of potentially lucrative export markets. Given how entrenched a supply managed regime can become, a major problem is devising an acceptable means of compensating dairy producers and dismantling the system. In this paper, I provided an underlying theoretical framework for

reforming supply management and estimates of the potential levels of compensation that might be required. The analysis in this study has provided a framework and related estimates that make explicit the political decisions that need to be made.

As Schmitz and his colleagues have warned (Schmitz and Schmitz 2010; Schmitz et al. 2016a, 2016b), evidence from quota buyback programs in tobacco and peanuts indicates that such programs have tended to overcompensate producers by a substantial amount. The results of the current analysis suggest that if SM is to be eliminated, one must be careful to avoid overcompensating producers. Doing so could result in undue burden on the Treasury and thus might be an unnecessary obstacle to political appetite for reform. My estimates of the required compensation are well below what was offered ($4 billion) to provide foreign exporters increased access to Canada's supply managed agricultural sectors under CETA and TPP-11.

Compensation estimates of $5.9 to $10.3 billion based on the actual sales value of quota during the past 15 years might be considered by the authority, particularly because these estimates already account for the high risk associated with the potential demise of SM, as well as the fact that many investments in quota assets have already been paid off. Nonetheless, these estimates fail to take into account the changes in quasi-rent. First, farmers do not lose their entire quota rent—a very large proportion is simply retained as producer surplus. Further, as output increases when SM is eliminated, there is an additional increase in quasi-rent, although it turns out to be relatively small. Once these adjustments are taken into account along with the risks inherent in the holding of quota, the buyout costs would fall somewhere between $0.2 and $1.9 billion, or $0.8-$1.3 billion if based on average outcomes.

Unless the authority targets payments at particular farmers (who purchased quota most recently) and/or regions (e.g., Quebec), the mechanism suggested in figure 3 might be an appropriate means for implementing compensation once its level is decided upon. Compensation could be used to provide producers with funds to expand their herds and invest in equipment to achieve greater efficiency while incentivizing dairy producers (and perhaps even certain processors) to leave the sector. If production costs are lowered, Canada could become a net exporter of dairy products, in which case the gains to the sector might well exceed the loss in quota rents. With this possibility in mind, it is important to design an efficient compensation scheme with the correct incentives. While rationalization of the dairy sector will be opposed, it has happened and continues in other agricultural sectors and countries, and is necessary if Canadian dairy farmers are to compete globally.

Acknowledgements

Subject to the qualifier that they not be held responsible for any errors of commission or ommission, the author wishes to thank Rick Barichello, Jim Vercammen, Roel Jongeneel, Michele Veeman, Andrew Schmitz, and particpants at various seminars for helpful comments, insights, and suggestions. The research was conducted as part of the author's general program of agricultural economics research related to his Canada Research Chair program; the views expressed herein and any errors and omissions are solely the author's responsibility.

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