Trade Liberalization and its Impacts on the Canadian Industrial Dairy Sector

by
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ABSTRACT

TRADE LIBERALIZATION AND ITS IMPACTS ON THE CANADIAN INDUSTRIAL DAIRY SECTOR

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Canada's participation in the Comprehensive Economic and Trade Agreement (CETA) and the Trans-Pacific Partnership negotiations may weaken the supply management policy with increased tariff rate quotas or decreased over-quota tariffs offered as trade barrier reductions. As such, negotiations could make Canada's dairy producers more susceptible to the volatility of world prices and, as a result, decrease and destabilize both prices and incomes. I investigate: 1) how CETA will impact the welfare of dairy producers and consumers and 2) how much trade liberalization is required to eliminate quota rents captured by dairy producers. Results indicate all forms of trade liberalization will decrease producer welfare moderately while increase consumer and net welfare. This increase in net welfare may be attributed to two factors: increased foreign competition driving down domestic prices and a weakened supply management policy.

For my family

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Chapter 1

Introduction

Supply management, implemented in the 1970s has generated controversy between protectionism and free trade policies which have been widely discussed in the economic literature (Meilke, Sarker, and Roy, 1998; Larivière and Meilke, 1999; Abbassi, Bonroy, and Gervais, 2008; Barichello, Cranfield, and Meilke, 2009; Rude and An, 2013). Supply management, being a protectionist policy, has insulated Canadian dairy producers (and processors) from free trade characterized by foreign competition, volatile prices, uncertain supplies and fluctuating revenues (CDC, 2014). Meanwhile, both economic theory and empirical literature has suggested that this policy is economically inefficient (Rafajlovic and Cardwell, 2013; Rude and An, 2013). Despite its criticisms and external pressures from trade agreements (for example, the Uruguay Round), supply management is still in effect today. As Canada seeks to liberalize trade, through participating in regional trade agreements, Canada is once again under pressure leaving the fate of supply management unknown.

Constant pressure from international sources is beginning to destabilize supply management within the Canadian dairy industry. The conclusion of a regional trade agreement between Canada and the European Union (EU) — the Comprehensive Economic and Trade Agreement (CETA) and

Canada's involvement with the Trans-Pacific Partnership (TPP) agreement have stirred up some concern among the Canadian dairy community. The countries involved present significant threats to the Canadian dairy industry as Canada has long operated under the protection of the supply management system. The TPP may present opportunities for Canada to expand export markets, however, major dairy producing nations are pushing for further access into Canada's dairy market.

1.1 Economic Problem

Current political positions claim to hold a strong stance in maintaining the supply management program, while the current Harper administration is ready to sign the TPP. These mixed messages present some uncertainty to Canadian dairy producers and organizations (e.g. Canadian Dairy Commission, Dairy Farmers of Canada, Dairy Farmers of Ontario) who have been reliant on and protected by the supply management system for over forty years. Although, there is a possibility that the TPP will not impact supply-managed industries, the probability of this outcome is low with existing external pressures. Canada's trading partners have already deregulated their dairy industries (e.g. Australia and New Zealand), are beginning to reform their own dairy policies (e.g. the EU) or have reduced their support levels to some extent (e.g. the United States). Furthermore, these countries have vocalized their interest in accessing Canada's dairy industry. With increased access, the supply management policy may begin to weaken and dairy producers will once again become vulnerable to decreased welfare and world price volatility.

1.2 Economic Research Problem

These current events have motivated my research questions: 1) How will CETA impact the Canadian dairy industry? 2) How much trade liberalization is necessary to eliminate quota rents under the supply management regime? To answer my research questions, I construct a partial equilibrium model (drawn heavily from Rude and An (2013)) of the Canadian dairy industry. I impose three trade scenarios onto the model that 1) mirror CETA 2) increase tariff rate quotas until quota rents are eliminated and 3) decrease over-quota tariffs until quota rents are eliminated.

Past studies (e.g. Meilke, Sarker, and Roy (1998); Larivière and Meilke (1999); Abbassi, Bonroy, and Gervais (2008); Rude and An (2013)) have used partial equilibrium models to describe the Canadian dairy industry and have imposed shocks onto these models. Overall, these studies demonstrated significant decreases in producer welfare and quota rents with the introduction of increased imports. Meilke, Sarker, and Roy (1998) investigate the effect of free trade of milk and dairy products between Canada and the US. Their results suggest that complete liberalization would be accompanied by large welfare losses (-47.9%) for dairy producers who currently own quota (licenses to produce milk). Larivière and Meilke (1999) extend the partial equilibrium model to analyze the potential outcomes of reforms on the Canadian, EU-15 and US dairy industries. Although free trade offers Canada potential to grow in many sectors, milk producers lose a substantial amount of economic rent. Abbassi, Bonroy, and Gervais (2008) simulate various trade liberalization scenarios on the Canadian dairy industry. Their results suggest that producer welfare will decrease considerably in all trade scenarios. Rude and An (2013) also examine the Canadian dairy industry in light of the TPP. By decreasing over-quota tariffs by 40% and 70%, producer surplus decreases by 9.23% and 6.86% on average.

The economic impact of CETA is currently unknown thereby investigating its implications on the Canadian dairy industry may reduce the level of uncertainty for Canadian dairy producers and organizations. Furthermore, understanding the degree of trade liberalization required to eliminate producer quota rents may inform organizations on the limits of supply management (with respect to its goal of increasing dairy producer income) and allow them to plan future programs that may mitigate potential producer welfare loss.

1.3 Thesis Outline

The development of my analysis follows sequential steps with each chapter forming a building block for my conclusion. The background for my analysis in Chapter 2 provides an overview of relevant policies influencing the Canadian dairy industry. Chapter 3 presents the conceptual framework describing the methods of trade liberalization. This is followed by Chapter 4 which explains the construction of the partial equilibrium model, the simulations imposed and the data used. Chapter 5 reports the findings from the different scenarios and provides results from sensitivity analyses. Chapter 6 concludes my thesis providing an overall summary, policy implications, limitations and directions for future research.

Chapter 2

Policy Review

This chapter discusses the three-pillared Canadian supply management system and Canada's current regional trade agreements. This is followed by case studies which illustrate the changing political climate and industry perspectives within dairy sectors across the world which are now exacerbating tensions regarding Canada's supply management policy. More specifically, I explain policy reforms that have taken place in the European Union, Australia, New Zealand and the United States. With relatively deregulated dairy industries (in comparison to Canada), these countries are seeking to expand their dairy export market. Canada's trade partners recognize the potential for expansion, particularly if Canada's supply management policy was lifted, and placing pressure on Canada to reform its own dairy policies.

2.1 Supply Management

Supply management was a policy implemented in the early 1970's to increase and stabilize producer income. The policy's efficacy and existence depends on three interdependent pillars—-

producer pricing, production discipline and import control—-where weakness in one pillar might weaken the system as a whole. My thesis demonstrates the erosion of import controls and how that impacts the producer pricing pillar.

2.1.1 Pricing

The first pillar, producer pricing, is built upon the support prices of butter and skim milk powder set annually by the Canadian Dairy Commission (CDC). In determining the support prices, the CDC uses a national formula which equally weighs the consumer price index and national cost of production (COP). The CDC also takes into consideration arguments from stakeholders and profit margins of processors (DFO, 2014; CDC, 2014). Provincial marketing boards then use these support prices as a baseline to determine the prices paid by processors to producers for raw milk. These prices vary depending on end use due to different compositions and required milk ingredients for each product. From the raw milk sales, the CDC then determines a blend price (price received by producers) for each regional milk pool which reflects the weighted average of the revenue received from the different dairy products. Processors will then consider their own COP and sell processed dairy products to retailers at a higher price, after which retailers account for their COP and sell their dairy products to consumers at a retail price.

2.1.2 Production

The production discipline pillar limits the overproduction of raw milk and, in doing so, equates the amount of milk produced to the expected demand. This is often referred to as the milk production quota which includes allocation to individual producers. In achieving this goal, the

Canadian Milk Supply Management Committee (CMSMC) sets a milk production target by using potential wholesale prices of dairy products to find the expected demand. The CMSMC then distributes market sharing quotas (MSQs) (licences to produce one kilogram of butterfat per day per unit of quota) among provinces based on historical production which adjust annually. Provincial marketing boards then allocate the MSQs among producers. If dairy producers want to buy or sell their MSQs, a provincial quota exchange is available to them. MSQs are generally sold at high prices restricting entry. Furthermore, MSQs are lucrative and provides profits that are known as economic quota rent.

2.1.3 Import Control

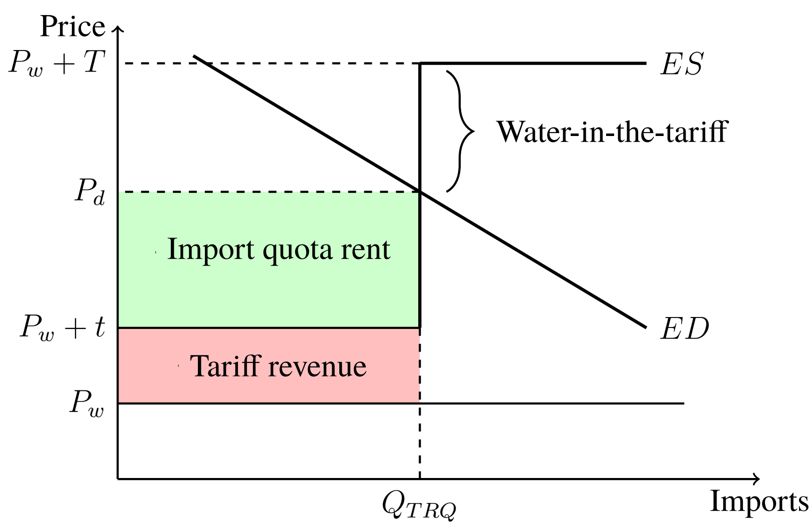

Figure 2.1: Tariff rate quota

Import control is the last pillar of supply management and the focus of this thesis. The control instrument used is a tariff-rate quota which is a two-part tariff, illustrated in Figure 2.1. The lower (in-quota) tariff is applied to imports up to the tariff-rate quota (TRQ), thereafter, a higher (over-quota) tariff is imposed. As shown in Figure 2.1, the excess supply curve is denoted by ES and consists of three components: the in-quota tariff (t), the tariff rate quota (Q_{TRQ}), and the over-quota tariff (T). As imports enter below Q_{TRQ}, t is added to the world price (P_w) of imports. When the amount of imports exceeds the Q_{TRQ}, an over-quota tariff of T is instead applied.

In Canada, the over-quota tariffs for dairy products unable to compete in world markets are set at prohibitive levels insulating Canadian dairy producers from foreign competition and world price volatility. The exorbitantly high over-quota tariffs create redundant protection and thereby water-in-the-tariff, indicated by the price wedge between $P_w + T$ and P_d in Figure 2.1. Since the water-in-the-tariff acts as a buffer for domestic prices, it must first be diminished before world prices influence the Canadian market.

2.2 Current Trade Agreements

As Canada continues to seek liberalization of trade by participating in regional trade agreements, the protection that supply management offers to dairy producers may potentially weaken. The Comprehensive Economic and Trade Agreement (CETA) and the Trans-Pacific Partnership (TPP) are recent agreements that are of main concern to the Canadian dairy industry due to the involvement of major dairy producing nations, namely Australia, New Zealand, the European Union (EU) and the United States (US). Trade negotiations with these countries may lead to substantial decreases in trade barriers, via increased TRQs or decreased over-quota tariffs, enabling Canada's trade partners to penetrate the domestic dairy market.

2.2.1 Comprehensive Economic and Trade Agreement

With negotiations concluded in April 2014, CETA (a trade agreement between Canada and the EU) is pending ratification. This agreement is thought to be more ambitious than the North American Free Trade Agreement as 98% of the EU's tariff lines and 98.4% of Canada's tariff lines will be immediately eliminated when implemented (DFATD, 2013). After seven years of enforcement, 99% of the EU's and 98.8% of Canada's tariffs, will be duty-free. For the dairy industry, this will mean an increase in the EU cheese TRQ by 17,700 tonnes[1] (DFATD, 2013). In addition, tariffs on milk protein substance will be phased out with this agreement. Other than cheese and milk protein substance, the protection for the remaining dairy products will remain untouched.

2.2.2 Trans-Pacific Partnership

In late 2012, Canada joined the TPP negotiations involving 12 countries–Australia, Brunei, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore, the US and Vietnam (DFATD, 2012). With many burgeoning countries participating, Canada is presented with an opportunity to open and diversify its markets for export. Conversely, this exclusive access requires Canada to offer equivalent substantial concessions. Major partners, namely Australia, New Zealand and the US, have expressed their interest in accessing Canada's supply-managed sectors which raises concerns and uncertainty for the Canadian dairy industry. Canada currently holds a strong position on maintaining its supply management system, but given that major trading partners have weakened and eliminated protection in their own dairy industries, Canada's participation in TPP may rest

[1] 16,000 tonnes of new market access, 1,700 tonnes for industrial use and 800 tonnes of existing World Trade Organization (WTO) TRQ which will be allocated to the EU

upon its decision to preserve, adjust or dismantle supply management.

The uncertainty of TPP has led some to question the sustainability of supply management despite surviving through the Uruguay Round. How much pressure can the current supply management policy withstand before quota rents (additional economic benefit producers receive from selling raw milk) are completely eliminated from the Canadian dairy industry?

2.3 Reforms in Agriculture Policy

Until recently dairy sectors across the world were heavily protected by their respective governments. Now, these sectors are in a period of reformation. Both external pressures from regional trade agreements and internal pressures from industry stakeholders have stressed to governments the importance of deregulation in their respective industries. The following case studies illustrate these changing policy environments, evolving perspectives of the global dairy industry, and government responses to these changes.

2.3.1 European Union

Since 1984, the EU used similar policy measures as Canada's three-pillard system to protect their dairy industry which involved market intervention (a quota system much like Canada's), rules concerning marketing and production, and trade with third countries (EC, 2015). However, as a reflection of opinions from some EU member states coupled with a response to growing global demand for dairy products, this policy framework was recently restructured. A five-year plan was instituted by the EU to increase the amount of quota by at least 1% each year starting in 2009 and ending in 2014 leading up to the abolition of the quota regime in April 2015 (EC, 2015).

Tensions about the quota system began during the 2003 Midterm Review of the Common Agricultural Policy when Italy, Denmark, Sweden and the United Kingdom (UK) pushed for its termination. The primary reason was because the policy hindered their access to growing export markets (Harvey and Colman, 2003; Binfield, Donnellan, and Hanrahan, 2008). This internal pressure for reform did not succeed until three years later when the EU Commission evaluated the quota system and saw no prospect of continuing it (Binfield et al., 2008). Nations producing the majority of Europe's milk (Germany, France, the UK, the Netherlands, Italy and Poland) are now expected to expand and increase production. With CETA negotiations concluded in August 2014, the eradication of quota comes at an opportune time for these member states.

2.3.2 Australia

Australia was the first to implement a supply management policy for dairy in the 1920s lasting for eight decades until it was dismantled in 2000 as the policy increasingly impeded international trade. Similar to Canada, each state had a marketing board or a statutory marketing authority that set prices of market (fluid) milk above export parity (Edwards, 2003; Harris, 2005). In order to manage the distribution of the coveted market milk premium, the statutory marketing authorities implemented one out of two distinct systems. For states producing a smaller percentage of market milk (e.g. Victoria), an 'equitable marketing' system was used which allocated the market milk premium to all producers proportionately. States producing a larger percentage of market milk (e.g. New South Wales), distributed milk quotas. For manufacturing milk (milk used for processing), policy instruments were aimed at supporting domestic prices, restricting imports, subsidizing exports and production, and restricting substitutes (Edwards, 2003). In aggregate, these policy measures led to effective assistance rates of 19% for manufacturing and 200% for market milk giving dairy the title of the most assisted and regulated industry in Australia for 1999-2000 (Edwards, 2003).

Deregulation began with Australia's pursuit for increasing international trade. The Hawke government found negotiations arduous as certain sectors, including dairy, limited concessions Australia was able to offer (Findlay, 2012). This prompted a series of reforms on agriculture legislation beginning with the Kerin plan, implemented on July 1, 1986, which ultimately decreased price supports and increased the competitiveness of processed dairy products (Edwards, 2003).[2] An announcement by the Commonwealth government followed in April 1992, bringing an end to the price support system used in manufacturing milk by June 30, 2000 (Edwards, 2003). Subsequent to that announcement was the Competition Principles Agreement in 1995, calling for a review of laws that restricted competition by 2000. The review suggested Victoria (and other states producing predominantly manufacturing milk) should eliminate protection. This, in turn, was supported by the dairy industry and state governments. The perspective of the dairy industry, particularly in Victoria, is noteworthy because producers and processors saw the potential of reduced costs and increased opportunities to expand their market with deregulation (Edwards, 2003). This pro-deregulation position was not shared by those in New South Wales and was expressed through its review. However, the Victorian review was more heavily weighted in the decision-making process given the unilateral stance for reform from both state and industry, forcing deregulation across the country (Edwards, 2003).

[2]collected an excise tax from producers to use as an export subsidy for firms exporting manufactured dairy products

2.3.3 United States

The US also has a protected dairy industry. As per the 2008 Farm Act, the US had four main dairy programs: (1) federal milk marketing orders, (2) dairy product price support program, (3) milk income loss contract and (4) the dairy export incentive program. In addition, an identical TRQ policy, shields the US dairy industry. Though there are slight differences, Canada's producer pricing pillar encompasses the first two US dairy programs which provides price and income support to producers. Income stabilization is also provided through the milk income loss contract which compensates producers when fluid milk falls below a certain threshold, while the export program distributes export subsidies (Hoskin, 2014).

The inauguration of the 2014 Farm Bill was initiated by evolving producer sentiments and was signed into law on February 7, 2014. This new bill induced a considerable amount of restructuring in US agriculture policy eliminating the four programs listed above. These past programs have been replaced with two new support programs: the margin protection program (MPP) and dairy product donation program (DPDP). Similar to an insurance program, the MPP provides payments to participating producers when a formula-based margin falls below an insured margin chosen by the producer. To participate, producers pay an administrative fee plus the premium for the selected level of protection offering producers a guaranteed profit margin (Schnepf, 2014). The objective of the second program, DPDP, is to decrease oversupply and provide nutrient assistance for low-income groups. If the formula-based margin falls below a predetermined level, the United States Department of Agriculture has the authority to acquire and allot dairy products to low-income parties. This occurs for 3 months or until US prices are well above world prices (Schnepf, 2014). Although these restructured programs do not completely deregulate the dairy industry, they reflect the changing industry perspective which are leaned towards supporting deregulation.

2.3.4 New Zealand

Unlike the aforementioned countries, New Zealand has had minimal protection on their dairy sector since 1871. There was a short period of time where New Zealand did provide assistance to its dairy producers around 1973. The New Zealand Dairy Board wanted to diversify their markets and boost exports, and in doing so, the government introduced export subsidies (Findlay, 2012). These supports for agricultural exports were, however, short-lived and endured until 1984 when they were put to an end by politicians and most notably by producers. Producer groups were among the first to advocate for its elimination recognizing that these supports were distorting markets and suppressing opportunities (Sayre, 2003; Findlay, 2012). The lack of regulation combined with consistent marketing and distribution has allowed the dairy industry to become New Zealand's largest export market where 95% of its dairy is produced for exports (Findlay, 2012).

2.4 Canada's Current Position

Common among these case studies is how deregulation emerges–the opinion of the industry was critical in changing governing policies in response to external pressures (predominantly trade-related). Unlike the case studies mentioned, the internal pressures are inadequate to initiate reforms in the Canadian dairy industry at this time and regardless of existing external pressures, Canada upholds its unrelenting support for supply management. As it stands, Canada's current market conditions have kept dairy producer's operating under this policy satisfied.

Despite Canada's stance for supply management, the Stephen Harper administration has shown its determination in signing the TPP. While Canada has been hesitant to make final concessions concerning agriculture, its standpoint may shift knowing that the US President has recently gained executive power from the United States Senate to negotiate trade deals.

If the marketing board's position persists into the future, my thesis can shed light on how an impaired import control pillar (derived from external pressures) weakens the producer pricing pillar (through reducing Canadian industrial milk prices). More specifically, I explore possible outcomes generated by CETA and scenarios where prices are pushed down to a competitive level (while still under the constraint of supply management) in the Canadian dairy industry.

2.5 Chapter Summary

This chapter provided a review of three crucial components of the supply management policy governing the Canadian dairy sector, while the importance and details of the regional trade agreements (CETA and TPP) were also discussed. CETA and TPP have presented a trade-off to Canada. These agreements both present opportunities for Canada to gain exclusive access into new and emerging markets. Simultaneously, Canada's CETA and TPP trade partners have shown interest in weakening or eliminating Canada's supply management system. Although Canada claims to support supply management, international pressures to reform this policy are relentless and this persistence may force the Canadian government to re-evaluate and reconsider their position on supply management.

Chapter 3

Conceptual Framework

The conceptual framework presented in this chapter provides the foundation for the analysis of trade liberalization implications on the Canadian dairy industry. This model is adapted from Rude and An (2013), Abbott and Morse (2000) and Larue and Lambert (2012) and describes two methods of liberalizing trade: increasing tariff rate quotas and decreasing over-quota tariffs. Using the conceptual framework, I also demonstrate how the Canadian dairy industry and other pillars of supply management (producer pricing) is impacted by reducing trade barriers.

3.1 Methods to Reduce Trade Barriers

As noted earlier, Canada's supply management's import control pillar imposes a two-part tariff. Recall Figure 2.1, the excess supply curve restricts imports at two sections caused by the TRQ and over-quota tariffs. Minimizing these trade barriers allow increased foreign access into Canadian markets which may ultimately decrease the price of domestic milk. Approaches to reducing these barriers would be to increase TRQs or to decrease the over-quota tariffs.

3.1.1 TRQ Increase

I begin with the assumption that TRQs are filled (imports enter the market up to the TRQs) at all times. With this assumption, importers are then faced with a prohibitive over-quota tariff deterring dairy imports from exceeding the TRQ. To alleviate this constraint, increasing the TRQ would allow for additional imports to enter the Canadian market at the lower tariff rate. This assumption also implies that the current domestic supply is unable to fill domestic demand at world prices.

This is shown in Figure 3.1, where the TRQ increase causes the vertical section of the excess supply curve to shift right (from Q_{TRQ} to Q'_{TRQ}). This enables more imports to enter the domestic market at the in-quota tariff rate and the excess demand and new excess supply curve intersect at a lower price. This price is transmitted into the Canadian dairy market and lowers the domestic price (from P_d to P'_d) accordingly as cheaper imports could squeeze out domestic dairy products from the Canadian market.

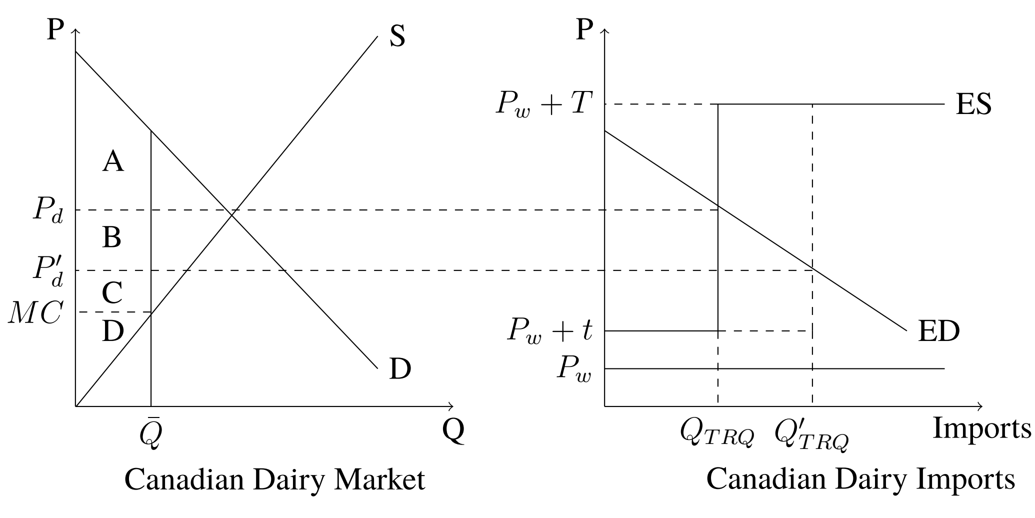

Figure 3.1: TRQ Increase

A in Figure 3.1 represents the original consumer surplus, while BCD represents the original producer surplus (with BC representing the quota rent). By introducing an increased TRQ, B is reallocated from producers to consumers. Consumer surplus increases by B while producer surplus (more specifically, quota rent) decreases by B.

3.1.2 Reducing Over-Quota Tariffs

Another approach to reducing trade barriers is to decrease the over-quota tariffs. As mentioned earlier, Canada maintains very restrictive over-quota tariffs which disincentivizes importers from importing more than the allotted TRQ. If over-quota tariffs are lowered a sufficient amount, then domestic prices may potentially decrease.

Figure 3.2 and Figure 3.3 illustrate the reduction in over-quota tariffs. As the over-quota tariffs decrease from T to T', the landed price proportionately decrease (from $P_w + T$ to $P_w + T'$). This lowers to upper horizontal portion of the excess supply curve creating a change in price. This price is again transferred to the domestic market causing a decrease in domestic price (from P_d to P'_d). This trade liberalization method is distinct from increasing the TRQ since this approach may create volatility in domestic prices (trasmitted through world price volatility). Due to the fluctuation in world prices, the less-restricted over-quota tariffs may be unable to insulate domestic prices from this volatility and exposes dairy producers to some risk with regards to their income. If world prices are relatively high, domestic prices will not be affected shown in Figure 3.2. Conversely, there may be periods where world prices drop and become relatively low, domestic prices must fall to match prevailing landed prices (seen in Figure 3.3).

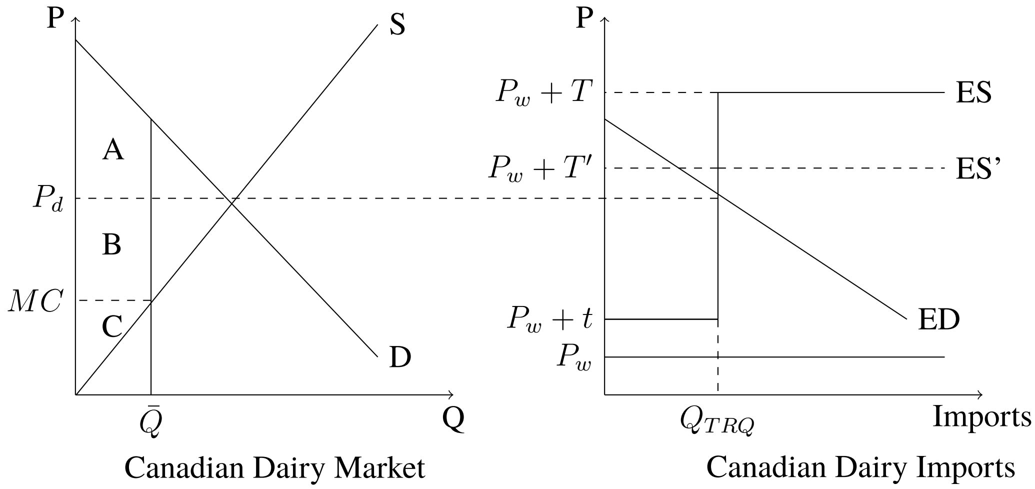

Figure 3.2: Over-Quota Tariff Reduction with Higher Landed Prices

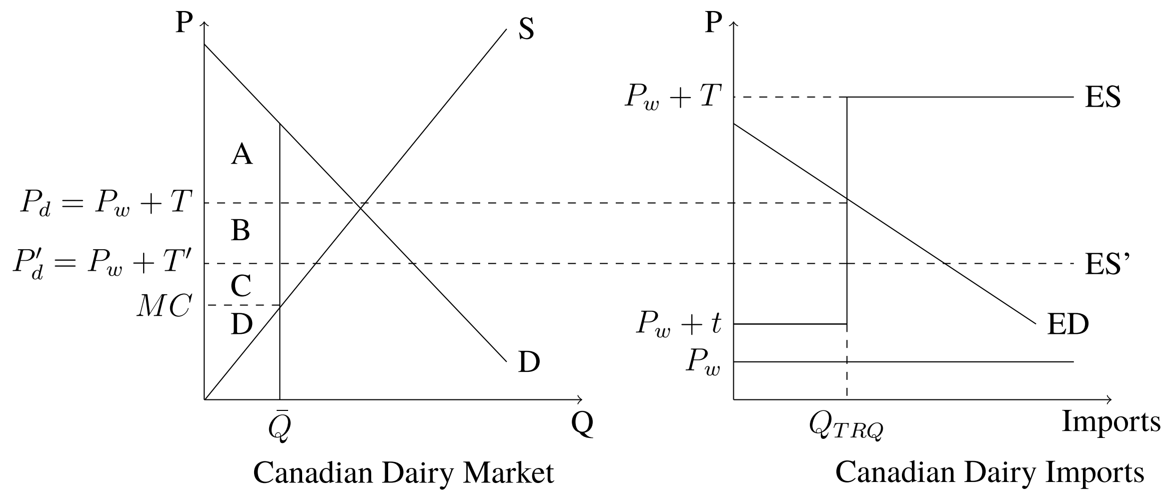

Figure 3.3: Over-Quota Tariff Reduction with Lower Landed Prices

In Figure 3.2, A denotes consumer surplus, B denotes quota rent and C represents pure producer surplus. Opposed to Figure 3.1, there is no change in welfare since the over-quota tariffs are adequate enough to shelter domestic prices. Figure 3.3, however, is similar to increasing TRQs. If the landed prices are lower relative to domestic prices, consumers experience an increase in welfare by B, while producers decrease in welfare by the same amount.

3.2 Chapter Summary

Any substantial form of trade liberalization ultimately decreases domestic prices due to increasing foreign competition. While increasing the TRQ can provide producers with income stability, domestic prices are likely to drop. On the other hand, decreasing over-quota tariffs may not change a producer's welfare, however, the probability for exposure to domestic price volatility increases.

Despite maintaining the production discipline pillar of supply management, weakening the import control pillar simultaneously weakens the producer pricing pillar. Each of the three pillars are equally crucial components in upholding supply management. With one pillar weakened, the whole system can falter.

Chapter 4

Partial Equilibrium Model

In this chapter, I describe how I create a partial equilibrium model of the Canadian dairy industry. The data used in constructing this model is also presented in this chapter. Next, I explain the three trade scenarios imposed onto the model. This first scenario aims to emulate CETA, while the second and third scenarios reduce trade barriers by increasing TRQs or decreasing over-quota tariffs until quota rents are eliminated.

4.1 Canadian Dairy Partial Equilibrium

In creating this partial equilibrium model, I follow a similar structure as Rude and An (2013) and Larivière and Meilke (1999) and calibrate the model to 2013 data acquired from a statistical report provided by the Canadian Dairy Information Centre (2014). This model highlights two levels of production–the farm level and the wholesale level–in which five processed dairy products (cheese, butter, skim milk powder (SMP), yogurt and ice cream) are included. Table 4.11 gives a snapshot of the partial equilibrium model of the Canadian dairy industry discussed in this section while Figure 4.1 gives a graphical representation.

I first construct linear demand and supply curves at the wholesale level for the five dairy products. In finding the explicit demand and supply functions, I substitute the demand and supply elasticities along with the wholesale prices of the processed dairy products shown in Tables 4.1, 4.2, and 4.3, respectively, into the identities: $\eta \equiv D'(p) \cdot p/D(p)$ and $\epsilon \equiv S'(p) \cdot p/S(p)$, where η and ϵ denote the demand and supply elasticities, $D'(p)$ and $S'(p)$ represent the slopes for the demand and supply functions and $D(p)$ and $S(p)$ denote the demand and supply functions. Solving for $D'(p)$ and $S'(p)$, I am able to derive the linear demand and supply functions–equations 4.1 and 4.2

$$D_i = \alpha_i^d + \beta_i^d \cdot P_i \tag{4.1}$$

where:
D denotes demand for dairy product i
α_i^d denotes the constant for the demand function
β_i^d denotes the slope for the demand function and
P_i denotes the price for good i.

$$S_i = \alpha_i^s + \sum_{j=1}^{5} \beta_{ij}^s \cdot (P_i - \mu_{bf}^j \cdot P_{bf} - \mu_{snf}^j \cdot P_{snf}) \tag{4.2}$$

where:
S_i denotes the supply for dairy product i
α_i^s denotes the constant of the supply function
β_{ij}^s denotes the slope of the supply function
μ_{bf}^j and μ_{snf}^j denote the proportions of butterfat and solids-non-fat in dairy product j and
P_{bf} and P_{nfs} are the prices of butterfat and solids-non-fat respectively.

Table 4.1: Demand Elasticities

	Cheese	Butter	SMP	Yogurt	Ice Cream
Demand	-0.23	-0.4	-0.19	-0.81*	-0.62*

Source: FAPRI (2014);(Rude and An, 2013)*

Table 4.2: Supply Elasticities

	Cheese	Butter	SMP	Yogurt	Ice Cream	Raw Milk
Cheese	0.28	-0.01	-0.017			
Butter	-0.039	0.1	0.011			
SMP	-0.015	0.031	0.038			
Yogurt				0.15*		
Ice Cream					0.32*	
Raw Milk						1*

Source: (Larivière and Meilke, 1999);(Rude and An, 2013)*

Table 4.3: Wholesale Prices

	Cheese	Butter	SMP	Yogurt	Ice Cream
Price ($/t)	9720	7310	6390	3400*	3870

Source: (AAFC, 2014);(Rude and An, 2013)*

Table 4.4: Milk Component Conversion Factors

	Cheese	Butter	SMP	Yogurt	Ice Cream	Raw Milk
Butterfat (kg/kg)	0.303*	0.816	0.003	0.025	0.120	3.6
Solids-non-fat (kg/kg)	0.816*	0.126	0.973	0.110	0.105	8.52

Source:(Rude and An, 2013); (USDA-ERS, 1992);calibrated to residual component supply*

The supply functions are dependent on their respective prices, milk component prices (butterfat and solids-non-fat) and prices of the other products, with the exception of yogurt and ice cream.[1] Including these cross-price effects in the supply function characterizes processors' ability to allocate raw milk such that profit is maximized. Thus a shock to the model may result in processors increasing the production of dairy products that return higher profit margins, while lowering the

[1]The cross-effects of yogurt and ice cream should have a minuscule effect and are thereby omitted for simplicity (Rude and An, 2013).

production of other dairy products.

Table 4.5: Beginning and Ending Stocks

	Cheese	Butter	SMP	Yogurt	Ice Cream
Beginning stock (t)	59110	13330	32760	0	0
Ending stock (t)	55640	13320	24970	0	0

Source: (CDIC, 2013)

Using the supply and demand equations and the beginning and ending stocks shown in Table 4.5, net imports are derived from a market clearing identity (equation 4.3) seen below:

$$S_i + Bstk_i + imports_i \equiv D_i + Estk_i + exports_i \tag{4.3}$$

where
S_i and D_i denote the supply and demand of dairy product i
$Bstk_i$ and $Estk_i$ denote beginning and ending stocks of dairy product i
$imports_i$ and $exports_i$ denote imports and exports of dairy product i

The supply functions of dairy products also make up the demand of milk and its components which are solved simultaneously with the supply of processed goods. Once the demand for milk and its components is established, the marketing board will match the supply of milk accordingly through the market clearing identities in equation 4.4 and 4.5. The prices of butterfat and solids-non-fat are recovered in the process,

$$shr_{bf} \cdot x^{milk} \equiv \sum_{j=1}^{5} \mu_{bf}^{j} \cdot S_j \tag{4.4}$$

$$shr_{snf} \cdot x^{milk} \equiv \sum_{j=1}^{5} \mu_{snf}^{j} \cdot S_j + import_{snf} \tag{4.5}$$

where
shr_{bf} and shr_{snf} denote proportions of butterfat and solids-non-fat in milk
x^{milk} denote the supply of milk
μ^j_{bf} and μ^j_{snf} denote proportions of butterfat and solids-non-fat in j
S_j represents the supply of dairy product j
$import_{snf}$ represents solids-non-fat imports.

As a note, I have made a minor modification to Rude and An's (2013) model by adding solids-non-fat imports in the supply (right-hand) side of equation 4.5. In the past, supply management has focused primarily on meeting butterfat demand. This is exemplified through the quota license which is allocated on the basis of butterfat produced per day. However, solids-non-fat have gradually increased the structural surplus to an amount that is bringing forth attention and urgency. Furthermore, processors are also replacing domestic solids-non-fat with cheaper, imported solids-non-fat and CETA aggravates this issue even further by eliminating trade restrictions on solids-non-fat coming from the EU. The addition I made acknowledges this issue but should be extended further so solids-non-fat imports are endogenous within the model to address this forthcoming issue in depth.

Using the prices of butterfat and solids-non-fat, I am able to establish the blend price, or in other words, the price producers receive for their raw milk based on its composition,

$$P^{blend} = shr_{bf} \cdot p_{bf} + shr_{snf} \cdot p_{snf} \tag{4.6}$$

where
P^{blend} denotes the blend price
shr_{bf} and shr_{snf} denote proportions of butterfat and solids-non-fat in milk
p_{bf} and p_{snf} denote the prices of butterfat and solids-non-fat.

Although the milk supply function is unobservable with the supply management policy, it is still derivable. It is assumed that the supply of milk is produced at suboptimal levels creating a divergence in blend price and marginal cost. This difference represents quota prices or the present value of anticipated net income of an extra unit of production (Romain and Sumner, 2001). Knowing this, I can obtain the marginal cost indirectly,

$$p^{mc} = P^{blend} - Q_{rent} \tag{4.7}$$

where
p^{mc} denotes marginal cost
P^{blend} denotes the blend price and
Q_{rent} denotes the quota rent.

Quota rent is obtained through a modified Capital Asset Pricing Model provided by Rude and An (2013): $QV = (p^{blend} - mc)/\delta$ where QV denotes the quota value and δ denotes the producer's discount rate. The discount rate considers the common lending rate for producers interested in purchasing quota (Cairns and Meilke, 2012) (prime plus 2%), a policy risk factor (as recommended by Barichello (1996)), and the quota value growth rate. Altogether, the discount rate of 10% is used with a growth rate and policy risk of 1% and 7%, respectively, which is similar with past studies (Rude and An, 2013; Cairns and Meilke, 2012).

Finally, with marginal cost accounted for in equation 4.7, I am able derive the milk supply function at the farm level:

$$x^{milk} = \kappa + \gamma \cdot p^{mc} \tag{4.8}$$

where
x^{milk} denotes the supply of milk
κ denotes the intercept of the milk supply and

γ denotes the slope of the milk supply equation.

The milk supply function in equation 4.8 is used when TRQs are the binding constraints on domestic prices. Conversely, when the over-quota tariffs are binding, there is a risk factor caused by world price volatility that must be taken into consideration. As a result, the milk supply function in equation 4.9 includes a risk coefficient which will be used when the over-quota tariffs dominate in this model in order to account for this risk factor.

$$x^{milk} = \kappa + \gamma \cdot p^{mc} / (1 + \theta \cdot \gamma \cdot \sigma_p^2) \tag{4.9}$$

where
θ denotes the absolute risk aversion coefficient and
σ_p^2 denotes the variance of unregulated milk prices.

4.2 Simulations

After calibrating the model, I impose shocks onto the model. The first simulations mirrors CETA. In the second and third simulations, I gradually reduce trade barriers (by increasing TRQs or decreasing over-quota tariffs) to the point where quota rent dissipates. In the instance of a shock, this dynamic model is constructed to conform conjointly as the two levels of production are interrelated through prices which is illustrated in Figure 4.1.

It is commonly assumed that a firm's objective is to maximize profits, but in the case of the Canadian dairy marketing board, this may not necessarily hold true. The marketing board may pursue a non-economic objective, or rather, the marketing board may either wish to preserve quota value, milk supply, or prices (while individuals producers may have an economic objective)

(Gervais and Rude, 2003). I begin my simulations by assuming the marketing board's objective is to ensure the stability of the supply management policy by keeping milk supply constant.

As previously mentioned, I assume that the TRQs are filled at 100% throughout the scenarios. This is done for simplicity despite being a strong assumption (refer to Table 4.6).

Table 4.6: 2013 TRQs and TRQ Fill Rates

	Cheese	Butter	SMP	Yogurt	Ice Cream
Imports (t)	23,990	6,380	2,770	720	1,060
TRQ (t)*	20,411.9	3,274	4,345	332	484
TRQ Fill Rate (%)	118	195	64	217	219

Source: (CDIC, 2013); (DFATD, 2014)*

4.2.1 CETA

The first simulation emulates CETA. The proposed changes in CETA will impact the cheese and milk protein substance sector allowing an extra 17,700 tonnes of cheese to enter Canada without over-quota tariffs while ridding duties and tariffs from EU-imported milk protein substances (DFATD, 2013).

For simulations that increase the TRQ, such as CETA, imports are exogenous (Table 4.7 shows dairy imports for 2013). This type of tariff liberalization allows more imported goods into the Canadian market at the in-quota tariff rate (in the CETA scenario, I increase cheese imports by 17,700 tonnes) thereby creating a more competitive environment as domestic prices are forced downwards. The domestic price change will then set in motion other changes in the dairy industry beginning at the wholesale level.

The changes made in this model may be larger than in reality due to the substitutabilty of

EU cheeses. Increased cheese access from the EU are primarily for specialty cheeses. Although domestic cheese demand may increase, it may only increase for specialty cheeses. If EU specialty cheeses are not substitutable with domestic producers, Canadian cheeses will not be displaced by increased imports instituted by CETA.

Table 4.7: 2013 Canadian Dairy Net Imports

	Cheese	Butter	SMP	Yogurt	Ice Cream
Net Imports (t)	14,760	2,830	-9,890	-5,340	660

Source: (CDIC, 2013)

4.2.2 Eliminating Quota Rents

These next two simulations are motivated by the uncertainty of the TPP negotiations. Despite speculations on whether TPP will disrupt the current system of supply management, the outcome is still unknown at this time. Considering TPP's uncertainty and Canada's persistence on maintaining supply management, I set price equal to marginal cost in these simulations to indicate that quota rents are eliminated. Instead of increasing imports or decreasing over-quota tariffs at a set rate, I gradually increase (decrease) imports (over-quota tariffs) to the point where quota rents equal zero, indicating the ineffectiveness of supply management[2]. As mentioned in Chapter 3, there are two approaches to reduce trade barriers: increasing TRQ and decreasing over-quota tariffs.

By increasing TRQs, the model behaves similarly in the CETA simulation. For simulations that reduce the over-quota tariff, prices are set exogenously. As the current over-quota tariffs (shown in Table 4.8) decrease, the water-in-the-tariff gradually diminishes becoming insufficient to buffer

[2] An objective of supply management is to increase income and income stability. With domestic prices lowered and/or more vulnerable to world price volatility, supply management's objective is not achieved.

Table 4.8: 2013 Canadian Dairy Tariffs

	Cheese	Butter	SMP	Yogurt	Ice Cream
Tariffs (%)	245.5	298.5	208	237.5	243

Source: (WTO,2015)

the price shock. Domestic prices then become vulnerable to world price volatility, consequently weakening supply management. In the absence of water-in-the-tariff, Canadian prices must fall to match prevailing world prices plus the new over-quota tariffs to remain competitive in the Canadian market. In the over-quota simulations, the variability of world prices will be represented by 1000 samples taken from a joint normal distribution with the dairy world price averages shown in Table 4.9 and de-trended world dairy price variance-covariance matrix shown in Table 4.10. As domestic prices fluctuate, other variables within the model will also adjust according to prices.

Table 4.9: Average World Dairy Prices

$Cdn/tonne	Cheese	Butter	SMP	Yogurt	Ice Cream
World Price	3891	3310	3940	3624*	3064

Source: (AAFC, 2014); (USDA-FAS, 2015)*

Table 4.10: Variance-Covariance Matrix of World Dairy Prices

	Cheese	Butter	SMP	Yogurt	Ice Cream
Cheese	897,072				
Butter	1,094,264	1,600,933			
SMP	676,829	826,207	627,771		
Yogurt	374,461	472,083	291,240	379,784	
Ice Cream	442,703	571,025	327,662	233,625	260,321

Source: (CDIC, 2014); (USDA-FAS, 2015); (Rude and An, 2013)

4.3 Chapter Summary

This chapter introduced and described the variables and equations used to construct the partial equilibrium model that is interconnected through prices. I first create the markets for the cheese, butter, skim milk powder, yogurt and ice cream sectors at the wholesale level. Through market clearing conditions and prices, I am able to construct the milk market at the farm level. Once the model is constructed and calibrated to 2013 data shown in the chapter, I impose three trade scenarios.

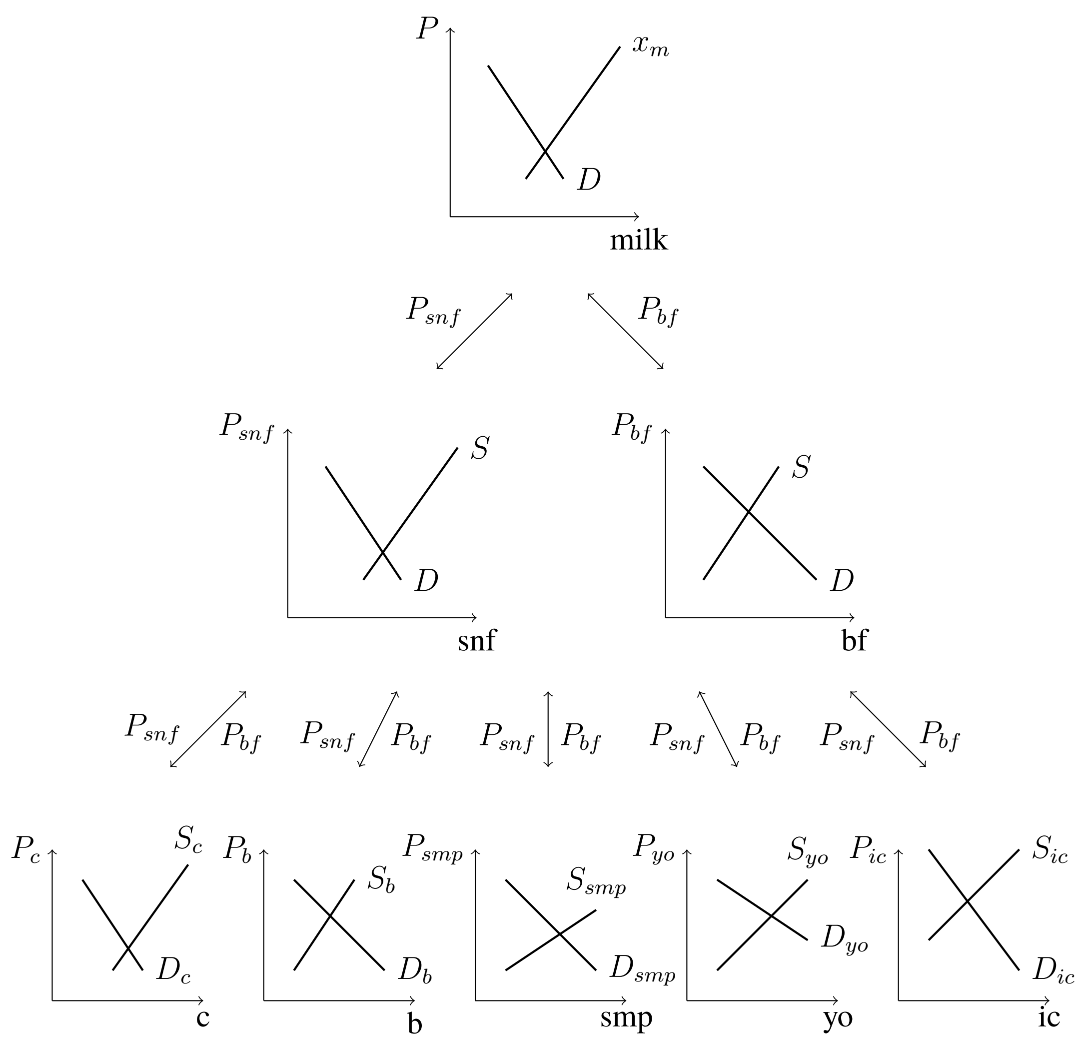

Figure 4.1: Canadian Dairy Partial Equilibrium Model

Wholesale level	
Demand	$D_i = \alpha_i^d + \beta_i^d \cdot P_i$
Supply	$S_i = \alpha_i^s + \sum_{j=1}^{5} \beta_{ij}^s \cdot (P_i - \mu_{bf}^j \cdot P_{bf} - \mu_{snf}^j \cdot P_{snf})$
Market clearing conditions	
Wholesale	$S_i + Bstk_i + imports_i \equiv D_i + Estk_i + exports_i$
Butterfat	$shr_{bf} \cdot x^{milk} \equiv \sum_{j=1}^{5} \mu_{bf}^j \cdot S_j$
Solids-non-fat	$shr_{snf} \cdot x^{milk} + imports_{snf} \equiv \sum_{j=1}^{5} \mu_{snf}^j \cdot S_j$
Farm level	
Blend price	$P^{blend} = shr_{bf} \cdot p_{bf} + shr_{snf} \cdot p_{snf}$
Marginal cost	$p^{mc} = P^{blend} - Q_{rent}$
Milk supply	$x^{milk} = \kappa + \gamma \cdot p^{mc}$
Milk supply with risk coefficient	$x^{milk} = \kappa + \gamma \cdot p^{mc} / (1 + \psi \cdot \gamma \cdot \sigma_p^2)$

Source: (Rude and An, 2013; Larivière and Meilke, 1999)

Table 4.11: Canadian Dairy Partial Equilibrium Model

Chapter 5

Simulation Results

In this chapter, I present the results from the simulations imposed on the partial equilibrium model. A discussion of these results follow, which includes the implication of these results and potential policy prescriptions. Since supply and demand elasticities are major drivers of my results, I conduct a sensitivity analysis. The sensitivity analysis suggests the results are quite sensitive to both supply and demand elasticities.

5.1 Partial Equilibrium Model

5.1.1 CETA

Results from the simulations performed on the partial equilibrium model are presented in Table 5.1. The first simulation is meant to mimic CETA—an agreement that would increase cheese net imports by 125% (17,700 tonnes). Imposing this agreement leads to a decrease in price in all five dairy products and two milk ingredients. Prices of cheese, skim milk powder and solids-non-fat drop dramatically decreasing by 14%, 28% and 26% respectively. The influx of European cheese entering the Canadian market creates increased competition within the domestic cheese sector and is transmitted to others. As processors notice a price decrease, they reallocate their raw milk into processed products that would give them a higher profit margin. In this case, the majority of raw milk is transferred into skim milk powder (resulting in a 5% increase in production). With the net imports kept constant, with the exception of cheese, the increased supply for these products lower prices. In response to reduced prices, demand for these dairy products increase as expected.

Consumers will benefit from this trade agreement with a 2% increase in consumer surplus as they take advantage of more cheese and skim milk powder at a lower price. Additionally, CETA reduces producer welfare by 1%. This can be attributed to increased European competition coupled with marketing board constraints (maintaining a constant supply of milk). Producers may naturally respond to CETA by producing more raw milk, however, barriers[1] prevent producers from remaining profitable in a competitive environment. There is a slight increase in overall welfare (2%) because consumers will gain more than what producers lose. This is a similar result to Rude and An (2013) despite the conditions imposed on the model.[2]

5.1.2 TRQ Increase

My results show that a 127.8% increase in TRQ and a 73.6% over-quota tariff decrease are the thresholds for eliminating quota rents.

Despite additional imports entering the Canadian market, there are slight increases in domestic production (with the exclusion of cheese). One would expect domestic supply to decrease, with lower prices. However, given the constraint of producing a predetermined amount of milk each

[1]requirement of a MSQ and national limit set by the marketing board
[2]Rude and An (2013) keep quota rents constant, while I keep the supply of milk constant.

Table 5.1: Simulation Results

		CETA		Eliminating Quota Rents			
	Base	Change	% Change	TRQ Increase (127.8%)	% Change	Tariff Cut* (73.6%)	% Change*
Supply (t)							
Cheese	382,058	376,760	-1.39%	377,696	-1.14%	411,268	7.65%
Butter	92,918	94,422	1.62%	93,491	0.62%	80,068	-13.83%
Skim Milk Powder	73,858	77,544	4.99%	76,445	3.50%	48,989	-33.67%
Yogurt	291,700	294,269	0.88%	294,304	0.89%	297,208	1.89%
Ice Cream	180,345	182,865	1.40%	186,854	3.61%	193,447	7.27%
Raw milk (Mhl)	4.95	—	—	—	—	—	—
Demand (t)							
Cheese	400,288	412,690	3.10%	426,585	6.57 %	429,751	7.36%
Butter	95,758	97,262	1.57%	104,485	9.11%	107,945	12.73%
SMP	71,758	75,444	5.14%	77,885	8.54%	74,646	4.02%
Yogurt	286,360	288,929	0.90%	300,409	4.91%	286,445	0.03
Ice Cream	181,005	183,525	1.39%	187,958	3.84%	181,894	0.49%
Price ($/t)							
Cheese	9,720	8,411	-13.47%	6,944	-28.56%	6,609	-32.00%
Butter	7,310	7,023	-3.93%	5,645	-22.78%	4,984	-31.82%
SMP	6,390	4,662	-27.04%	3,518	-44.94%	5,036	-21.18%
Yogurt	3,400	3,362	-1.11%	3,194	-6.06%	3,399	-0.04
Ice Cream	3,870	3,783	-2.25%	3,630	-6.20%	3,839	-0.79%
Butterfat	7,886	7,786	-1.27%	6,286	-20.29%	5,413	-31.36%
Solids-non-fat	6,648	5,009	-24.65%	3,802	-42.81%	4,370	-34.26%
Marginal cost ($/hl)	44.43	—	—	—	—	47.79	2.91%
Blend price ($/hl)	76.45	62.13	-18.73%	46.44	-39.25%	48.14	-37.03%
Net trade (t)							
Cheese	14,760	32,460	125.34%	42,924	190.81%	15,013	1.71%
Butter	2,830	—	—	10,320	264.67%	27,867	884.70%
SMP	-9,890	—	—	-6,638	-32.88%	17,867	-280.66%
Yogurt	-5,340	—	—	5,549	-203.92%	-10,763	101.55%
Ice Cream	660	—	—	1,035	56.80%	-11,553	-1,850.51%
Welfare ($ billions)							
Producer surplus	5.86	5.25	-1.04%	4.49	-23.38%	4.55	-22.35%
Consumer surplus	205.41	210.04	2.25%	218.02	6.14%	214.75	4.55%
Net welfare	211.27	215.29	1.90%	222.51	5.32%	219.30	3.80%

Source: (CDIC, 2014); "—" indicates no change; * averages from 1000 simulations year, dairy producers sell the same amount of raw milk to processors regardless of unfavourable market conditions (e.g. lower prices). This milk supply requirement ultimately increases the amount of dairy products in the Canadian market and because processors are unable to export this excess supply[3], wholesale and milk ingredient prices decrease. Cheese, butter, skim milk powder and solids-non-fat experience the largest price reduction by 29%, 23%, 45% and 43% respectively. Additionally, consumers demand more in response to lower prices.

Since the purpose of this scenario (and the next) is to diminish the quota rents, there is an 100% reduction in quota rental value. Consumer surplus increases by 6% while producer surplus drops by 23%. Together, this results in a 5% increase of net welfare. By eliminating quota rents, consumers gain more than what producers lose.

5.1.3 Over-Quota Tariff Decrease

In this scenario, wholesale prices and milk ingredient prices decline (except for yogurt) with cheese, butter, skim milk powder and solids-non-fat again decreasing the most. Domestic demand for cheese, butter, skim milk powder and ice cream respond accordingly by increasing, while the demand for yogurt does not change because the wholesale yogurt price remains the same. In terms of supply, processors reallocate their milk from butter and skim milk powder to cheese, yogurt and ice cream. Large percentage changes occurred with net imports because they were endogenous and not restricted in this scenario. Imports increased for butter and skim milk powder while cheese, yogurt and ice cream decreased in net imports (indicating an increase in exports) which coincides with the changes in supply. Processors find it profitable to decrease their production of butter and skim milk powder and using that raw milk to increase their production of cheese, yogurt and ice

[3] net imports are set exogenously in this scenario

cream for export.

Compared to the TRQ increase scenario, producer welfare decreases less on average when over-quota tariffs are reduced. This can be credited to the volatility of prices. Although there is a probability that world prices will outcompete domestic prices, there will be periods when domestic wholesale prices are more competitive given a sufficient decrease in over-quota tariffs. Producers can take advantage of the fluctuating prices, but domestic prices on average still exceed world prices which results in a 22% decrease in producer welfare. In aggregate, net welfare increases by 4% since the gains from consumer surplus (5%) are larger than the losses in producer surplus.

5.1.4 General Simulation Results

The condition I imposed (of keeping raw milk supply constant) is quite strong especially when interacting with higher domestic prices (in comparison to world prices). By keeping supply constant, raw milk may go to waste because processors may have too little or too much to produce certain dairy products (due to requirements for butterfat and solids-non-fat for each product). As a consequence, the slightest shift in the industrial dairy market may be enough to unbalance these delicate proportions. Given that domestic prices exceed international prices (refer to Tables 4.3 and 4.9), Canada is also unable to export any surplus of dairy products. Keeping in mind that processors do not necessarily decrease production (because of a raw milk quota that must be met), prices must decrease in order for the market to clear. Regardless of market conditions, producers must supply a certain amount of raw milk. As such, if prices decrease, producer surplus also decreases. In terms of consumers, they will generally benefit from a decrease in prices and that is seen throughout the scenarios.

Solids-non-fat and skim milk powder are prime examples that demonstrate how much the milk supply constraint impacts the industry. There is a considerable amount of solids-non-fat in a hectolitre of milk (8.52 kg) and in order to utilize all the solids-non-fat and extract the most profit from each hectolitre of milk, processors may increase the production of skim milk powder. While processors produce a large quantity of skim milk powder, they are unable to export, with Canadian prices too high for international markets, and as a result solids-non-fat and skim milk powder prices are driven down in my model. These results can speak to the structural surplus issue that Canada is currently facing. Currently large amounts of high-priced solids-non-fat are being displaced by cheaper imports and as a result, domestic solids-non-fat are being dumped[4]. To avoid this wastage, the market could perhaps clear if the price of solids-non-fat were lowered (suggested in my results).

Throughout the simulations, the wholesale prices of cheese, skim milk powder, solids-non-fat and, at times, butter are sensitive to changes in the model. Conversely, yogurt and ice cream wholesale prices are quite robust across the simulations. The behavior in prices may be explained by the difference between domestic and world prices. Referring back to Table 4.9, the world prices for cheese, butter and skim milk powder are 3,891$/t, 3,310 $/t, and 3,940 $/t respectively. Differences between domestic and world prices are 5,829 $/t, 4,000 $/t and 2,450$/t for cheese, butter and skim milk powder while the different between domestic yogurt and ice cream prices are -540 $/t and 806 $/t. With a wide gap between domestic and world price, the domestic price has a larger potential of decreasing compared to a dairy producer with a relatively smaller gap between its respective domestic and world price. Additionally, dairy products with a smaller gap are low

[4]Dumping solids-non-fat do not have significant consequences for Canadian dairy producers because they are paid based on the amount they are required to produce, not on market conditions, allowing them to enjoy higher quota rents and welfare. In my model, dairy producers are constrained by the blend price and the market needs to clear. Consequently, the quota rent and producer surplus for dairy producers may be considerably lower (e.g. CETA scenario) than in reality.

enough to compete with foreign goods. Thus having competitive prices may decrease its volatility.

The welfare results are also common across the three scenarios and are consistent with past studies (e.g. Rude and An (2013); Rafajlovic and Cardwell (2013)). By liberalizing trade in each scenario, producer welfare declines while consumer welfare increases. In addition, net welfare is observed to increase because the gains in consumer welfare outweigh the welfare losses experienced by producers. This result occurs because reducing trade barriers allow additional imports to enter the Canadian market. Increased imports then stimulate competition within the Canadian dairy industry and ultimately drives down domestic prices. The downwards pressure on prices reduces producer welfare meanwhile increasing consumer welfare because consumers are able to benefit from the increased imports and lower prices. Furthermore, the increase in net welfare indicates policies restricting natural market behaviours (e.g. supply management) may create some deadweight loss in the Canadian industrial dairy industry. As these protectionist policies are weakened through trade liberalization, economic actors (as a whole) in the dairy market are able to gain further benefits.

5.2 Sensitivity Analyses

Since these results are driven by elasticities, I conduct two sensitivity analyses on the supply and demand elasticities for cheese, butter and skim milk powder.

5.2.1 Supply Elasticities

In general, supply elasticities measure producers' response to prices and this response, in turn, influences producer surplus and the price producers face (particularly within a regulated industry that sets a certain market quantity). In the past, many studies borrowed estimated US supply elasticities which do not characterize the Canadian dairy market adequately due to differences in policy and structure (Meilke, Sarker, and Roy, 1998). Thus, in my thesis, I used medium-run Canadian elasticities estimated by Larivière and Meilke (1999). Further, these elasticities are also used by Rude and An (2013).

I first conduct a sensitivity analysis of the cheese, butter and skim milk powder supply elasticities. I begin with my base elasticities provided by Larivière and Meilke (1999) and shocked them by 25% and 50% in both directions. Table 5.2 presents the range of supply elasticities tested.

Table 5.2: Tested Supply Elasticities

	Cheese	Butter	SMP
-50%	0.14	0.05	0.019
-25%	0.21	0.075	0.0285
Base Elasticity	0.28	0.1	0.038
+25%	0.35	0.125	0.0475
+50%	0.42	0.15	0.057

Source: (Larivière and Meilke, 1999)

The results from this analysis is reported in Table 5.4. The blend price (which also impacts total producer surplus) seem to be the most responsive to changes in elasticities. With inelastic supply elasticities (-50% measure), the blend price decreased by 24%. Relatively elastic supply elasticities, on the other hand, result in an increase in blend price and quota rent (6.54%). Figure 5.1 illustrates the dynamics in blend price as the supply elasticities change. There is a positive relationship between the two variables so as the elasticities become more elastic, the blend price increases as well.

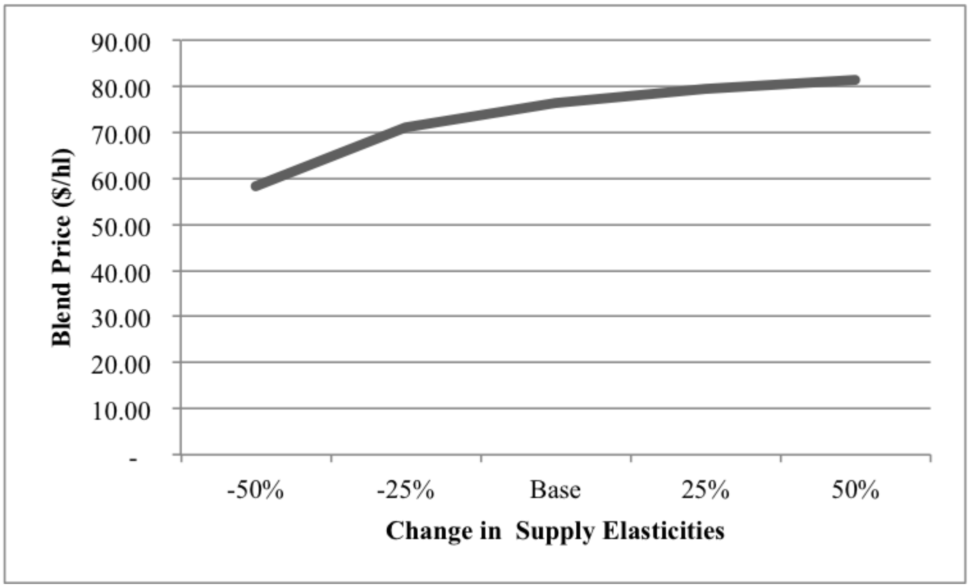

Figure 5.1: Supply Elasticities Sensitivity Analysis: Blend Price

Cheese, butter and skim milk powder prices are also sensitive to the changes in elasticities. As the elasticities increase, wholesale cheese prices decrease. Conversely, butter and skim milk powder prices increase as supply becomes more elastic. Figure 5.2 displays these changes.

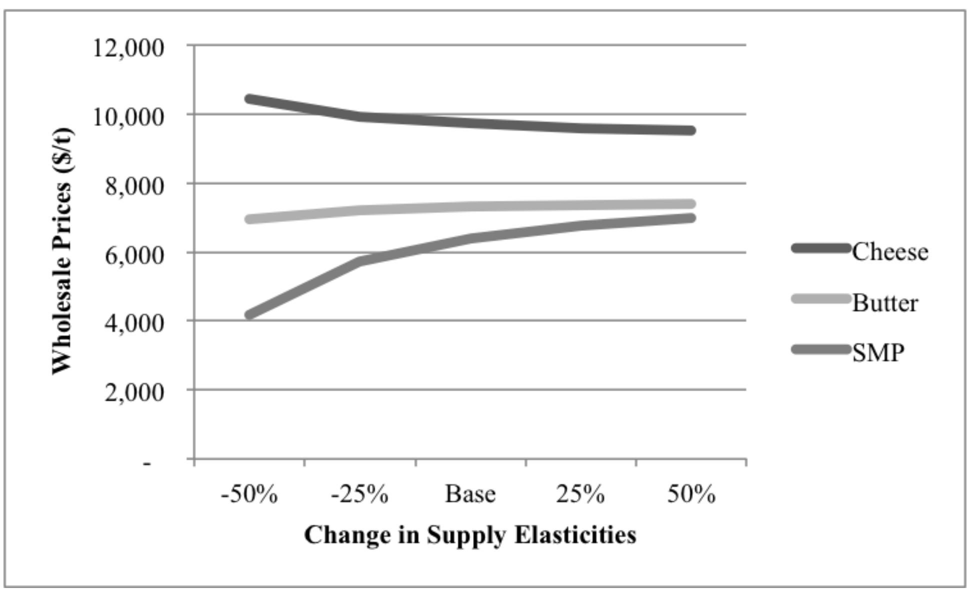

Figure 5.2: Supply Elasticities Sensitivity Analysis: Wholesale Prices

5.2.2 Demand Elasticities

Demand elasticities depict consumers' response to price changes. While there is a range of literature that provides estimated demand elasticities for Canadian industrial milk products (reported in Table 5.3), I used FAPRI (2014) elasticities. These elasticities are more recent and have been used in a recent study conducted by Rude and An (2013).

Table 5.3: Demand Elasticities

	Cheese	Butter	SMP
FAPRI (2014)	-0.23	-0.4	-0.19
Goddard and Amuah (1989)	—	-0.78	—
Moschini and Moro (1993)	-0.36	-0.3	—
Veeman and Peng (1995)	-0.66*	-1.11	—
Larivière and Meilke (1999)	-0.002	-0.2	-0.15

Source: (Meilke, Sarker, and Roy, 1998); *cheddar cheese elasticity

Table 5.4: Supply Elasticity Sensitivity Analysis

	Base	-50%	% Change	-25%	% Change	+25%	% Change	+50%	% Change
Supply (t)									
Cheese	382,058	375,279	-1.77%	380,030	-0.53%	383,183	0.29%	383,900	0.48%
Butter	92,918	94,835	2.06%	93,491	0.62%	92,600	-0.34%	92,398	-0.56%
Skim Milk Powder	73,858	78,575	6.39%	75,269	1.91%	73,076	-1.06%	72,578	-1.73%
Yogurt	291,700	294,926	1.11%	292,669	0.33%	291,158	-0.19%	290,809	-0.31%
Ice Cream	180,345	183,636	1.82%	181,329	0.55%	179,797	-0.30%	179,446	-0.50%
Raw milk (Mhl)	4.95	—	—	—	—	—	—	—	—
Demand (t)									
Cheese	400,288	393,509	-1.69%	398,260	-0.51%	401,413	0.28%	402,130	0.46%
Butter	95,758	97,675	2.00%	96,331	0.60%	95,440	-0.33%	95,238	-0.54%
SMP	71,758	76,475	6.57%	73,169	1.97%	70,976	-1.09%	70,478	-1.78%
Yogurt	286,360	289,586	1.13%	287,329	0.34%	285,818	-0.19%	285,469	-0.31%
Ice Cream	181,005	184,296	1.82%	181,989	0.54%	180,457	-0.30%	180,106	-0.50%
Price ($/t)									
Cheese	9,720	10,436	7.36%	9,934	2.20%	9,601	-1.22%	9,525	-2.00%
Butter	7,310	6,944	-5.00%	7,201	-1.50%	7,371	0.83%	7,409	1.36%
SMP	6,390	4,179	-34.60%	5,729	-10.35%	6,756	5.73%	6,990	9.39%
Yogurt	3,400	3,353	-1.39%	3,386	-0.42%	3,408	0.23%	3,413	0.38%
Ice Cream	3,870	3,757	-2.93%	3,836	-0.88%	3,889	0.49%	3,901	0.80%
Butterfat	7,886	7,664	-2.81%	7,823	-0.80%	7,919	0.42%	7,940	0.68%
Solids-non-fat	6,648	4,612	-30.63%	6,036	-9.21%	6,991	5.16%	7,212	8.48%
Marginal cost ($/hl)	46.43	—	—	—	—	—	—	—	—
Blend price ($/hl)	76.45	58.30	-23.74%	71.01	-7.12%	79.49	3.98%	81.45	6.54%
Welfare ($ billions)									
Producer surplus	5.86	5.87	0.17%	5.87	0.17%	—	—	—	—
Consumer surplus	205.41	205.37	-0.02%	205.4	—	205.42	—	205.42	—
Net welfare	211.27	211.24	0.01%	—	—	211.28	—	211.28	—

Source: (CDIC, 2014); "—" indicates no change

To ensure reasonable demand elasticities are accounted for, I conduct a sensitivity analysis decreasing and increasing the cheese, butter and skim milk powder elasticities by 10% and 20%. Table 5.5 reports the demand elasticities tested.

Table 5.5: Tested Demand Elasticities

	Cheese	Butter	SMP
-20%	-0.184	-0.32	-0.152
-10%	-0.207	-0.36	-0.171
Base Elasticity	-0.23	-0.4	-0.19
+10%	-0.253	-0.44	-0.209
+20%	-0.276	-0.48	-0.228

Source: FAPRI (2014)

The results indicate the partial equilibrium model is highly sensitive to changing demand elasticities. To elaborate, wholesale prices and the blend price more in this analysis compared to the supply elasticity sensitivity analysis. As demand becomes more inelastic, cheese, butter, skim milk powder and blend prices increase by 22%, 24%, 30% and 31% respectively under the -20% measure. A more elastic demand (20% elasticity increase) drops these prices (cheese, butter, skim milk powder and blend) by 15%, 17%, 21% and 21% respectively. Similar to findings in the supply elasticity sensitivity analysis, the model is more sensitive under inelastic demands. Figures 5.3 and 5.4 provide graphical representations of these relationships.

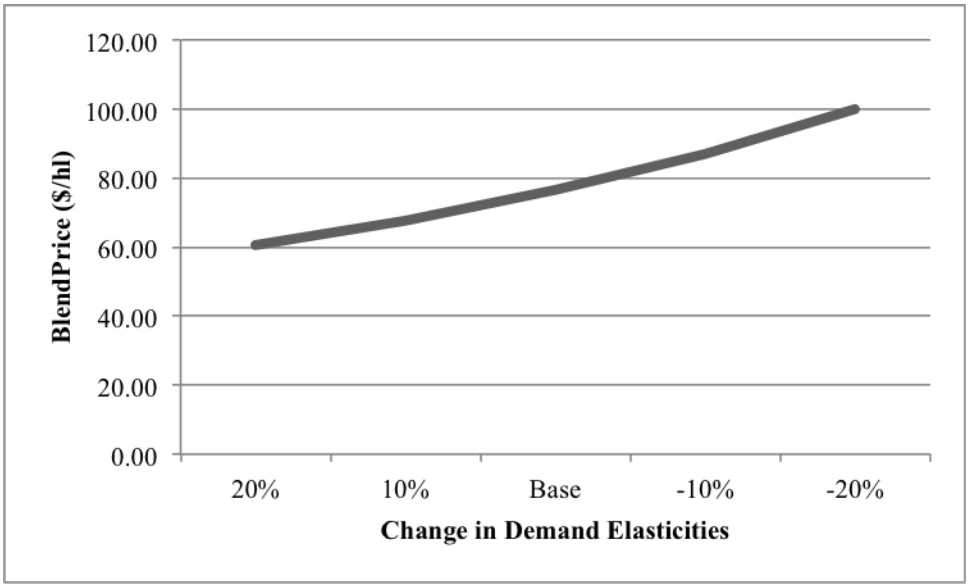

Figure 5.3: Demand Elasticities Sensitivity Analysis: Blend Price

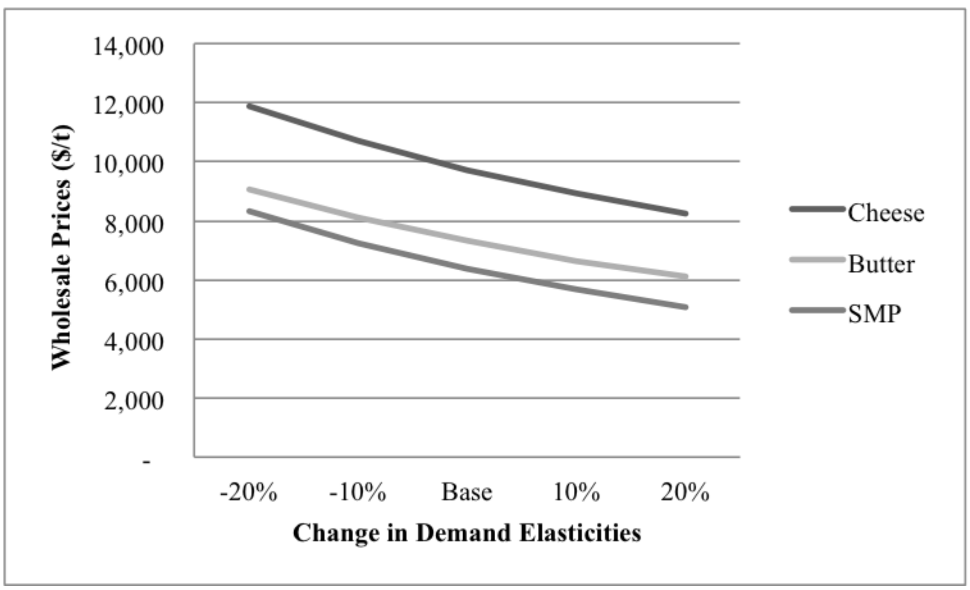

Figure 5.4: Demand Elasticities Sensitivity Analysis: Wholesale Prices

Table 5.6: Demand Elasticity Sensitivity Analysis

	Base	-20%	% Change	-10%	% Change	+10%	% Change	+20%	% Change
Supply (t)									
Cheese	382,058	383,981	0.50%	382,973	0.24%	381,209	-0.2%2	380,408	-0.43%
Butter	92,918	93,183	0.29%	93,017	0.11%	92,870	-0.05%	92,862	-0.06%
Skim Milk Powder	73,858	73,262	-0.81%	73,548	-0.42%	74,187	0.45%	74,533	0.91%
Yogurt	291,700	288,006	-1.27%	290,048	-0.57%	293,064	0.47%	294,209	0.86%
Ice Cream	180,345	174,469	-3.26%	177,713	-1.46%	182,523	1.21%	184,355	2.22%
Raw milk (Mhl)	4.95	—	—	—	—	—	—	—	—
Demand (t)									
Cheese	400,288	402,211	0.48%	401,203	0.23%	399,439	-0.21%	398,638	-0.41%
Butter	95,758	96,023	0.28%	95,857	0.10%	95,710	-0.05%	95,702	-0.06%
SMP	71,758	71,162	-0.83%	71,448	-0.43%	72,087	0.46%	72,433	0.94%
Yogurt	286,360	282,666	-1.29%	284,708	-0.58%	287,724	0.48%	288,869	0.88%
Ice Cream	181,005	175,129	-3.25%	178,373	-1.45%	183,183	1.20%	185,015	2.22%
% Price ($/t)									
Cheese	9,720	11,896	22.39%	10,693	10.01%	8,918	-8.25%	8,245	-15.17%
Butter	7,310	9,074	24.13%	8,101	10.82%	6,654	-8.98	6,101	-16.54%
SMP	6,390	8,336	30.46%	7,261	13.63%	5,669	-11.29%	5,061	-20.79%
Yogurt	3,400	3,454	1.59%	3,424	0.71%	3,380	-0.59%	3,363	-1.08%
Ice Cream	3,870	4,073	5.24%	3,961	2.34%	3,795	-1.94%	3,732	-3.57%
Butterfat	7,886	9,742	23.53%	8,719	10.56%	7,195	-8.77%	6,611	-16.16%
Solids-non-fat	6,648	8,616	29.60%	7,527	13.22%	5,923	-10.91%	5,315	-20.06%
Marginal cost ($/hl)	46.43	—	—	—	—	—	—	—	—
Blend price ($/hl)	76.45	99.89	30.67%	86.94	13.72%	67.78	-11.34%	60.50	-20.86%
Welfare ($ billion%s)									
Producer surplus	5.86	6.92	18.09%	6.34	8.19%	5.47	-6.65%	5.14	12.29%
Consumer surplus	205.41	203.45	-0.95%	204.55	-0.42%	206.11	0.34%	206.68	0.62%
Net welfare	211.27	210.37	-0.43%	210.88	-0.18%	211.58	0.14%	211.82	0.26%

Source: (CDIC, 2014); "—" indicates no change

5.2.3 General Sensitivity Analysis Results

From these tests, the variables within the partial equilibrium model show sensitivity to changing supply and demand elasticities, particularly when confronted with inelasticity. Supply and demand quantities remain fairly robust through the analyses while prices and welfare results are responsive to different elasticities.

Minimal modifications made to the partial equilibrium model may activate major changes to the model and is demonstrated in these analyses. These sensitivities highlight the importance of choosing “reasonable” elasticities especially with a wide range available in the literature.

5.3 Chapter Summary

This chapter discussed simulation and sensitivity analysis results. Overall, consumer surplus increase while producer surplus decreased. In total, net welfare increased marginally because the gains in consumer surplus were greater than the losses in producer surplus. Furthermore, the sensitivity analysis suggested the results are very sensitive to both supply and demand elasticities.

Chapter 6

Conclusions

Since the 1970s, supply management has maintained stable revenues for Canadian dairy producers which have been supported by its three pillars–producer pricing, production discipline and import control. With the conclusion of CETA and TPP negotiations wrapping up, the future of supply management and is still unknown. Countries who already have and are beginning to deregulate their dairy industries are pushing Canada to reform its dairy industry. With this amount of external pressure, it becomes difficult for Canada to offer many concessions and participate in these trade agreements because of their trade partners' strong position on the matter.

Previous studies have demonstrated a decrease in producer welfare with the introduction of additional imports. I explored this issue further, in light of recent events (e.g. TPP and CETA), to determine how CETA will specifically impact the Canadian industrial dairy industry and explore possible trade scenarios where producer quota rents are eliminated. In doing so, I created a partial equilibrium model of the 2013 Canadian dairy industry and imposed three trade scenarios. The first scenario mirrors CETA. The second and third scenarios increases TRQs and decreases over-quota tariffs, respectively, to the point where quota rents are eliminated.

Results for all scenarios show an increase in consumer surplus, decrease in producer surplus Consumer and increase in net welfare. As additional imports enter the Canadian market, producers and processors must face a lower price in order to compete with these imports. In turn, this lower price decreases their welfare. Meanwhile, consumers enjoy slightly more dairy products at a lower price increasing their overall welfare. In addition, consumers gain more than what producers lose and this results in an increase in net welfare.

Supply and demand quantities remain fairly robust throughout the simulations. Conversely prices (cheese, butter, skim milk powder and solids-nonfat in particular), are especially sensitive to increased imports because of its large difference between world prices. Low yogurt and ice cream prices enable processors to export when the opportunity arises while an abundance of cheese, butter and skim milk powder are stuck in Canada.

6.1 Policy Implications

Drawing from my results, if any type of trade liberalization may occur, producers may want to consider decreasing over-quota tariffs versus increasing TRQs so that they may take advantage of the price volatility. Although producer surplus decreases in both "eliminating quota rents" scenarios, producers in fact increase in pure producer surplus. Although international prices may be more competitive, there will be situations when world prices exceed Canadian prices. With relatively lower domestic prices, Canadian dairy producers earn a higher profit and are able to export any excess supply. Nevertheless, it is important to keep in mind that decreasing over-quota tariffs come with a risk, while increasing TRQs provide producers with stability in domestic prices to a certain extent.

The large decreases in skim milk powder and solids-non-fat prices show that there is an excess supply of these goods in the Canadian market. My model depicts a situation familiar to Canada with regards to its structural surplus of solids-non-fat. Canada's difficulty in competing with imported solids-non-fat can be largely attributed to high prices set by the marketing board.

With the trade liberalization scenarios conducted in my thesis, holding the supply of raw milk constant has shown to be extremely restrictive as it prohibits producers from responding to market conditions. Weakening the import control pillar severely impacts the prices which producers face. These prices, in turn, influence quota rents. As the supply management pillars are interdependent, production discipline may need to also weaken or support for producer pricing and import control may be necessary to achieve supply management's objective when trade liberalization occurs.

Finally, the net welfare results suggest that supply management may be constricting the aggregate welfare of economic actors (composed of primarily consumers) within the Canadian dairy industry. When discussing whether to maintain, adjust or eliminate supply management under trade pressures, there is a trade off to consider. It is important to acknowledge the impact of different economic actors at the individual level. Due to the amount of consumers compared to producers, the benefits experienced by an individual consumer may be minuscule compared to the losses faced by an individual producer. Thus deciding the future of supply management may be a sensitive topic, particularly for Canadian dairy producers.

6.1.1 Limitations

Using a partial equilibrium model to describe an entire industry comes with many challenges. With the real world being so flexible, it is difficult to explain it using very rigid models. With this in mind, the following limitations should be considered when analysing my results:

- I have restricted the model by assuming linear supply and demand curves. In reality, these curves may not be straight lines and this can impact the quantities and responses to prices.
- Imports of solids-non-fat are exogenous in my model. To further explore Canada's structural surplus issue, one must make this variable endogenous.
- The true supply and demand elasticities are unknown, along with the discount rate. Despite the sensitivity analyses conducted, I took (old) elasticities used in other studies. Thus, to be more precise, future research may look into estimating supply and demand elasticities for industrial dairy products.
- The assumption of keeping the supply of raw milk constant may be overly restrictive. The marketing board has and can vary this amount slightly. Future studies may look to allowing milk supply to vary between a certain range.
- Assuming the TRQs are always filled may not be accurate. Imports may exceed the TRQ or may exceed the TRQ.

6.1.2 Future Research

Can producers be better off without the supply management system? If so, at what point? In light of recent developments with the TPP, this can be a possible direction for future research. Compelling evidence has shown that producer surplus, in aggregate, decreases in response to any trade liberalization approaches. However, cost efficiency heterogeneity has not been accounted for and as such results may differ.

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Appendix A

Simulation Code

A special thank you to James Rude for sharing his expertise and code. The following TSP International code is re-modelled to 2013 data:

```
options crt;
freq n;
smpl 1 1;

? Cheese sector ?
genr pc = 9720;
genr qdc = 400288;
genr tariff_c = 2.455;
genr pc_base= 9720;
genr p_world_c = 3891;
genr qsc = 382058;
genr pbf = 7886;
genr pbf_base = 7886;
genr pnfs = 6648;
genr pnfs_base = 6648;
genr blendp = 76.45;
genr pb = 7310;
genr psmp = 6390;
genr betadc = -0.23*(qdc/pc);
genr alphadc = qdc-betadc*pc;

genr betascc = 0.28*(qsc/(pc-0.303*pbf-0.816*pnfs));
genr betascb = -0.01*(qsc/(pb-0.816*pbf-0.126*pnfs));
genr betascs = -0.017*(qsc/(psmp-0.003*pbf-0.973*pnfs));
genr alphasc = qsc-betascc*(pc-0.303*pbf-0.816*pnfs)-betascb*(pb-0.816*pbf-0.126*pnfs)-betascs*(psmp-
0.003*pbf-0.973*pnfs);
genr importc = 14760;
```

```
ident pcid pc = pc_base-pos(pc_base-p_world_c*(1+tariff_c));
frml qdceq qdc = alphadc + betadc*pc;
frml qsceq qsc = alphasc + betascc*(pc-0.303*pbf-0.816*pnfs)+ betascb*(pb-0.816*pbf-0.126*pnfs)
+ betascs*(psmp-0.003*pbf-0.973*pnfs);
ident mktclc qdc = qsc + importc+59110-55640;

? Butter sector ?
genr qdb = 95758;
genr tariff_b = 2.985;
genr pb_base = 7310;
genr p_world_b = 3310;
genr qsb = 92918;
genr importb = 2830;

genr betadb = -0.4*(qdb/pb);
genr alphadb = qdb-betadb*pb;
genr betasbb = 0.1*(qsb/(pb-0.816*pbf-0.126*pnfs));
genr betasbc = -0.039*(qsb/(pc-0.303*pbf-0.816*pnfs));
genr betasbs = 0.011*(qsb/(psmp-0.003*pbf-0.973*pnfs));
genr alphasb = qsb-betasbb*(pb-0.816*pbf-0.126*pnfs)-betasbc*(pc-0.303*pbf-0.816*pnfs)-betasbs*(psmp-
0.003*pbf-0.973*pnfs);

ident pbid pb = pb_base-pos(pb_base-p_world_b*(1+tariff_b));
frml qdbeq qdb = alphadb + betadb*pb;
frml qsbeq qsb = alphasb + betasbb*(pb-0.816*pbf-0.126*pnfs) + betasbc*(pc-0.303*pbf-0.816*pnfs)
+ betasbs*(psmp-0.003*pbf-0.973*pnfs);
ident mktclb qdb=qsb+importb+13330-13320;

? Skim milk powder ?
genr qdsmp = 71758;
genr tariff_smp = 2.08;
genr psmp_base = 6390;
genr p_world_smp = 3940;
genr qssmp = 73858;
genr importsmp = -9890;

genr betadsmp = -0.19*(qdsmp/psmp);
genr alphadsmp = qdsmp-betadsmp*psmp;
genr betaspp = 0.038*(qssmp/(psmp-0.003*pbf-0.973*pnfs));
genr betaspc = -0.015*(qssmp/(pc-0.303*pbf-0.816*pnfs));
genr betaspb = 0.031*(qssmp/(pb-0.816*pbf-0.126*pnfs));
genr alphassmp = qssmp - betaspp*(psmp-0.003*pbf-0.973*pnfs) - betaspc*(pc-0.303*pbf-0.816*pnfs)
- betaspb*(pb-0.816*pbf-0.126*pnfs);

ident psmpid psmp = psmp_base-pos(psmp_base-p_world_smp*(1+tariff_smp));
```

```
frml qdsmpeq qdsmp = alphadsmp + betadsmp*psmp;
frml qssmpeq qssmp = alphassmp + betaspp*(psmp-0.003*pbf-0.973*pnfs) + betaspc*(pc-0.303*pbf-0.816*pnfs) + betaspb*(pb-0.816*pbf-0.126*pnfs);
ident mktclsmp qdsmp = qssmp + importsmp + 32760-24970;

? Yogurt sector ?
genr qdyo = 286360;
genr pyo = 3400;
genr pyo_base = 3400;
genr tariff_yo = 2.375;
genr p_world_yo = 3624;
genr qsyo = 291700;
genr importyo = -5340;

genr betadyo = -0.81*(qdyo/pyo);
genr alphadyo = qdyo-betadyo*pyo;
genr betasyo = 0.15*(qsyo/(pyo-0.025*pbf-0.11*pnfs));
genr alphasyo = qsyo - betasyo*(pyo-0.025*pbf-0.11*pnfs);

ident pyoid pyo = pyo_base-pos(pyo_base-p_world_yo*(1+tariff_yo));
frml qdyoeq qdyo = alphadyo + betadyo*pyo;
frml qsyoeq qsyo = alphasyo + betasyo*(pyo-0.025*pbf-0.11*pnfs);
ident mktclyo qdyo = qsyo + importyo;

? Ice cream sector ?
genr qdic = 181005;
genr pic = 3870;
genr tariff_ic = 2.43;
genr pic_base = 3870;
genr p_world_ic = 3064;
genr qsic = 180345;
genr importic = 660;

genr betadic = -0.62*(qdic/pic);
genr alphadic = qdic - betadic*pic;
genr betasic = 0.32*(qsic/(pic-0.12*pbf-0.105*pnfs));
genr alphasic = qsic - betasic*(pic-0.12*pbf-0.105*pnfs);

ident picid pic = pic_base-pos(pic_base-p_world_ic*(1+tariff_ic));
frml qdiceq qdic = alphadic + betadic*pic;
ident mktclic qdic = qsic + importic;
frml qsiceq qsic = alphasic + betasic*(pic-0.12*pbf-0.105*pnfs);

? Milk supply ?
genr xm = 495134.9986;
```

```
genr mc = 46.43;
genr qv = 300.16;?
genr i = 0.1;
genr qr = qv*i;
genr mc = blendp-qr;

genr gamma = 1*xm/mc;
genr kappa = xm-gamma*mc;
genr bho=0;

frml xmeq xm=kappa+gamma*(mc-bho);

genr importnfs = 16.249;

ident eq1 pbf = pbf+ ((qsc*0.303+qsb*0.816+qssmp*0.003+qsyo*0.025+qsic*0.12)-0.4457163857*xm)
/1000000000000000;
ident eq2 pnfs = pnfs + ((qsc*0.816+qsb*0.126+qssmp*0.973+qsyo*0.11+qsic*0.105)-(importnfs+
(0.9017521812*xm)))/1000000000000000;

genr dif = blendp - (3.6*pbf/1000 + 8.52*pnfs/1000);
ident blendpeq blendp = 3.6*pbf/1000 + 8.52*pnfs/1000 + dif;
ident mceq mc=blendp-qr;

??? Base model ???

siml(tag=b, endog=(qsc, qsb, qssmp, qsyo, qsic, qr, qdc, qdb, qdsmp, qdyo, qdic, pc, pb, psmp,
pyo, pic, pbf, pnfs, mc, blendp, importc, importb, importsmp, importyo, importic)) eq1, eq2, qsceq,
qsbeq, qssmpeq, qsyoeq, qsiceq, blendpeq, mceq, xmeq, qdceq, mktclc, qdbeq, mktclb, qdsmpeq,
mktclsmp, qdyoeq, mktclyo, qdiceq, mktclic, pcid, pbid, psmpid, picid, pyoid;

? Base results ?
genr ps_c=1/2*pc*(alphasc+qsc);
genr ps_b=1/2*pb*(alphasb+qsb);
genr ps_smp=1/2*psmp*(alphassmp+qssmp);
genr ps_yo=1/2*pyo*(alphasyo+qsyo);
genr ps_ic=1/2*pic*(alphasic+qsic);
genr ps = ps_c + ps_b + ps_smp + ps_yo + ps_ic;

genr cs_base_c=1/2*(alphadc-pc)*(qdc);
genr cs_base_b=1/2*(alphadb-pb)*(qdb);
genr cs_base_smp=1/2*(alphadsmp-psmp)*(qdsmp);
genr cs_base_yo=1/2*(alphadyo-pyo)*(qdyo);
genr cs_base_ic=1/2*(alphadic-pic)*(qdic);
genr cs_base = cs_base_c + cs_base_b + cs_base_smp + cs_base_yo + cs_base_ic;
```

```
??? TRQ increase ???
genr chg = 2.278; ?17700;
genr importc = (23990*chg) - 9230;
genr importb = (6380*chg) - 3550;
genr importsmp = (2770*chg) - 12660;
genr importyo = (5340*chg) - 6060;
genr importic= (660*chg) - 400;

siml(tag=s, noprint, endog=(qsc, qsb, qssmp, qsyo, qsic, qr, qdc, qdb, qdsmp, qdyo, qdic, pc, pb,
psmp, pyo, pic, pbf, pnfs, mc, blendp)) eq1, eq2, qsceq, qsbeq, qssmpeq, qsyoeq, qsiceq, blendpeq,
mceq, xmeq, qdceq, mktclc, qdbeq, mktclb, qdsmpeq, mktclsmp, qdyoeq, mktclyo, qdiceq, mktclic;

genr cs_new_c=1/2*(alphadc-pcs)*(qdcs);
genr cs_new_b=1/2*(alphadb-pbs)*(qdbs);
genr cs_new_smp=1/2*(alphadsmp-psmps)*(qdsmps);
genr cs_new_yo=1/2*(alphadyo-pyos)*(qdyos);
genr cs_new_ic=1/2*(alphadic-pics)*(qdics);
genr cs_new=cs_new_c+cs_new_b+cs_new_smp+cs_new_yo+cs_new_ic;

genr ps_c_new=1/2*pcs*(alphasc+qscs);
genr ps_b_new=1/2*pbs*(alphasb+qsbs);
genr ps_smp_new=1/2*psmps*(alphassmp+qssmps);
genr ps_yo_new=1/2*pyos*(alphasyo+qsyos);
genr ps_ic_new=1/2*pics*(alphasic+qsics);
genr ps_new = ps_c_new + ps_b_new + ps_smp_new + ps_yo_new + ps_ic_new;

??? Tariff decrease ???
genr shift = 0.264;
genr tariff_c = 2.455*shift;
genr tariff_b = 2.985*shift;
genr tariff_smp = 2.08*shift;
genr tariff_yo = 2.375*shift;
genr tariff_ic = 2.43*shift;

? risk component ?
genr profit=((blendp*xm)-((-1*kappa/gamma)*xm-1/gamma*(xm^2/2)))/10;
genr crra = 4;
genr cara = crra/profit;
genr sigmasq = 1668318;
genr bho = cara*sigmasq;

frml xmeq xm = kappa+gamma*(mc-bho);

load (type=sym, nrow=5) paper; 897072 1094264 1600933 676829 826207 627771 374461 472083
291240 379784 442703 571025 327662 233625 260321;
```

```
load (type=general, ncol=5, nrow=1) xmean; 4004 2861 3298 3624 3064;

freq n;
smpl 1 1000;

random(vmean=xmean, vcov=paper) p_world_c p_world_b p_world_smp p_world_yo p_world_ic;

genr p_world_c=(p_world_c<1500)*1500+(p_world_c>=1500)*p_world_c;
genr p_world_b=(p_world_b<1000)*1000+(p_world_b>=1000)*p_world_b;
genr p_world_smp=(p_world_smp<1200)*1200+(p_world_smp>=1200)*p_world_smp;
genr p_world_yo=(p_world_yo<1200)*1200+(p_world_yo>=1200)*p_world_yo;
genr p_world_ic=(p_world_ic<1000)*1000+(p_world_ic>=1000)*p_world_ic;

siml(tag=t, noprint, endog=(qsc, qsb, qssmp, qsyo, qsic, qr, qdc, qdb, qdsmp, qdyo, qdic, pc,
pb, psmp, pyo, pic, pbf, pnfs, mc, blendp, importc, importb, importsmp, importyo, importic)) eq1,
eq2, qsceq, qsbeq, qssmpeq, qsyoeq, qsiceq, blendpeq, mceq, xmeq, qdceq, mktclc, qdbeq, mktclb,
qdsmpeq, mktclsmp, qdyoeq, mktclyo, qdiceq, mktclic, pcid, pbid, psmpid, picid, pyoid;

genr cs_new_c=1/2*(alphadc-pct)*(qdct);
genr cs_new_b=1/2*(alphadb-pbt)*(qdbt);
genr cs_new_smp=1/2*(alphadsmp-psmpt)*(qdsmpt);
genr cs_new_yo=1/2*(alphadyo-pyot)*(qdyot);
genr cs_new_ic=1/2*(alphadic-pict)*(qdict);
genr cs_new=cs_new_c+cs_new_b+cs_new_smp+cs_new_yo+cs_new_ic;

genr ps_c_new=1/2*pcst*(alphasc+qsct);
genr ps_b_new=1/2*pbt*(alphasb+qsbs);
genr ps_smp_new=1/2*psmpt*(alphassmp+qssmpt);
genr ps_yo_new=1/2*pyot*(alphasyo+qsyot);
genr ps_ic_new=1/2*pict*(alphasic+qsict);
genr ps_new = ps_c_new + ps_b_new + ps_smp_new + ps_yo_new + ps_ic_new;
```