

The Impact of Market Access Reforms on the Canadian Dairy Industry

By

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Master of Science

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Abstract

The World Trade Organization's (WTO) latest round of negotiations, the Doha Development Agenda (DDA), has the potential to change the way most agricultural products are traded around the world. These new liberalization (how does the reader know that these policies are liberal) policies will affect the Canadian production and consumption of dairy products. The research in this thesis uses a partial equilibrium model with stochastic world prices to evaluate the effects of these trade reforms on the Canadian dairy industry. The results of the welfare analysis demonstrate that if the cut in the over-quota tariff is less than the water in the tariff, then there will be no impact on producer and consumer welfare. However, if the cut in the over-quota tariff is larger than the water in the tariff there is a negative impact on producer welfare and positive impact of consumer welfare. Increases in minimum access commitment will also impact producer welfare negatively and consumer welfare positively. Adding stochastic world prices to the simulation model results in distributions of producer and consumer welfare. Dairy liberalization will have a positive impact on consumer and overall welfare.

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Chapter 1: Introduction

The current modalities in the ongoing Doha Development Agenda (DDA) negotiations on agriculture will impact the ways in which agricultural products are traded. These changes will most likely affect supply managed sectors, including the Canadian dairy industry, which generates over \$13.1 billion in sales and \$5.3 billion in total net farm receipts (CDIC 2009a). Its processing sector alone employs over 27,730 people, and the dairy sector ranks third in term of value in Canadian agriculture behind grains and red meats (CDIC 2009a). Thus, any changes in dairy policy are expected to affect the Canadian economy.

In the early 1970s, in the face of volatile world dairy prices, dairy became the first industry in Canada to be supply managed (Schmitz, Furtan & Baylis 2002, CDC 2009). This supply managed system was created in order to offer greater price, supply and revenue stability. In order to achieve this stability, the supply of milk within Canada is constrained, below competitive levels and the farm price for milk is based on a cost of production formula. In order to keep production below the competitive level, producers are also required to purchase production quota, (the right to produce milk). This quota is typically sold at a high price creating a barrier to entry. This quota is a valuable asset to producers.

Currently, the Canadian dairy industry is protected by tariff-rate quotas (TRQs). These TRQs reduce the amount of foreign competition within the Canadian market. These TRQs may change when with the implementation of the new WTO agreement. The analysis of the impact of TRQ liberalization is important since it impacts dairy imports. Changes in quantity imported may impact domestic supply, prices and the marketing

structure. Its potential impact is a double-edged sword as these changes may negatively impact producer welfare but may also increase the level of competition and positively affect consumer welfare. If the consumer welfare increase outweighs the producer welfare decrease there will be an overall gain in the welfare effect for Canada. Thus, the analysis, within this thesis, of the impact of liberalization policies on the Canadian dairy industry will be helpful for both policy makers and the dairy industry.

The first stage of this research is to build an up-to-date, partial equilibrium model of the Canadian dairy industry. This model will then be used to simulate the effects of policy changes that could arise from a new WTO agreement. The second stage is to include the proposed changes from the DDA round of the WTO negotiations. The results from these simulations will then be analyzed and discussed in the context of the Canadian dairy industry in light of liberalization. The analysis will include welfare impacts and discuss the potential issues and benefits for the Canadian economy.

This study differs from previous studies of the liberalization of the Canadian dairy industry, in that, a partial equilibrium model is used to simulate market access reforms on the Canadian dairy industry. The partial equilibrium model recognizes that world prices are stochastic and will influence the Canadian market if imports are increased. It also offers an empirical welfare analysis while adding uncertainty to the supply and price of imports. Previous studies (Barichello, Cranfield and Meilke 2007, Abbassi, Bonroy and Gervais 2007, and Larivière and Meilke 1999) focussed solely on the liberalization of butter, cheese and skim milk powder (SMP) TRQs. This thesis expands upon the previous research to include the five most important processed dairy products: butter, cheese, SMP, yogurt and ice cream.

World price volatility may affect the dairy market if trade barriers are reduced. While supply management currently insulates the Canadian dairy industry against world price volatility, a reduction in trade barriers may decrease this protection as price volatility not only affects prices but also the quantity of imports. Without predictable imports, the supply managed dairy system will not be able to offer the same level of protection for domestic products, since varying import levels affect domestic supply. Ultimately, volatile prices will affect the retail price for dairy products and in the end impact consumer welfare.

The objective of this thesis is to quantitatively measure the impact of market access reforms on consumer and producer welfare in the context of different Canadian dairy liberalization scenarios. This thesis will use a simulation model to analyze the potential impact of decreasing over-quota tariffs and increasing minimum access commitments (MAC). It will also look at the impact of exposing the Canadian dairy market to international price volatility. Findings will then be used to estimate potential welfare effects and the implication of these findings on the Canadian dairy industry will be discussed.

This thesis consists of eight chapters. The first chapter introduces the study. The second is an overview of both international and Canadian dairy industries, supply management and the current dairy trade situation. Chapter three provides an overview of the relevant literature. Model specification and theory are reviewed in chapter four. More specifically, this chapter will discuss model selection, dairy representation, world price risk as well as TRQs, focussing on import quota expansion and the reduction of over-quota tariffs. Chapter five discusses data and the simulation model, including parameters

and data, description of the simulation model, demand, supply, and addition of the risk premium. Chapter six focuses on procedure. It will discuss the trade liberalization scenarios, while discussing DDA draft modalities, as well as go through how the liberalization scenarios will impact the welfare analyses. Chapter seven discusses the results of the liberalization scenarios and the impact on overall welfare, as well as goes through a range of sensitivity analyses. The final chapter of this thesis serves as a summary. It provides conclusions drawn from the results section, offers policy action recommendations and discusses the limitations of the study.

Chapter 2: Background

2.1 World dairy production, consumption and trade

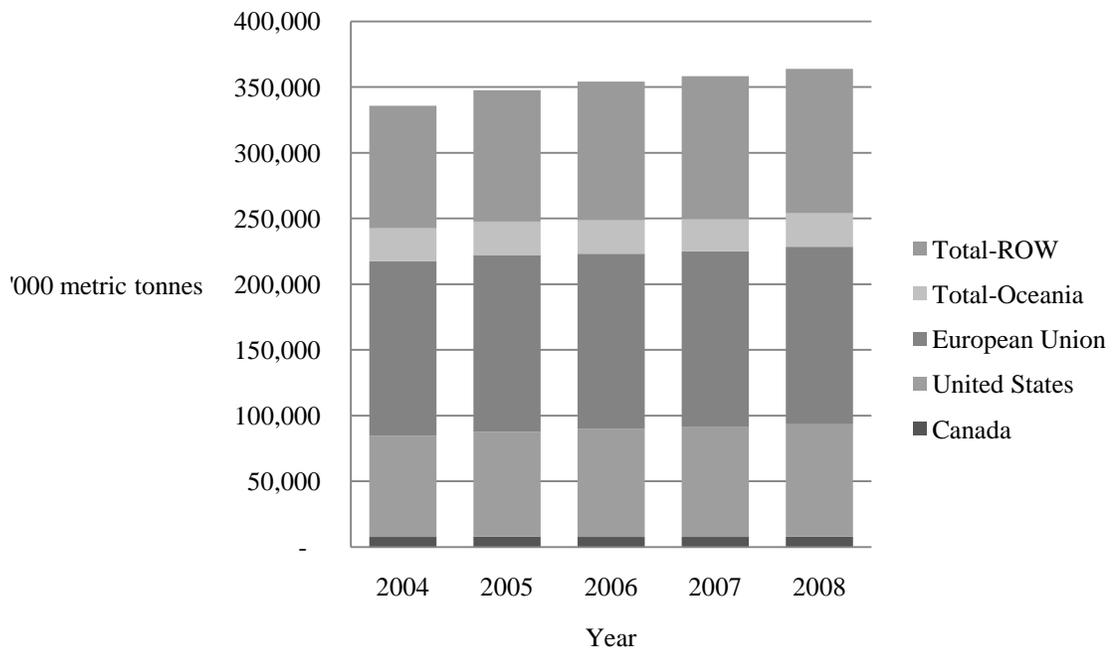
World dairy production has remained relatively constant in the last 6 years. One of the reasons for the stable worldwide production of milk is that the European Union (EU) still works under a quota system. The EU has two types of milk quota (Réquillart *et al* 2008), which is allocated to every member country, one for deliveries to dairies and one for direct sales to consumers. The quotas are shared amongst individual farmers based on historical production. Both of these quotas are to be phased out gradually, increasing them annually to slowly liberalize the dairy industry. On the other hand, Australia and New Zealand's dairy industries are deregulated, meaning supply is not restricted (DAFF 2010). The Australian dairy industry was slowly deregulated with a combination of government buyouts and consumer taxes. This combination bought out the production quota from producers. The United States dairy industry does not operate under a quota system; however there are dairy support programs in place.

The demand for milk and dairy products is fairly inelastic. The inelastic demand may also be one of the reasons why production has remained stable even with changes in prices. However, there has been a shift in demand from some dairy products (such as butter, homogenized milk, 2% milk) to others (yogurt, both 1% and skim milk, and cheese). This shift in demand can be explained by the changes in consumer preferences. Consumers are becoming more health conscious, and are purchasing lower fat products, such as skim milk.

Figure 2.1 illustrates the production of milk between 2004 and 2008. In order of production, the largest dairy producers are the EU (133,789,000 tonnes of milk produced

in 2007) followed by the US (83,682,000 tonnes) and Oceania (24,573,000 tonnes). Canada produced 7,577,000 tonnes of milk in 2007 (CDIC 2009). The group that saw the largest increase in production is the rest of the world (ROW) (ROW=World-Canada-US-EU-Oceania). Most of the countries in ROW are developing economies. As their populations grow and standards of living increase, dairy demand and thus dairy production increase as well.

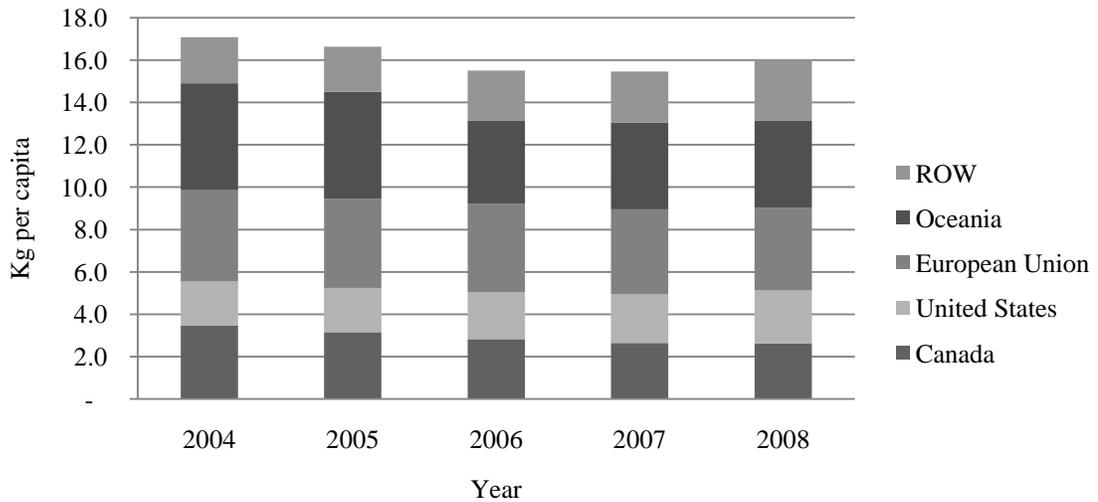
Figure 2.1. World milk production



Source: CDIC 2009a

Dairy consumption patterns vary across the globe. Some countries such as Finland, Norway and Sweden, have extremely high consumption rates for fluid milk and, on average, consume 150 litres per capita of fluid milk (CDIC 2009a). Countries such as France and Greece may not consume much fluid milk but do consume over 20 kg per capita of cheese every year (CDIC 2009c, CDIC 2009d).

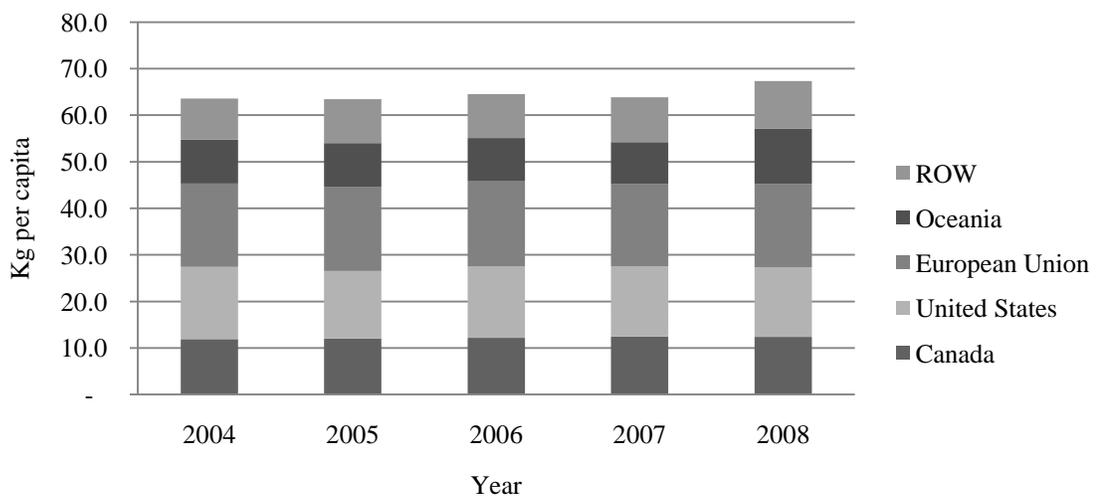
Figure 2.2. Global butter consumption



Source: CDIC 2009c

Figure 2.2 illustrates the butter consumption among the largest dairy producers and Canada. The EU consumes the most butter per capita, with France and Germany being the top consumers at 7.8 and 6.2 kg per year respectively. Oceania consumes 4.1 kg per capita annually. In comparison, the Canada and United States are meagre butter consumers, at 2.6 and 2.5 kg per capita (CDIC 2009c).

Figure 2.3. Global cheese consumption



Source: CDIC 2009d

Figure 2.3 illustrates world cheese consumption. The largest consumers of cheese are by far the Europeans. For example, in 2008, France, Germany and Italy consumed 24.6, 22.1 and 21.4 kg per capita respectively while the United States, Canada and Oceania only consumed 15, 12.4 and 11.8 kg per capita of cheese, respectively (CDIC 2009d). Since Europe consumes so much cheese, it is a large, potential market for Canadian exports.

During the next decade, there is an expected growth in dairy demand in the developing countries. The Organization for Economic Co-operation and Development (OECD) and Food and Agriculture Organization (FAO) outlook expects that the consumption of dairy commodities will exhibit the highest growth rates among all food commodities, mostly in developing countries (OECD 2010). The increase in consumption is partially due to income and population growth, however; it is also influenced by changing consumer preferences (OECD 2010). There has also been a shift to improving retail channels in developing countries which has resulted in an increase in dairy marketing. These are but some of the reasons that it is expected to see an increase in demand.

2.2 Canadian dairy industry

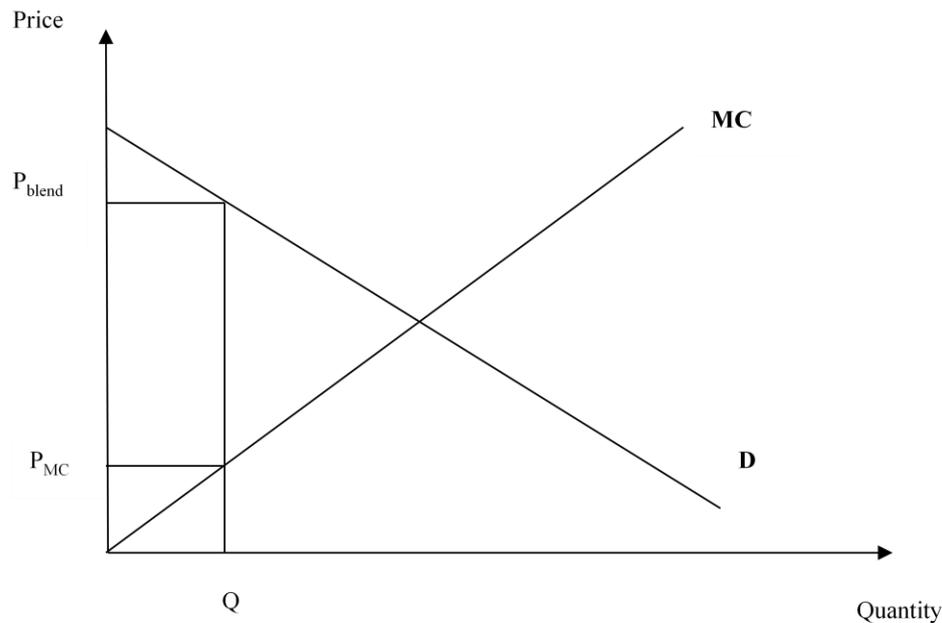
2.2.1 Supply management

Canadian supply management was created at a time when there was a call for a stable economic environment for producers due to losses in export markets and depressed prices, as well as producer stabilization payments were at an all time high (Schmitz, Furtan and Baylis 2002). Supply management was introduced in order to stabilize and increase

prices of certain commodities such as dairy and poultry. It rests upon three pillars: production planning, pricing mechanism and predictable imports.

Supply management works by keeping production under the competitive level. In Figure 2.4, domestic output (Q) is held below the competitive level. As a result, the administered price (P_{blend}) is maintained above marginal cost (P_{MC}).

Figure 2.4. Dairy supply management mechanism



Source: Fulton, Katz and Vercaemmen, 1996

Dairy production is controlled through the market sharing quota (MSQ) which is measured as the right to produce one kg of butterfat per day per quota. Every province is allowed a certain amount of MSQ, based on historical production, and the quota is traded on an exchange. This production control attempts to set production at the point where marginal cost is equal to marginal revenue.

Market sharing quota, when supply management was first established, was free and a certain amount was given to each producer based on historical production. Shortly after supply management was put into effect, producers started trading their MSQ, to

reach certain production levels. There has been a steady climb in the value of MSQ. For example, in 2007 producers paid upwards of \$27,000 per production quota.

Quota policies vary from province to province. In general, it is possible to pass quota through a direct, family or going concern transfer (selling the farm with the quota). It is also possible to sell only the quota. In most provinces there is a quota exchange system, where the seller and a buyer are matched based on the seller's set price and a buyer's willingness to pay. There is also the possibility, in some provinces, to buy quota through a lottery system. Some provinces also have quota lease, where the right to produce is sold for the month, and goes back to the original owner at the end of the month. Only a portion of the quota can be leased this way.

Producers are paid an administered price (blend price) for their milk which is based on a cost of production formula. This formula is based, by weight, on three categories (MPRA 2009). The first, which has a thirty percent weight, is the Consumer Price Index (CPI). The CPI is obtained by a monthly cost calculation for a fixed basket of commodities. The second category, which also has a thirty percent weight in the formula, is the Personal Disposable Income (PDI). The PDI is the amount of disposable income left after the payment of personal direct taxes, contributions to social insurance plans and other fees. Finally, the Cash Cost plus Interest (COP) has forty percent of the weight in the formula. The COP is derived from the annually conducted Canadian Dairy Commission COP survey of 260 producers. The components of the survey include the cost of purchased feed, vaccinations, depreciation, return to capital, transportation, machinery, land and building repairs, fuel and oil, property taxes and insurance, hired labour, utilities and interest paid (MPRA 2009). This base cost of production is used by

all provinces who then add certain costs to the formula, to reflect prices in their area. Cost of production, thus prices vary by province.

Across Canada, there is price discrimination for each milk class. Every milk class is composed of different portions of the main milk components: butterfat (bf), and non-fat solids (nfs). For every class, bf and nfs have a different value (CDIC 2009a). This is important to note since all dairy products have different amounts of bf and nfs. For simplification, the prices are blended in order to give one blended price for producers, using the weighted average of different prices of milk within the different classes (Schmitz, Furtan and Baylis 2002). This blended price is used so all producers receive the same price for their milk, regardless of end use.

The conversion rates, as shown below in Table 2.1, are used to identify the amount of bf and nfs in all dairy products. These conversion factors are used in the simulation model in this study in order to: a) define the amount of bf and nfs in milk and b) to distribute the finite amount of these solids, found in the fluid milk, into each product category.

Table 2.1. Dairy composition

	Milk ^a	Cheese	SMP	Butter	Ice cream	Yogurt
Butterfat	3.600	0.324	0.003	0.816	0.120	0.025
Non-fat solids	8.520	0.764	0.973	0.126	0.105	0.110

^aMilk is measured as kg/hl. Cheese, SMP, butter, ice cream and yogurt are measured as kg/kg.
Source: USDA 2009

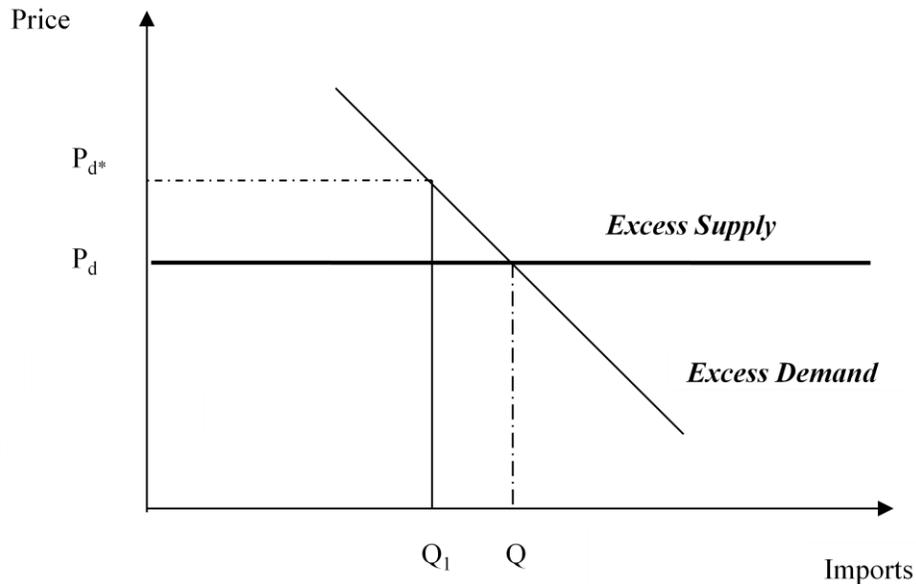
The Canadian Dairy Commission sets annual support prices for butter and SMP, which are used as a reference for the wholesale price paid by processors (CDIC 2009a). At this point the processors will add their own costs to the price, and finally the distributors and retailers add their cost margin, resulting in a final retail price.

The third supply management pillar is control of dairy import. An effective supply management system requires the ability to both predict imports and reduce exports. Currently, the import control measures for dairy in Canada consist of TRQs, which include low minimum access commitments (MAC), and prohibitive over-quota tariffs. This will be discussed further in the following chapters.

2.2.2 Canadian Dairy Trade

Before the Uruguay Round Agreement on Agriculture (URAA), quantitative trade restrictions in the form of import quotas were the main dairy trade policy. These quotas were primarily used to protect domestic producers and restrict imports. In order for an import quota to be effective, it needs to restrict the imports below what would be imported under a free market. Through the restriction of imports, the price of the commodity in question is increased in the importing country. Figure 2.5, demonstrates the import quota mechanism. Q is the quantity imported without trade restrictions. Q_1 is the import quota. This elevates the price in the importing country from P_d to P_{d^*} .

Figure 2.5. Import quota mechanism



Source: Woo and Kennedy 2005

Following the Uruguay round, import quotas were abolished and were replaced with TRQs. Most countries, including Canada, set their over-quota tariff so high that the TRQs still act like import quotas. Table 2.2 illustrates the over-quota tariffs for dairy products.

Table 2.2. Current tariff lines for Canadian dairy imports

Dairy product	Cheese	SMP	Butter	Ice cream	Yogurt
Over-quota tariff (%)	245.6	201.5	298.7	243.4	237.5

Source: WTO 2008

MACs were set at a percent that remained fixed. As Table 2.3 demonstrates, these over-quota tariffs make the landed price for foreign dairy goods higher than the domestic prices, and thus not competitive.

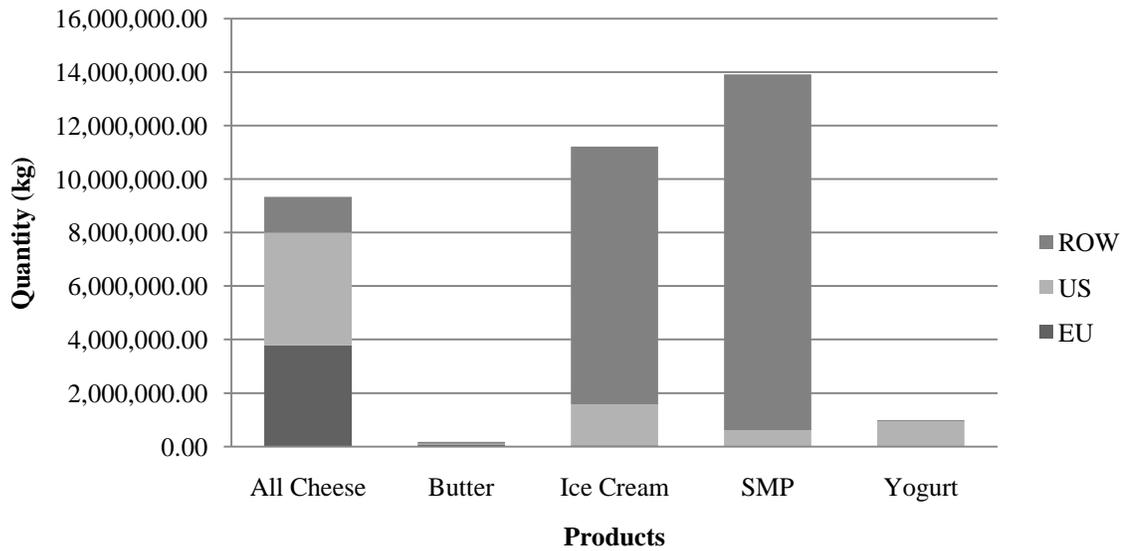
Table 2.3. Domestic and landed prices

\$CDN/Tonne	Cheese	Butter	SMP	Yogurt	Ice cream
Domestic price	8,740.00	6,900.00	5,950.00	3,172.35	3,660.00
Landed price	11,619.07	10,045.84	7,047.56	6,003.00	6,649.94

Source: CDIC and authors calculations

International trade in Canadian dairy products is extremely limited. Canada's top dairy imports (2007) were cheese, casein products, whole milk powder, and butter, which were valued at \$622 million (AAFC 2008b). In 2007, the value of total Canadian dairy exports was \$284.4 million (CDIC 2009a). The majority of these exports are cheese, SMP, and ice cream.

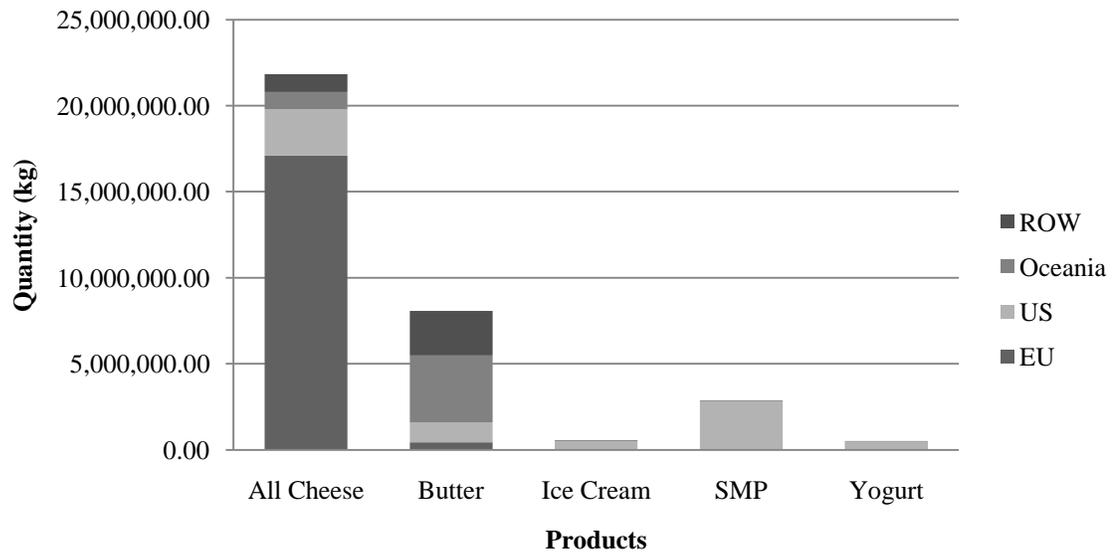
Figure 2.6. Canadian dairy exports



Source: CDIC 2009e

Figure 2.6 demonstrates Canadian exports to other countries. The largest importer of Canadian dairy is dependent on the product. For example, the US is the largest importing nation for Canadian cheese and yogurt, followed by the EU, who imports mostly cheese and butter. Lower valued products, such as SMP, usually go to developing countries.

Figure 2.7. Canadian dairy imports

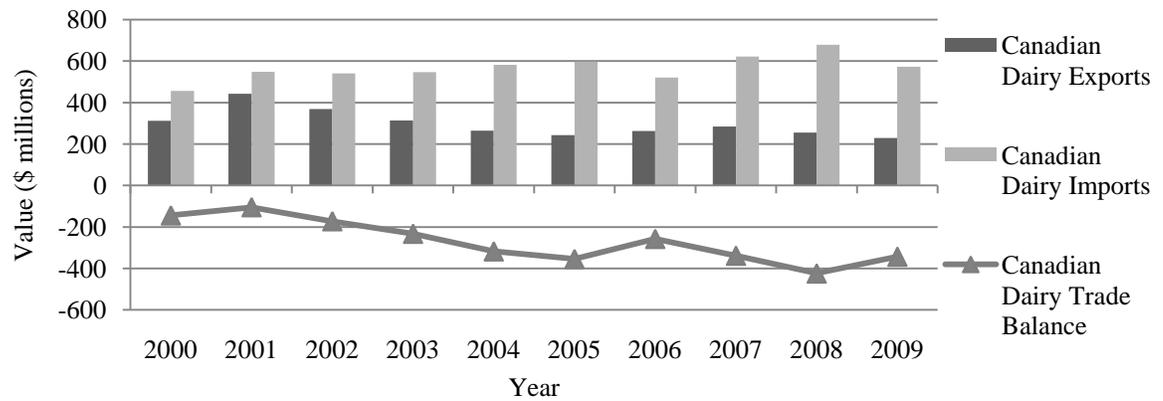


Source: CDIC 2009e

Figure 2.7 illustrates that the majority of Canadian imports are cheese from the EU. The majority of imported butter comes from Oceania, which provides the lowest priced product (CDIC 2009b). Due to its highly perishable state, most yogurt and ice cream imports come from United States.

Figure 2.8 illustrates the Canadian dairy trade balance. The amount of Canadian exports are negligible mostly due to the fact that Canadian dairy products are not competitive due to their higher price in competing markets. In the last decade, the dairy trade balance deficit has more than doubled. This deficit has implications for the future of the Canadian dairy industry.

Figure 2.8. Canadian dairy trade balance



Source: CDIC 2009f

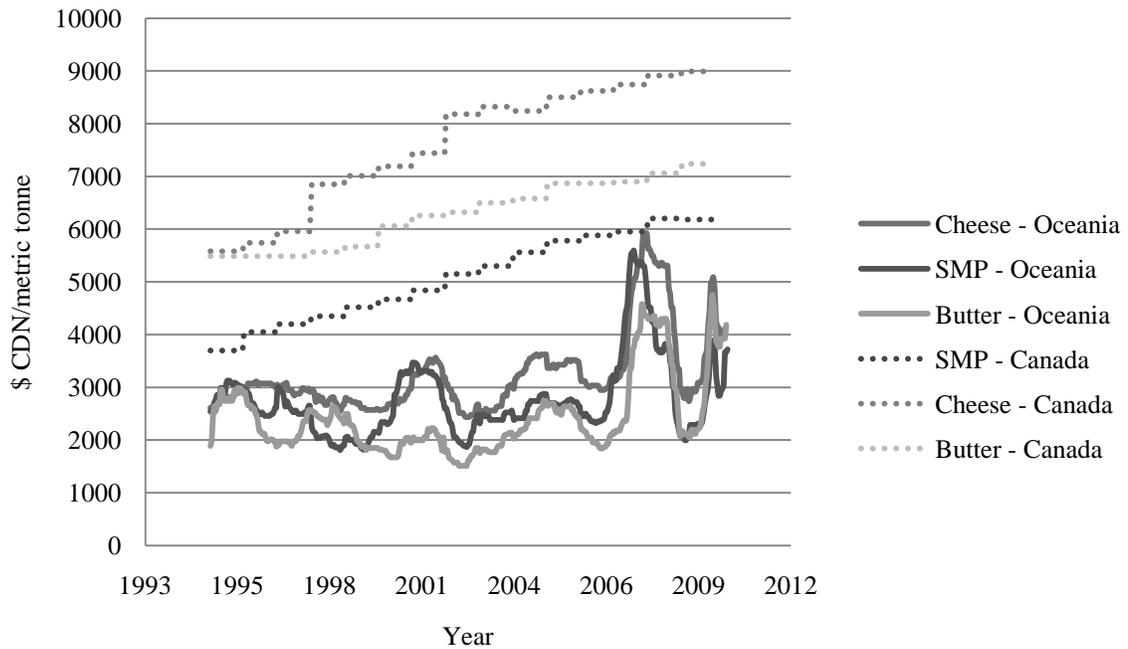
Domestic dairy prices are based on an administered price. This administered price, in turn, is based on the cost of production and diminishes the possibility of Canadian competitiveness on the world market. As Table 2.4 and Figure 2.9 illustrate, Canadian dairy products have a much higher price than Oceania dairy products. Despite a competitively set market price, Oceania’s prices, as shown in Figure 2.9, are volatile when compared to the stable administered price of Canadian dairy products.

Table 2.4. 2007 Dairy wholesale prices

\$CDN/Tonne	SMP	Butter	Cheddar
Oceania	4,378	2,896	4,032
Canada	5,950	6,900	8,740

Source: CDIC 2009

Figure 2.9. International world dairy prices



Source: USDA, CDIC 2009a

Import controls, in 2007, have kept both the amount of dairy imports (215,404 tonnes in 2007) and exports (109,316 tonnes) quite low (CDIC 2009a). The 2008 DDA modalities in agriculture contain several threats to the current supply managed regulation of the Canadian dairy industry; the greatest of which would be the change in the current level of market access and a decrease in the current over-quota tariffs. Given these changes, it may not be possible for Canada to maintain the current high levels of border protection for its supply managed industries.

Changes to TRQs, both through MAC increases and over-quota tariff reductions will also affect imports, and, ultimately the output and prices of Canadian dairy products. In order to plan for the potential effects of these policies, which will impact producer and consumer welfare, it is important to assess the possible effects of trade policy changes.

Chapter 3: Literature Review

A number of studies have focused on the potential impact that trade liberalization might have on Canadian supply managed industries. Barichello, Cranfield and Meilke (2007) focused on options for Canadian supply management if tariffs were liberalized. They examined the current state of the Canadian dairy industry and how any change in the status quo would affect producers and consumers. Using a stylized economic model, the authors found that changes in the supply management system could affect domestic prices, demand and supply and then described the outcomes for various scenarios. For example, they found that if the over-quota tariff for dairy products were reduced by only the amount of water in the tariff¹ (WIT), then no significant changes in the system would occur. However if the reduction is greater than the water in the tariff, then there might be an erosion of producer income and quota rents, and increase in consumer surplus.

Abbassi, Bonroy and Gervais (2007) discussed the impact of dairy trade liberalization on the Canadian economy. Using a spatial equilibrium model calibrated from the 2003 dairy year, the model spatially linked seven Canadian regions with the rest of the world. The first situation assumes that production remains constant and the second MSQ is reduced to maintain production quota rents. The authors considered four liberalization scenarios, varying from moderate to aggressive changes from the status quo. Also, since liberalization impacts depend on the relationship between domestic production and the increase in market access, two different production decisions are made. The first production decision kept production constant, and the second reduced

¹ Water in tariff (WIT): difference between the bound and applied tariffs, where the tariff is not a binding constraint on imports.

production in order to maintain production quota rents. In each scenario the authors looked at the impact of tariff cuts, and increases in the MAC.

Abbassi, Bonroy and Gervais (2007) found that the impact of liberalization on the dairy industry varies directly with the amount of tariff liberalization. The more extreme the liberalization scenario, the greater the decline in price and output of dairy products, primarily cheese. Welfare effects were empirically measured and the study found that, in the short run, the worst case scenario for producer surplus is to cut tariffs by fifty percent but keep MAC constant. The best-case scenario for overall welfare, in the short run, is to keep tariffs constant but increase MACs by fifty percent. In the long run, the best-case scenario, for producer welfare, is to have products deemed sensitive and reduce bound tariffs² and increase MAC. The worst-case scenario, in the long run, for overall welfare would be to cut tariffs by fifty percent.

Larivière and Meilke (1999) looked at the potential effect of the expansion of tariff rate quotas and the reduction of export subsidies in the dairy industry. The authors used a non-spatial, multi-regional model of the world dairy industry to look at the potential impact of these changes on SMP, butter, and cheese in the Canadian, EU-15, and U.S. dairy industries. Their study discussed several different liberalization scenarios: a) decreasing over-quota tariffs by fifty percent, b) decreasing tariffs to the fifty percent level, c) increasing MAC by five or seven percent, d) elimination of export subsidies, and e) free trade. Study results demonstrated there is no type of trade reform that would be beneficial to all players. The authors concluded that free trade offers the largest potential for production growth for most dairy sectors, other than cheese, in Canada.

² Bound tariff: A tariff is binding when it restricts imports in a given period below the amount that would otherwise occur (Houck 1986).

Rude and Gervais (2006) focused on the options for liberalizing TRQs when domestic production is supply managed and when stochastic world prices are included. This study modeled the vertical relationship between the producer and processors, for the Canadian chicken industry, as most traded supply-managed products are processed rather than raw. The findings demonstrated that: a) lowering over-quota tariffs and increasing MACs are not equivalent, as there are trade-offs between both trade reforms, and b) in order for supply-managed marketing boards to keep their existing marketing structures, they must account for the price uncertainty that is introduced when imports are increased. In fact, increasing world price volatility will result in a distribution of welfare effects for the different groups in the supply-managed industry. Consumers and processors would gain more by tariff liberalization than by an increase in MAC; however, producer surplus would only be affected negatively by these trade reforms.

The existing research on TRQ liberalization and supply management has determined that there is no one scenario which is beneficial for all players. If consumer welfare increases, it is usually accompanied by a loss of producer welfare. Building on these previous studies, this thesis will first look at the option of reducing the WIT. It will also apply different production decisions to the supply of milk. These production decisions approximate how a marketing board would react to the TRQ liberalization of dairy products. Secondly, this thesis will apply liberalization to the five largest groups of dairy products (cheese, butter, SMP, yogurt and ice cream), rather than to the top three (cheese, butter and SMP). Finally, this thesis will apply world price volatility to TRQ liberalization which, when included in the simulation model, will give a distribution of welfare effects.

Chapter 4: Model Specification and Theory

4.1. Model selection

A simulation model is needed to properly represent the dairy industry. Types of equilibrium models, such as general equilibrium models and partial equilibrium models, have been previously used in the dairy industry; however, each model is appropriate for different problems. General equilibrium (GE) models are better suited to large, broad, aggregated coverage across industries, regions and countries as they are able to capture the effects of extensive changes for a country's economy. However, it is harder to introduce more institutional detail in a general equilibrium model (Rude and Meilke 2004) and it is difficult to disaggregate commodities using this model than it is in a partial equilibrium model.

Partial equilibrium (PE) models are best used to simulate the impact of policy changes on a specific sector (Rude and Meilke 2004). A PE model is flexible. It can introduce more detail than a GE model and is best suited to analyze the welfare effects of trade policies. Since this thesis focuses on the supply managed dairy industry, and analyzes the welfare effects, a partial equilibrium model is used.

4.2. Dairy representation

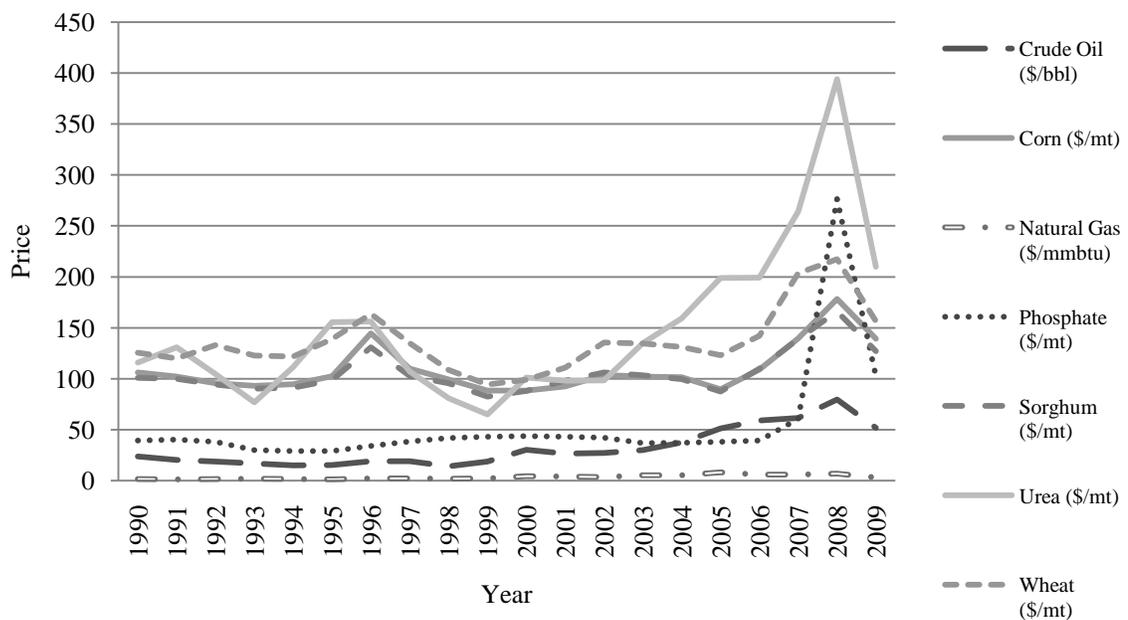
Viable economic models of the dairy industry can be difficult to construct because fluid milk is transformed into many different products. Thus, a model must not focus upon a primary product such as fluid milk, but rather on all of its transformed products. This thesis focuses on dairy manufactured products rather than fluid milk because fluid milk is not largely traded between countries as its perishable and bulky nature makes it difficult and expensive to ship.

4.3. World price risk

World agricultural prices tend to be volatile due to their vulnerability to exogenous shocks such as droughts, floods, low stock levels, trade policy responses and speculative behaviours in the commodity markets. Shocks impact supply and demand (Martin and Anderson 2010) and can impact other commodities through the ripple effect. For example, a surge in feed and energy costs in 2007 had an impact on world dairy prices. This shock in dairy prices may have happened for a number of reasons, such as one of the shocks previously mentioned.

Figure 4.1 shows the spike in commodity prices in 2007. Non-supply managed dairy product prices are based on their input prices and are volatile due to the volatility of input costs. Supply management was implemented in the Canadian dairy sector to not only provide a stable market for producers but also to reduce the impact of world price volatility domestically. The COP formula is adjusted to reflect changes in input costs.

Figure 4.1. World commodity prices



Source: The World Bank

While supply management has insulated the Canadian dairy industry, world dairy prices have been volatile for the last few years (CDIC 2009b). Rude and Gervais (2006) argue that if supply-managed industries wish to keep their current marketing structure, they must account for world price uncertainty when simulating trade liberalization scenarios. Thus, models must also account for the stochastic nature of the world dairy markets. Adding this stochastic element exposes the PE model to the volatility of world prices and it will affect the simulated domestic prices.

4.4. Basic mechanism of TRQs

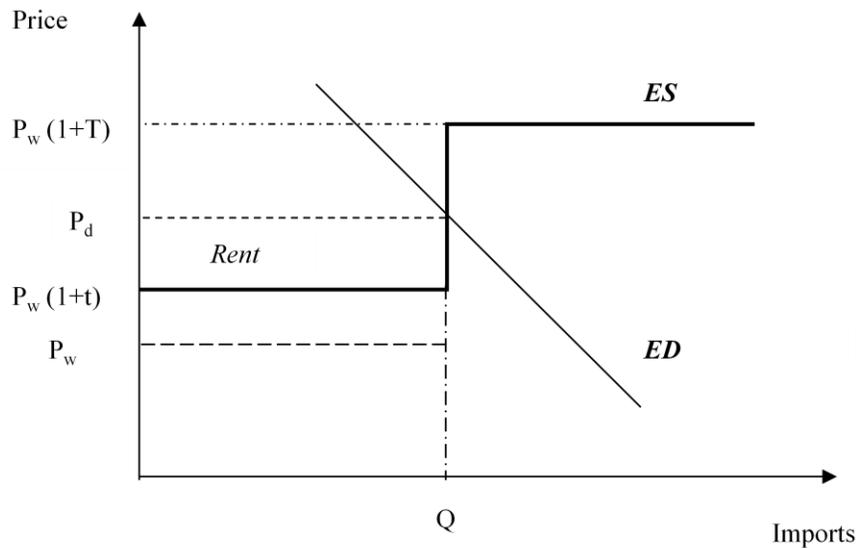
The Uruguay round of the WTO negotiations eliminated import quotas in favour of TRQs. A TRQ functions under the most favoured nation policy (MFN), and allows equal access for all WTO members. As well, TRQs are seen as transparent, allowing the level of protection to be easily determined. Thus TRQs are seen provide protection to the commodity in question while enabling the market to function, since TRQs are not supposed to act as quantitative restrictions, like import quotas (Skully 2001).

TRQs are currently structured for Canadian dairy products to ensure low import levels, with prohibitive over-quota tariffs. They restrict the level of imports to the quota level determined by the MAC. The over-quota tariffs are high enough that it is not feasible for most Canadian importers to exceed the in-quota amount of dairy products. Imported products are non-competitive at their landed prices.

A TRQ is a two-tiered tariff. The first tariff (t) is applied to a set amount of imports (Q), and any amount imported over the quota (Q) sees a second, higher tariff applied (T). Since Canada is considered a small country (as is demonstrated in chapter five), the excess supply curve can be set as a horizontal line. In Figure 4.2, the quota is

binding. P_w represents the world price, P_d is the domestic price, $P_w (1+t)$ is the world price plus the in-quota tariff, and $P_w (1+T)$ is the world price plus the over-quota tariff. In this scenario, it is possible to acquire quota rents of $((P_d - P_w (1+t)) * Q)$ since P_d is above $P_w (1+t)$.

Figure 4.2. Tariff-rate quota mechanism



Source: Koo and Kennedy 2005

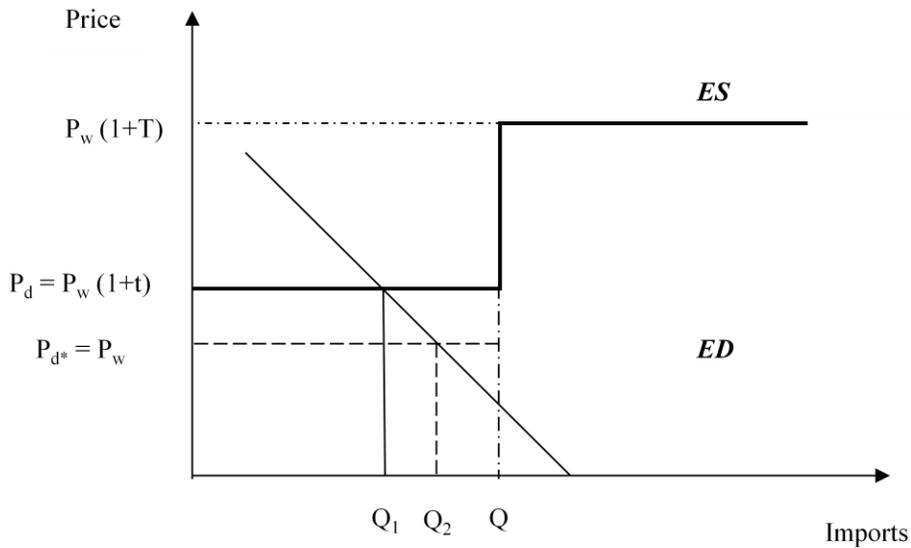
Tariff liberalization and MAC increases are different policies. The impact of changing the over-quota tariff on the Canadian industry will be different than the impact from increasing MAC. They will both have welfare impacts; however, literature suggests that they will not be equal (Abbassi, Bonroy and Gervais 2007, Larivière and Meilke 1999, Rude and Gervais 2006).

4.5. Elimination of in-quota tariff

Figure 4.3 represents the elimination of the in-quota tariff. In this case, t is the in-quota tariff, and is binding. When the in-quota tariff is eliminated the landed price decreases

from $P_w (1+t)$ to P_w . Domestic prices are then lowered from P_d to P_{d^*} , and imports are increases from Q_1 to Q_2 . This elimination of in-quota tariff ultimately impacts the size of the quota rents, and effectively eliminates the quota rent.

Figure 4.3. Elimination of in-quota tariff

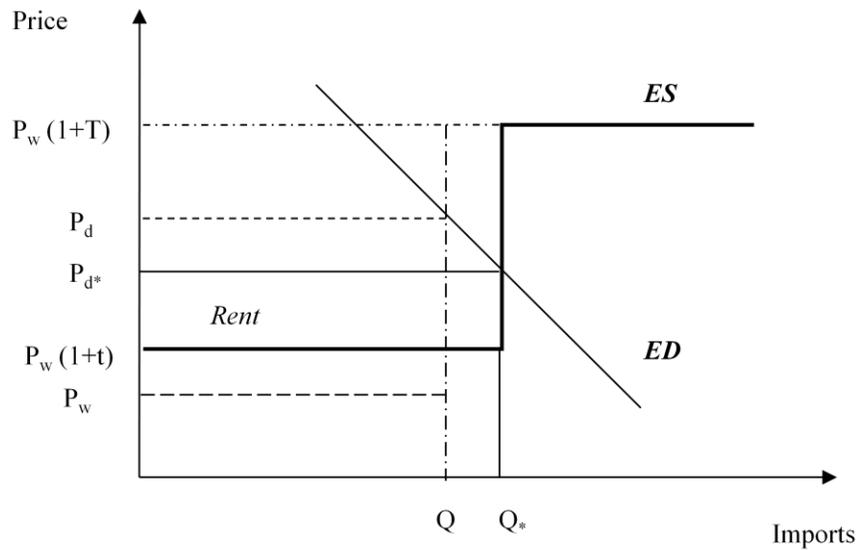


Source: Skully 2001

4.6. Import quota expansion

An increase in the MAC by the importing country means the quantity of the imported products under the in-quota tariff is increased. As Figure 4.4 shows, the import quantity with an increased MAC is Q^* . Since quantity is increased, it intersects the excess demand curve at a new point. This yields a new domestic price of P_{d^*} , and the quota rent is changed to $((P_{d^*} - P_w (1+t)) \times Q^*)$.

Figure 4.4. Increase in minimum access commitment



Source: Skully 2001

4.7. Reduction of over-quota tariff

To analyze the effects of a reduction in the over-quota tariff, it is first necessary to ascertain how much these tariffs can be lowered before domestic prices and profits are affected. In order to discover what portion of the over-quota tariff is redundant, the current study will examine how much water is in the tariff (WIT). If there is water in the over-quota tariff, it could be reduced without a cost to the Canadian dairy producers.

Barichello and Zhang (2008) demonstrate how to find the level of water in the tariff.

$$WIT = T_c - NRP, \quad (1)$$

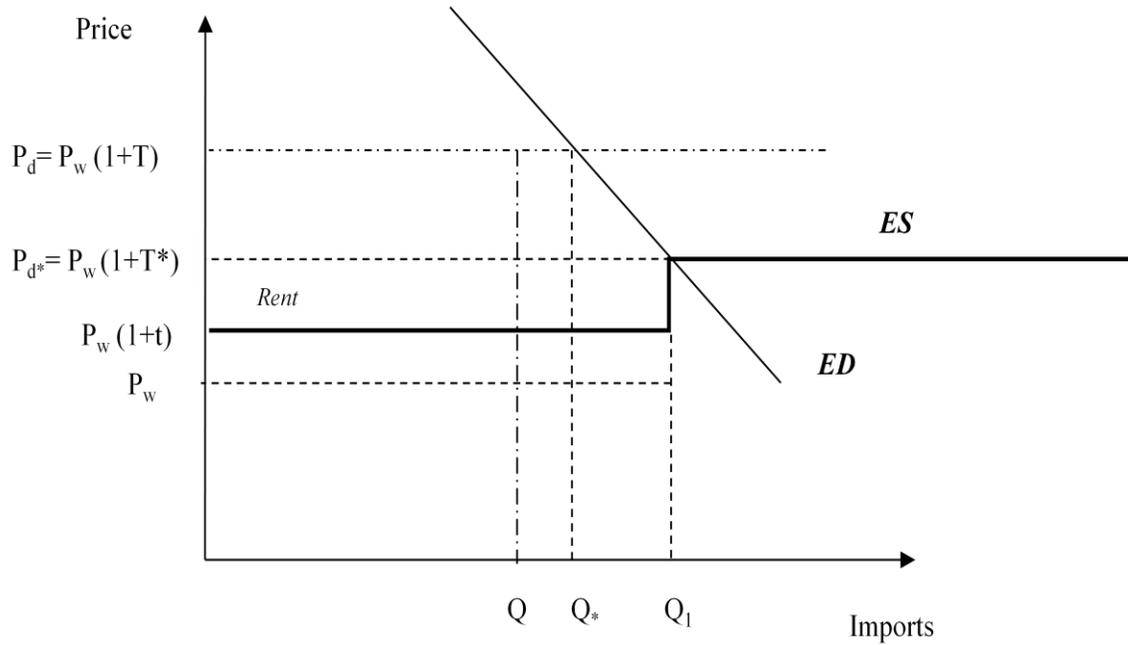
where T_c is the tariff currently in effect and NRP is the nominal rate of protection.

$$NRP = (P_c - P_L) / P_L * 100\%, \quad (2)$$

where P_c is the Canadian domestic wholesale price and P_L is the landed foreign wholesale price.

If the tariff reduction is more than the WIT, there will be an effect on price and imports. Figure 4.5 demonstrates the effect of removing all the WIT. The over-quota tariff is reduced from T to T^* , where the over-quota tariff is now binding. Price is decreased from P_d to P_{d^*} and imports are now Q^1 .

Figure 4.5. Over-quota tariff decrease



Source: Skully 2001

Chapter 5: Data and Simulation Model

5.1 Parameters and data

In 2007, Canada imported 215,404 tonnes of dairy products with a value of \$621.4 million (CDIC 2009e). For the same year, the European Union exported around 1.9 million tonnes of dairy products and the United States exported 1.15 million tonnes (USDEC 2009). It is important to note that the EU and the U.S. are the two largest suppliers of Canadian dairy imports. Canada can be classified as a small country importer due to its relatively small level of imports when compared to the large volumes exported by the EU and the US. This is important as modelling a small country is different than a large country as the trade policies of small countries will have almost no impact on the world price. This thesis treats Canada as a small country in the trade of dairy products.

The PE model used in this study was calibrated using 2007 data, based on the 2009 Medium Term Canadian Outlook (AAFC 2008a). Data from 2007 was used to calibrate the model because it coincided with a year of commodity price increases. In 2007, world dairy prices were high, making high Canadian dairy prices more competitive than usual. Since supply management insulated Canadian dairy prices from the world market, the commodity price jump of 2007 had little, if any, impact on supply and demand in Canada. When the model was calibrated to another year, the results were similar. Choosing a 2007 baseline versus a 2008 year baseline did not have a large impact on simulated results.

Domestic dairy supply and disposition data was used to build the PE model. Table 5.1 illustrates production, opening and ending stock, imports and exports, as well as

quantity supplied and demanded in 2007. These figures were used to calibrate the PE model so it accurately represents the effect of external shocks on the dairy industry.

Table 5.1. Dairy supply and disposition

Product	Opening stocks	Exports	Imports	Production	Ending stocks	Disappearance
Cheese (kt)	62.6	10.8	20.8	373.8	68.8	377.0
Butter (kt)	14.6	0.3	5.8	84.0	18.6	83.2
SMP (kt)	18.3	16.3	0.0	80.7	25.2	30.3
Yogurt (kt)	0.0	1.3	0.5	265.1	0.0	264.0
Ice Cream (kt)	0.0	12.5	0.4	203.6	0.0	192.0

Source: Medium term outlook (AAFC 2008a)

Accurate representation of the impact of shocks on supply and demand, for the five dairy products listed above, necessitated the inclusion, in the model, of their supply and demand elasticities. Table 5.2 shows the elasticities that were used.

Table 5.2. Canadian dairy elasticities

	Cheese	SMP	Butter	Ice cream	Yogurt
Demand	-0.23	-0.19	-0.4	-0.62	-0.81
Supply	0.06	1.18	0.39	0.32	0.15

Source: FAPRI 2009

As previously mentioned, in 2007, there was a hike in most commodity prices. For example, oil prices jumped, thus increasing transportation costs, which in turn increased crop prices. This also meant that the cost of production for milk increased around the globe. World prices used in this study are based on a 2003-2008 average price, which should be more representative of market conditions.

In order for stochastic prices of all dairy products to move together, the simulation model needed a variance-covariance matrix which would add real world price parameters to the stochastic world price shocks. Using Excel, a covariance matrix was built using world price data from 1995-2010, for the five dairy products. This also gave the variance and mean for each product. Correlations between price pairings were then calculated.

The covariance matrix and means were then placed into the uncertainty portion of the model, in order to simulate the reaction of domestic prices to world price volatility. The stochastic portion of the model then ran 1200 iterations, each time choosing random world prices for each product. These prices were linked by their covariances, and, accordingly, their movement patterns were based on historical data so that when world prices were higher than the original domestic prices, the model would default to the original domestic price.

The prices, which were generated using the stochastic section of the model, were then used to calculate the supply and demand of the dairy products and were also used to calculate producer and consumer surplus. The difference in welfare for both producers and consumers were then put into a distribution. It was found that some products were highly correlated such as butter and SMP, and some were not, such as ice cream and SMP. Table 5.3 illustrates the correlation of the relationships between dairy prices. The correlation measures the magnitude of the relationship between products.

Table 5.3. World price correlation matrix

	Cheese	Butter	SMP	Yogurt	Ice Cream
Cheese	1				
Butter	0.7844	1			
SMP	0.6202	0.8478	1		
Yogurt	0.1653	0.5209	0.3666	1	
Ice Cream	-0.2673	-0.1998	-0.4293	0.4996	1

Source: Author's calculations

5.2 Simulation model

5.2.1 Demand

The PE model is constructed using a linear demand and supply equation for dairy products. The demand equation for a product is a function of its intercept, slope and price.

$$D_x = \alpha_x + \beta_x * P_x \quad (3)$$

Its functional form is linear. The demand for each product is based on its own demand elasticity and price. In this study, cross price effects were not considered for demand, instead, cross price effects were applied to supply.

5.2.2 Supply

It is not possible to specify a supply function for supply managed commodities such as dairy, since the quantity of supplied product is restricted below the competitive level. The output is not determined by the market, and thus the farm price exceeds the marginal cost. Thus, supply is a function of marginal cost, however marginal cost is unobserved. Using methods proposed by Moschini and Meilke (1991), a supply curve was constructed using the marginal cost from the value of production quota

$$P_{MC} = P_{blend} - Qr, \quad (4)$$

where P_{MC} is the marginal cost price, P_{blend} is the blend price, and Qr is the rental rate of production quota.

Table 5.4. Discount rates and marginal costs

Quota value (\$)	Discount rate	Rental rate (\$)	Blend price (\$)	Marginal cost (\$)
27,993.470	0.050	1,399.673	5,787.161	4,387.488
27,993.470	0.125	3,499.184	5,787.161	2,287.977
27,993.470	0.200	5,598.694	5,787.161	188.467

Source: Author's Calculations

Table 5.4 demonstrates how a range of different discount rates will provide a different rental rate and different marginal costs. The more accurate the discount rate, the more accurate the marginal cost.

The quota rental value can be determined by using the capital value of production quota and the discount rate.

$$Qr = Qv * i, \quad (5)$$

where Q_v is the capital value of production quota and i is the discount rate.

The supply of milk is a combined function of its slope, the blend price for raw milk, the marginal cost of milk, and the elasticity of supply for fluid milk. Milk production targets are set by the National Milk Marketing Plan, and it is divided between producers through MSQ. As a result, milk production is not set competitively but is administered.

$$X_m = \alpha_{xm} + (\varepsilon_{xm}(\text{milk}_{\text{produced}}/P_{\text{blend}}) * P_{MC}). \quad (6)$$

The supply equation for dairy products is a function of its price, the price and weight of bf and nfs, and the price of the other dairy products. This is formalized as:

$$S = f [(P_c - \mu_1 * P_{bf} - \mu_2 * P_{nfs}), (P_b - \mu_3 * P_{bf} - \mu_4 * P_{nfs}), (P_{smp} - \mu_5 * P_{bf} - \mu_6 * P_{nfs}), \\ (P_y - \mu_7 * P_{bf} - \mu_8 * P_{nfs}), (P_{ic} - \mu_9 * P_{bf} - \mu_{10} * P_{nfs})] \quad (7)$$

where P_c , P_b , P_{smp} , P_y and P_{ic} , are the prices of cheese, butter, skim milk powder, yogurt and ice cream respectively. μ_x represent the weights of butterfat or non-fat solids in the dairy products and P_{bf} and P_{nfs} are the price of butterfat and non-fat solids.

In order for the model to reach equilibrium it must adhere to a few constraints. The first market clearing identity requires that the demand of a dairy product must equal its supply, the change in inventory, and the imports.

$$D_x = S_x + F_x + I_x. \quad (8)$$

The supply of milk must also be equal to the demand for the milk that is used for the production of all dairy products. This needs to be accounted for since a change in the supply of one product creates a change in the demand for butterfat and non-fat solids necessitating the reallocation of bf and nfs to a new dairy product. These market clearing conditions are:

$$X_m = (S_c * \mu_2 + S_b * \mu_4 + S_{smp} * \mu_6 + S_y * \mu_8 + S_{ic} * \mu_{10}) / \lambda_{nfs} \quad (9)$$

$$X_m = (S_c * \mu_1 + S_b * \mu_3 + S_{smp} * \mu_5 + S_y * \mu_7 + S_{ic} * \mu_9) / \lambda_{bf} \quad (10)$$

Table 5.5 illustrates the partial equilibrium model used in this research. It defines supply and demand functions both at the farm and wholesale level. As well, the market clearing conditions are included.

Table 5.5. Partial equilibrium model of the Canadian dairy sector

Farm level

Supply of milk for processing (X_m)	$X_m = \alpha_{xm} + (\varepsilon_{xm} (\text{milk}_{\text{produced}} / P_{\text{blend}}) * P_{MC})$
Producer blend price of milk (P_{blend})	$P_{\text{blend}} = P_{\text{bf}} * w_{\text{bf}} + P_{\text{nfs}} * w_{\text{nfs}}$
Marginal cost (P_{MC})	$P_{MC} = P_{\text{blend}} - Qr$
Quota rental value (Qr)	$Qr = Qv * i$

Wholesale level

Cheese demand (D_c)	$D_c = \alpha_c + \beta_{dc} * P_c$
Butter demand (D_b)	$D_b = \alpha_{db} + \beta_{db} * P_b$
SMP demand (D_{smp})	$D_{\text{smp}} = \alpha_{\text{dsmp}} + \beta_{\text{dsmp}} * P_{\text{smp}}$
Yogurt demand (D_y)	$D_y = \alpha_{dy} + \beta_{dy} * P_y$
Ice cream demand (D_{ic})	$D_{ic} = \alpha_{dic} + \beta_{dic} * P_{ic}$
Domestic supply of cheese (S_c)	$S_c = \alpha_{sc} + \beta_{sc} * (P_c - \mu_1 * P_{\text{bf}} - \mu_2 * P_{\text{nfs}})$
Domestic supply of butter (S_b)	$S_b = \alpha_{sb} + \beta_{sb} * (P_b - \mu_3 * P_{\text{bf}} - \mu_4 * P_{\text{nfs}})$
Domestic supply of SMP (S_{smp})	$S_{\text{smp}} = \alpha_{\text{ssmp}} + \beta_{\text{ssmp}} * (P_{\text{smp}} - \mu_5 * P_{\text{bf}} - \mu_6 * P_{\text{nfs}})$
Domestic supply of yogurt (S_y)	$S_y = \alpha_{sy} + \beta_{sy} * (P_y - \mu_7 * P_{\text{bf}} - \mu_8 * P_{\text{nfs}})$
Domestic supply of ice cream (S_{ic})	$S_{ic} = \alpha_{sic} + \beta_{sic} * (P_{ic} - \mu_9 * P_{\text{bf}} - \mu_{10} * P_{\text{nfs}})$

Market clearing conditions

$$D_c = S_c + F_c + I_c$$

$$D_b = S_b + F_b + I_b$$

$$D_{\text{smp}} = S_{\text{smp}} + F_{\text{smp}} + I_{\text{smp}}$$

$$D_y = S_y + F_y + I_y$$

$$D_{ic} = S_{ic} + F_{ic} + I_{ic}$$

$$X_m = (S_c * \mu_1 + S_b * \mu_3 + S_{\text{smp}} * \mu_5 + S_y * \mu_7 + S_{ic} * \mu_9) / \lambda_{\text{bf}}$$

$$X_m = (S_c * \mu_2 + S_b * \mu_4 + S_{\text{smp}} * \mu_6 + S_y * \mu_8 + S_{ic} * \mu_{10}) / \lambda_{\text{nfs}}$$

where:

μ_1 and μ_2 are the proportions of bf and nfs in cheese

μ_3 and μ_4 are the proportions of bf and nfs in butter

μ_5 and μ_6 are the proportions of bf and nfs in SMP

μ_7 and μ_8 are the proportions of bf and nfs in yogurt

μ_9 and μ_{10} are the proportions of bf and nfs in ice cream

Qv is the quota value

i is the discount rate

w_{bf} and w_{nfs} are the proportions of bf and nfs in raw milk

$F_c, F_b, F_{\text{smp}}, F_y, F_{ic}$ are the current amount of cheese, butter, SMP, yogurt and ice cream imports

$I_c, I_b, I_{\text{smp}}, I_y, I_{ic}$ are the potential amount of cheese, butter, SMP, yogurt and ice cream imports

λ_{bf} and λ_{nfs} are the proportions of bf and nfs in processed milk

5.2.3 Supply when producers are risk averse

Producers, when faced with risk, are either risk averse³ or risk neutral. Both reactions will have a different utility curve. The utility curve will then impact the supply curve in the model. The more risk averse the producer, the less inclined he or she will be to increase the quantity supplied as prices increase because of a possible risk premium. Risk aversion will shift the supply curve to the left.

Constant relative risk aversion (CRRA) means that preferences among risky choices remain unchanged if all of the payoffs are multiplied by a positive constant (Hardaker, Huirne, Anderson and Lien 2004). Thus, if the wealth of one person increases, that person will still hold the same percentage of risky assets that they had when they had more or less wealth. Their risk aversion is constant at all points of wealth.

According to Anderson and Dillon (1992), risk aversion can be measured on a scale of 0.5 to 4 where 0.5 is hardly risk averse and 4 being extremely risk averse. Studies using this measure of risk aversion for producers, suggest that producers should be considered as extremely risk averse. Gunjal and Legault (1995) looked at the risk aversion of hog and dairy producers and determined that producers of both commodities are very risk averse. This study supported what agricultural economic theory has assumed for the last century.

Previous studies have assumed that chicken producers are extremely risk averse, and were assigned a CRRA of 4 (Rude and Gervais 2006). This thesis proposes that dairy producers are more risk averse than hog producers but less risk averse than chicken producers. This is proposed because dairy quota is much more expensive than chicken

³ Risk aversion: The reluctance to accept a riskier outcome, even though more profitable, than one which has a certain outcome.

quota and thus has a greater start up cost. As well, should supply management undergo a restructuring and see the elimination of the MSQ, dairy producers would have more to lose than chicken producers. This thesis has thus assigned a CRRA value of 3.

Table 5.6. Constant relative risk aversion classification

$r_r(w)$	Degree of risk aversion
0.5	hardly risk averse at all
1.0	somewhat risk averse
2.0	Rather risk averse
3.0	very risk averse
4.0	extremely risk averse

Source: Anderson and Dillon (1992)

In order to introduce price uncertainty into the model, TSP International was used to simulate and account for the covariance between products. This covariance was taken from time series data for all five dairy products from 1995-2010 and the mean was calculated for all dairy prices. The covariance matrix and the means were then inserted into the risk simulation and the distribution of welfare impact was measured.

Chapter 6: Conceptual Model

6.1. Trade liberalization scenarios

6.1.1 Latest modalities

Since the DDA round of negotiations has not been concluded, this thesis will focus on the proposed options for trade liberalization. The DDA proposes to increase the MAC of agricultural products, while lowering their over-quota tariffs. Proposed reforms for developed countries will reduce over-quota tariffs by anywhere from fifty to seventy percent (WTO 2008), unless the product is deemed as “sensitive.” Each member country may determine which of their products are to be considered as “sensitive”. Non-sensitive products for developed countries will be required to abide by a tiered formula for their tariff reductions. If tariffs are over seventy-five percent (all dairy products are in this tier) then the tariffs need to be cut by seventy percent. The DDA also proposes that MAC be increased by an additional five percent of the previous year’s domestic consumption.

Four to six percent of tariff lines (per country) can be deemed as sensitive. This is decided by the country in question. Since dairy is the largest supply managed commodity in Canada, it is quite likely that some (if not all) of its tariff lines will be considered as sensitive products. If dairy products are deemed as sensitive, then the modalities are slightly different. Tariffs on sensitive products could be cut by one-third, one-half, or two-thirds of the reduction that would be required by the non-sensitive product reduction formula. Since all dairy products would normally need to be cut by seventy percent, then the three tier cuts would be: forty-six, thirty-five or twenty-three percent. However, in order to be eligible for lower tariff cuts, access needs to be expanded by a greater amount.

In order to be able to choose the forty-six percent tariff cuts, import expansion must be between three to five percent of domestic consumption. If the smallest tariff cut of twenty-three percent is chosen, import expansion needs to be increased by four to six percent of domestic consumption.

6.1.2 Liberalization with supply management

If a TRQ is not filled, and thus not binding, then the TRQ mechanism is not working. The quota fill rates refer to the amount of the quota that is actually used. If the fill rates are above one hundred percent, then the tariff is binding. In 2007, all twenty lines of dairy products were binding.

Table 6.1. Canadian dairy import quota fill rates

2007	TRQ (000 kg)	Imports under TRQ (000 kg)	Quota fill rate (%)
Butter	3,274.0	3,274.0	100.0
Cheese	20,411.9	25,493.7	125.0
SMP	0.0	2,864.8	-
Ice cream	484.0	543.6	112.0
Yogurt	332.0	496.9	150.0

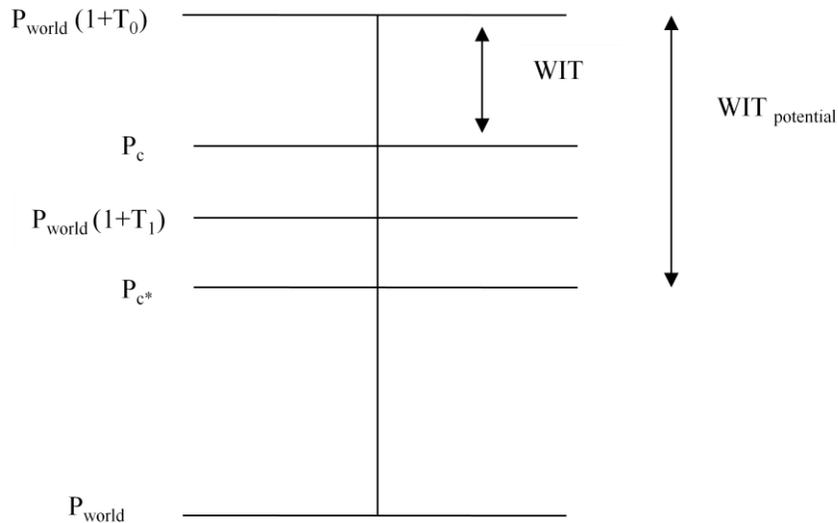
Source: WTO 2009

6.1.2.1. Over-quota tariff reduction

In order to calculate the impacts of tariff reduction, the WIT first needs to be calculated. If the tariff reduction is more than the WIT, then it will impact prices and welfare. If the tariff reduction is less than the WIT, it will not impact prices or welfare.

Figure 6.1 illustrates the point where over-quota tariffs have decreased from T_0 to T_1 . In this case, the landed price ($P_{\text{world}}(1+T_1)$) is less than the domestic price (P_c) and imports are able to enter the market. However, if domestic prices were P_{c^*} , then the landed price would be higher than the domestic price and no additional imports would enter the country. In the second case, the nominal rate of protection in the WIT would be enough to keep the landed price at a higher level than the domestic product.

Figure 6.1. Water in tariff



Source: Barichello and Zhang (2008)

Once the WIT has been calculated, and ruled that indeed the over-quota tariff reduction will be larger than the water, then it is necessary to add the tariff reductions to the simulation model. In order to keep production constant, milk supply and landed prices were held exogenously. This means that, depending on demand, the supply for dairy products would need to shift to the dairy product that would be the most profitable. Given that production remained constant, there should not be an increase or decrease in marginal cost. Assuming that the marketing board would not change the way it functions, this is most likely a short run assumption. The marketing board's stance would most likely change once cheap imports flood the market and producers see an erosion of both revenue and welfare.

Assuming the marketing board is rational, it would set the domestic wholesale price at the same level as the landed world price. This would increase domestic production to the level of domestic consumption causing the shortfall in dairy supply to

be met by domestic production and not imports. In order to model this scenario, fixed milk production was: increased by three percent, a risk premium was added to the supply of milk and product prices and imports were treated endogenously. This scenario has the potential to improve the competitiveness of Canadian dairy on the world market.

Table 6.2. Potential dairy cuts (%)

	Current tariff	New tariff (70% cut)	New tariff (46% cut)	New tariff (35% cut)
Butter	298.70	89.61	161.29	194.15
SMP	201.50	60.45	108.81	130.97
Cheese	245.60	73.68	132.62	159.64
Yogurt	237.50	71.25	128.25	154.37
Ice Cream	243.40	73.02	131.43	158.21

Source: WTO 2009

6.1.2.2 MAC increases

The proposed WTO modalities suggest that increases in MAC are based on the previous year's consumption. This thesis used 2007 consumption data (AAFC 2008a) and calculated the increases in MAC based on a percentage (three to six percent) of the consumption data.

In order to simulate the impact of increasing market access commitments, it was necessary to look at potential import increases. Depending on the chosen modality, imports could increase an additional three to six percent (of previous year's consumption) from what is currently imported into Canada. As this thesis applied the same percentage increase in imports equally to all five dairy products, the shock in imports will equally impact the entire dairy sector. In order to apply this import shock, 2006 consumption was calculated and a three, four, five and six percent increase in the import quota was calculated. This would be the new additional imports. This increase in MAC was added to the model. The import shock was introduced exogenously and the model then determined how the increase in imports affects supply, demand, price and welfare.

6.1.2.3 Producer risk aversion

A risk premium was added to the supply function. The risk premium is defined as the amount that a risk-averse producer is willing to pay as insurance against a price risk (Rude and Gervais 2006). If producers are risk neutral, a risk premium would have no impact on domestic supply; however, if producers are risk averse, as assumed by this study, the risk premium would impact domestic supply. The risk premium is only added to the over-quota tariff liberalization scenarios, since increases in MAC will still ensure price certainty. This is due to the fact that MAC increases are increased by a set amount, and it is assumed they will not vary with world prices. When adding the risk premium for a risk averse producer, the marginal cost increases as well. Thus, the original marginal cost would increase.

The risk premium was added to the supply of milk. Processors are assumed to be risk neutral. The risk premium (θ), is calculated by taking the constant absolute risk aversion (CARA), multiplying it by the supply variance and multiplying it by the original quantity of milk supplied for 2007 (AAFC 2009a).

$$\theta = \text{CARA} * \sigma^2 * Q \quad (11)$$

where θ is the risk premium and the σ^2 is the variance of the producer blend price.

In order to obtain the CARA, the CRRA needs to be divided by π .

$$\text{CARA} = \text{CRRA} / \pi ; \quad (12)$$

where CRRA is taken from Table 5.6.

Where

$$\pi = P_{\text{blend}} * Q - \left(-\frac{\kappa}{\gamma} \right) * Q - \frac{1}{\gamma} * \frac{Q^2}{2}; \quad (13)$$

where

$$\gamma = \varepsilon_s * Q / MC ; \quad (14)$$

and

$$\kappa = Q - \gamma + MC ; \quad (15)$$

where Q is the raw milk supply for industrial use for 2007, MC is the marginal cost for 2007, and ε_s is the supply elasticity for milk.

If a producer is risk neutral (CRRA=0), the risk premium will not impact the amount of milk produced. When the CRRA is greater than 0, it will impact the milk supply. For instance, a CRRA of 3 will theoretically decrease production, since a risk averse producer is more likely to produce less than a risk neutral producer, and much less than a risk seeking producer.

Once these scenarios have been simulated, a welfare analysis will be conducted. This analysis will examine effects on producers and consumers. This overall welfare analysis will estimate how expected trade reforms will impact the Canadian dairy industry.

6.1.3 TRQ liberalization scenarios

Scenario 1 assumes that dairy products are deemed sensitive, the over-quota tariff will be cut by thirty-five percent and production will remain constant. In this scenario, the cut in the over-quota tariff eats up a large portion of the WIT; however, the nominal rate of protection is not eroded. Since there is still WIT, landed prices will remain higher than domestic prices and the over-quota tariff reduction will not impact welfare. This scenario is then run stochastically.

Scenario 2 assumes that dairy products are not considered as sensitive products and that the over-quota tariff is cut by seventy percent. The cut in the over-quota tariff

will be larger than the WIT with landed prices lower than domestic prices. In this scenario a risk premium is added to the milk supply and the marketing board will increase production.

In scenario 3, dairy products are deemed sensitive; however, over-quota tariffs are cut by forty-six percent. This decrease in the over-quota tariff is larger than the WIT for cheese, butter and SMP. Due to this, the marketing board will lower the domestic prices for these three products to equal the landed price and yogurt and ice cream will keep their original domestic price. A risk premium is added to the supply and the marketing board will increase production.

Since the DDA negotiations have not yet been completed, this thesis will explore a few possible scenarios, given certain assumptions. The first assumption which will impact scenario 1 is that production will be held constant. That means that MSQ will be at the same level as it was previously and that all additional demand will be fulfilled by imports. Scenarios 2 and 3 will include a risk premium while increasing production. Scenario 1 will cut over-quota tariffs by thirty-five percent. Scenario 2 will decrease over-quota tariffs by seventy percent. Scenario 3 will decrease over-quota tariffs by forty-six percent. In all the scenarios, world price uncertainty will be added in order to create a distribution of welfare effects. Looking at the entire distribution of welfare effects, gives this thesis the scope to examine all potential impacts of trade liberalization and not just one point in the distribution. As well, scenarios 1 and 3 consider dairy products to be sensitive, and scenario 2 considers dairy products to be non-sensitive. Table 6.3 demonstrates the scenarios.

Table 6.3. Over-quota tariff liberalization scenarios

	Scenarios		
	1	2	3
Product classification	Sensitive	Non-Sensitive	Sensitive
Tariff reduction (%)	35	70	46
Production	Constant	Increased	Increased
Domestic Prices	Constant	Lowered	Lowered
Risk Premium	N/A	Applied	Applied

This thesis will then explore four MAC increase scenarios. The first scenario will increase MAC by three percent, the second will increase MAC by four percent, the third will increase MAC by five percent, and the last scenario will increase MAC by six percent. All four scenarios will examine the impact of MAC increases on domestic and landed prices, supply, demand, marginal cost, producer revenue and surplus, consumer surplus, and overall welfare impacts. The four scenarios will also look at imports and the shift of supply from one dairy product to the other.

6.2. Welfare analysis

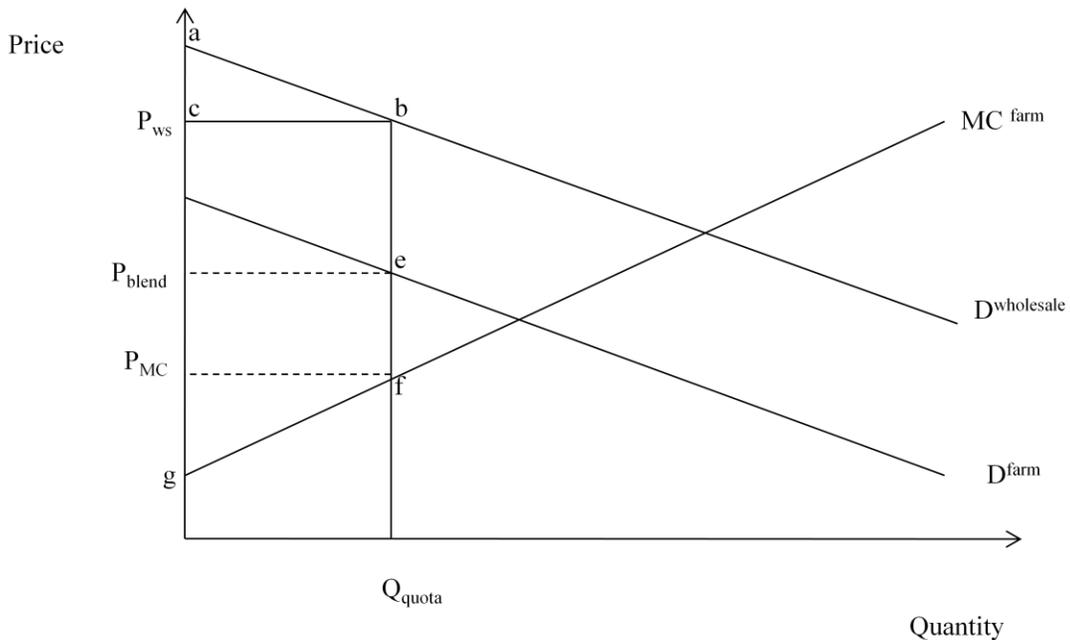
All over-quota tariff and MAC liberalization scenarios will be compared to the baseline. Overall welfare will be measured by changes in consumer and producer surplus relative to the baseline. All scenarios will then be analyzed and discussed.

Assumptions were made when constructing the scenarios. First, as previously shown in this thesis, Canada is considered a small country and its pricing policies have no impact on world prices. Secondly, wholesale price margins are assumed to remain constant. Thirdly, if production remains constant, so will marginal cost.

6.2.1 Baseline

The base welfare analysis for this study demonstrates what is currently happening in the supply-managed dairy system. Figure 6.2 illustrates the current dairy market situation with supply management at the farm level and the importation of a small quantity of imports under the in-quota tariff.

Figure 6.2. Baseline



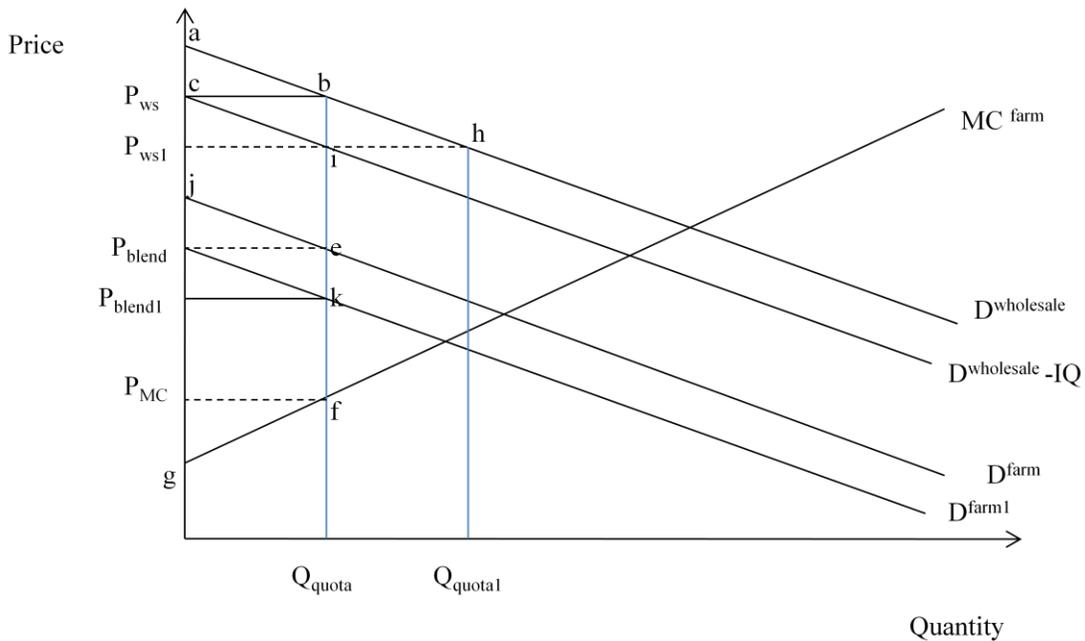
Under the pricing mechanism pillar of supply management, prices are set at an administered level. This administered level is P_{blend} , while marginal cost is represented by P_{MC} , as well the domestic wholesale price is represented by P_{ws} . $D^{wholesale}$ is the demand at the wholesale level, D^{farm} is the demand at the farm level. Q_{quota} is the domestic supply of dairy products. Processor cost is the $cbeP_{blend}$ area. Consumer surplus, which in this study is wholesaler's surplus, is the area under the $D^{wholesale}$ curve and above the wholesale price P_{ws} . The original consumer surplus is the abc area. Producer surplus is the area under the demand curve and above the supply curve; it is measured as $P_{blendefg}$.

6.2.2 MAC increase with constant production

An increase in the MACs will occur at the wholesale level. Facing an increase in MACs, this thesis assumes that a marketing board will do one of two things: a) hold production constant and let prices fall or b) hold price constant and decrease production⁴.

Figure 6.3 illustrates the impact of increasing MACs while holding production constant on consumer and producer surplus. The increase in the in-quota access will be illustrated as IQ , and the difference between Q_{quota} and Q_{quota1} are imports. An increase in market access decreases the domestic wholesale demand, which, in turn, decreases the wholesale price from P_{ws} to P_{ws1} . With the increase in MAC, there will be a decrease of demand at the farm level. Domestic prices will decrease from P_{blend} to P_{blend1} . Since production remains constant, the marginal cost remains the same. Consumer surplus has increased by $cbhP_{ws1}$ and producer surplus has decreased by $P_{blend}ekP_{blend1}$.

Figure 6.3. MAC increase with constant production

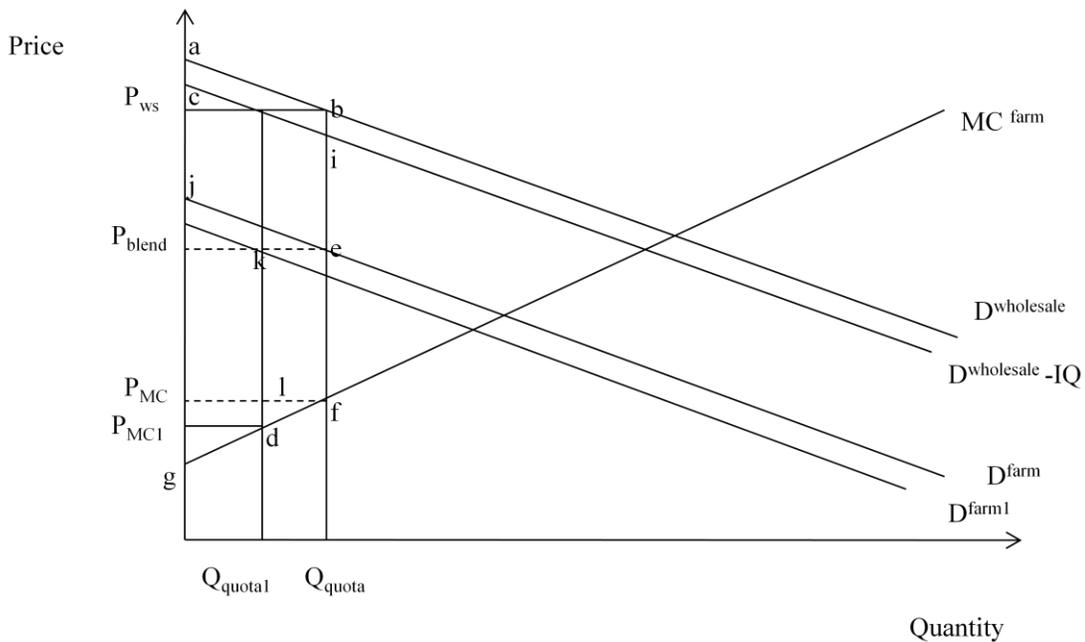


⁴ There are intermediate cases; however this research focused on the two extreme cases.

6.2.3 MAC increase with decrease in production

Figure 6.4 demonstrates the impact of MAC increase, on welfare when prices remain constant. The increase in the in-quota access will be illustrated as IQ. Domestic farm demand has decreased by the same amount as the increase in IQ. Domestic production is now Q_{quota1} and the difference between Q_{quota} and Q_{quota1} are the imports. In this case, P_{ws} remains constant, and so does P_{blend} . Marginal cost decreases to P_{MC1} . Consumer surplus remains constant at abc . Producer surplus is now $P_{\text{blend}}kgd$.

Figure 6.4. MAC increase with constant prices, and decrease in production

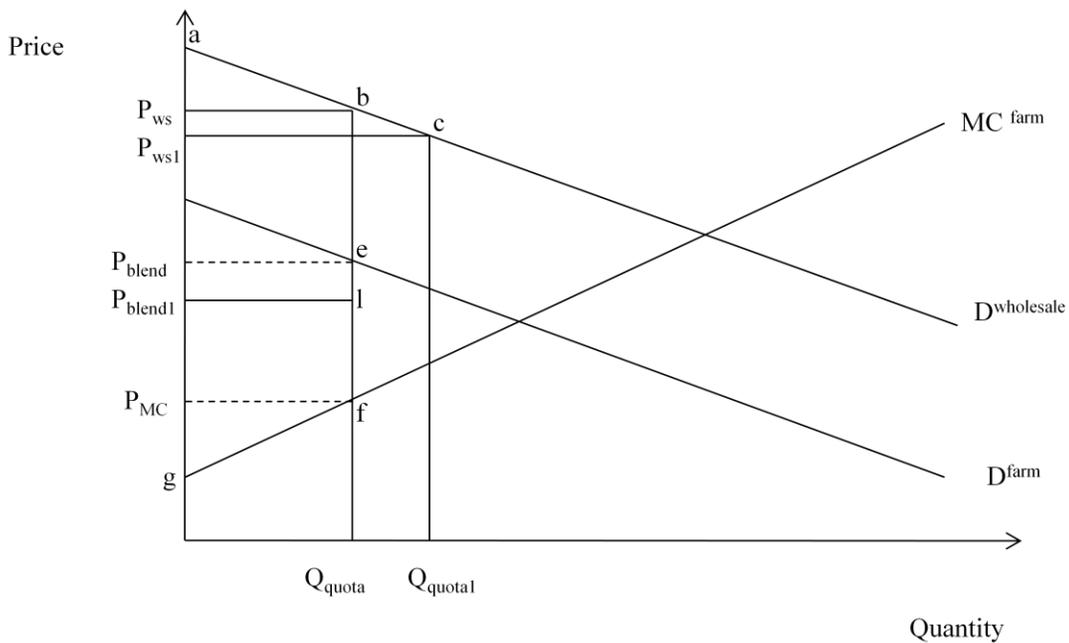


In both MAC scenarios there is a change in producer surplus. Constant production makes producer surplus equal to $P_{\text{blend}}kfg$ and decreasing production makes producer surplus $P_{\text{blend}}kdg$. Producer surplus is impacted when production is kept constant. This area can be measured as $P_{\text{ws}}lha$. Decreasing production to keep prices constant will also keep consumer surplus constant as the abc area.

6.2.4 Tariff reduction with constant production

If over-quota tariffs are reduced by more than the WIT, and that landed prices fall below the domestic price, this research assumes that the marketing board may make one of two decisions: hold production constant, or make the landed price the new administered price, and set production quota accordingly. Figure 6.5 illustrates the impact of decreasing over-quota tariffs while keeping production constant.

Figure 6.5. Over-quota tariff decrease with constant production

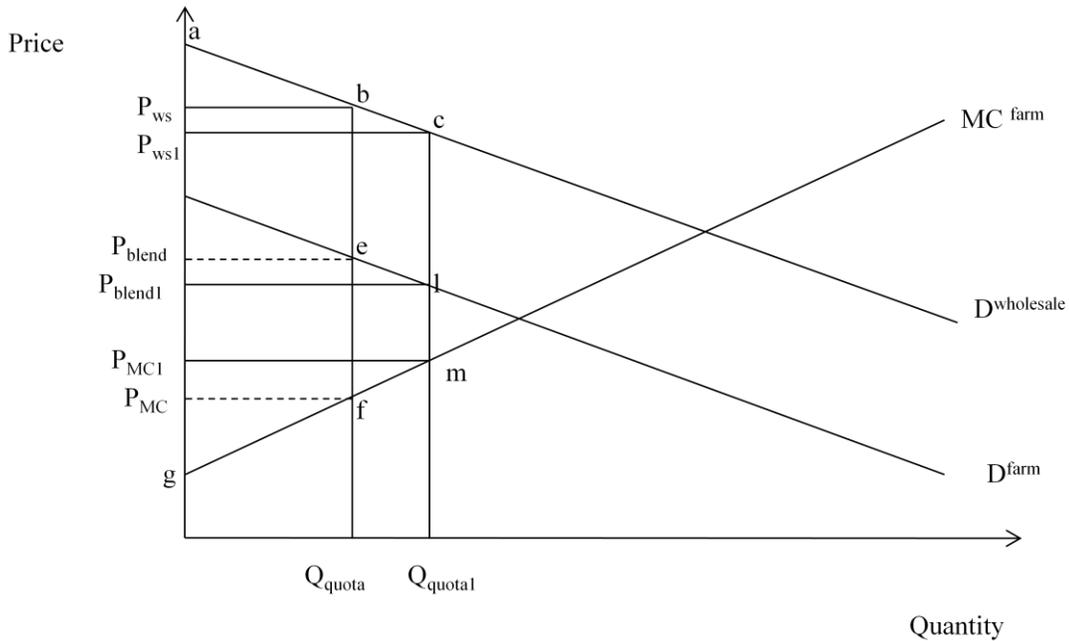


When production is held constant, the marketing board will lower the P_{ws} to be equal to the landed price, which in the case is P_{ws1} . Since it is assumed that marketing margin will stay the same, P_{blend} will be lowered to the P_{blend1} . Since production is constant, P_{MC} will remain constant. Consumer welfare will increase by $P_{ws}bcP_{ws1}$. Producer surplus will decrease by $P_{blend}elP_{blend1}$. The imports are the difference between Q_{quota1} and Q_{quota} .

6.2.5 Tariff reduction with increased production

The extreme second option, that a marketing board may pursue, is to set the administered price on the basis of the landed price and to then set production quota accordingly. Figure 6.6 illustrates this option.

Figure 6.6. Over-quota tariff decrease with increased production



In this case, P_{ws1} is the new domestic price which equals landed price. P_{blend1} is the new farm price. Production quota has been increased from Q_{quota} to Q_{quota1} . Since production has increased, so has marginal cost, which is represented by P_{MCI} . Consumer welfare has increased by $P_{ws1}bcP_{ws}$. Producer welfare is now $P_{blend1}lmg$.

While reducing over-quota tariff in both scenarios should increase consumer surplus by the same amount, $P_{ws1}bcP_{ws}$, the reduction impacts the producer welfare differently. In the case of holding production constant, the difference between Q_{quota} to Q_{quota1} is the level of additional imports. This means that producer surplus is decreased to now equal $P_{blend1}fkg$. In the case where production is increased to a point where no

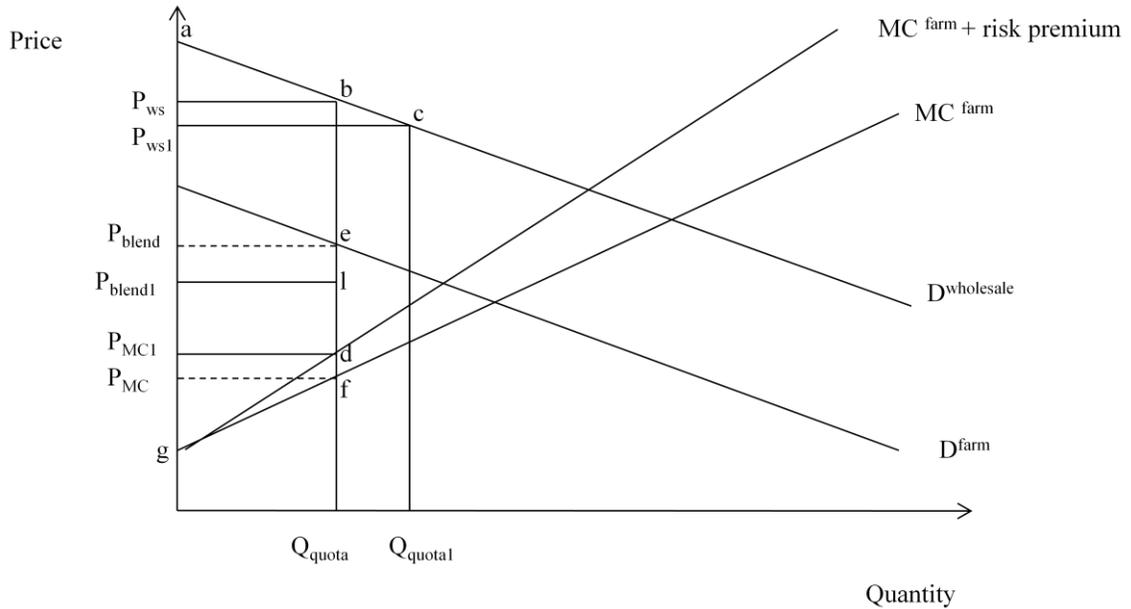
additional imports are permitted, the difference between Q_{quota} to Q_{quota1} is the increase in production quota. Thus, producer surplus will now equal $P_{\text{blend1}}lmg$.

Applying price uncertainty to both these scenarios will generate a distribution of consumer and producer surplus. This is because the stochastic nature of world prices will give a different landed price in each iteration; these landed prices may be above or below domestic prices. If the landed price is below the domestic prices, then domestic prices will decrease to match the landed price. If domestic prices are lower, then consumer surplus will increase. With lower domestic prices, the blend price decreases as well. If the blend price is lower than the original blend price, then producer surplus will change. In every iteration, there will be a new producer and consumer surplus due to changes in the domestic price. Due to the above, the impact of stochastic world prices is better illustrated in a distribution than in a static graph.

6.2.6 Over-quota tariff reduction with risk premium

When a risk premium is added to supply and there is a reduction in the over-quota tariff beyond the WIT, the supply curve will shift to the left by the amount of the risk premium. Figure 6.7 illustrates this scenario. P_{ws1} is the new domestic price, and P_{blend1} is the new farm price. The difference between Q_{quota1} and Q_{quota} is the amount of imports entering the market. Marginal cost increases from P_{MC} to P_{MC1} . Adding the risk premium to the marginal cost curve shifts the curve to the left by the amount of the premium. Consumer surplus does not change from a scenario that would not add a price premium, and remains as acP_{ws1} . Producer surplus is now however $P_{\text{blend1}}ldg$.

Figure 6.7. Tariff increase with a risk premium



6.3 Sensitivity analysis

Parameters such as discount rates and supply elasticities are estimated values previously obtained from different sources and methods. It is important to ascertain how sensitive the results of welfare analysis are to these parameters. A sensitivity analysis allows this study to determine sensitivity in the results by changes in the value of the parameters. This research will analyse the sensitivity of both discount rates and supply elasticities. This is because the both parameters were taken from previous research and were not estimated directly from the situation that is being analysed.

6.3.1 Discount rate

The discount rate is used to calculate the rental value of production quota and to estimate marginal cost. In order for the partial equilibrium model to accurately simulate supply and demand change, the discount rate should be properly estimated, since it is the basis for the marginal cost used in this study. Due to the supply-managed nature of the dairy industry, initial marginal cost may have less impact on supply than in a competitive

market since output in a supply managed system is not determined by market conditions but, rather, is set. However, the discount rate will still impact supply if the production quota is not filled.

The discount rate should reflect the risk associated with the asset in question. The greatest risk associated with production quota is that the value might be lost, if supply management is abolished. The risk assessment is also affected by expected capital gains, expected interest rates, and farm planning (Meilke, Sarker and Le Roy 1998). Discount rates used in other studies of the dairy industry have varied from 0.125 (Doyon, Brodeur and Gervais 2006) to 0.2 (Meilke, Sarker and Le Roy 1998), while discount rates for other supply managed commodities range from 0.07 to 0.10 (Moschini and Meilke 1991). This thesis will use the discount rate of 0.125. A sensitivity analysis will look at a range of discount rates (5, 12.5 and 20 percent) and will examine how sensitive the results in the model are to changes in the discount rate.

6.3.2 Supply elasticities

Supply elasticities are fundamental when determining producer welfare of the dairy market. Since elasticities for this study were not estimated but taken from previous studies (FAPRI 2009), it is possible that the actual supply elasticities will be more or less elastic than previously thought. Since each product has different supply elasticity, a sensitivity analysis will be conducted to see how sensitive producer welfare is to the change in the relationship between the elasticity of dairy supply and the slope of the supply curve. The sensitivity analysis will look at increasing and decreasing supply elasticities.

Chapter 7: Results and Discussion

7.1 Simulation model outcomes

The model was calibrated to observe 2007 quantities and prices using estimated supply and demand elasticities, as well as 2007 quantities and prices. These functions, described in section 5.2, are the parameters for the partial equilibrium model. TSP International was used to simultaneously solve the model's equations. The model was calibrated to historic levels of prices and quantities for 2007 so that the supply disposition equation balanced. Demand was a function of each dairy product and their relationship to each other, while the supply of milk was a function of its marginal cost. Marginal cost was subtracted from the average rental value of production quota for 2007.

7.2 Model results

7.2.1 Over-quota tariff reductions

Scenario 1: In this scenario, where over-quota tariffs are reduced by thirty-five percent, there are no changes in price, supply or demand. As table 7.1 illustrates, there is enough WIT that a thirty-five percent reduction in the tariff will not be large enough to allow foreign import entry into the domestic market. The over-quota tariffs will still ensure that landed prices remain higher than the domestic prices and that no additional foreign imports enter the market. As table 7.2 illustrates, the domestic market is still able to function as it did previously. This scenario ensures that the Canadian industry is relatively insulated from foreign imports. This scenario also looked at the impact of the addition of stochastic prices to the simulation to determine if the over-quota tariff would be binding. The distribution results are discussed later on in this chapter.

Table 7.1. Water in tariffs

	Butter	Cheese	SMP	Ice cream	Yogurt
CDN wholesale price (\$CDN/tonne)	6,900.00	8,740.00	5,950.00	3,660.00	3,172.35
Landed wholesale price (\$CDN/tonne ⁵)	2,119.65	2,962.00	2,513.51	2,005.10	1,778.67
Over-quota tariff (%)	298.70	245.60	201.50	243.40	237.50
Nominal rate of protection (%)	225.53	195.07	136.72	82.53	78.36
WIT (%)	73.17	50.53	64.78	160.87	159.14

Source: CDIC, USDA

Scenario 2: In scenario 2, dairy products are considered non-sensitive, over-quota tariffs are cut by seventy percent, milk production is increased, and a risk premium is added to the supply of milk. This scenario has the greatest impact on producers. As Table 7.2 illustrates, domestic cheese, butter and SMP prices are cut by at least thirty percent. Quantity demanded for all products increase, with the largest increase in butter demand (twelve percent). Despite the increase in domestic production, additional imports still enter the market. However, the SMP exports also increase.

The large cut in the over-quota tariffs also has an impact on the blend price of milk. In this case, milk prices decrease by forty percent; however, the blend price is still higher than marginal cost. Since production increases, there is also an increase in the marginal cost. Producer revenue is cut by over thirty-nine percent and producer surplus by fifty-nine percent while consumer surplus increases by over twelve percent. The increase in consumer surplus offsets the loss of producer surplus, ending with an eleven percent increase in overall welfare. Once price uncertainty is added to this scenario, there is a distribution of value for consumer and producer welfare, which will be discussed further in the chapter.

⁵ In order to calculate landed prices, 2003-2007 average Oceania wholesale dairy prices for cheese, butter and SMP, and US prices for yogurt and ice cream (CDIC 2009b), were multiplied by the average exchange rate for that period. Transportation costs and the applied tariff were added to the wholesale dairy prices, in turn generating a landed price for the dairy products.

Scenario 3: In scenario 3, products are considered sensitive, over-quota tariffs are cut by forty-six percent, milk production is increased, and a risk premium is added to the milk supply. In this scenario, the cut in the over-quota tariff does not erode the WIT for yogurt and ice cream. The cut in the tariff; however, is larger than the WIT for butter, cheese and SMP, whose prices are lowered to equal landed prices. Domestic prices for these products are thus reduced by ten, four and eighteen percent respectively.

With an increase in production, marginal cost increases as well. The domestic demand for cheese, butter and SMP is increased, the latter increasing by more than three percent. Imports for all products, except cheese, decrease. Producer revenue and surplus decrease by fourteen and twenty-seven percent, but these decreases are meagre in relation to the decreases for producer revenue and surplus in scenario 2. The decrease in producer surplus is offset by the increase in consumer surplus, and overall welfare increases by two percent.

Table 7.2. Results: over-quota tariff reduction

	Baseline	Scenario 1 (% change)	Scenario 2 (% change)	Scenario 3 (% change)
Landed price (\$CDN/ MT)				
Blend price of industrial milk (/tonne of solids)	5,786.95	0.00%	-40.70%	-15.85%
Cheese	11,619.07	-24.87%	-49.75%	-32.69%
Butter	10,045.84	-26.22%	-52.44%	-34.38%
SMP	7,047.56	-23.39%	-46.78%	-30.74%
Yogurt	6,003.00	-24.63%	-49.26%	-39.13%
Ice cream	6,649.94	-24.81%	-49.62%	-39.34%
Domestic price				
Cheese	8,740.00	0.00%	-33.19%	-10.52%
Butter	6,900.00	0.00%	-30.76%	-4.46%
SMP	5,950.00	0.00%	-36.97%	-17.97%
Yogurt	3,172.35	0.00%	-3.98%	0.00%
Ice cream	3,660.00	0.00%	-8.46%	0.00%
Marginal cost	2,287.57	0.00%	37.49%	37.49%
Domestic demand (MT)				
Cheese	377,200.00	0.00%	7.63%	2.42%
Butter	83,200.00	0.00%	12.30%	1.78%
SMP	30,300.00	0.00%	7.02%	3.41%
Yogurt	264,400.00	0.00%	3.23%	0.00%
Ice cream	191,500.00	0.00%	3.55%	0.00%
Imports (MT)				
Cheese	3,400.00	0.00%	938.21%	273.36%
Butter	-800.00	0.00%	442.43%	-493.84%
SMP	-50,400.00	0.00%	-17.77%	-14.88%
Yogurt	-700.00	0.00%	769.37%	-321.28%
Ice cream	-12,100.00	0.00%	3.49%	-38.24%
Domestic supply (MT)				
Cheese	373,800.00	0.00%	-0.83%	0.19%
Butter	84,000.00	0.00%	7.79%	6.52%
SMP	80,700.00	0.00%	13.73%	10.57%
Yogurt	265,100.00	0.00%	1.19%	0.85%
Ice cream	203,600.00	0.00%	3.13%	2.27%
Raw milk ('0 tonnes)	600,042.00	0.00%	2.42%	2.42%
Welfare results (\$ CDN '000 000)				
Producer revenue	3,472.41	0.00%	-39.27%	-13.82%
Producer surplus	2,786.09	0.00%	-59.00%	-27.28%
Consumer surplus	179,402.00	0.00%	12.14%	2.60%
Total welfare	182,188.00	0.00%	11.05%	2.14%

Source: Author's calculations

7.2.2. Uncertainty

Adding the stochastic world prices to the simulation model, impacts both producer and consumer welfare. Instead of having one static price, the simulation model ran over twelve hundred iterations of the model, each time using random world prices, which are based on historical means and covariances. This enabled the study to gather a distribution of results rather than one static result. Table 7.3 shows the distribution of adding price uncertainty to scenarios 1, 2 and 3.

Table 7.3. Welfare analysis under price uncertainty (\$ CDN '000 000 000)

	5%	95%	Mean	Std dev.	Kurtosis	Skewness
Scenario 1: 35% over-quota tariff cut with uncertainty						
Producer surplus	1.578	3.387	2.482	0.452	2.57	-1.757
Consumer Surplus	171.579	196.308	183.943	6.182	1.376	1.4244
Total Welfare	173.157	199.695				
Scenario 2: 70% over-quota tariff cut with uncertainty						
Producer Surplus	0.834	2.178	1.506	0.336	-0.282	0.552
Consumer Surplus	189.414	221.963	205.688	8.137	0.312	0.368
Total Welfare	190.248	224.141				
Scenario 3: 46% over-quota tariff cut with uncertainty						
Producer Surplus	1.245	3.036	2.141	0.447	-0.286	-0.967
Consumer Surplus	172.53	199.72	186.125	6.797	1.983	1.099
Total Welfare	173.775	202.756				

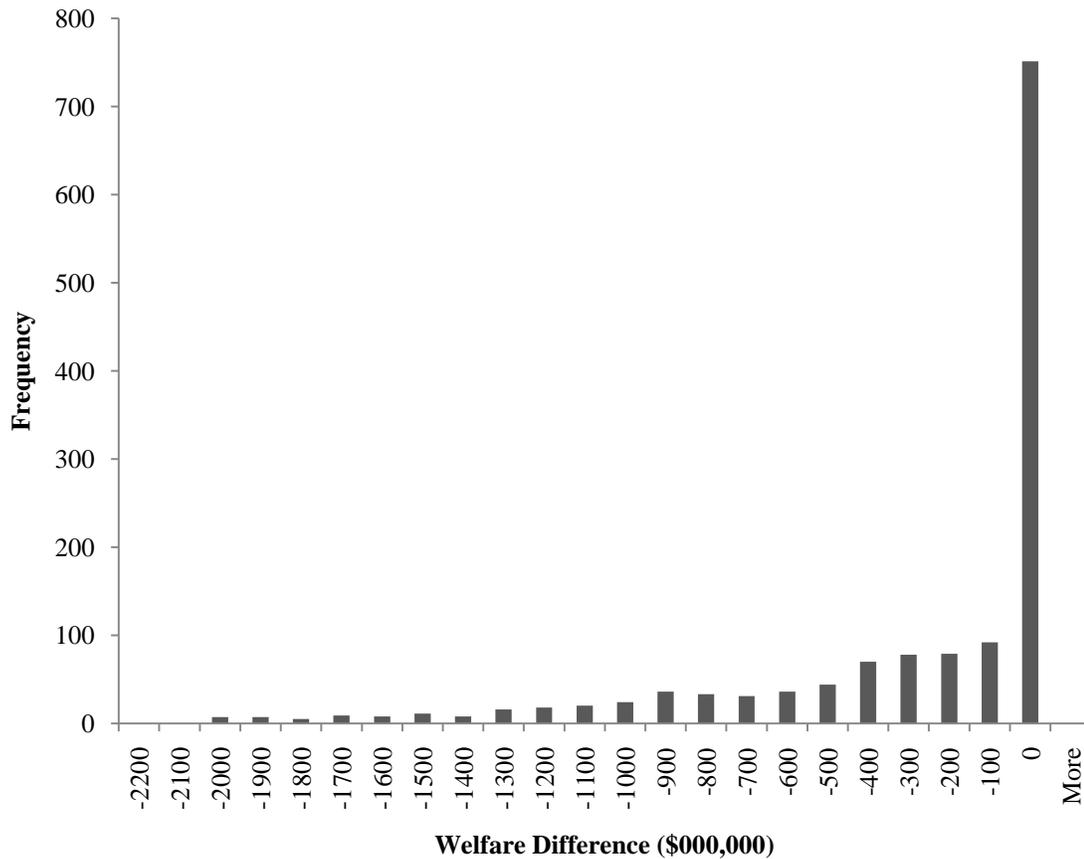
Source: Author's calculations

In scenario 1, where over-quota tariffs are cut by thirty-five percent, adding the price uncertainty to the scenario resulted in a distribution of welfare effects. Ninety percent of the time, producer surplus fell between \$1.58 and \$3.39 billion. Figure 7.1

illustrates the difference between the original producer surplus and the producer surplus when domestic prices are subject to world price volatility. The histogram demonstrates that the majority of the time the producer surplus does not change. This is because even with a thirty-five percent cut, the over-quota tariffs are still large enough to keep out foreign products. However, about fifty percent of the time, world prices are low enough that landed prices for dairy products are competitive on the Canadian market. This impacts producer surplus negatively.

Figure 7.1, shows the histogram for over twelve hundred iterations of the difference between original producer welfare and stochastic prices producer welfare for scenario 1. This producer surplus data has a skewed distribution. The kurtosis for this distribution is 2.57, while the kurtosis for a normal distribution is 3. The skewness is -1.757, which means that it is skewed to the left. The new producer surpluses are not normally distributed, and there is a large variability between the tails.

Figure 7.1 Changes in producer surplus for scenario 1

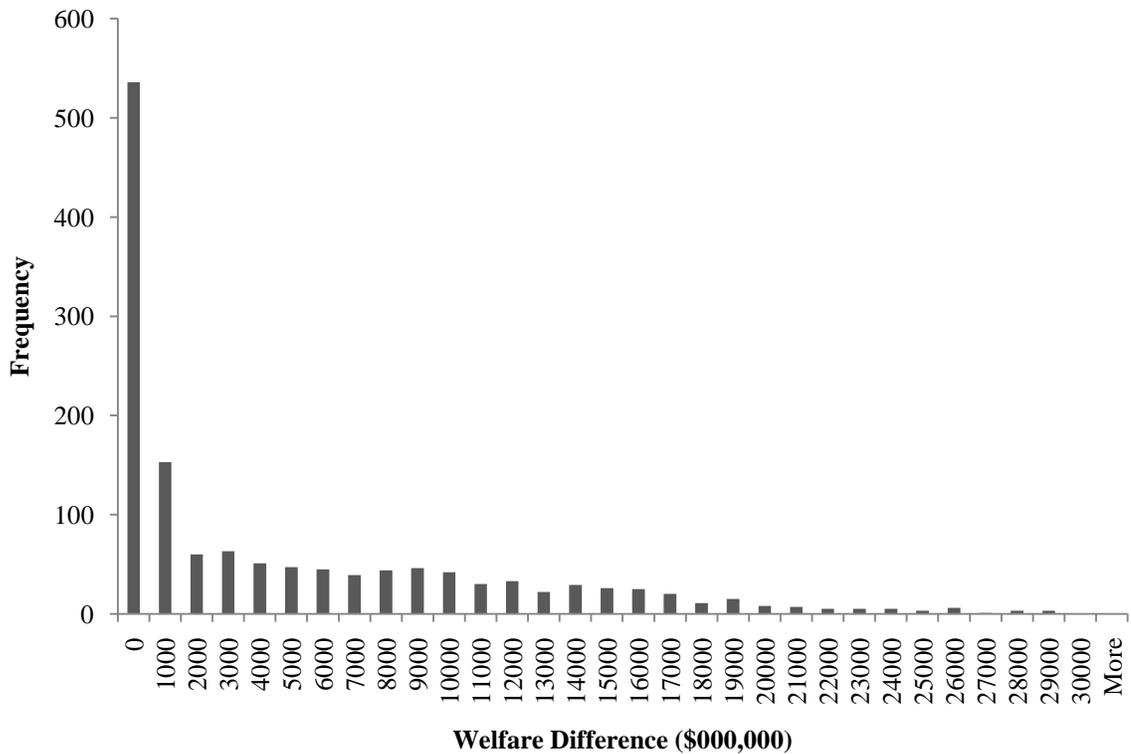


When there is a thirty-five percent cut in the over-quota tariff, consumer surplus is not impacted if the world dairy prices remain constant. This is unlikely to happen; however, given the volatility of international commodity prices. Ninety percent of the time, consumer surplus falls between \$171.58 and \$196.31 billion. This data has a skewed distribution. The kurtosis for this distribution is 1.376, which means the peak is lower than the peak of a normal distribution. The skewness is 1.424, which means that it is skewed to the right. The new consumer surpluses are thus not normally distributed, and there is a large variability between the tails.

Figure 7.2, which graphs the difference between original consumer welfare and the consumer welfare, was generated from the results of the stochastic simulations and

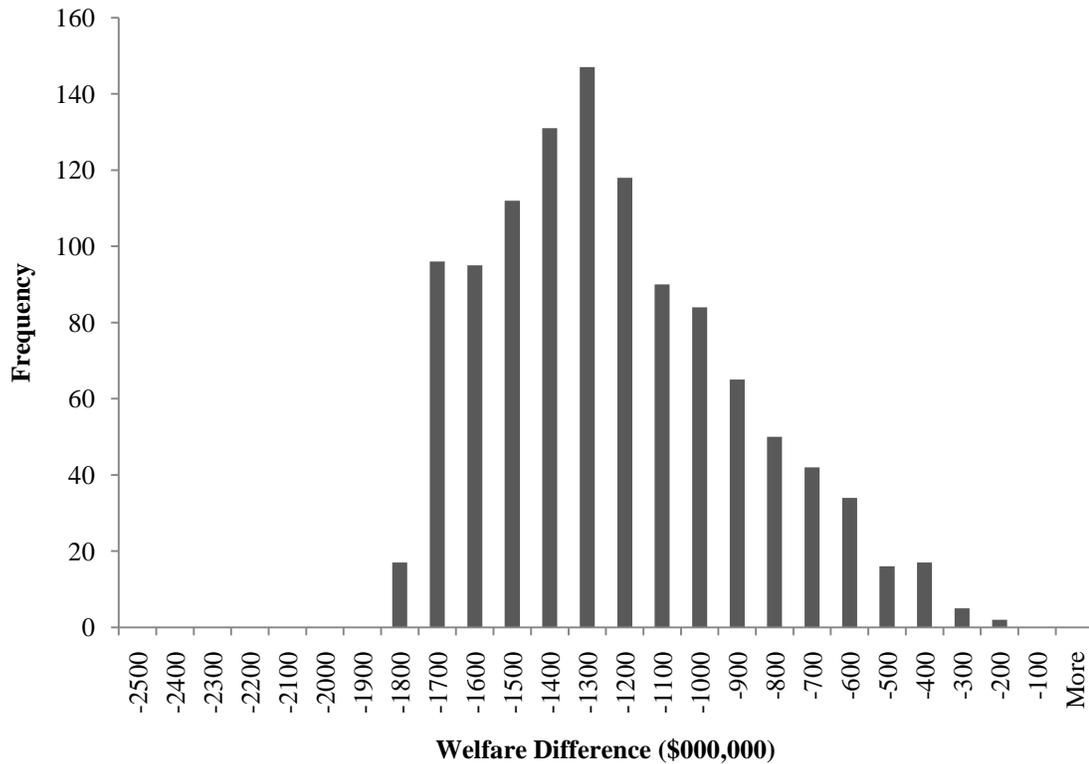
demonstrates the impact of volatile world prices on consumer surplus. This is shown with a histogram of the changes between original and new consumer surplus. The majority of the time, there is no change in consumer welfare, however there is an opportunity for consumer welfare to increase significantly.

Figure 7.2 Changes in consumer surplus for scenario 1



In scenario 2, where over-quota tariffs were cut by seventy percent, ninety percent of the time producer surplus falls between \$0.834 and \$2.178 billion. Thus, over ninety percent of the time, producer surplus falls below the original surplus of \$2.786 billion. Adding price variability to this scenario has an enormous impact on producers. Figure 7.3 illustrates the changes in producer surplus.

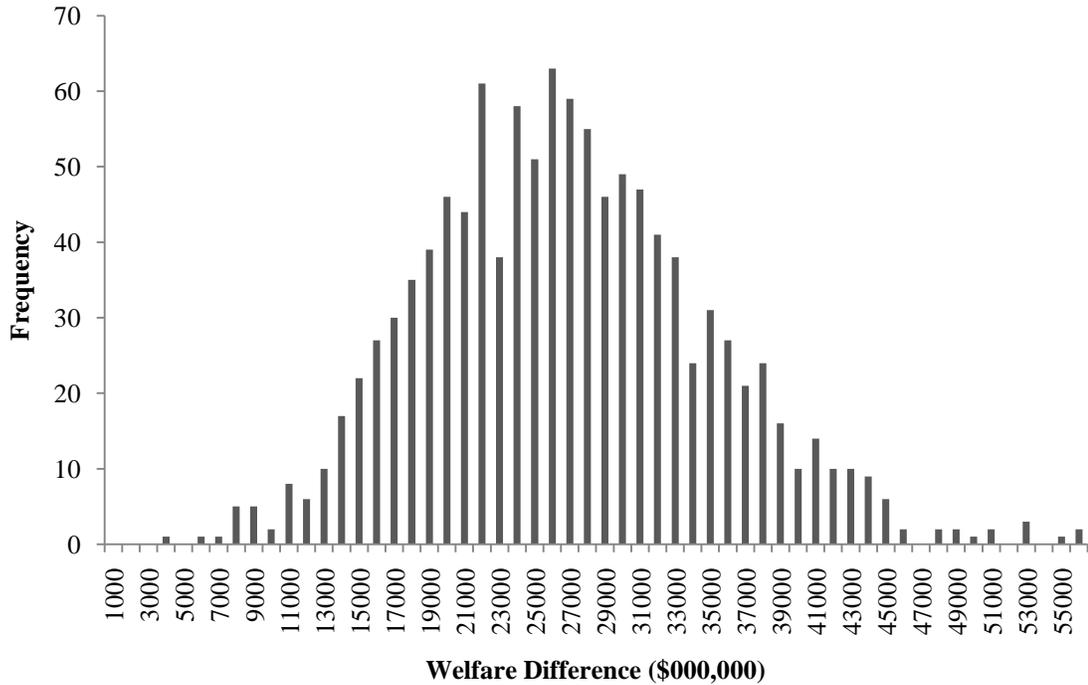
Figure 7.3. Changes in producer surplus for scenario 2



Source: Author's calculations

Consumer surplus varies when over-quota tariffs are cut by seventy percent, and a risk premium and world price variability is added. Ninety percent of the time, consumer surplus will be between \$189.414 and \$221.963 billion. This is much larger than the original consumer surplus of \$179.402 billion. Thus the majority of the time consumers will be better off with a seventy percent cut in over-quota tariffs. The distribution of consumer surplus, which was derived from twelve hundred iterations, shows that the kurtosis for consumer surplus is 0.312, making the peak lower than a normal distribution. As well, the data is skewed slightly to the right, with a skewness of 0.368. Figure 7.4 illustrates the impact of stochastic world prices on the change in consumer surplus.

Figure 7.4. Changes in consumer surplus for scenario 2



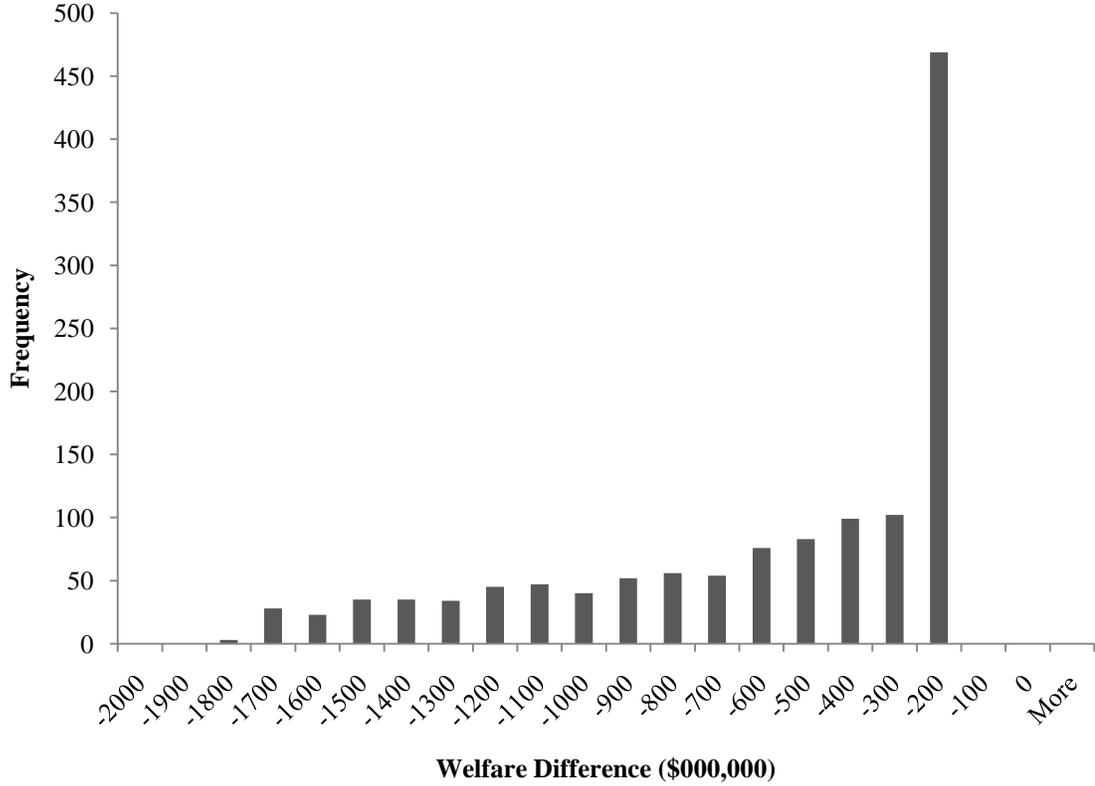
Source: Author's calculations

In Scenario 3, where over-quota tariffs are cut by forty-six percent and a risk premium is added to the milk supply, adding price uncertainty has a large impact on both consumers and producers welfare. Ninety percent of the time, producer surplus will fall between \$1.245 and \$3.036 billion. The distribution derived from twelve hundred iterations has a kurtosis of -0.286 and is skewed to the left with a skewness of -0.967.

Figure 7.5 demonstrates the changes in producer surplus over twelve hundred iterations. The changes producer surplus are constrained on the right hand side of the histogram, this is due to a built in constraint in the model so that if world prices go higher than original domestic prices, domestic prices will stay at their original price. Thus, domestic prices can go lower than in the original scenario, yet cannot increase. Since the risk premium was added to the milk supply, it decreases the original producer surplus by

\$0.25 billion, ensuring that the smallest change in producer surplus, even when price uncertainty is added, will be -\$0.25 billion.

Figure 7.5. Changes in producer surplus for scenario 3



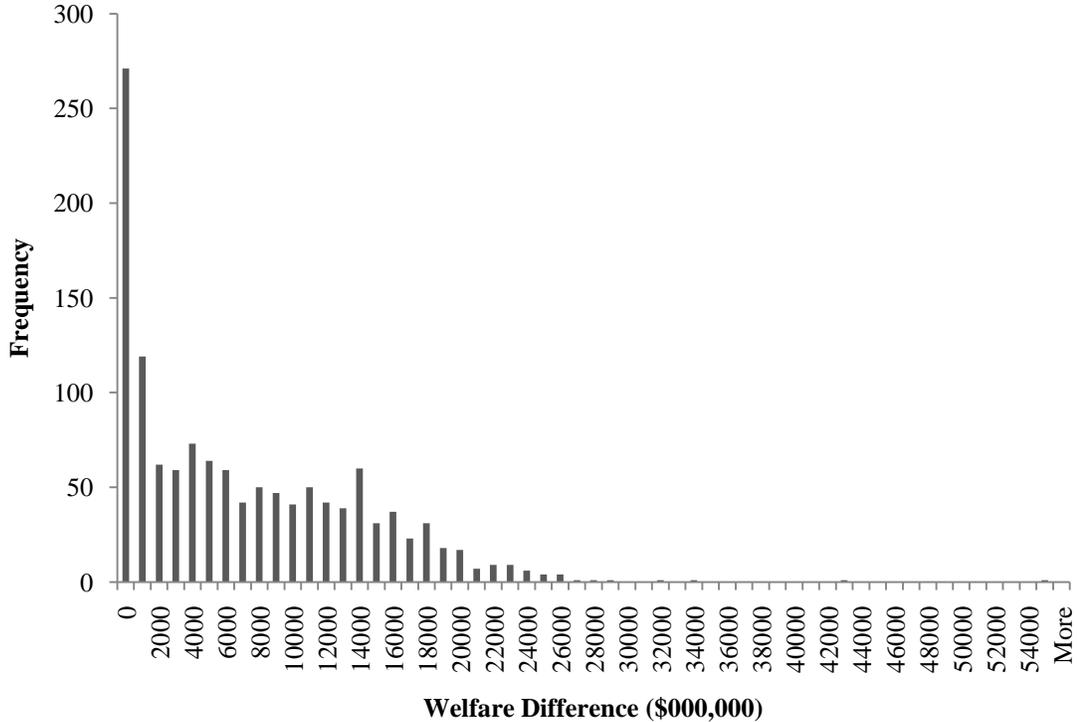
Source: Author's calculations

Adding stochastic world prices to scenario 3 will also impact consumer surplus. Ninety percent of the time, consumer surplus will fall between \$172.53 and \$199.72 billion. The consumer surplus distribution, derived from twelve hundred iterations, has a kurtosis of 1.983 and is skewed to the right with a skewness of 1.099.

Figure 7.6 demonstrates the changes in consumer surplus over twelve hundred iterations. The changes consumer surplus are constrained on the left hand side of the histogram, this is since there is a constraint in the model that if world prices increase above the original domestic price level, the domestic prices will revert to the original domestic price Thus domestic prices can go lower than in the original scenario, yet

cannot increase. The new consumer surplus will not go lower than the original surplus, making all of the changes between new and old consumer surplus positive.

Figure 7.6. Changes in consumer surplus for scenario 3



Source: Authors calculations

7.2.3 MAC increases

In table 7.4, when MAC is increased by three percent, the blend price decreases by over seven percent and the marginal cost decreases by close to twenty percent. The largest cut in domestic price is seen in cheese; however, it sees the second largest growth in demand, after yogurt. The largest decrease in supply occurs in the SMP market. Production decreases by almost one percent, and producer revenue and surplus decrease by over eight and five percent respectively. Once again, the increase in consumer surplus is large enough to offset the loss in producer welfare and total welfare increases by nearly five percent.

Table 7.4 also shows that every percentage increase in the MAC decreases the blend price by \$151/tonne. Production also decreases by 18,750 tonnes with every increase in MAC percentage. In every MAC increase, scenario cheese prices decrease the most, followed by SMP and butter. The smallest increase in demand is SMP followed by ice cream and then butter. The largest decrease in producer revenue and surplus is when MACs are increased by six percent; however, this is also the MAC scenario that sees the largest increase in both consumer surplus and total welfare.

Table 7.4. MAC increase

	Baseline	3% MAC (% change)	4% MAC (% change)	5% MAC (% change)	6% MAC (% change)
Domestic price					
Blend price of industrial milk (\$/ MT of solids)	5,786.95	-7.87%	-10.49%	-13.11%	-15.73%
Cheese	8,740.00	-9.53%	-12.71%	-15.88%	-19.06%
Butter	6,900.00	-4.81%	-6.42%	-8.02%	-9.63%
SMP	5,950.00	-8.66%	-11.54%	-14.42%	-17.30%
Yogurt	3,172.35	-3.38%	-4.50%	-5.63%	-6.75%
Ice cream	3,660.00	-4.51%	-6.01%	-7.51%	-9.02%
Marginal cost	2,287.57	-19.89%	-26.53%	-33.16%	-39.79%
Demand (MT)					
Cheese	377,200.00	2.19%	2.92%	3.65%	4.38%
Butter	83,200.00	1.92%	2.59%	3.21%	3.85%
SMP	30,300.00	1.64%	2.19%	2.74%	3.29%
Yogurt	264,400.00	2.73%	3.65%	4.56%	5.47%
Ice cream	191,500.00	1.89%	2.52%	3.16%	3.79%
Supply (MT)					
Cheese	373,800.00	-0.83%	-1.11%	-1.38%	-1.66%
Butter	84,000.00	-1.15%	-1.54%	-1.92%	-2.31%
SMP	80,700.00	-1.52%	-2.03%	-2.53%	-3.04%
Yogurt	265,100.00	-0.26%	-0.35%	-0.44%	-0.53%
Ice cream	203,600.00	-1.04%	-1.39%	-1.73%	-2.08%
Raw milk ('0 MT)	600,042.00	-0.94%	-1.25%	-1.56%	-1.88%
Welfare analysis (\$CDN '000 000)					
Producer revenue	3,472.41	-8.73%	-11.61%	-14.47%	-17.31%
Producer surplus	2,786.09	-5.80%	-7.71%	-9.61%	-11.50%
Consumer surplus	179,402.02	4.87%	6.52%	8.18%	9.86%
Total welfare	182,188.10	4.71%	6.30%	7.91%	9.53%

Author's calculations

When comparing all the scenarios, a few are better for producers while others are better for consumers. The majority of scenarios; however, have demonstrated that most liberalization scenario would have a positive impact on the total welfare of the dairy industry. Assuming that the savings would be passed onto the consumers, and not become part of the processing or the retail margin, each liberalization scenario has the potential to positively impact consumer welfare.

The worst-case scenario for producers would occur if dairy products were deemed non-sensitive and if the over-quota tariffs were cut by seventy percent. Scenario 2 is the worst for producer surplus but the best for consumer surplus. As well if scenario 2 were to happen, there would be a five percent increase in MAC which increases the amount of in-quota imports. However, an over-quota tariff cut of seventy percent, while keeping production constant, will have the largest increase in total welfare.

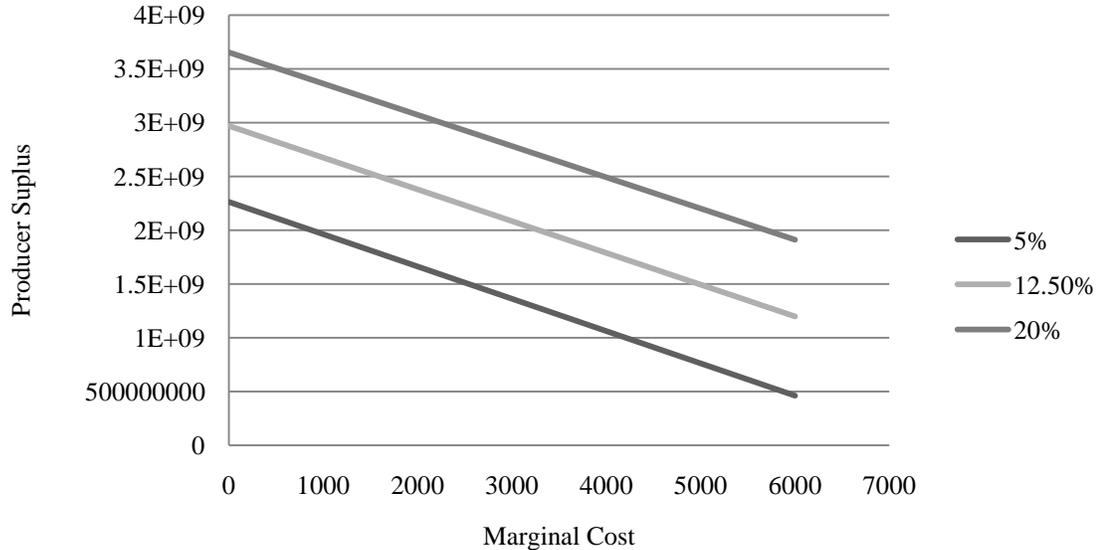
Scenario 1, which decreases over-quota tariffs by thirty-five percent, is the best-case scenario for producers. It signals no change in producer or consumer welfare. However, if dairy products are deemed sensitive and there is a smaller cut in the over-quota tariff, there will most likely be a greater increase in MACs of four to six percent. Four percent would be the best-case for producers and six percent would be the best for consumers. Giving up a portion of the over-quota tariff is a sound solution for producers, since there is enough WIT that it will not affect prices. It may also be viewed by producer groups that it is better to give up some WIT than to have a larger increase in MACs.

7.3 Sensitivity analyses

The first conducted sensitivity analysis looked at the impact of discount rates on the model. Three different discount rates were used, 0.05, 0.125 and 0.2. After the model was run with the three different rates, producer surplus was graphed against marginal cost. Marginal cost was changed to examine the impact of different discount rates on producer surplus. This analysis found that a higher discount rate increases the level of producer surplus due to the fact that a higher discount rate will result in a lower marginal cost.

Figure 7.7 demonstrates the impact of discount rates on the relationship between producer surplus and marginal cost.

Figure 7.7. Sensitivity analysis: discount rates



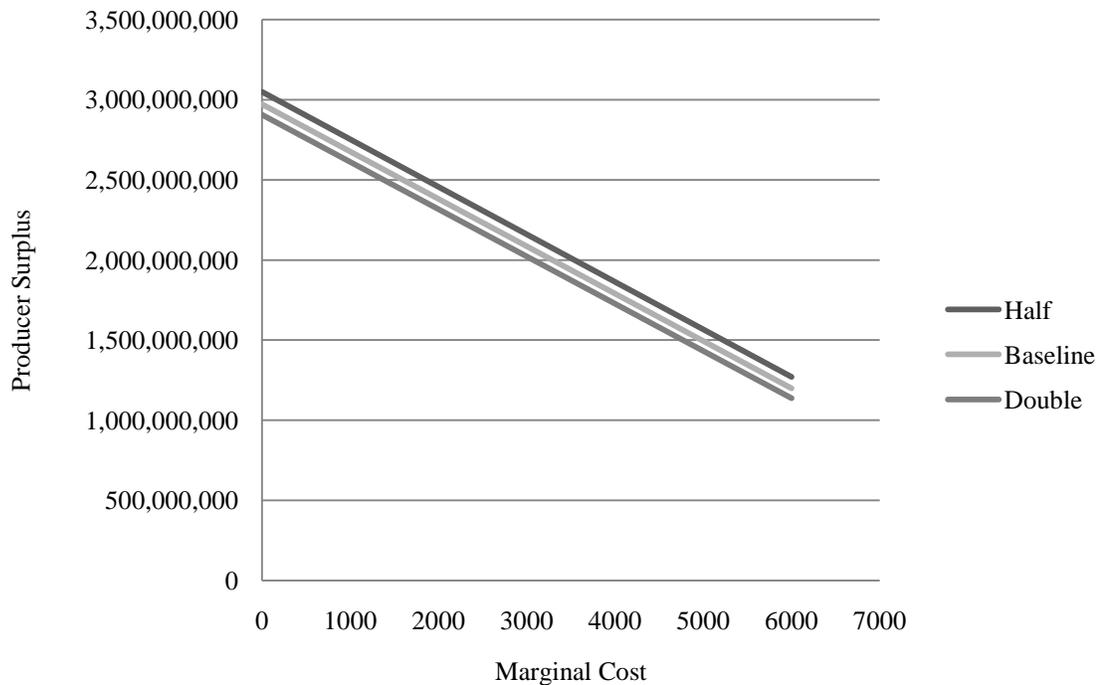
Source: Author's calculations

The second sensitivity analysis looked at the impact of supply elasticities on the simulation model. In order to determine the impact of elasticity, three different supply elasticity levels were measured against producer surplus and marginal cost. The supply elasticities used in this sensitivity analysis were gathered from FAPRI (FAPRI 2009). These elasticities were halved, not changed (baseline) and doubled. It was found that the more inelastic the supply, the higher the producer surplus. A more elastic supply of dairy products lowered the producer surplus. Figure 7.8 illustrates the impact of supply elasticities on the producer surplus and marginal cost. Table 7.5 demonstrates the elasticities used in the sensitivity analysis.

Table 7.5. Canadian supply elasticities

	Cheese	SMP	Butter	Ice cream	Yogurt
FAPRI ^a	0.06	1.18	0.39	0.32	0.15
Halved	0.03	0.59	0.195	0.16	0.075
Doubled	0.12	2.36	0.78	0.64	0.30
Larivière and Meilke ^b	0.28	0.038	0.10	0.32	0.15

Source: ^aFAPRI (2009), ^bLarivière and Meilke (1999)

Figure 7.8. Sensitivity analysis: supply elasticities

Source: Author's calculations

This study also looked at the impact on replacing the FAPRI (FAPRI 2009) supply elasticities with those used by Larivière and Meilke (1999); respectively, these elasticities are, for cheese, butter and SMP, 0.28, 0.1 and 0.038. The impact of changing these elasticities was minimal. These elasticities decreased the blend price and SMP price by 1.53% and 6.44% respectively; however, it increased cheese prices by 1.81%. The change in domestic demand for the five dairy products ranged from -0.37% to 1.10%.,

while the change in domestic supply ranged from -0.38% to 0.43%. Producer surplus was 5.97% lower than with original elasticities and consumer surplus was decreased by 0.29%. Overall, the changes, due to replacing the FAPRI supply elasticities with the Larivière and Meilke supply elasticities, were not large.

Table 7.5. Marginal cost and supply elasticities sensitivity analyses

	Marginal cost			Supply elasticity		
	0.050	0.125	0.200	Half	Normal	Double
Domestic price						
Blend price of industrial milk for ('0 tonnes)	3,764.67	5,028.30	6,292.09	5,147.44	5,028.30	4,929.85
Cheese	6,691.75	7,351.83	8,012.00	7,214.72	7,351.83	7,465.12
Butter	6,013.64	6,346.53	6,679.47	6,350.69	6,346.53	6,341.44
SMP	3,427.69	5,091.98	6,756.66	5,232.20	5,091.98	4,964.71
Yogurt	2,955.84	2,993.85	3,031.83	2,988.16	2,993.85	3,000.40
Ice cream	3,270.56	3,384.99	3,499.42	3,343.84	3,384.99	3,418.82
Marginal cost	2,364.99	1,529.12	693.39	1,648.53	1,529.12	1,430.67
Domestic demand (MT)						
Cheese	397,531.61	390,979.40	384,426.37	392,340.46	390,979.40	389,854.83
Butter	87,476.53	85,869.49	84,263.67	85,849.41	85,869.49	85,889.24
SMP	82,740.50	31,130.18	29,519.50	30,994.52	31,130.18	31,253.33
Yogurt	279,016.72	276,450.31	273,883.45	276,834.84	276,450.31	276,008.08
Ice cream	200,058.07	197,543.41	195,028.84	198,447.71	197,543.41	196,800.07
Domestic supply (MT)						
Cheese	375,181.61	368,629.40	362,076.37	369,990.46	368,629.40	367,504.83
Butter	83,991.53	82,384.49	80,778.67	82,364.41	82,384.49	82,404.24
SMP	80,265.50	78,655.18	77,044.50	78,519.52	78,655.18	78,778.33
Yogurt	266,501.72	263,935.31	261,368.45	264,319.84	263,935.31	263,493.08
Ice cream	202,583.07	200,068.41	197,553.84	200,972.76	200,068.41	199,325.07
Raw milk ('0 tonnes)	600,999.10	590,666.00	580,334.89	592,138.78	590,666.00	589,449.03
Welfare results (\$ CDN '000 000)						
Producer revenue	2,262.56	2,970.05	3,651.52	3,048.00	2,970.05	2,905.90
Producer surplus	1,551.88	2,518.92	3,450.32	2,560.00	2,518.92	2,484.24
Consumer surplus	199,665.92	194,083.93	188,589.82	195,201.69	194,083.93	193,103.18
Total welfare	201,217.80	196,698.67	192,040.14	197,761.68	196,698.67	195,587.43

Source: Author's calculations

7.4 Discussion

The results of the welfare analysis show that the liberalization of the dairy industry, in most scenarios, other than in scenario 1, is positive for the overall welfare. In the majority of scenarios, the gain in consumer welfare outweighs the loss in the producer welfare.

Calculating the water in the tariffs shows that the over-quota tariffs provide redundant protection. These over-quota tariffs are a large barrier to imports and, if Canada liberalizes the over-quota tariffs, there is room to do so without conceding protection. If over-quota tariffs are cut by thirty-five percent, which is one of the scenarios possible under the DDA modalities, then the over-quota tariff would still be prohibitive. In fact, even with a forty-six percent cut in over-quota tariffs, two of the five dairy products, yogurt and ice cream, would still be protected. Reducing the over-quota tariff by more than the WIT has the potential to have a huge impact on the Canadian dairy industry and domestic Canadian prices.

The impact of price uncertainty can vary. As shown in section 7.2.2 the effect of price volatility can lead to a huge distribution in both consumer and producer welfare. Since supply management was established in order to stabilize prices, accounting for world price volatility in the model was necessary when simulating liberalization impacts on the dairy industry.

Even though there are still trade barriers in all of the scenarios examined in this thesis, the impact of moderate liberalization can be quite large. Producers see no benefit in any of these scenarios, and consumers see gains in all but one of the scenarios. The overall social welfare gain of trade liberalization is a gain for Canada.

Sensitivity analyses were conducted on both the discount rate and supply elasticities. As table 7.6 demonstrates, the results of these analyses show that producer surplus is sensitive to both of these. In fact, the smaller the marginal cost, the larger the producer surplus. If dairy producers want to become more efficient, productive, and be less affected by trade liberalization, they will need to lower their marginal cost. A lower marginal cost is accompanied by a larger discount rate, or even a lower MSQ value.

The sensitivity analysis regarding supply elasticities is important because it measures the response of producers to price. A more elastic supply curve decreases the level of producer surplus. Liberalization will cause a decrease in prices and Canadian producers will need to improve efficiency and decrease costs in order to be competitive on the world stage. This may or may not be possible with the current supply managed system. If Canadian producers are to increase efficiency, then it may be possible to develop a larger an export market since there is a worldwide demand for competitively priced dairy products.

Chapter 8: Summary and Conclusions

8.1 Summary

The DDA round of the WTO negotiation proposes improved market access which may have an impact on the Canadian dairy industry. This thesis used a partial equilibrium model to evaluate the impacts of proposed liberalizations modalities on the Canadian dairy industry. The increases in liberalization may be reached either by increasing minimum access commitments or by decreasing over-quota tariffs. Increasing MACs and decreasing over-quota tariffs had a differing impacts on the Canadian dairy industry. This thesis built a partial equilibrium model calibrated to 2007 supply and demand data and prices. The PE model was built around a farm level supply function and a wholesale level demand function. Trade was limited to 2007 levels in the baseline model. The supply function was built from the marginal cost function from the 2007 rental rate for production quota. The model looked at different scenarios, including price certainty and uncertainty and then compared them to the baseline model. The impact of each liberalization scenario was measured against producer, consumer and overall welfare.

8.2 Conclusions

The liberalization of TRQs will have a huge impact on the Canadian dairy industry. The liberalization of over-quota tariffs has an impact on the industry if more than the WIT is removed. If dairy products are considered as sensitive items, then the industry will most likely gain a protected status, since the decreases in over-quota tariffs, other than in the forty-six percent tariff reduction, will be within the WIT. With a forty-six percent tariff reduction, there will be a negative impact on producers but a positive gain for consumers. If dairy is considered a non-sensitive product then the reduction in the over-quota tariff

will be larger than the WIT and producers will see the largest loss in their revenue and surplus. However, the greater the liberalization of the over-quota tariff, the larger the gain in consumer surplus.

Increasing MACs will also have an impact on producer welfare. The increase in the volume of imports will lower both the domestic and blend price, which will impact producer revenue and surplus negatively. The increase in MAC will have a larger impact on producer surplus than tariff liberalization, especially if products are considered sensitive. Despite the negative impact on producers, consumer welfare increases with every percentage increase in MACs. If products are not considered sensitive and if over-quota tariffs need to be cut by the full seventy percent, then tariff liberalization will have a larger impact on overall welfare than an increase in MAC.

Adding the component of price uncertainty to the trade liberalization scenarios has a large impact on both producer and consumer welfare. The extent of the impact varies, as it is dependent on world prices. If landed prices are lower than domestic prices, domestic prices will decrease

Most liberalization scenarios will negatively impact dairy producers. Even though supply management can still operate under moderate liberalization, it is difficult to calculate the magnitude of the required change in order for producers to realize the same benefits as supply management is heavily supported by the federal government (Richardson 2009). The federal government will defend supply management during the WTO negotiations and it is highly unlikely that they will support anything that would affect the status of supply management.

8.3 Policy Recommendations

The quantitative results, found in this thesis, provide a broad picture on how producers and consumers may be affected by TRQ liberalization. Even though this study was conducted before the end of the DDA round, it provides insight on who will be the major losers and winners in TRQ liberalization and it identifies which scenarios will have the smallest impact on the Canadian dairy industry. If the government's goal is to minimize the impact on producers, they should consider giving up some WIT; this will still protect the Canadian dairy industry. This is one option that the policy makers could consider in order to keep the impact on producers at a minimum.

There are many different players in the dairy industry and each group has different interests. For instance, the dairy producers prefer to keep their industry supply managed since it allows stable profits while processors prefer to have competitive milk pricing in order to produce dairy products at a reduced cost. Consumers, ever mindful of their pocketbooks, would also prefer to pay less for dairy products.

Currently, the dairy producers have a strong lobby group, the Dairy Farmers of Canada (DFC). The DFC is currently lobbying the federal government to keep supply management and to not allow liberalization of any kind. Canadian dairy producers also have many supporters within the federal government who are pressing to keep supply management and who are reluctant to put supply management on the table during free trade agreement negotiations. Due to this support, the dairy industry will most likely be considered sensitive and the smallest cuts in over-quota tariffs will be agreed upon.

8.4 Limitations and Future Study

This thesis built a PE model around a linear supply and demand function. One of the problems in building this model was in building the supply function from the rental rate value of production quota. Future studies may want to build the true cost of production into the model and find the true marginal cost in order to construct the supply curve. As well, for the demand curve, future studies may also wish to include feed substitutes, such as soy based products, in the model.

This study was based on potential trade modalities and not the actual decisions made in the DDA. Further studies may want to include the agreed upon TRQ liberalizations into their model. This would provide more relevant and up to date results.

This model assumed that processing margins remained constant and that all the price reductions would be passed onto the consumers. Future studies should examine the impact on farm, wholesale and retail levels of supply and demand. It would be also be interesting to discover if processors would, in fact, pass on any savings, or if these saving would be absorbed at the processor level. A change in processing and retail margins would impact consumer welfare differently than if it is assumed that margins remain constant.

Parameters used in this study, such as the supply and demand elasticities as well as the discount rates were taken from previous research. These parameters may cause inconsistencies and problems within the model. Sensitivity analyses were conducted to see if the model would be impacted by changes in these parameters; however, finding that the model is, in fact, sensitive to those parameters does not fix the problem. Future studies may want to derive parameters from primary data.

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