The Implications of Doha Development Agenda WTO Negotiations on the Canadian Chicken Market: Two Representations of Chicken and Stochastic World Prices

by

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A thesis presented to the Faculty of Graduate Studies of

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Abstract

The Doha Development Agenda (DDA) negotiations include proposals to improve market access that may have an impact on Canadian supply-managed industries. Two baseline scenarios of the Canadian chicken market are generated to calculate welfare measures before trade liberalization (one includes the stochastic nature of world prices). A partial equilibrium analysis is developed with two different representations of chicken: one with chicken differentiated by cut and one with chicken as a single homogeneous good. These two models are compared to evaluate how different market representations affect the distribution of welfare and the outcomes of trade liberalization when international prices are stochastic. The results of the welfare analysis reveal that tariff liberalization would have no effect on the Canadian chicken market if the over-quota tariff reduction proposed by the latest WTO draft modalities was applied. In contrast, import quota liberalization is likely to affect Canadian chicken producers, processors, and consumers. The results of the welfare analysis demonstrate that the distribution of welfare among various stages of the supply chain varies between the two representations of chicken. When considering the potential effects of stochastic world prices on the Canadian chicken market, there is an overall larger welfare effect and a redistribution of welfare between producers and import quota-rent holders after trade liberalization. The overall social welfare effect of trade liberalization among the two representations of chicken and the two scenarios (with and without price risk) is positive.

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Chapter 1: Introduction

The current Doha Development Agenda (DDA) negotiations on agriculture are likely to change international trade policies and may affect Canadian chicken production, as well as consumption. The chicken industry contributes close to C$9.5 billion to Canadian economy, employs more than 49,700 people who work on chicken farms or in related areas, such as processing (CFC 2008). In 2007, Canada was the 12th largest chicken producer in the world, and annual per capita consumption of chicken was 31.7 kg (CFC 2008). The potential impacts of trade liberalization on the Canadian chicken market will reverberate to all the stages of the supply chain affecting producers, processors, and consumers. Therefore, the outcomes of the World Trade Organization (WTO) negotiations and their impact on the Canadian chicken market are important policy issues in agricultural economics.

The Canadian chicken industry has operated under a system of supply management since 1979. Current WTO negotiations could jeopardize supply management in Canada. These negotiations include proposals that will have an impact on the import control measures that are currently protecting Canadian chicken producers from foreign competition. From producers' perspectives, the continuation of supply-managed industries in Canada guarantees the maintenance of market stability, defined as stable domestic prices, production, and producer income. The supply-managed chicken industry restricts domestic output below the competitive level, and the domestic price is not determined by market conditions (when supply equals demand). Instead, the price is predetermined with a live-price formula. Since output is restricted to less than the quantity that producers would supply in a competitive market, they must hold production

quota in order to produce during a quota period and to place their product on the market. Producers pay fees for the right to produce which means that the production quota is a valuable asset.

The Canadian chicken market is currently protected from foreign competition by tariff-rate quotas (TRQ). These TRQs are likely to be disciplined in a new WTO agreement in a manner that will expose Canadian producers to more foreign competition. Increased competition from imported chicken may reduce domestic prices, increase income instability for producers, and affect production quota values. On the other hand, lower domestic prices generated by increased foreign competition would benefit Canadian consumers. If the gains in consumer surplus outweigh the loss in producer's welfare, then the overall welfare effect would be a gain for Canada. An analysis of the impacts of TRQ liberalization in the Canadian chicken market is required to inform policy makers and develop industry positions.

The first stage of this project is to build an up-to-date partial equilibrium model of the Canadian chicken market that can be used to simulate the effects of trade policy changes. The second stage of the project is to incorporate current WTO proposals into the economic model and generate economic welfare measures for a range of trade liberalization regimes. The latest WTO proposals and position papers emerging from ongoing DDA negotiations are used as the bases for the policy simulations. The results of these estimates are analyzed in the context of the Canadian supply-managed chicken industry and international trade negotiations. The analysis presents and discusses estimated economic costs and benefits of new trade regulations throughout the supply chain.

In previous studies (ERS/PENN 2003, FAPRI/CARD 2009, and OECD/FAO 2006), chicken is represented as a single homogeneous good in consumption, production and trade; however, Huff *et al.* (2000), in their study of Canada-United States chicken trade, noted that the current Canadian trading situation suggests that chicken is not a homogeneous good, but is differentiated by cut. Some studies (Alston and Scobie 1987, Peterson and Orden 2004) have addressed the differentiation issue by using the Armington specification, which represents chicken as a heterogeneous good based on its country of origin. In recent studies (Thompson *et al.* 2008), chicken meat has been differentiated by country-of-origin and by type of cuts (white and dark meat). Canada exports nearly as much chicken as it imports by weight however the value of exports is much smaller than the value of imports (AAFC 2007) due to the nature of the products traded, indicating that chicken is not a single homogeneous product. Therefore, this thesis models chicken along two lines of differentiation. The first model represents chicken as a single homogeneous good, and the second model differentiates chicken meat by cut (white and dark meat). These two models are compared to evaluate how different representations of chicken affect economic welfare measures and the outcomes of simulated trade policies.

Price volatility is primarily caused by the inelastic demand for agricultural products and inelastic short-run supply response of agricultural outputs. Volatility in world prices will potentially affect the Canadian chicken market if import barriers are reduced. Since the aim of the supply management system is to stabilize prices and producer's income, price volatility should be a concern for chicken producers not only because of its impact on production and investment decisions, but also because it leads to volatile flows of

imports. Price volatility also affects consumers who are faced with markets where prices for final goods vary. Therefore, this research takes into account the impact of stochastic world prices on the Canadian chicken market, and it is relevant to the entire chicken supply chain. Import prices are of great importance to processors who may benefit from low-cost imports; also, Canadian consumers would benefit from lower domestic prices.

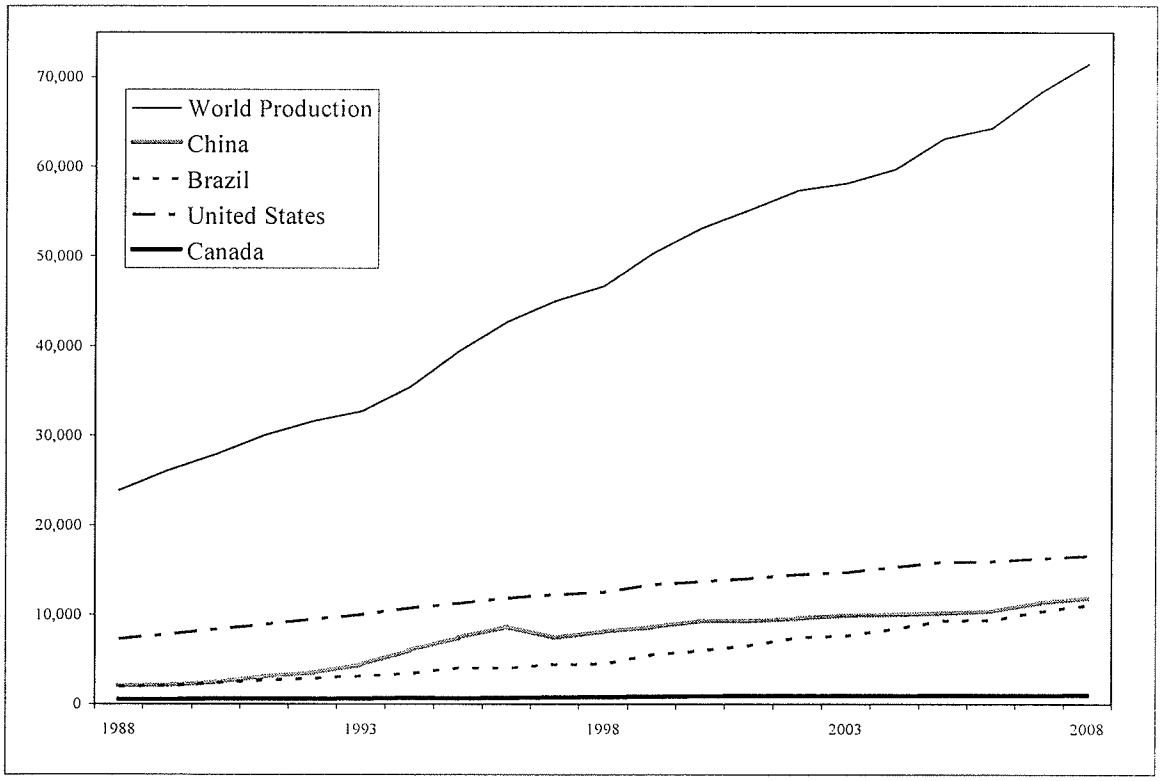
This thesis consists of seven chapters. Followed by the introduction in the first chapter, chapter two presents an overview of the Canadian chicken industry, the supply management system, and the current Canadian chicken trade situation. This chapter also deals with global chicken production, consumption, and trade. The model selection and specifications, the representation of chicken, and the stochastic nature of world prices are described in chapter three. Chapter four introduces the tariff-rate quota mechanism and different ways to liberalize trade when this policy tool is in effect. Chapter five provides a description of the data and parameters used in this thesis, as well as data sources and calculations, the structure of the simulation model, and the trade liberalization scenarios. Chapter six presents the welfare and sensitivity analyses of trade liberalization when chicken is represented as a single homogeneous product and as differentiated products. The results of the welfare and sensitivity analyses are reported and discussed in chapter seven. The final chapter of this thesis serves as a summary and offers conclusions drawn from the welfare analysis, and discusses the limitations of this study.

Chapter 2: Overview of the Canadian Chicken Industry

2.1. World Chicken Production, Consumption, and Trade

As shown in figure 2.1, world chicken production has grown significantly, by approximately 200% between 1988 and 2008. Over that period, China and Brazil increased their production by 478% and 466% respectively, followed by 235% grow in Mexico, 128% in the United States, and 90% in Canada (USDA 2009). World chicken production grew by 4.6% from 2007 to 2008 (USDA 2009). According to the OECD-FAO Agricultural Outlook, poultry meat production will rise by 28.3% during the projection period from 2008 to 2018.

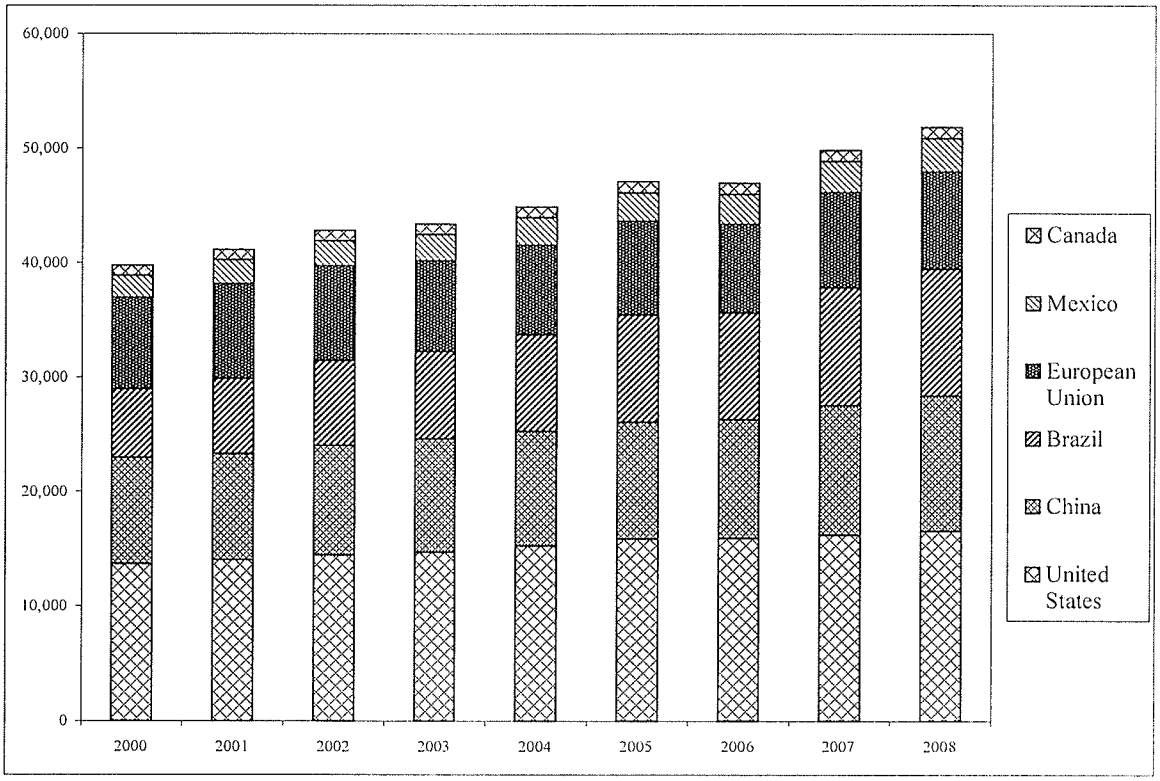
Figure 2.1: World chicken production from 1988 to 2008 (000,000 kg eviscerated)



Source: USDA 2009

Figure 2.2 shows the most important chicken producers in the world from 2000 to 2008. The five largest producers in 2008 were the United States (23% of world's production), China (16.6%), Brazil (15.4%), European Union (12%), and Mexico (4%). That year, Canada was the thirteenth largest chicken producing country with 1.4% of the world's chicken production (USDA, 2009).

Figure 2.2: Largest chicken producers from 2000 to 2008 (000,000 kg eviscerated)

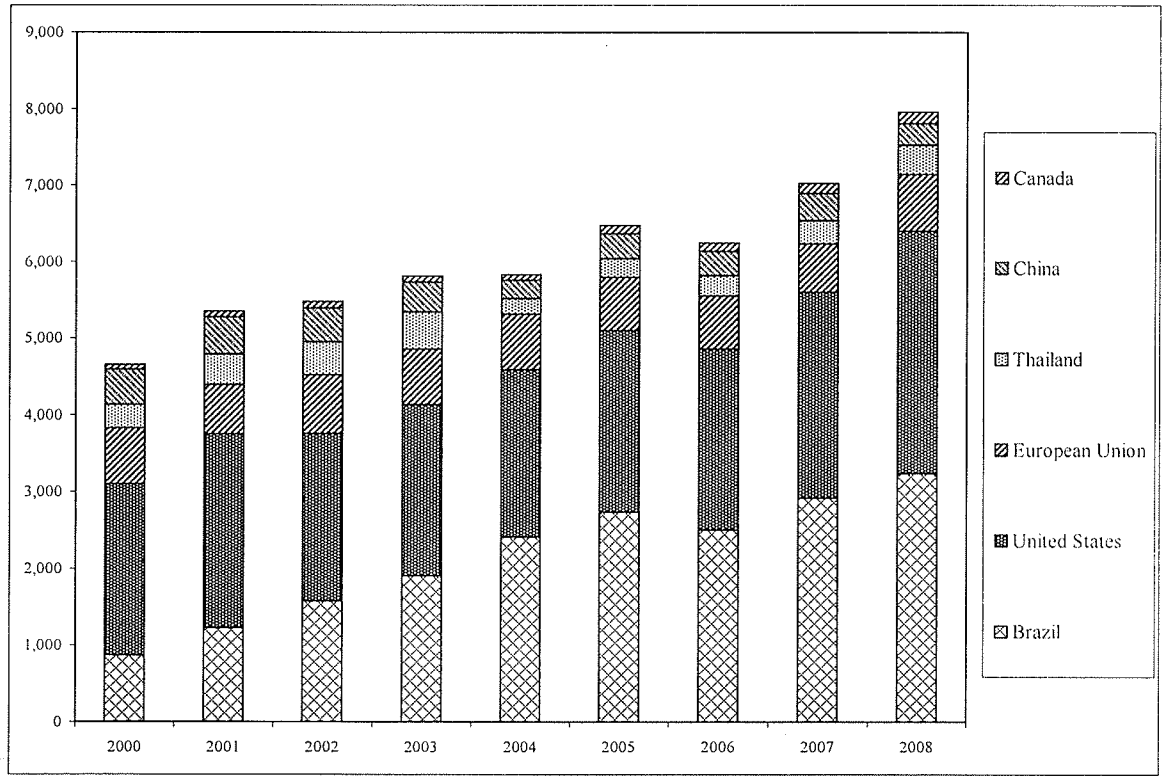


Source: USDA 2009

World chicken consumption rose by 3.9% from 2007 to 2008 (USDA 2009). Countries with the highest per capita chicken consumption in 2008 were the United Arab Emirates (66.2 kg/person), Kuwait (59.7 kg/person), the United States (44.1 kg/person), Venezuela (39.4 kg/person), and Brazil (38.5 kg/person). That year, Canada was ranked

as the eleventh country with respect to per capita consumption of chicken (31.7 kg/person). Chicken was mostly consumed in the Middle East (19%), the Former Soviet Union (22%), East Asia (19%), the European Union (9%), and North America (8%) in 2008 (USDA 2009). On the trade side, world chicken exports grew by 13.9% from 2007 to 2008 (USDA 2009). As illustrated in figure 2.3, most of the exports in 2008 were from Brazil (38.5%), the United States (37.5%), and the European Union (8.8%). Canadian exports increased by 9.4% in 2008 with respect to 2007, representing 1.8% of the world's exports.

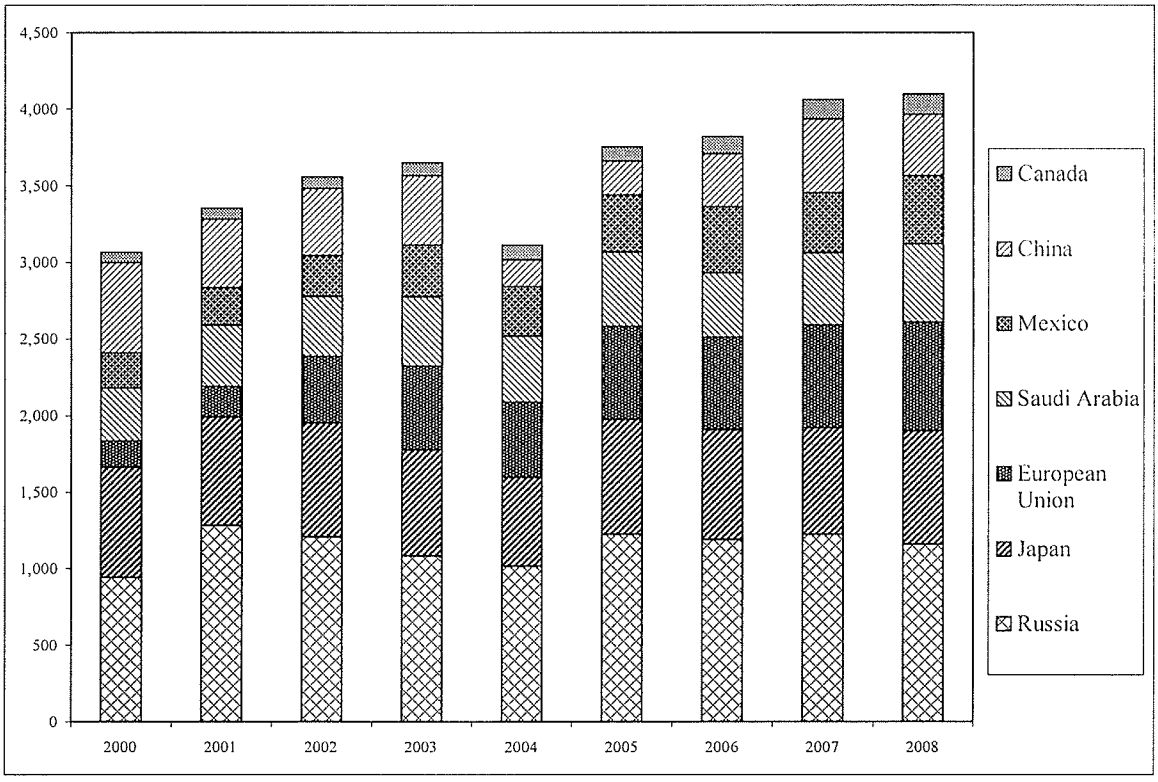
Figure 2.3: Largest chicken exporters from 2000 to 2008 (000,000 kg eviscerated)



Source: USDA 2009

In 2008, chicken imports worldwide were 9.8% greater than in 2007. Figure 2.4 shows the most important chicken importers in the world from 2000 to 2008. The largest importers in 2008 were Russia (15%), Japan (9.4%), European Union (9.1%), Saudi Arabia (6.5%), and Mexico (5.7%). Canadian imports of chicken were 1.7% of the world's imports that year.

Figure 2.4: Largest chicken importers from 2000 to 2008 (000,000 kg eviscerated)



Source: USDA 2009

2.2. Canadian Chicken Industry

2.2.1. Supply Management

Since 1979, the Canadian chicken industry has operated under a supply management system. This system has its origin in the establishment of the Chicken Farmers of Canada

(CFC), which was created in 1978 under the Farm Products Agencies Act. Supply management is based on three pillars; import limits, production controls, and price determination. CFC has the authority to regulate chicken production in Canada under this system. The supply of chicken is regulated using a production quota system; thus, regulated chicken producers (home consumption is exempted) must hold production quota in order to produce and to ship their product to the market. Producers pay fees for the right to produce which means that the production quota is a valuable asset. Each province in Canada obtains a share of the national quota and commits to produce a quantity corresponding to its periodic production quota allocation without exceeding it. This production quota allocation is set periodically every 6 or 7 weeks depending on the year of production. In Canada, prices paid to producers are determined at the provincial level. From 1992 to 2003, farm prices were set through negotiations between marketing boards and processors in each province. Since May 2003, the chicken pricing process has changed. The live chicken price is determined by a live-price formula; this price formula includes input costs based on a cost-of-production formula (the price of chicks and feed) plus a producer margin. The live-price is adjusted every quota period for changes in production costs. The producer margin includes the following expenses: financing of assets, interest on working capital, labor (general/skilled and management), overhead (supplies, phone, services, etc.), property taxes and insurance, repairs and maintenance, energy and depreciation. The producer margin is adjusted once every six-quota periods (every year) (CFO 2007). The price established in Ontario (by the Chicken Farmers of Ontario CFO) sets a reference price for other provinces because Ontario is the biggest chicken-producing province.

To maintain the stability of supply in Canada, the supply management system limits imported products. The Export and Import Controls Bureau of the Department of Foreign Affairs and International Trade (DFAIT) is responsible for the issuance of permits for goods on the Import Control List (ICL). Chicken imports are divided into products that are on the ICL (live chickens, eviscerated fresh and chilled or frozen chicken, processed and smoked chicken products) and products not on this list (TV dinners, soup, etc.). Chicken products that are on the ICL are subject to tariff-rate quotas, while non-ICL products are not. Chicken was first placed on the ICL in 1979 when the supply management system became effective (AAFC 2006).

2.2.2. Canadian Chicken Trade

The implementation of free trade agreements, such as the Canada-United States Free Trade Agreement (CUSTA), the North America Free Trade Agreement (NAFTA), and the outcomes of the Uruguay Round Agreement on Agriculture (URAA), has changed the Canadian trading system. Before URAA, Canada used import quotas negotiated under the General Agreement on Tariffs and Trade (GATT) to limit the quantity of foreign chicken entering the Canadian market. As of January 1, 1995, the implementation of the URAA resulted in import quotas being replaced by tariff-rate quotas (TRQ), under which high tariffs are applied to imports above a specific level of access to the Canadian market.

There are three components to a TRQ: a low duty rate, a minimum access level (import access quantity) for entry at that low tariff rate, and a higher tariff rate for over-access imports. The in-quota tariff for chicken under NAFTA is zero percent, and under the WTO agreement is 5% (Canada Border Service Agency, 2009). The over-quota tariff

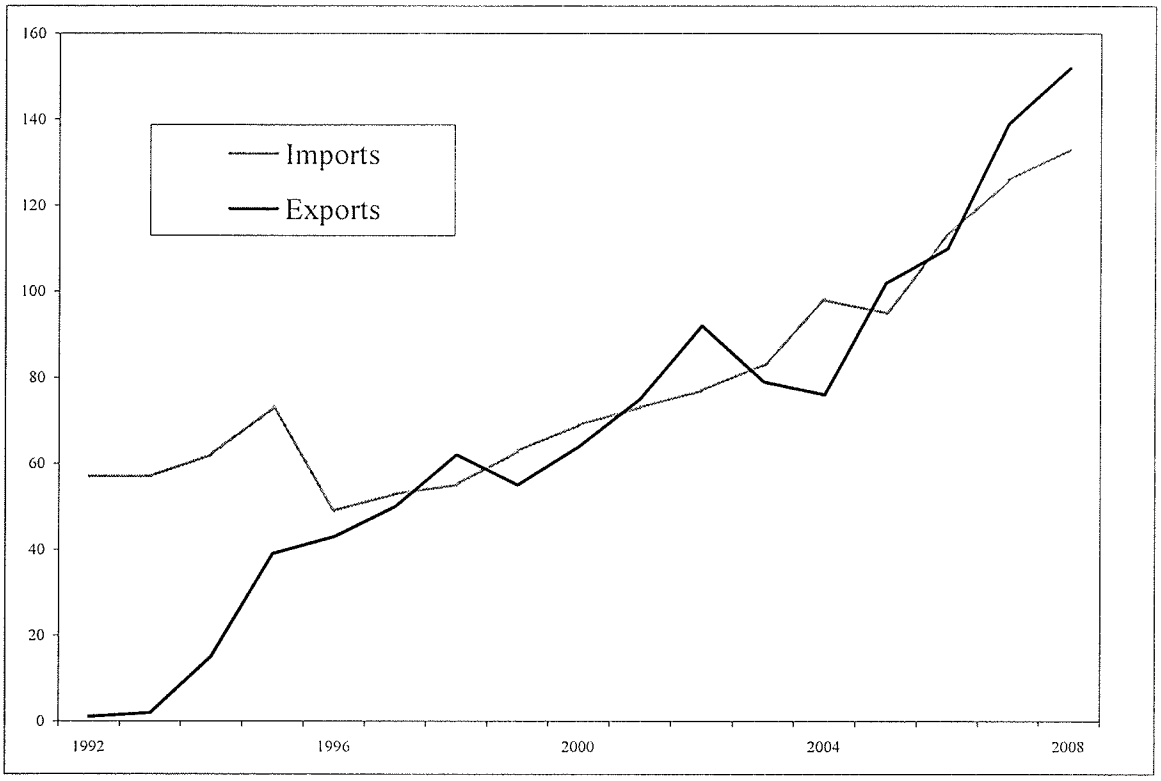
for chicken was set at 280% with a required 15% reduction in the level of this tariff by 2001 (which brings the rate down to 238%). The over-quota tariff rate is prohibitive: the tariff is so high that imports entering the Canadian market at that rate have landed import prices that are greater than the domestic price, and are uncompetitive. To be competitive, imports must enter the domestic market with a landed-price, including the tariff in place, below or equal to the domestic wholesale price. Under NAFTA, the annual import access for chicken is calculated as 7.5% of the previous year's domestic production as reported by Statistics Canada. Under the WTO agreement, the annual import access was established as 5% of the domestic consumption of the base period 1986-1988. The Canadian chicken minimum market access is set to the higher limit between the levels negotiated under NAFTA or the WTO commitments (*i.e.* the minimum market access is set at 7.5% of the previous year's domestic production). However, the real volume of imports is above the minimum access commitments due to supplementary imports under the "import-to-re-export" program, which allows imports of chicken and chicken products into Canada to be further processed with the restriction that all imports under this program must be exported within a six-month period.

The Export and Import Controls Bureau of DFAIT is responsible for allocating import quotas to individual Canadian residents. The annual 7.5% minimum import access level for chicken is allocated to three groups: the traditional group, members of the processor, distributor, and food-service sectors, and the non-Import Control List or Free Trade Agreement group (FTA). The traditional group consists of firms that were importing chicken before the introduction of import controls in 1979. The traditional group, along with the members of the processor, distributor, and food-service sectors,

maintains import quotas for the ICL products. The FTA group holds import quotas for non-ICL products (DFAIT 2009). Applicants under the processor, distributor, and food-service group should apply for import allocations within one pool (processor pool, distributor pool or food-service pool) and must meet the specific pool's minimum volume threshold and activity requirements in order to be eligible for a share of the pool. As well, traditional allocation holders must demonstrate their active involvement in the chicken industry by meeting the same criteria as the distributor, processor, and food-service group in order to maintain their import allocations. The available TRQ, after the import allocations for the traditional group and the processor, distributor and food-service group, is allocated to the FTA group. All chicken input requirements for production of FTA products beyond the authorized allocation need to be supplemented through the "import-to-compete program", which allows chicken imports for processors to produce non-ICL products (DFAIT 2009). All import allocations expire at the end of each calendar year.

The cost-of-production formula, production quotas, and import restrictions have driven Canadian chicken prices considerably higher than world prices, putting Canadian chicken processors who are willing to export at a disadvantage against their competitors in the world market. However, since the Canadian chicken market is predominantly a white meat market (AAFC 2006), Canadian processors have an opportunity to sell dark meat surplus on the international market. In order to compete, Canadian processors are forced to lower their export prices to the international level. Therefore, the value of Canadian chicken exports is much lower than the value of Canadian chicken imports, although their volumes are roughly the same. Since 1996, Canada has exported nearly as much chicken as it has imported (figure 2.5).

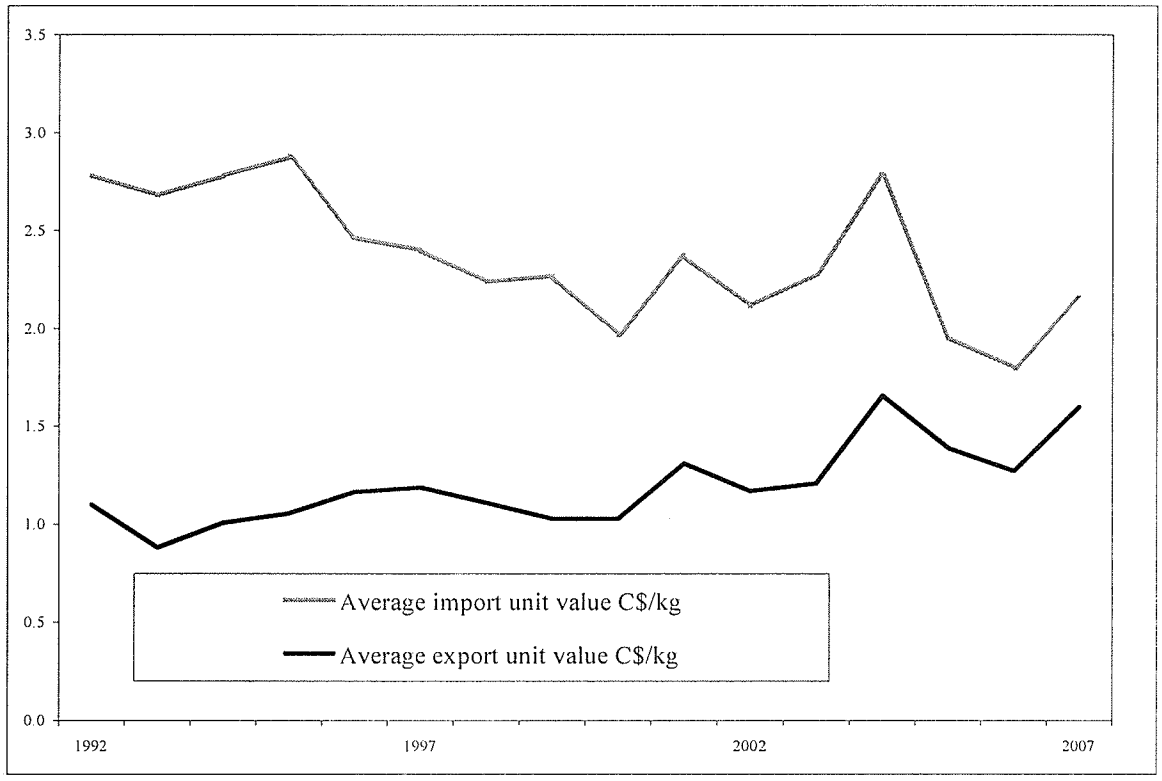
Figure 2.5: Canadian chicken imports and exports from 1992 to 2008 (000,000 kg)



Source: USDA 2009

Figure 2.6 shows the average import and export unit value of Canadian chicken from 1992 to 2008. The average import-unit value of chicken is greater than its average export-unit value. In 2007, the average value of an import-unit of chicken (mostly white meat, see table 2.3) was C$2.61/kg while the average value of an export-unit (mostly dark meat, see table 2.2) was C$1.87/kg (AAFC 2007). The fact that traded white and dark meats are priced differently tells us that chicken is not a single homogeneous product, but rather a number of products differentiated by cut.

Figure 2.6: Average import and export unit value of chicken from 1992 to 2007



Source: FAO 2009

As illustrated in figure 2.5, Canadian chicken exports have risen from near zero in 1992 to approximately 140 million kg in 2007. The sharp increase in chicken exports could partly be attributed to the implementation of the URAA, which expanded Canada's access to foreign markets. Canadian chicken exports by country in 1997 and in 2007 are shown in Table 2.1. Exports of chicken grew by 96.4% from 1997 to 2007. The most important destinations of Canadian chicken in 1997 were China and Cuba, and in 2007 were the US and the Philippines.

Table 2.1: Canadian exports of chicken by country (top ten) in 1997 and 2007

Country	Exports in 1997 (000,000 kg)	Country	Exports in 2007 (000,000 kg)
China	25.1	United States*	51.1
Cuba	22.4	Philippines	13.1
Russia	11.9	Hong Kong	11
United States	3.4	Taiwan	7.1
Hong Kong	2	Russia	6.6
South Africa	1.5	Ghana	6.2
Peru	1.1	Macedonia	5.7
Ghana	0.9	South Africa	5.3
Poland	0.6	Jamaica	3.6
Jamaica	0.2	Armenia	2.3
Total	70.7	Total	138.9

Sources: AAFC, Poultry Section, chicken and mature chicken 2007, * USDA 2009

Canada exports a variety of chicken products where dark chicken meat, which is in lower demand in the Canadian market, account for approximately 85% of total exports (table 2.2). As shown in table 2.2, the main components of Canadian chicken exports are primary processed products such as chicken legs, representing a little over 60% of total chicken exports, and further processed products (mostly dark chicken meat) such as mechanically separated meat, which represent 22.8% of total Canadian chicken exports (AAFC 2008). On the other hand, Canadian imports of chicken are mostly white meat (chicken breast and wings, bone-in and boneless). As shown in table 2.3, in 2008 68.3% of total Canadian chicken imports were white chicken meat.

Table 2.2: Breakdown of Canadian chicken exports in 2008 (000,000 kg eviscerated)

Products	Exports	Share of exports (%)
Live (eviscerated weight)	0.0	0.0
Whole carcass	0.3	0.4
Parts		
Bone-in breasts	0.01	0.01
Bone-in legs	45.3	61.6
Bone-in parts	3.21	4.37
Bone-in wings	2.84	3.87
Boneless breasts	1.04	1.42
Boneless parts	0.07	0.09
Mechanically separated meat (MSM)	16.8	22.8
Boneless burgers, strips, nuggets	0.03	0.03
Others		
Others bone-in	3.03	4.1
Others boneless	0.97	1.3
Total	73.6	100
Dark chicken meat (legs and MSM)	62.1	84.4

Source: AAFC 2008 (mature chicken is not included)

Table 2.3: Breakdown of Canadian chicken imports in 2008 (000,000 kg eviscerated)

Products	Imports	Share of imports (%)
Live (eviscerated weight)	0.1	0.08
Whole carcass	0.5	0.43
Parts		
Bone-in breasts	21.6	18.35
Bone-in legs	0.6	0.48
Bone-in parts	2.6	2.17
Bone-in wings	27.9	23.67
Boneless breasts	30.9	26.26
Boneless parts	7.4	6.29
Cooked		
Cooked bone-in	6.5	5.54
Cooked boneless	8.7	7.38
Others		
Others bone-in	10.8	9.16
Others boneless	0.2	0.19
Total	117.8	100
White chicken meat (breast and wings)	80.4	68.3

Source: AAFC 2008 (mature chicken and further processed chicken are not included)

Chapter 3: Model Specification

3.1. Model Selection

Econometric and simulation models are alternative approaches to measure the effects of trade policies. These two approaches differ in how values are assigned to the model parameters. In econometric models, the parameters are estimated using statistical techniques whereas parameter values in simulation models are obtained from prior econometric studies and prior simulation models (McKitrick 1998). According to Abler (2006), econometric models are more appropriate to determine the historical impacts of a trade agreement already in place. This type of *ex-post* analysis quantifies the effects of past trade policies. On the other hand, simulation models are the most suitable approach when a future trade agreement is significantly different from current trade agreements. This type of *ex-ante* analysis simulates the future impact of alternative trade policies.

Among econometric models, two groups can be distinguished: models designed to predict trade flows between countries (*e.g.* gravity model) and models designed to predict the economic impacts of trade (*i.e.* economic impacts on employment, wages, productivity, technological change, etc.). In the case of simulation models, two general classes are defined: partial equilibrium (PE) models and computable general equilibrium (CGE) models. Partial equilibrium analysis focuses on the direct impacts of a trade policy on a single market, and general equilibrium trade analysis provides a broad picture of the impact of trade policy on the economy as a whole (Koo and Kennedy 2005). According to Rude and Meilke (2004), the structure of PE models is more flexible than CGE models, making it easier to incorporate agricultural policy mechanisms that are often very complex in nature. A partial equilibrium model is best suited to analyze the welfare

effects of agricultural trade policies in the framework of supply management because facilitates the analysis of an imperfectly competitive market. Therefore, this research develops a PE simulation model to estimate the impact of trade liberalization on the Canadian chicken market and to calculate economic welfare measures.

3.2. Chicken Representation

Traditionally, chicken trade policy analyses are developed in the framework of partial equilibrium models that represent chicken as a single homogeneous product (regardless of production location or cut) in consumption, production and trade (ERS/PENN State Trade Model, ERS/PENN 2003; FAPRI/CARD International Livestock and Poultry Model, FAPRI/CARD 2009; and AGLINK-COSIMO Model, OECD/FAO 2006). However, the Armington specification has been used to build CGE models that assume product differentiation based on country of origin (GTAP Model-Global Trade Analysis Project, 1997). Under the Armington assumption, a commodity is represented as a heterogeneous good based on the country in which it was produced. A model with a single homogeneous good and one based on differentiation based on country of origin has been analyzed in the framework of the effects of the European Union's agricultural policies in international poultry markets and the effects of US poultry export subsidies (Alston and Scobie 1987). However, models that are based on the Armington assumption have received some criticisms. Von Arnim and Taylor (2007) showed that because of the Armington assumption, tariff cuts could reduce consumption. Lower import prices will reduce domestic prices inducing consumption; on the other hand, the government's loss associated with tariff revenue could be offset by an equal increase in lump-sum taxes,

which may reduce consumption. According to Von Arnim and Taylor (2007), the fiscal effect generated by the Armington specification shifts the total real spending of consumers when tariffs are reduced. According to Zhang (2008), Armington models tend to underestimate the effects of trade liberalization. Alston *et al.* (1990) noted that the Armington specification does not fit agricultural trade data well, and its assumptions are usually violated in practice.

In their analysis of Canada-United States chicken market after the implementation of the URAA, Huff *et al.* (2000) treated chicken as a homogeneous good, but found that the pattern of consumption and trade in 1998 suggested that chicken meat had become a differentiated product. Hence, they proposed differentiation by cut as an area for further research. The differentiation by type of cut has been addressed by some analysts. A competitive partial equilibrium model with disaggregated high value (white meat) and low value (dark meat) cuts of chicken, and a country-of-origin differentiation within each of these types has been studied in the context of sanitary measures (Peterson and Orden, 2004). Thompson *et al.* (2008) conducted research to analyze how three models that are based on three different representations of the chicken (chicken as a single homogeneous good, as two homogeneous co-products, and as heterogeneous goods based on country of origin) respond to different external shocks and different trade policy scenarios. Thompson *et al.* (2008) found that responses in chicken production, consumption, and prices are similar across models when the shocks are not directly related to the chicken market (feed price shock, changes in income, or changes in substitute's prices). However, when considering changes that are specific to chicken markets, the similarity across models disappears.

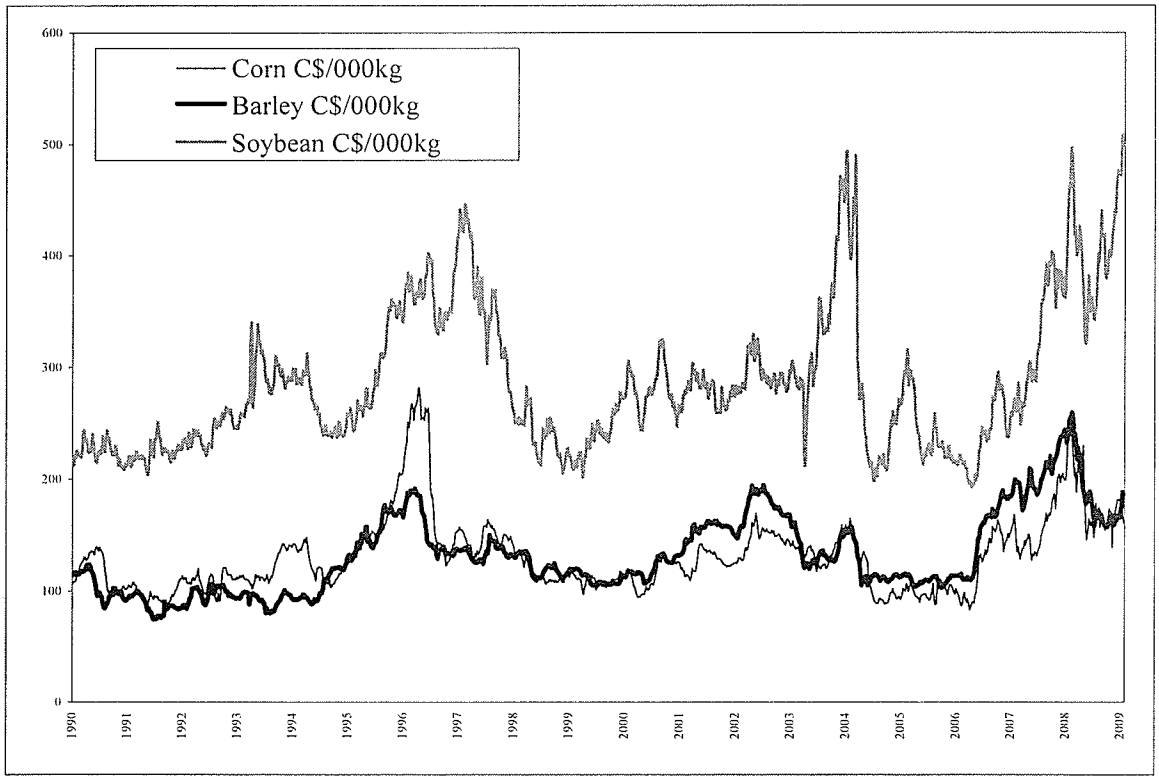
Given the patterns of Canadian chicken consumption and trade that suggest that chicken is not a single homogeneous good, as mentioned in chapter two, two simulation models are developed in this research. One treats chicken as a single homogeneous product, and the second represents chicken as two differentiated products (white meat and dark meat). The comparison of the two models is relevant not only to the main purpose of this paper (*i.e.* analysis of the effects of trade liberalization on the chicken market), but also to the question of the significance of addressing product differentiation in policy models. Given the criticisms of the Armington specification effects on trade liberalization, the differentiated model does not take into account differentiation based on country of origin; white meat is treated as one homogeneous good and dark meat as another homogeneous good regardless of production location.

3.3. World Price Risk

Price hikes and falls are common events in agricultural markets. Price volatility happens as a result of inherent characteristics of agricultural markets such as inelastic demand for agricultural products and inelastic short-run supply response of agricultural outputs. The inelasticity of the supply is attributed to productive factors that are fixed in the short run such as labor, capital, and land, all of which are relatively slow to respond to price changes. Price volatility is also caused by the susceptibility of agricultural production to weather fluctuations. Prices of agricultural products jumped between the end of 2007 and beginning of 2008, as exemplified by the data for three major feed grains in figure 3.1. The prices of rice, wheat, corn, dairy products, meat, poultry, and other agricultural commodities experienced severe hikes, which was followed by a significant fall in the

period since August 2008 (United Nations 2009). The impacts of climate change, including land degradation and droughts in tropical areas, all contribute to growing uncertainty about crop yields, and pose further treats to agricultural production that are likely to increase price volatility in the long-term. Even though the Canadian chicken industry operates under a supply management system, which ensures price stability, price volatility may affect the Canadian chicken market. Canadian chicken producers face volatile input prices that affect chicken prices (*e.g.* in 2008 chicken producers faced rising feed costs owing to high grain prices causing an increase in the live-price of chicken obtained using the cost-of-production formula, figure 3.1), and volatility in world prices that influence chicken imports (*i.e.* foreign chicken prices).

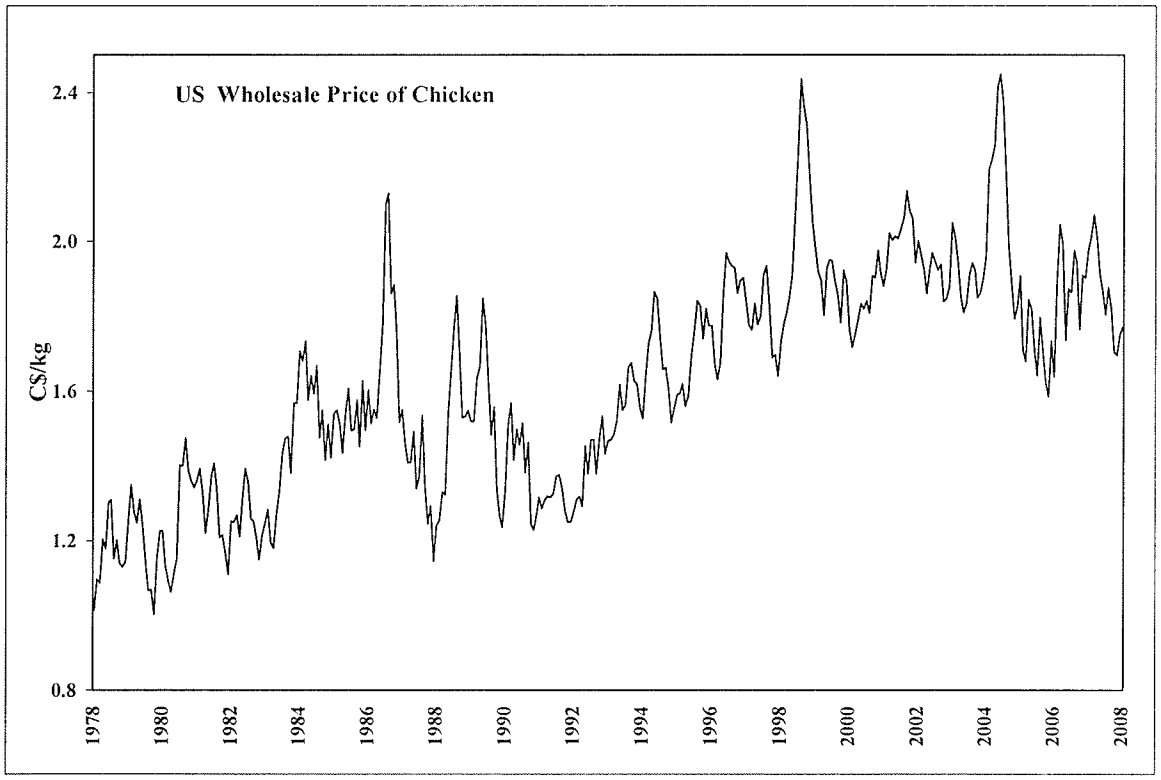
Figure 3.1: Wholesale price of Corn, Barley, and Soybean from 1990 to 2008



Source: AAFC 2008

As shown in figure 3.2, time series data of the US price of chicken exhibit a stochastic process and the price has doubled in the past 30 years. Volatility in world prices could lead to volatile imports if import barriers are reduced. According to Rude and Gervais (2006), the combination of trade liberalization and world price uncertainty threatens one of the core objectives of supply-management policies: producers' income stability.

Figure 3.2: US wholesale price of chicken from 1978 to 2008



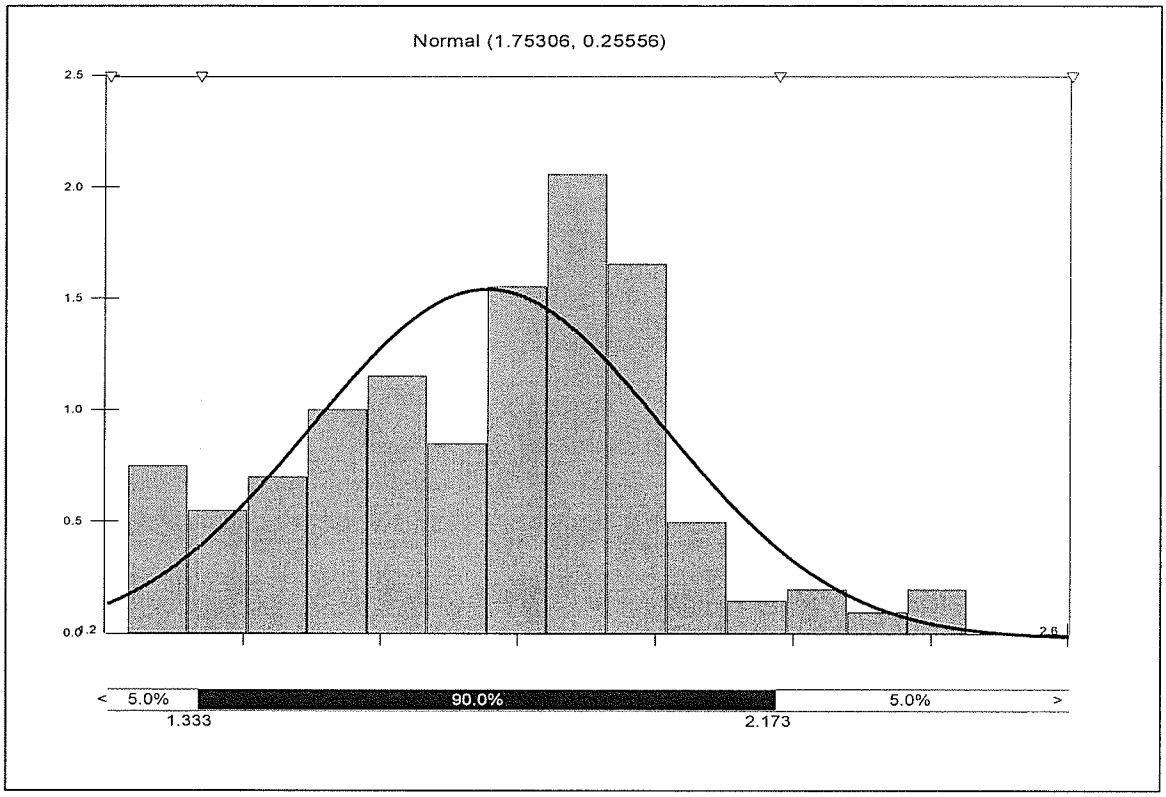
Source: USDA 2008

Since the aim of the supply management system is to stabilize prices and producers' income, world price volatility should be a concern for chicken producers because it could lead to variable flows of imports, and destabilize domestic prices and producers' profits.

Volatile imports affects producers, who become uncertain about their future production or investment decisions, and exposes processors and retailers to uncertain revenues and expenditures. Consumers will also be affected by price volatility due to frequent fluctuations in product prices.

Following Rude and Gervais (2006), a time series of US chicken prices is used to find the best fitting probability distribution for the world price using the distribution fitting software BESTFIT. The time series data set is an 18-year series of monthly US prices (12-city composite wholesale price of chicken) plus a transportation cost (C$ 0.1/kg, CFC 2009), converted to Canadian dollars using an 18-year series of monthly exchange rates (Federal Reserve Bank of St. Louis, 2009). As shown in figure 3.3, the best fitting distribution for the time series was a normal distribution with 1.75 mean and standard deviation of 0.25. Once this distribution is found, a stochastic risk-normal simulation is generated with the risk-analysis software @RISK. The same procedure is followed to determine the appropriate probability distribution for the world price of white and dark meats. In this case, time series data sets of monthly wholesale prices of breast (for white meat) and legs (for dark meat) are used. The best fitting distribution for the world indicator price of white chicken meat is a normal distribution with a 2.63 mean and standard deviation of 0.42. The world indicator price of dark chicken meat has a normal distribution, with a 1.35 mean and a 0.22 standard deviation.

Figure 3.3: Distribution of US wholesale price of chicken (C$/kg)



Source: USDA 2008, author's calculations

Chapter 4: Tariff-Rate Quota Liberalization

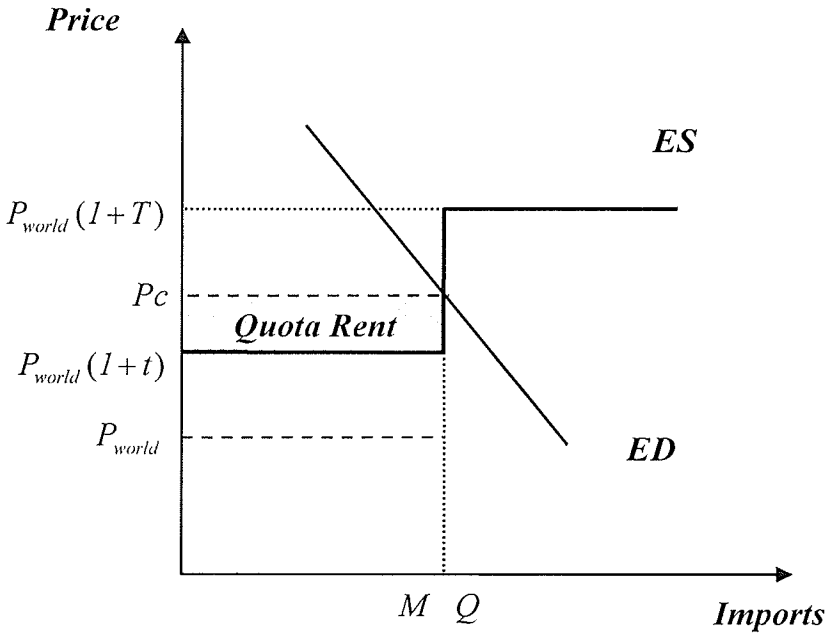
4.1. Basic Mechanisms of Tariff-Rate Quotas

According to Boughner *et al.* (2000), liberalizing trade via reduction of over-quota tariffs or in-quota tariffs has a different effect than increasing market access by expanding the size of the import quota. They found that in order to achieve a trade liberalizing effect it is necessary to determine whether the import quota or one of the two tariffs is the effective tool. A policy instrument is effective when it directly affects domestic prices and imports. Depending on the effectiveness of a particular policy tool, different trade scenarios can be simulated to determine how they will affect the Canadian chicken market. Before setting up the trade scenarios, it is important to understand the basic mechanisms of TRQs. Rude and Gervais (2000) developed a partial equilibrium model in their analysis of trade liberalization in supply-managed industries, based on Abbott and Paarlberg (1998), to illustrate the functioning of TRQs. The model assumes a small importing country in a competitive market with a perfectly elastic excess supply function that is equal to the world price.

In figure 4.1, the excess demand ED represents demand for the commodity that is unfulfilled by domestic production, and the excess supply ES represents supply of the commodity available for sale in the international market from other countries. The step-shape in the excess supply curve arises from the two-tiered tariff on imports from foreign countries. When the in-quota tariff (t) is greater than zero, the first part of the excess supply curve lies above the world price by the amount of the tariff ($P_{world}(1+t)$). When the minimum access (Q) is exceeded, the over-quota tariff (T) applies so that the excess

supply curve rises to the world price plus the higher tariff ($P_{world}(1+T)$). Import quota rents will occur as long as the domestic price (Pc) is greater than the landed-price ($P_{world}(1+t)$). Import quota rents are defined as the difference between the landed-price and domestic wholesale price times the volume of import (M) (in this case the volume of the import quota (Q)). In figure 4.1, import quota rents are represented by the area $[Pc - P_{world}(1+t)]^{*}Q$.

Figure 4.1: Basic TRQ diagram



4.2. Elimination of In-quota Tariff

The in-quota tariff is the low duty rate at which imports (below the minimum access level) enter the Canadian market. The elimination of the in-quota tariff may increase market access (increase the volume of imports) depending on whether the in-quota tariff

is the effective tool (*i.e.* the in-quota tariff is binding). Figure 4.2 represents the case when the excess demand curve (ED) intersects the lower part of the excess supply curve (ES) to the left of the import quota level (Q) (*i.e.* the in-quota tariff (t) is binding). The elimination of t increases imports from M to M^*, lowers the domestic price from Pc to Pc^*, and eliminates import quota rents, because the domestic price is equal to the world price (P_{world}).

Figure 4.2: Elimination of in-quota tariff: binding in-quota tariff

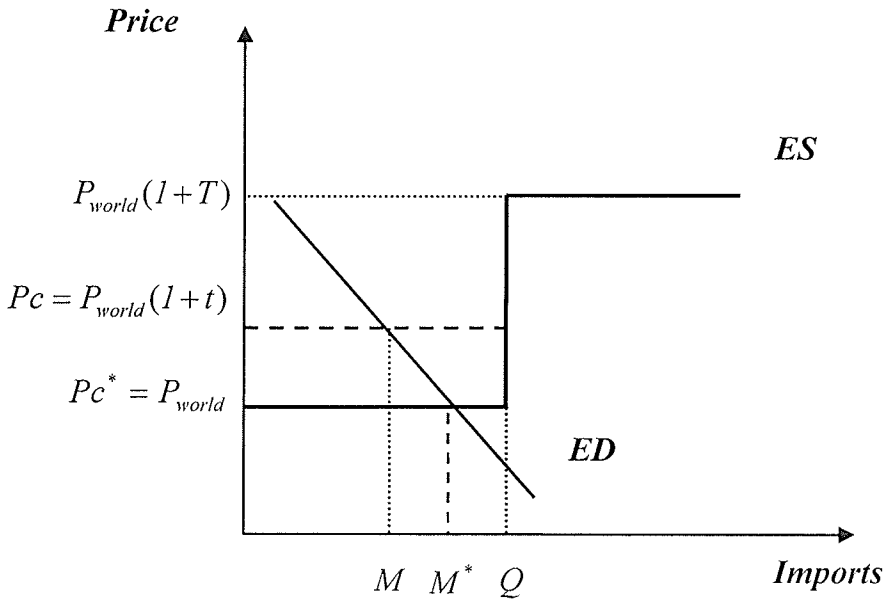
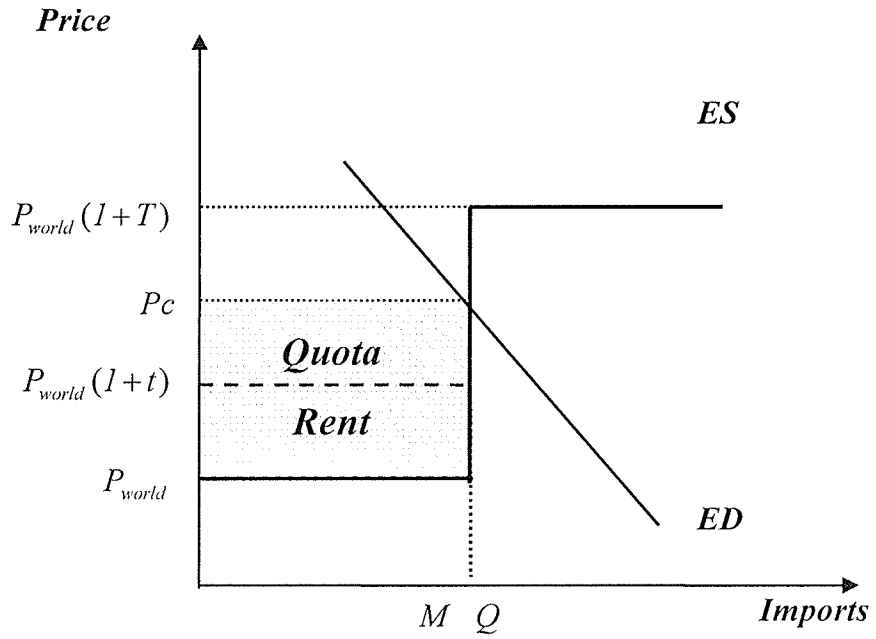


Figure 4.3 represents the case when the in-quota tariff is not the effective tool. In this case, the excess demand function intersects the vertical portion of the excess supply function (*i.e.* the import quota is binding). As mentioned before, in order to affect the level of domestic prices and the volume of imports it is necessary to identify which

policy instrument is effective; the effect of reducing or eliminating a non-effective tool is zero. In figure 4.3, the elimination of t affects neither the domestic price nor the volume of imports. The only effect of the reduction of t is the increase of import quota rents from $[Pc - P_{world}(1+t)]*Q$ to $[Pc - P_{world}]*Q$.

Figure 4.3: Elimination of in-quota tariff: binding import quota

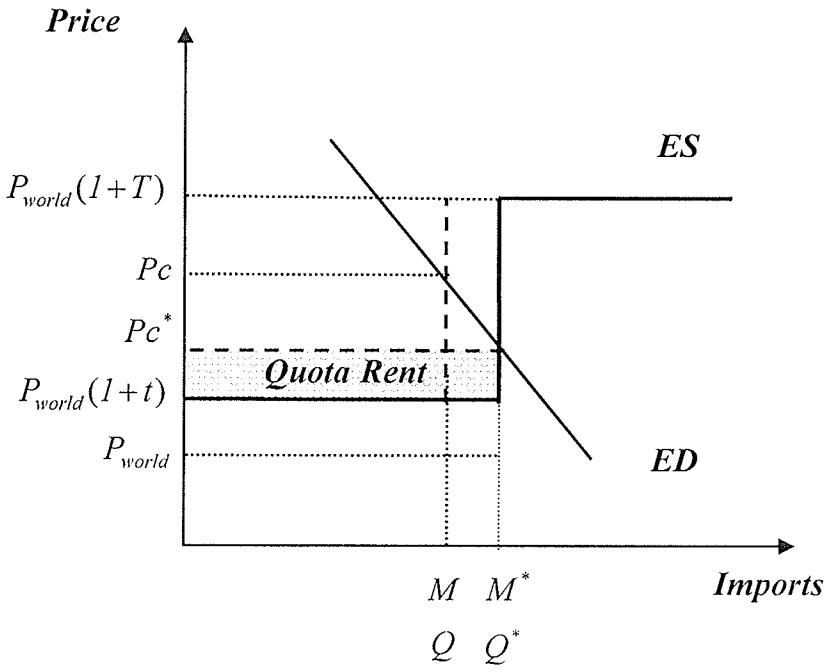


4.3. Import Quota Expansion

Another way to liberalize trade is by expanding the import quota. Figure 4.4 represents the case when the import quota is binding and the level of minimum access increases from Q to Q^*. The expansion of the import quota reduces the domestic price from Pc to Pc^*, increases the volume of imports from M to M^*, and changes import quota rents. The unit-import-quota value (landed-price less domestic prices) decreases and it is zero

when the excess demand curve intersects the lower segment of the excess supply curve (as shown in figure 4.2). The total value of import quota rents (unit-import-quota value multiplied by the volume of imports) can increase or decrease in this case, depending on whether the increase in the import quota ($[Q^* - Q]$) exceeds the decrease in the unit-import-quota value ($[Pc - P_{world}(1+t)] - [Pc^* - P_{world}(1+t)]$).

Figure 4.4: Import quota expansion: binding import quota



4.4. Reduction of Over-quota Tariff

The over-quota tariff is a higher tariff rate for imports over the minimum access level. To analyze the effects of changes to the over-quota tariff, it is necessary to determine how much the over-quota tariff can be cut while still restricting over-access imports. According to Barichello and Zhang (2008), the minimum protective tariff or nominal rate

of protection (NRP) is a rate that represents the difference between domestic and landed prices. Martin and Wang (2004) defined the difference between the over-quota tariff and the nominal rate of protection as the amount of water in the tariff (WIT). Following Barichello and Zhang (2008), the nominal rate of protection can be expressed by equation 4.1:

$$NRP = \frac{(Pc - P^{cif}_{world})}{P^{fob}_{world}} * 100 \qquad \textbf{(4.1)}$$

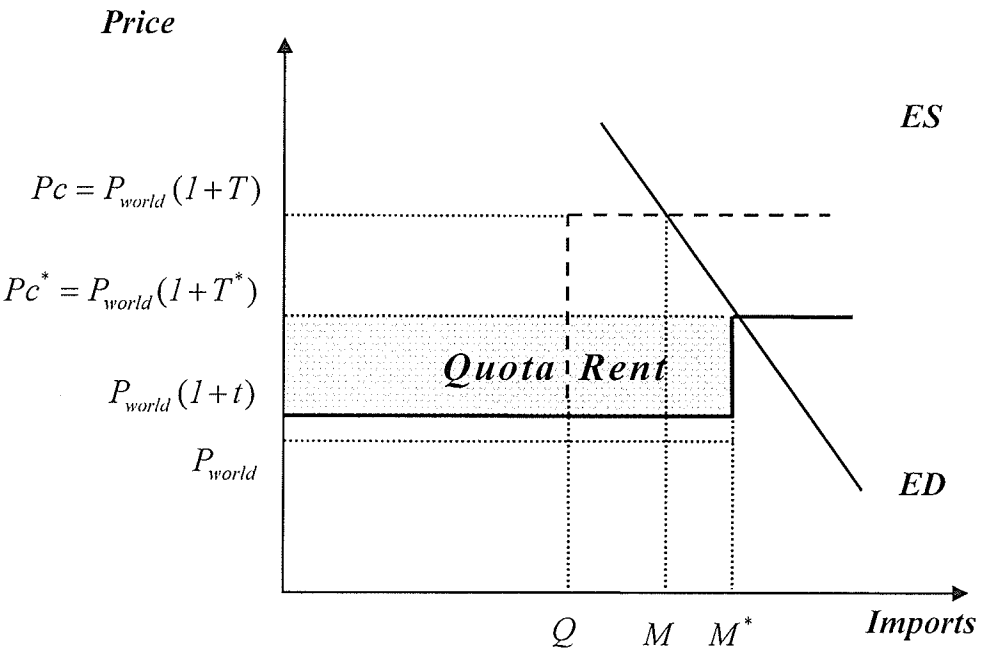
Where Pc is the Canadian wholesale price of chicken, P^{cif}_{world} is the landed-price of chicken, and P^{fob}_{world} is the world free-on-board price of chicken. The c.i.f. price (*i.e.* cost, insurance, and freight price) is the price of a good delivered at the frontier of the importing country, including any insurance and freight charges incurred to that point, and transportation costs. The f.o.b. price (*i.e.* free-on-board price) is the market value of the good, which is equal to the c.i.f. price less the costs of transportation and insurance charges, between the customs frontier of the exporting (importing) country and that of the importing (exporting) country. Then, the water in the tariff can be defined as:

$$WIT = T - NRP \qquad \textbf{(4.2)}$$

Where T is the over-quota tariff. If T is reduced by no more than the WIT , then neither the domestic price nor the volume of imports change. In this case, the only effect of lowering T is a reduction in the WIT . If the reduction of T exceeds the amount of

WIT (the new landed-price is less than the initial domestic price), then imports will increase, the domestic price will fall, and import quota rents will fall. Figure 4.5 illustrates a reduction in the over-quota tariff from T to T^* when the over-quota tariff is binding.

Figure 4.5: Reduction of over-quota tariff: binding over-quota tariff



The reduction of T reduces domestic prices from Pc to Pc^*, increases imports from M to M^*, and changes import quota rents. It is important to note that if the over-quota tariff is reduced when the import quota is the binding tool, neither the domestic price nor the volume of imports will change until the point where the over-quota tariff becomes the effective tool (when the landed-price with the over-quota tariff in place is equal to the domestic price).

Chapter 5: Data and Simulation Model

5.1. Parameters and Data

The US was the largest foreign supplier of chicken products to Canada in 2007, accounting for 117.2 million kg, or 84.3% of Canadian chicken imports. The same year, imports from Brazil totaled 19.4 million kg, representing 14% of Canadian chicken imports. Since the US and Brazil represent almost 98% of Canadian chicken imports, only these two countries are included in the model. Table 5.1 presents the percentage share of world chicken exports accounted for by the US, Brazil and Canada in 2008, and given the relative size of these markets, Canada can be considered a small country (Canadian chicken exports represents only 2% of world exports compared to 38% and 39% of the shares of US and Brazil respectively).

Table 5.1: Chicken exports in 2008 (000,000 kg eviscerated)

	Total chicken exports	Percentage share of world exports
US	3.15	37.5%
Brazil	3.24	38.5%
Canada	0.15	1.80%
ROW	1.88	22.3%
World	8.42	100%

Source: USDA 2009

Since there are two different representations of chicken in this research (one model represents chicken as a single homogeneous product and the second model represents chicken differentiated by type of cut), it is necessary to gather two sets of data, *i.e.* one for each model. In order to build the one-good model, the elasticities of demand and supply, and the farm-level marginal cost are required. The elasticity of demand is a

previously estimated value calculated at the retail level[1] from AAFC. Moschini and Meilke (1991) noted that published demand elasticities typically are estimated at the retail level. If the analysis is made at a different stage of the supply chain (*e.g.* wholesale level), an assumption about the marketing margins is needed in order to derive the slope of the wholesale-level demand function. Moschini and Meilke (1991) assumed that the processing margin was constant; the same assumption is made in this model. An elasticity of supply of 0.8 is assumed based on an estimate of US long-run broiler supply by Chavas (1978). According to Moschini and Meilke (1991), Canadian supply may be more elastic than the US supply because of unused capacity at the farm level due to supply restrictions. Therefore, the supply equation is estimated over a range of elasticities to provide some sensitivity analysis. Table 5.2 lists the parameters used to build the one-good model for the US, Brazil, Canada, and the ROW.

Table 5.2: Parameters: one-good model

	Brazil	Canada	US	ROW
Price elasticity of supply	0.6 [a]	0.8 [b]	0.8 [b]	0.8 [b]
Price elasticity of demand	-0.2 [a]	-0.7 [c]	-0.6 [d]	-1.0 [d]

Sources: [a] FAPRI, [b] Chavas 1978, [c] AAFC 2007, and [d] USDA 2000

The data used in the welfare calibration model for the representation of chicken as a single homogeneous product represent markets of Canada, Brazil, US, and the rest of the world (ROW), and correspond to national supply-disposition for each country (USDA 2009). Rest of world represents aggregate data from all countries that are not individually

[1] The demand elasticity of chicken at the retail level is obtained from "The Estimation of Food Demand Elasticities in Canada" reported by AAFC (2007).

included in the model. The average over a base period is taken that includes the most recent years (2004-2007) wherein all data are available at the time of writing. Table 5.3 provides the average values of chicken supply and disposition for 2004-2007. The domestic supply is calculated as total production plus opening stocks.

Table 5.3: Chicken supply and disposition: one-good model (000,000 kg eviscerated)

Country	Opening Stocks	Exports	Imports	Production	Ending Stocks	Qs	Qd
Brazil	0	2645	0.5	9355	0	9355	6710
Canada	31	107	108	975	34	1006	973
US	3334	2392	19	15828	347	16161	13441
ROW	286	1563	6092	37609	263	37896	42162

Sources: USDA 2009, ROW = World - (Canada + US + Brazil)

Additional parameters are required to build the second model that differentiates chicken by type of cut, such as the own-price and cross-price elasticities of demand. Previously estimated own-price and cross-price elasticities calculated at the retail level are used. Table 5.4 lists the parameters used to build the two-good model.

Table 5.4: Parameters: two-good model

	Brazil	Canada	US	ROW
White chicken meat				
Own-price elasticity of demand	-0.81 [a]	-1.47 [b]	-0.5 [a]	-1.0 [a]
Cross-price elasticity of demand	0.19 [a]	0.07 [b]	0.11 [a]	0.25 [a]
Dark chicken meat				
Own-price elasticity of demand	-0.74 [a]	-0.93 [b]	-0.3 [a]	-1.0 [a]
Cross-price elasticity of demand	0.12 [a]	0.49 [b]	0.12 [a]	0.25 [a]

Sources: [a] Thompson *et al.* 2008, [b] Goddard *et al.* 2007

The production, consumption, and trade data needed to build the two-good model are not available as such, and therefore a mechanical process is used. Chicken production, consumption, and trade data are separated into white meat (chicken breasts) and dark meat (chicken legs). Chicken production is separated based on an assumed chicken cut-out rate (53.3-to-46.7% distribution between white and dark meat is applied for all countries (CFC 2009)). This cut-out rate cannot be applied to calculate the trade data because the volume of trade of each type of meat does not reflect this ratio. Following Thompson *et al.* (2008), the shares of white and dark meat as components of total trade are estimated with traded prices of white and dark meat and the average price of all chicken trade. The shares of imports and exports of each type of meat are calculated with the following formula:

$$ATP = Sh_{white} * P_{world}^{white} + \left[1 - Sh_{white}\right] * P_{world}^{dark} \qquad \textbf{(5.1)}$$

Where ATP is the average traded price (C$), Sh_{white} is the share of imports/exports of white meat, P_{world}^{white} represents the world indicator price of white meat (C$), and P_{world}^{dark} is the world indicator price of dark meat (C$). Average traded prices for imports (value of imports/volume of imports) and for exports (value of exports/volume of exports) can be calculated using available data. The world price indicators are the average US wholesale price of breast for white meat and the average US wholesale price of legs for dark meat, plus a transportation cost (C$0.1/kg, CFC 2009). Solving for Sh_{white} from equation 5.1, the share of white meat as a component of total trade is calculated. The share of dark meat as a component of total trade is equal to $1 - Sh_{white}$. In order to calculate stocks of

each type of chicken meat an approach used by Thompson *et al.* (2008) is applied. The following formula is used to estimate stocks of white chicken meat:

$$ST_w = ST_c * \left[\frac{PRD_w + IMP_w - EXP_w}{PRD_c + IMP_c - EXP_c} \right] \quad \textbf{(5.2)}$$

Where ST represents stocks, PRD is production, IMP represents imports, and exports are represented by EXP. The suffix $_w$ indicates white chicken meat, and the suffix $_c$ denotes chicken as an aggregated product. Stocks of dark chicken meat are derived from:

$$ST_d = ST_c - ST_w \quad \textbf{(5.3)}$$

Where ST_d represents dark chicken meat stocks. Equation 5.2 is used to calculate opening and ending stocks of white meat and the same applies for equation 5.3 in the case of dark meat. Consumption of each type of meat is calculated as the residual of the market clearing balance (*i.e.* consumption is equal to opening stocks plus production plus imports minus exports minus ending stocks). Table 5.5 shows the supply and disposition data used in calibrating the welfare model for the representation of chicken as differentiated products. The data correspond to national supply-disposition for Brazil, Canada, and the US for 2004-2007 (USDA 2009) that has been separated between white and dark meat as described above.

Table 5.5: Chicken supply and disposition: two-good model (000,000 kg eviscerated)

	Opening Stocks	Exports	Imports	Production	Ending Stocks	Qs	Qd
Brazil							
White meat	0	335	0.1	4986	0	4986	4609
Dark meat	0	2310	0.4	4369	0	4369	2101
Canada							
White meat	19	22	90	520	21	536	587
Dark meat	12	85	18	455	13	470	386
US							
White meat	210	0	19	8436	218	8614	8447
Dark meat	124	2392	0	7392	129	7547	4994
ROW							
White meat	139	1215	1693	20046	129	20198	20578
Dark meat	147	348	4399	17564	134	17697	21584

Source: USDA 2009, author's calculations

5.2. Simulation Model

5.2.1. Demand: One-good Model

The model is built around a linear wholesale domestic demand equation for chicken in which trade takes place, and a linear farm-level domestic supply function wherein production controls are applied. Canada is treated as a small country. Following Moschini and Meilke (1991), the model is calibrated using the average of observed quantities and prices; the period 2004 – 2007 is used in this research. The demand curve can be represented as:

$$D = Qd(1-\eta) + \frac{\eta Qd}{P_{wholesale}} P \qquad \textbf{(5.4)}$$

Where D is the domestic demand, Qd is the observed quantity demanded, $P_{wholesale}$ is the observed wholesale price, η is the elasticity of demand, and P is the domestic price that solves $D - S = Qd - Qs$. The inverse demand curve can be expressed as:

$$P = \frac{1}{\delta} D - \frac{\gamma}{\delta} \qquad \textbf{(5.5)}$$

Where $\gamma = Qd(1-\eta)$, and $\delta = \frac{\eta Qd}{P_{wholesale}}$.

5.2.2. Demand: Two-good Model

Moschini and Meilke's methodology (1991), denoted by equation 5.4, is expanded in order to represent the demand side for the two-good model. Since white and dark chicken meat can be considered substitutes[2], the linear demand curves for each type of meat can be expressed as:

$$D_{white} = Qd_{white}(1-\eta_w) + \frac{\eta_w Qd_{white}}{P_{white}} Pw + \frac{\eta_{wd} Qd_{white}}{P_{dark}} Pd \qquad \textbf{(5.6)}$$

$$D_{dark} = Qd_{dark}(1-\eta_d) + \frac{\eta_d Qd_{dark}}{P_{dark}} Pd + \frac{\eta_{dw} Qd_{dark}}{P_{white}} Pw \qquad \textbf{(5.7)}$$

[2] Canadian Chicken Industry: Consumer Preferences, Industry Structure and Producer Benefits from Investment in Research and Advertising. Goddard *et al.* 2007

Where D_{white} is the domestic demand for white chicken meat, Qd_{white} is the quantity demanded of white meat, η_w is the own-price elasticity of demand, P_{white} is the observed wholesale price of white meat, Pw is the domestic price of white meat that solves $D_{white} - S_{white} = Qd_{white} - Qs_{white}$, and η_{wd} is the cross-price elasticity of demand for white meat with respect to the price of dark meat. D_{dark} is the domestic demand for dark chicken meat, Qd_{dark} is the quantity demanded of dark meat, η_d is the own-price elasticity of demand for dark meat, P_{dark} is the observed wholesale price of dark meat, Pd is the domestic price of dark meat that solves $D_{dark} - S_{dark} = Qd_{dark} - Qs_{dark}$, and η_{dw} is the cross-price elasticity of demand for dark meat with respect to the price of white meat.

5.2.3. Supply

It is not possible to observe the farm-level supply function under a supply-managed system because output is restricted below the competitive level and the observed farm price is greater than the marginal cost. There are no observable price and quantity combinations from which a supply curve can be deduced at the competitive level. However, it is possible to construct a supply function if the departure from marginal-cost pricing (that would exist in a competitive, non-supply managed industry) can be determined from the values of production quotas (Moschini and Meilke 1991). A linear supply curve can be fitted through the observed output and the implied marginal cost and it can be represented as:

$$S = Qs(1-\varepsilon) + \frac{\varepsilon Qs}{Mc} P \qquad \textbf{(5.8)}$$

Where S is the domestic supply, Qs is the observed quantity supplied, P is the domestic price that solves $D - S = Qd - Qs$, Mc is the implied marginal cost, and ε is the elasticity of supply. Since Mc is not observable, it can be estimated from the values of production quota and can be defined as:

$$Mc = P_{farm} - Qr \qquad \textbf{(5.9)}$$

Where Mc is the marginal cost at the competitive level, P_{farm} is the price paid to producers at the farm gate reported by CFC, and Qr is the rental value of production quota. Because production quota is a valuable asset, the rental value of production quota can be estimated using the capitalization formula. The capitalization formula measures the ratio between the net operating income produced by an asset (rental value) and its capital cost (asset value). The average reported selling price of one unit of production quota (capital value of one unit of production quota) in 2007 was C$57.63 (CFO 2007). Production quota is the amount of chicken, expressed in live weight that a grower may produce every eight weeks in one year. In Ontario, one unit of production quota allows the quota holder to produce one chicken weighing 1.86 kg every eight weeks or 6.5 times per year. Then, a unit of quota represents production of approximately 12 kg of chicken (live weight) per year (CFO 2007). The capitalization formula can be defined as:

$$\lambda = \frac{Qr}{Qv} \qquad (5.10)$$

Where λ is the discount rate, Qr is the rental value of production quota (measured in kg of eviscerated meat), and Qv is the asset value or capital value of production quota (C$/12 kg of live weight). The rental value of production quota can be estimated with the observed capital values of production quotas and an assumed discount rate. The discount rate is the producer's expected rate of return (or yield). To provide some sensitivity analysis a range of discount rates is assumed in this thesis (7, 10, and 13%), based on the information of the 10-year period rates of return for poultry farms shown in table 5.6.

Table 5.6: Rates of return for poultry farms (%)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Average
Rate	13	10.9	10.2	10	9.7	8.6	7.4	10.8	11.9	8.3	10

Source: Current rates of return in Canadian farming by farm type AAFC 2009

Based on one unit of production quota valued at C$57.63 (representing approximately 12 kg live weight of chicken), a conversion value of 0.738 between live and eviscerated weight (CFO 2007), and a discount rate of 10%, the rental value of production quota is C$0.65. Then, the marginal cost (M_c), with a farm price of C$1.73 (CFC 2007), is C$1.08. Table 5.7 presents the marginal cost values computed with discount rates of 7%, 10%, and 13% from 2004 to 2007.

Table 5.7: Marginal cost

Year	Capital value of quota (C$)	Rental value of quota (C$) 7%	10%	13%	Farm Price (C$)	Marginal cost (C$) 7%	10%	13%
2004	52.57	0.42	0.59	0.77	1.66	1.24	1.06	0.88
2005	53.97	0.43	0.61	0.79	1.62	1.19	1.01	0.83
2006	56.51	0.45	0.64	0.83	1.55	1.10	0.91	0.72
2007	57.63	0.46	0.65	0.85	1.73	1.28	1.08	0.89
Average	55.17	0.44	0.62	0.81	1.64	1.20	1.02	0.83

Sources: Capital Value of one unit of production quota (C$/12 kg live weight) from CFO 2007.
1 kg live weight is 0.738 kg eviscerated weight (CFC 2007).
Rental value of production quota is equal to the capital value of quota multiply by the producers' discount rate (C$).
The farm price (CFC 2007) is converted to kg-eviscerated weight.
Marginal cost price is equal to farm price less the rental value of production quota (C$).

The inverse supply function can be expressed by:

$$P = \frac{1}{\beta} S - \frac{\alpha}{\beta} \qquad \textbf{(5.11)}$$

Where $\alpha = Qs(1-\varepsilon)$, $\beta = \frac{\varepsilon Qs}{Mc}$, S is the farm supply, and P is the price that solves $D - S = Qd - Qs$. The two-good case uses the same supply equation as a function of the chicken price. Chicken supply is separated into white and dark meat supplies according to the fixed shares (53.3-to-46.7%). The baseline scenarios are used to calculate the welfare measures (consumer surplus, producer surplus, etc.) of the Canadian chicken market without trade liberalization. These baselines serve as starting points to calculate the distribution of welfare effects and the trade-offs in the Canadian chicken market following trade liberalization, when international prices are stochastic. Even though the

analysis is made at the wholesale level, the demand side is expanded to the retail level in order to calculate an aggregated consumer surplus in the Canadian chicken market.

5.2.4. Supply when Producers are Risk Averse

As mentioned in section 3.3, stochastic world prices could lead to volatile imports if import barriers are reduced, thereby jeopardizing Canadian producers' income stability. Producers react to risk in different ways; they could be risk takers, risk neutral or risk averse. This thesis assumes that Canadian chicken producers are risk averse[3]. The price risk faced by producers can be accounted for with a risk premium. The risk premium is the amount that a risk-averse producer is willing to pay as insurance against risk. Following Rude and Gervais (2006), the supply curve described above is adjusted for the risk premium associated with volatile prices. The supply curve plus the risk premium can be represented as:

$$P = \frac{1}{\theta} S - \frac{\varphi}{\theta} + \rho \qquad \textbf{(5.12)}$$

Where $\varphi = Qs(1-\varepsilon)$, $\theta = \frac{\varepsilon Qs}{Mc}$, S is the farm supply, P is the expected marginal cost, and ρ represents the risk premium. The risk premium is determined as follows:

$$\rho = \text{CARA} * \sigma^2 * S \qquad \textbf{(5.13)}$$

[3] For an empirical study showing that firms may be risk-averse, see Gunjal and Legault (1995).

Where CARA is the coefficient of absolute risk aversion, σ^2 is the variance of the producer's price, and S is the farm supply. The variance of the producer's price is taken from the normal probability distribution of the world price (σ^2). The CARA is defined as:

$$CARA = \frac{CRRA}{\pi} \qquad \textbf{(5.14)}$$

Where CRRA is the coefficient of relative risk aversion and π is the level of producer surplus. There is a large range of empirical estimates for the coefficient of risk aversion, and it is difficult to assign an appropriate value for this parameter. The value used in this thesis (CRRA = 4) is the average value derived from the empirical work shown in Table 5.8. If producers are risk neutral, risk effects become zero and the supply function will be the same as the one presented in equation 5.11. If producers are risk averse, as it is assumed in this thesis, then the supply function is as described by equation 5.12.

Table 5.8: Empirical estimates of farmers' relative risk aversion coefficient (CRRA)

Authors	Farm Type	Min	Max	Mean
Brink and McCarl, 1978	Crop farmers, U.S.	0.0	2.0	1.0
Chavas and Holt, 1990	Maize and Soybeans, U.S.	1.4	7.6	4.5
Love and Buccola, 1991	Crop farmers, U.S.	2.4	18.8	10.6
Saha, Shumway, and Talpaz, 1994	Wheat farmers, U.S.	3.8	5.4	4.6
Lence, 2000	All farms, U.S.	1.1	1.1	1.1
Lien, 2002	Crop farmers, Norway	0.1	10.8	2.2
Mean		1.5	7.6	**4.0**

Source: OECD 2004

5.3. Trade Liberalization Scenarios

5.3.1. Latest WTO Draft Modalities

Since the launch of the Doha Development Agenda negotiations on agriculture, there have been several proposals to improve market access, and tariff reduction is the focus of much of the debate. The latest draft modalities (WTO 2008) proposed tariff cuts in agricultural products according to a tiered formula, in which higher tariffs (out-of-quota tariffs) would have to be cut by more. Developed and developing country members would have different thresholds and tariff reductions. For developed countries, tariffs below 20% are to be cut by 50% and tariffs above 75% are to cut by 70%. All lower bound tariffs (in-quota tariffs) will be reduced either by 50% or to 10%, whichever results in a lower tariff. Where the in-quota tariff rate is already bound at or below 5%, it should be reduced to zero at the end of the first year of the implementation period (WTO 2008). The minimum market access would be expanded from 5 % to 10% of previous year's domestic consumption (WTO 2004). Although these numbers are still under negotiation, they represent the best estimate of the possible consensus, should the current framework be accepted as a modalities package. Therefore, these numbers serve as the bases for the trade liberalization scenarios that are analyzed in the following section.

5.3.2. Sensitive Products

The treatment of sensitive agricultural products is one of the most complex issues in the Doha Development Agenda. According to the latest draft modalities (WTO 2008), both developed and developing countries could declare a product sensitive for political reasons. The criteria for sensitive products is left for individual countries to decide (*i.e.*

WTO members are free to choose which products to classify as politically sensitive). There is no universal criterion to determine which products can be selected and treated as sensitive; they should reflect the internal politics of each country and the domestic vulnerabilities of each sector (WTO 2008). In the case of Canada, supply-managed products (broiler hatching egg, chicken, dairy products, eggs, and turkey), which have strong domestic political support, would be considered as sensitive products (House of Commons 2009). Sensitive products will not be totally exempted from tariff reductions, and members that make use of such exemptions will be required to provide additional market access. Developed countries would be able to designate 4-6% of their products as sensitive, or 6-8% if more than 30% of their products are in the top band of the tariff formula (WTO 2008). Tariffs on products designated as sensitive may be cut by one-third, one-half or two-thirds of the reduction that would otherwise have been required by the tiered reduction formula. To compensate for smaller tariff cuts, members must expand the level of import quotas at the lower tariff rate (in-quota tariff). For developed countries, if the minimum deviation from the tiered reduction formula (one-third) is selected, the minimum import quota expansion should be 3-5% of domestic consumption. If the maximum deviation from the tiered reduction formula (two-thirds) is selected, the minimum import quota expansion should be 4-6% of domestic consumption (WTO 2008).

5.3.3. TRQ Liberalization with Supply Management

According to the latest draft modalities (WTO 2008), the Canadian in-quota tariff for chicken products, which under the WTO agreement is 5%, would be reduced to zero

percent. The elimination of the in-quota tariff may or may not change market access, depending on whether the import quota is binding. As shown in table 5.9, the import quota rate fill for Canadian chicken industry is above 100% (*i.e.* the import quota is binding), therefore the elimination of the in-quota tariff will not change the volume of imports as long as the import quota continues to be filled. However, if the world price is below the domestic price, which is generally the case in supply-managed industries, then the elimination of the in-quota tariff will reduce domestic prices leading to a decrease in domestic producers' revenue. The in-quota tariff for chicken under NAFTA is zero percent, and because the US is the largest foreign supplier of chicken products to Canada (approximately 85% of total chicken imports in 2008), the elimination of the in-quota tariff may not have a significant effect on domestic prices or producer's revenue. The elimination of the in-quota tariff may diversify chicken imports, because those countries that are not currently exporting to Canada may find it profitable to do so after the elimination of the in-quota tariff.

Table 5.9: Canadian chicken import quota fill rate

	TRQ (000,000 kg)	Imports under TRQ (000,000 Kg)	Quota fill rate (%)
2004 [a]	69.7	70.4	101
2005 [a]	72.5	72.6	102
2006 [b]	73.3	77.3	105
2007 [b]	72.8	76.2	104

Source: [a] CFC 2005, [b] CFC 2007

The current over-quota tariff for Canadian chicken products is 238%, and the corresponding tariff cut would be 70%. According to the House of Commons and CFC, Canadian chicken products will be selected and treated as sensitive products. As

mentioned before, WTO members may deviate from the applicable tiered reduction formula on products designated as sensitive, a deviation of one-third from 70% means a reduction of 46.6% (similarly, one-half deviation equals a reduction of 35% and two-thirds deviation equals a reduction of 23.3%). For the purposes of this thesis, the maximum deviation from the tiered reduction formula (two-thirds) is selected. That means that the over-quota tariff will be reduced from 238% to 182.5%, and the import quota level will be set at 10% of domestic consumption. Current Canadian chicken minimum market access is set at 7.5% of previous year's domestic production. Canadian chicken consumption (1036.9 million kg in 2007) is higher than Canadian chicken production (1003.6 million kg in 2007); therefore increasing the import quota level to 10% of previous year's domestic consumption will increase foreign access. These scenarios are modeled to determine the overall welfare effects on the Canadian chicken market after trade liberalization.

As mentioned in chapter 4, in order to evaluate if the over-quota tariff reduction will have an effect on the Canadian chicken market it is necessary to calculate how much the over-quota tariff can be reduced without allowing out-of-quota imports into Canada. This is known as the water in the tariff, the gap between the nominal rate of protection and the over-quota tariff. If the wholesale price (Pc) used to calculate the nominal rate of protection (equation 4.1) is not at the competitive level, then the water in the tariff may not be an accurate representation of how much the over-quota tariff can be reduced without affecting the Canadian chicken market. As mentioned by Barichello and Zhang (2008), the water in the tariff may be underestimated if it is calculated using a wholesale

price that is not at the competitive level. The wholesale price (Pc) under a supply-managed industry can be expressed by equation 5.15:

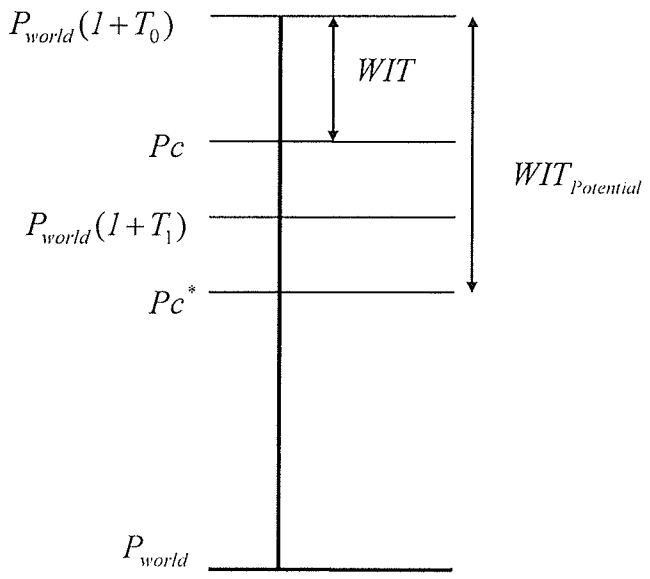
$$Pc = P_{farm} + P_{margin} \tag{5.15}$$

Where P_{farm} is the producers' price of chicken at the farm-level (under the supply-managed industry), and P_{margin} is the processing margin, which is assumed to be constant. The farm price (equation 5.9) is equal to the marginal cost price (producers' price at the competitive level) plus the rental value of production quota (Qr). Then, the wholesale price in a perfect competitive market, which is essentially a marginal cost at the competitive level augmented by the processing margin, can be denoted by equation 5.16:

$$Pc^* = Mc + P_{margin} \tag{5.16}$$

Where Pc^* is the Canadian wholesale price of chicken at the competitive level, Mc is the marginal cost, and P_{margin} is the processing margin. Figure 5.1 shows a situation where the over-quota tariff was reduced from T_0 to T_1, and $T_0 - T_1 > WIT$. In this case, chicken imports will enter the Canadian market because the landed-price (world price plus the applicable over-quota tariff) is less than the domestic price ($P_{world}(1+T_1) < Pc$). However, if the water in the tariff is calculated with the Canadian wholesale price described by equation 5.16, then the landed price would be greater than the domestic price ($P_{world}(1+T_1) > Pc^*$), and no imports would enter the Canadian market.

Figure 5.1: Water and potential water in tariff



Source: Barichello and Zhang 2008

The nominal rate of protection calculated with Pc^* is defined by Barichello and Zhang (2008) as the potential nominal rate of protection and can be defined by equation 5.17:

$$NRP_{Potential} = \frac{(Pc^* - P_{world}^{cif})}{P_{world}^{fob}} 100 \qquad \textbf{(5.17)}$$

Where Pc^* is the domestic wholesale price of chicken at the competitive level, P_{world}^{cif} is the landed price without a tariff, and P_{world}^{fob} is the free-on-board world price. Then the potential water in tariff is defined as:

$$WIT_{Potential} = T - NRP_{Potential} \qquad \textbf{(5.18)}$$

Where T is the over-quota tariff rate in place, and $NRP_{potential}$ is the potential nominal rate of protection calculated by equation 5.17. This potential water in the tariff provides a better estimate of how much the over-quota tariff can be reduced while restricting over-quota access of foreign chicken into Canada. If the over-quota tariff if reduced beyond the water in the tariff but less than the potential water in the tariff, imports over the minimum access level would be restricted if the domestic wholesale price of chicken is reduced approaching competitive levels. This thesis estimates both the WIT and the $WIT_{potential}$ for comparison.

Chapter 6: Welfare and Sensitivity Analysis

6.1. Welfare Analysis

The welfare analysis is conducted using two baselines (with and without price risk), each using a different representation of chicken (chicken as a single homogeneous product vs. chicken as differentiated products). Each of these baselines is then analyzed through trade liberalization. A graphical representation of the Canadian chicken market (figure 6.1) is used to describe the baseline scenario.

There are two key assumptions in these representations:

(a) Canada is modeled as a small country. Canada's share in the world chicken export market was approximately 2% in the period from which the baseline data are drawn. The model assumes that Canada cannot affect the world price.

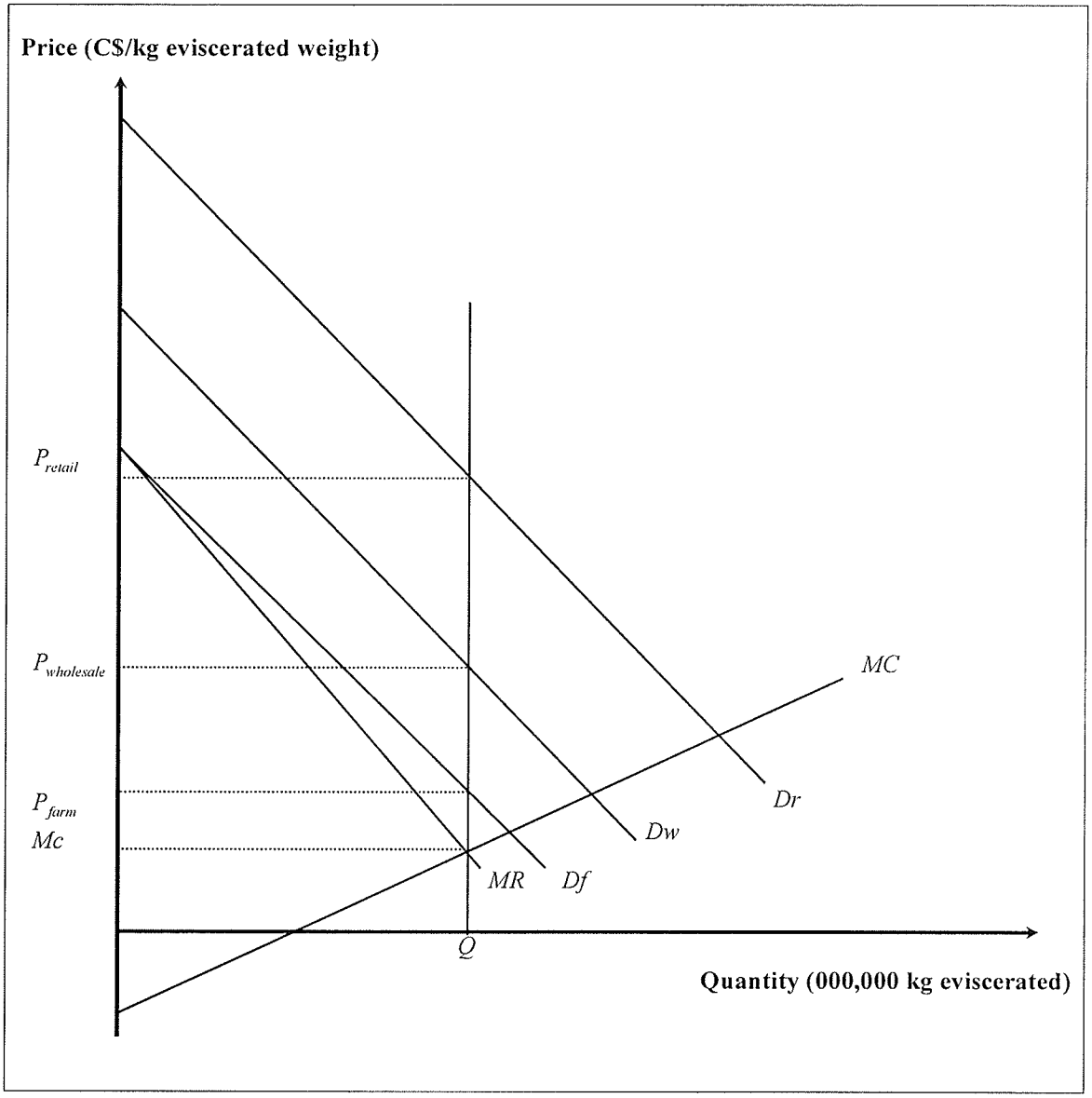
(b) Processing and marketing margins are constant. The processing margin is the farm-wholesale price spread, which is the difference between the price paid to producers at the farm gate and the price paid to processors (*i.e.* the processing cost). The marketing margin is the wholesale-retail price spread, which is the difference between the price paid to retailers and the price paid to processors (*i.e.* the marketing cost). In order to analyze a vertical marketing system in a simple framework, it is necessary to assume fixed proportions between the retail and wholesale levels and between the wholesale and farm levels. As mentioned in section 5.1, the demand elasticities used in the model are estimated at the retail level. Therefore, in order to derive the slopes of the wholesale level and the farm level demand functions the marketing and processing margins are assumed to be constant. The marketing margin is calculated as the difference between the retail price and the wholesale price of chicken. The value of the marketing margin is

C$2.41/kg, which is the average of the period 2004-2007. The processing margin is calculated as the difference between the wholesale price and the farm price of chicken. The average value of the processing margin for the period 2004-2007 is C$1.31/kg.

6.1.1. Autarky: One-good Model

There are three stages of the supply chain represented in figure 6.1, the farm-level supply (wherein production controls are applied using production quotas), the processing level (*i.e.* wholesale level, in which trade takes place), and the retail level. The retail-level demand curve (Dr) represents the demand for chicken products by consumers. The retail price (P_{retail}) is the price paid to retailers. The demand facing processors is represented by the wholesale-level demand curve (Dw), which is obtained by subtracting the marginal cost of marketing services from the retail demand function (Dr). The wholesale price ($P_{wholesale}$) is the price paid to processors by retailers. The farm-level demand curve (Df) represents the demand facing producers, which is obtained by subtracting the marginal cost of processing services from the wholesale demand function (Dw). The marginal cost curve (MC) represents the supply of chicken at the farm-level. The farm price (P_{farm}) is the price paid to producers at the farm gate. The marginal cost (M_c) is implied using the rental value of production quota (see equation 5.9).

Figure 6.1: Baseline autarky: one-good model



The CFC has the authority to regulate chicken production and determines the production quota level of the supply-managed chicken industry. Therefore the level of production quota has to be determined assuming a decision making process by the marketing board. If the marketing board acts as a pure monopoly, the profit-maximizing

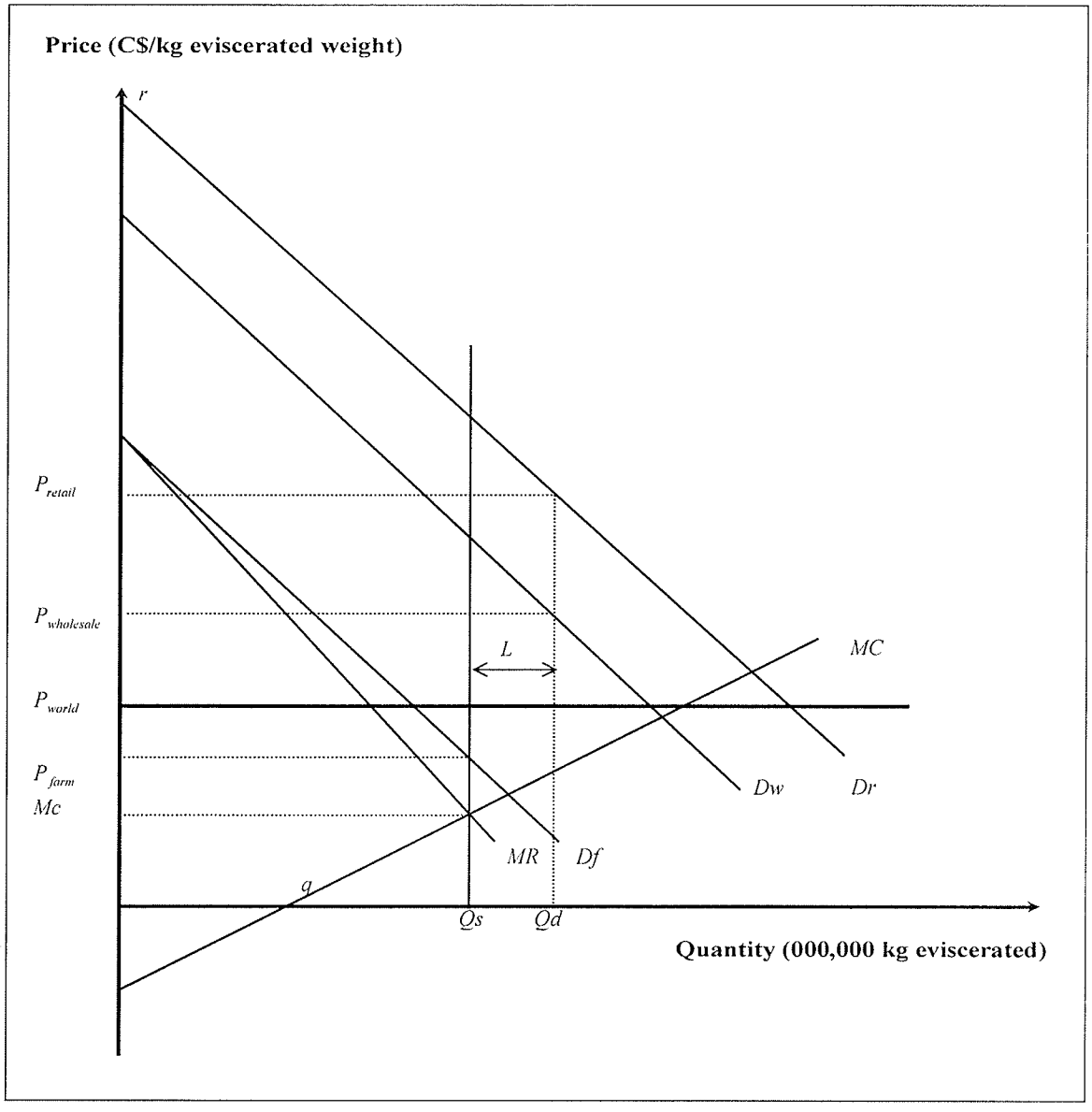
production decision involves equality between marginal revenue and marginal cost. However, given that the demand for chicken is inelastic, the marginal revenue received by the monopoly would be negative (Rude and Gervais 2006). A monopoly can only maximize profit in the elastic range of the demand curve. Also, the monopoly solution (as inferred from setting output where marginal cost equals marginal revenue) results in a smaller level of output than the current observed production quota level. This suggests that the production quota is not set at the profit-maximizing level. Following Rude and Gervais (2006), this thesis assumes that the marketing board behaves as a constrained monopoly. A constrained monopoly has price-setting power and maximizes profits however it is constrained by the price elasticity of demand of the commodity. An adjusted marginal revenue curve (MR) is calibrated to intersect the marginal cost curve (MC) at the initial level of production (Q). Figure 6.1 illustrates the Canadian chicken market under autarky when there are no imports and consumption is Q.

6.1.2. Baseline Scenario: One-good Model

Figure 6.2 illustrates the current Canadian chicken market situation with supply management at the farm level and imports subject to TRQs entering the Canadian chicken market at the wholesale level. The import quota level is represented by L. The production quota (Qs) plus the volume of imports (L) give the level of domestic quantity demanded (Qd). The world price (P_{world}) is the price at which imports enter the Canadian market. Producer surplus is measured as the difference between the producer revenue (price at the farm level multiplied by domestic supply), and the area under the marginal cost curve between the intercept and the level of domestic supply. In figure 6.2,

producer surplus is represented by the area: $[P_{farm} * Qs] - 0.5 * M_c * [Qs - q]$. Exports are removed from the baseline; the level of domestic supply is determined as the difference between production and exports. Then, domestic consumption is equal to domestic supply plus imports ($Qd = Qs + L$).

Figure 6.2: Baseline scenario: one-good model



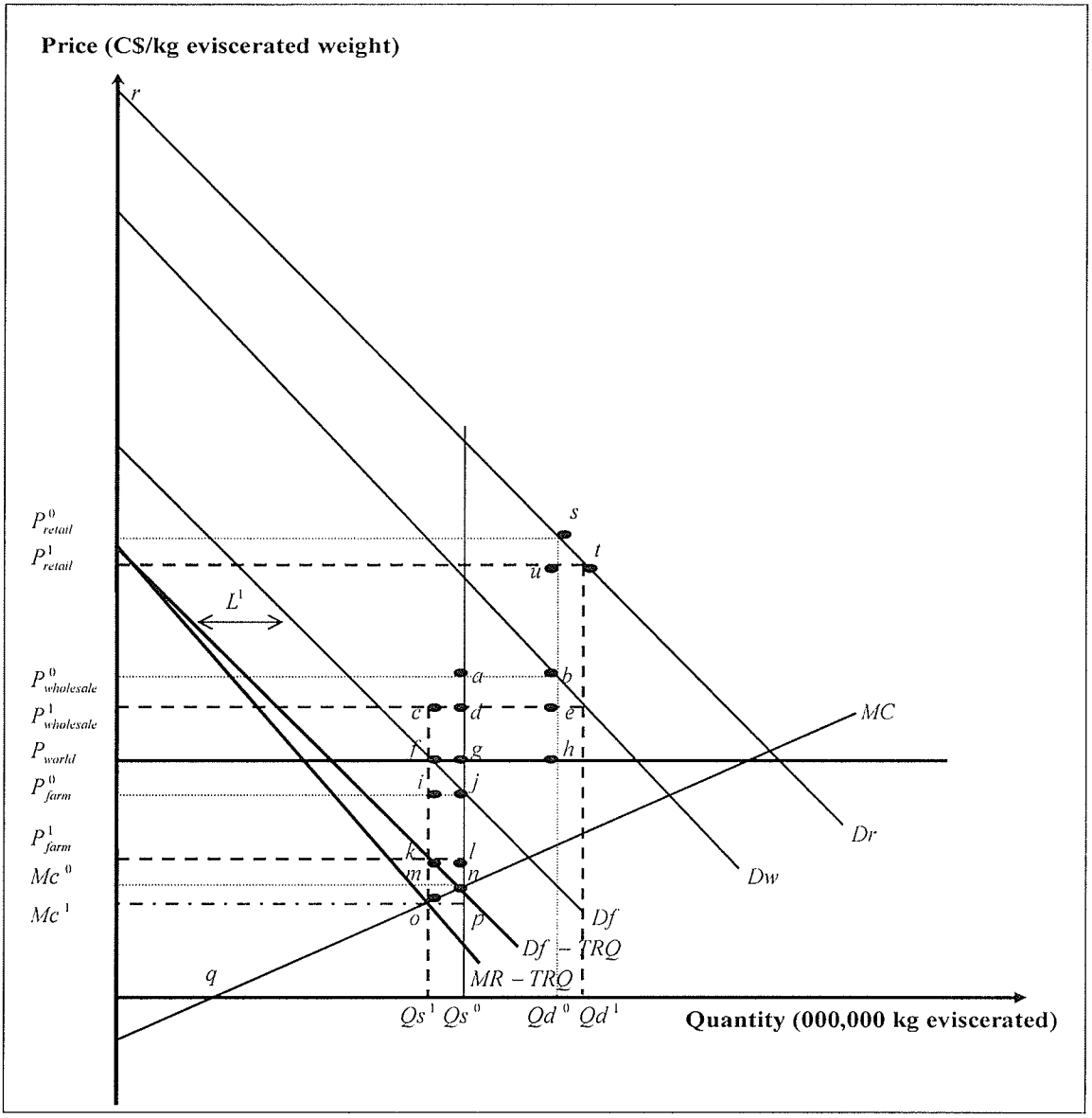
Processor revenue is calculated as the difference between the wholesale price and the farm price of chicken multiplied by the level of domestic supply ($[P_{wholesale} - P_{farm}]^* Qs$). Consumer surplus is an aggregated value that includes the processors', retailers', and consumers' surplus. It is calculated as the difference between the retail price and the wholesale price, multiplied by the level of domestic consumption, plus the area under the retail demand curve up to the level of the retail price. In figure 6.2 consumer surplus is represented by the area: $[P_{retail} - P_{wholesale}]^* Qd + 0.5^* [r - P_{retail}]^* Qd$. Import quota rents are calculated as the difference between the wholesale price and the world price multiplied by the volume of imports. In figure 6.2 import quota rents are represented by the area: $[P_{wholesale} - P_{world}]^* [Qd - Qs]$. The import quota level for 2007 was calculated as 73 million kg; however, the volume of imports that year was 152 million kg (CFC 2007). The volume of Canadian chicken imports is above the minimum market access. Import data include imports under the "import to re-export" program and imports that are not subject to TRQs (*e.g.* imports of non-ICL products). In 2007, a total of 74 million kg was imported under the "import to re-export" program (CFC 2007), which is a little over 50% of total Canadian chicken imports. According to the latest draft modalities (WTO 2008), imports to re-export (including where the obligation to re-export is in a processed form) should not be counted as imports under the minimum market access commitment. Therefore, the initial level of imports is calculated as 7.5% of production (the value of the current minimum access level) in order to compare the increased market access from 7.5% of domestic production to 10% of domestic consumption. Total welfare is calculated as the sum of producer surplus, consumer surplus, processor revenue, and import quota rents.

6.1.3. Import Quota Expansion: One-good Model

Figure 6.3 depicts the effects of import quota expansion on the Canadian chicken market. As mentioned in section 6.1.1, the level of production quota has to be determined by assuming some form of behavior by the marketing board. This thesis assumes that the marketing board acts as a constrained monopoly, and it would treat $Df - TRQ$ as its effective demand. With the increase in market access, the producer's residual demand curve ($Df - TRQ$) and its corresponding marginal revenue curve ($MR - TRQ$)[4] shift downward. As a result, the level of domestic supply goes down from Qs^0 to Qs^1, the farm price declines from P^0_{farm} to P^1_{farm}, and the marginal cost decreases from Mc^0 to Mc^1. Since more low-priced foreign chicken enters the Canadian market, the domestic wholesale price decreases from $P^0_{wholesale}$ to $P^1_{wholesale}$, and domestic consumption increases from Qd^0 to Qd^1. The change in producer surplus consists of two areas: the rectangle $P^0_{farm}\,jl\,P^1_{farm}$, which is the loss associated with lower farm price, and the trapezoid $lkon$ representing the loss due to lower domestic supply. The change in import quota rents consist of three areas: the rectangle $abed$ that is the loss caused by lower wholesale price, the area $[P^1_{wholesale} - P_{world}]*[Qd^1 - Qd^0]$ representing the gain due to higher domestic demand, and the area $cdfg$, which is the gain attributed to lower domestic supply. The change in processor revenue consists of three areas: the area $P^0_{wholesale}\,adP^1_{wholesale}$ representing the loss associated with lower wholesale price, the area $cdlk$ that is the loss owing to lower domestic supply, and the rectangle $P^0_{farm}\,ikP^1_{farm}$ indicating the gain generated by lower farm price.

[4] Note that the original MR function is not included in the diagram for neatness.

Figure 6.3: Import quota expansion: one-good model

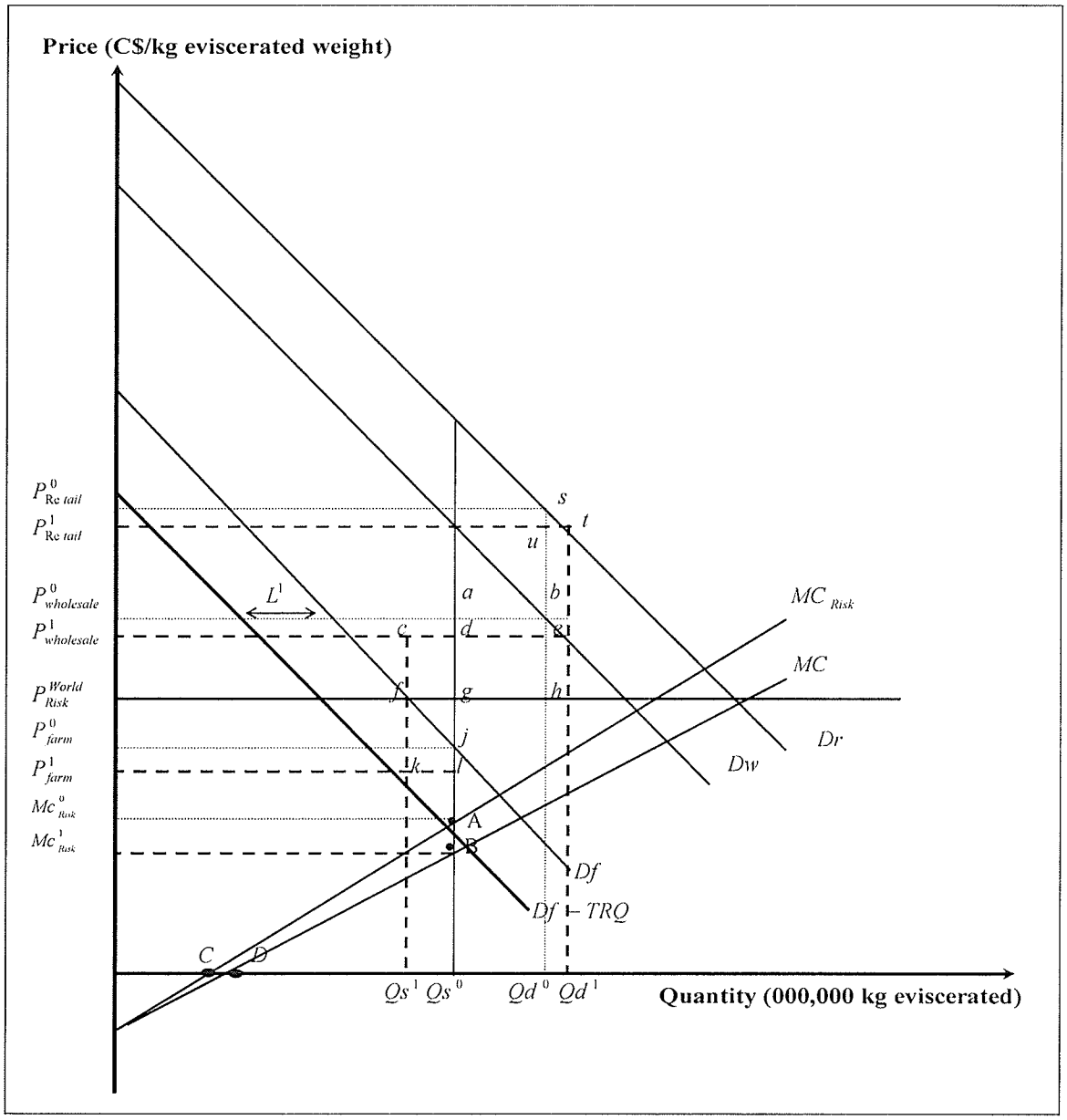


The change in consumer surplus consists of three areas: the trapezoid $P^{0}_{retail}\ stP^{1}_{retail}$, which is the gain caused by lower retail price, the area $[P^{1}_{retail} - P^{1}_{wholesale}]*[Qd^{1} - Qd^{0}]$ representing the gain associated with higher domestic demand, and the area $P^{0}_{wholesale}\ beP^{1}_{wholesale}$ that is the gain attributable to lower wholesale price.

6.1.4. Import Quota Expansion and Price Risk: One-good Model

The welfare analysis when world prices are stochastic considers a marginal cost curve that is adjusted for a risk premium, as described by equation 5.12, assuming that Canadian chicken producers are risk averse. The risk premium represented by equation 5.13 is calculated with an assumed CRRA of 4 (OECD 2004), a primary producer surplus obtained from the base scenario, the initial level of output, and the variance of the world price obtained from the normal probability distribution parameters of the world price (0.07). The marginal cost curve adjusted for the risk premium (MC_{Risk}) is presented in figure 6.4. Since the risk premium changes the slope of the marginal cost curve, the curve pivots upward; as a result, MC_{Risk} is steeper than MC. With the increase of the volume of imports, producers' residual demand curve ($Df - TRQ$) shifts downward, lowering the farm price. The level of domestic supply is reduced from Qs^0 to Qs^1, and the marginal cost declines from Mc^0_{Risk} to Mc^1_{Risk}. As result of additional low-priced foreign chicken in the Canadian market, the domestic wholesale price declines, thereby increasing domestic consumption. The calculation of import quota rents, processor revenue, and consumer surplus are the same as described for the welfare analysis without price risk in section 6.1.3. However, producer surplus will change not only due to the expansion of the import quota but also because of the steeper marginal cost curve. The change in producer surplus includes the losses associated with lower farm price and lower domestic supply, and the loss associated with the risk premium that induced the shift in the marginal cost curve that is represented in figure 6.4 by the trapezoid $ABCD$.

Figure 6.4: Import quota expansion and price risk: one-good model

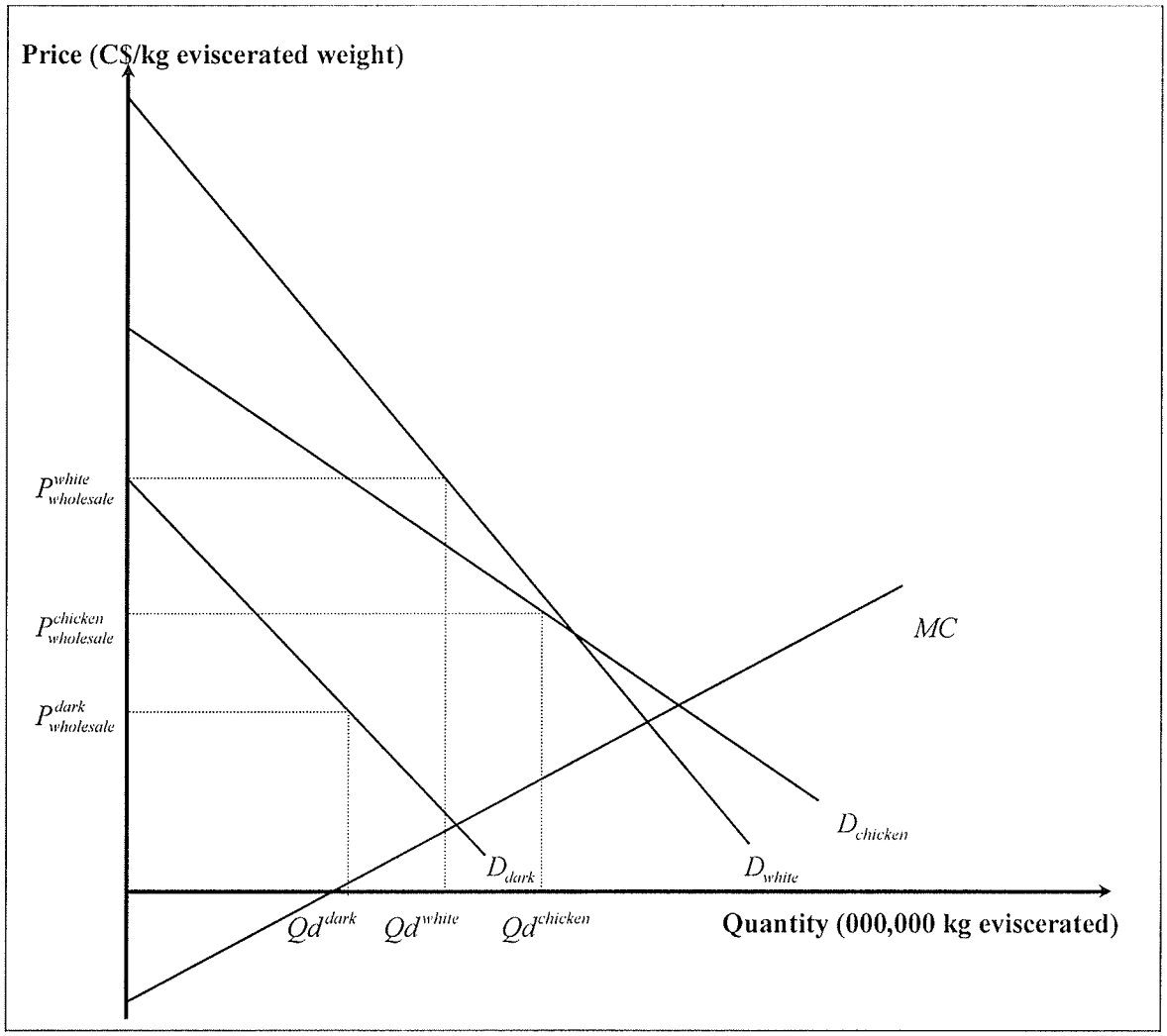


6.1.5. Baseline Scenario: Two-good Model

As mentioned in section 3.2, the pattern of consumption and trade of chicken in Canada suggests that chicken is not a single homogeneous good. Therefore, in addition to the

one-good model this research represents chicken as two differentiated products (white meat and dark meat). In figure 6.5, the demand curve for white meat (D_{white}) is to the right of the demand for dark meat (D_{dark}) implying a higher demand, demonstrating the Canadian preference for white chicken meat. The chicken demand curve ($D_{chicken}$) is less steep than D_{white}, meaning that demand for chicken as an aggregated product is more elastic than demand for white chicken meat. The wholesale price of white meat ($P^{white}_{wholesale}$) is higher than both the wholesale price of chicken ($P^{chicken}_{wholesale}$) and the wholesale price of dark meat ($P^{dark}_{wholesale}$). The welfare analysis for the two-good model is similar to the one conducted when chicken is represented as a single homogeneous good. The main difference is that production, consumption, and trade are separated between white and dark meat. Producer surplus for white meat is obtained by multiplying the farm price of chicken by the level of white meat supply minus the area below the marginal cost curve (MC). Processor revenue for white meat is calculated as the difference between the wholesale price of white meat ($P^{white}_{wholesale}$) and the farm price of chicken multiplied by the level of white meat domestic supply. Import quota rents for white meat are calculated as the difference between the wholesale price of white meat ($P^{white}_{wholesale}$) and the world price of white meat multiplied by the volume of imports of white meat. Consumer surplus for white meat is calculated as the difference between the retail price and the wholesale price of white meat multiplied by level of white meat consumption, including the area under the retail-level demand curve for white meat. Similarly, processor revenue, consumer surplus, producer surplus, and import quota rents are calculated for dark meat.

Figure 6.5: Baseline Scenario: two-good model

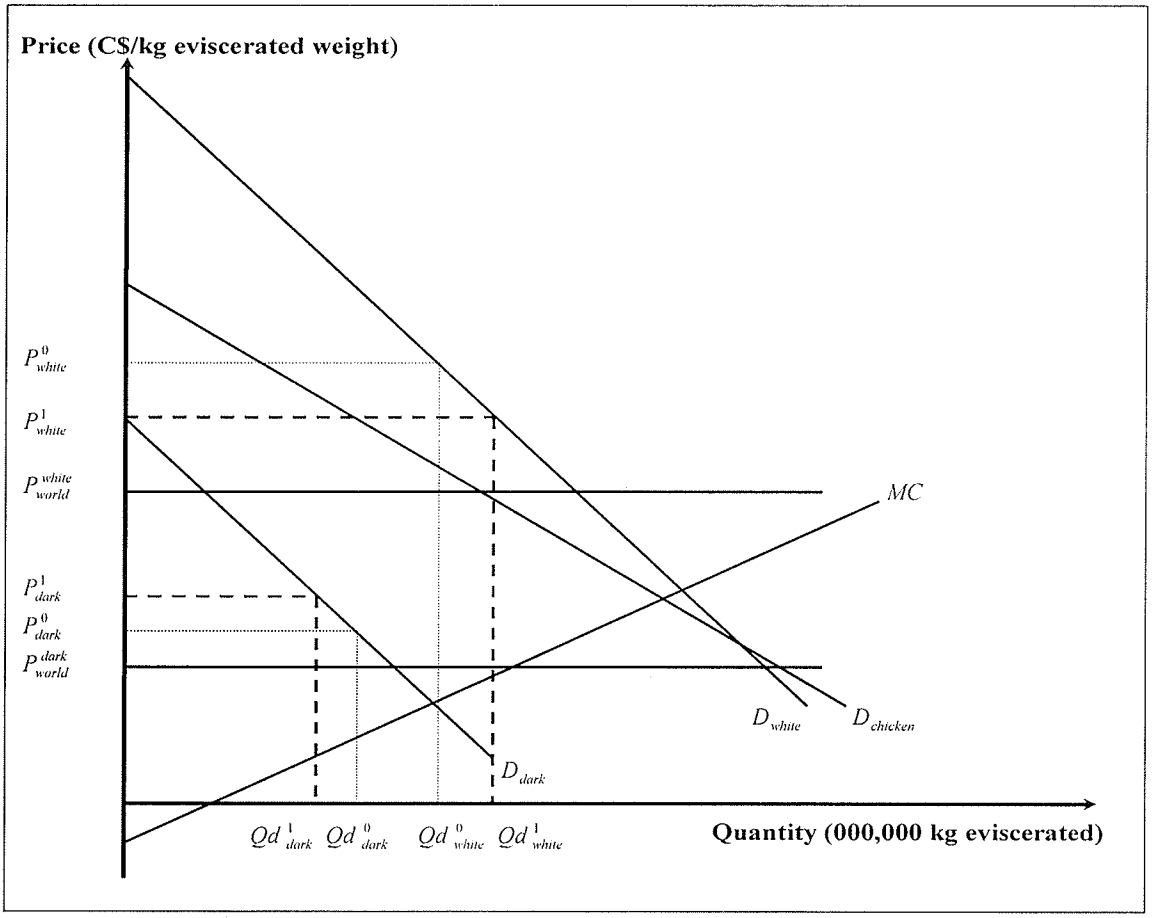


6.1.6. Import Quota Expansion: Two-good Model

As shown in table 2.3, approximately 70% of total Canadian chicken imports are white chicken meat. An increase on the volume of imports will mainly increase the volume of low-priced white meat in the Canadian market, lowering the domestic wholesale price of white meat. As a result, consumption of white meat increases (figure 6.6). The increase of foreign low-priced white meat in the domestic market brings about less quantity

demanded for high-priced domestic white meat, leading to less domestic quantity supplied of white meat. This necessarily leads to less quantity supplied of dark meat (at the farm level chicken is produced and sold as a single product). The lower quantity supplied of dark meat leads to a higher domestic price for dark meat. Also, since white and dark chicken meat can be considered substitutes, the reduction of the price of white meat will cause a decrease in the quantity demanded for dark meat, and *vice versa*. Lower quantity demanded for dark meat raises its price (*i.e.* there is an upward movement along the demand curve for dark meat). In the case of the welfare analysis when world prices are stochastic, the adjusted marginal cost curve mentioned in section 6.1.3 is used.

Figure 6.6: Import quota expansion: two-good model



6.2. Sensitivity Analysis

The parameters used in this research are previously estimated values obtained from different sources and different methodologies; therefore, it is important to determine how sensitive the results of the welfare analysis are to these parameters. A sensitivity analysis allows determining the degree of sensitivity in the model output caused by changes in the value of the input parameters. Sensitivity analysis of the producer's discount rate, the chicken supply elasticity, and own and cross price elasticities of demand for white and dark meats (two-good model) is conducted to examine the potential economic impacts of trade liberalization on prices, supply and demand quantities, and welfare measures.

6.2.1. Producer's Discount Rate

The discount rate is used to calculate the rental value of production quota, which is then used to estimate the marginal cost of Canadian chicken production in a perfectly competitive market. The range of discount rates (7, 10, and 13%) is based on the rates of return for poultry farms estimated by AAFC in 2009. The initial level of marginal cost may not have a significant effect on production, given that output under a supply-managed industry is not determined by market conditions. However, if the initial level of marginal cost affects the level of domestic supply (if the production quota is not filled), then domestic demand will also be affected (domestic demand is defined as domestic supply plus imports). Changes in consumption and production will affect consumer and producer surplus, and impact total welfare in the chicken market.

The US marginal cost of chicken production in 2007 was C$1.19 (USDA 2008). If a discount rate of 7% is chosen, then the marginal cost of Canadian chicken producers is

C$1.28, which is higher than the marginal cost of their US counterparts, meaning that Canadian chicken producers are less productive. Koo and Golz (1994) evaluate the competitiveness of broiler producers in North America based on production costs, labor wages of processing, and transportation. Koo and Golz (1994) concluded that the US broiler industry has a comparative advantage over Canada's broiler industry, and that Canadian producers cannot compete with US producers given that they do not produce at full capacity and their production costs are above US production costs. A discount rate of 10% gives a marginal cost of C$1.08 meaning that Canadian chicken producers are roughly as productive as US producers. With a discount rate of 13% the marginal cost of Canadian chicken production is C$0.89, which means that Canadian chicken producers have a lower marginal cost of production and are more productive than their US counterparts. Sensitivity analysis allows an evaluation of how much more productive Canadian chicken producers must be for welfare to increase if market access increases and allows low-cost foreign chicken products into Canada.

6.2.2. Supply Elasticity

The relationship between the elasticity of chicken supply and the slope of the supply curve is fundamental in determining the welfare measures of the Canadian chicken market. Therefore, a sensitivity analysis of the supply elasticity is conducted to find out how prices, supply quantities, and welfare measures change after trade liberalization. The baseline value of the supply elasticity is 0.8, which is based on an estimate of US long-run broiler supply. Due to supply restrictions at the farm-level, Canadian chicken supply response may be more elastic than the US supply response (Chavas 1978). The supply

function (equation 5.8) is calibrated over a range of supply elasticities of 0.6, 0.8, and 1.0. The supply elasticity may affect the value of the producer surplus, which will change the total welfare.

6.2.3. Own and Cross Price Elasticities of Demand for White and Dark Meats

In order to build the second model that differentiates chicken by type of cut, previously estimated own and cross price elasticities of demand for white and dark chicken meats are used. The values of the own and cross price elasticities used for Canada are obtained from Goddard *et al.* (2007) and the values used for the US, Brazil, and the ROW are from Thompson *et al.* (2008). The fact that these values are obtained from different sources and different methodologies may cause problems of consistency in the model. Therefore, a sensitivity analysis of the own and cross price elasticities of demand for white and dark meats is conducted to determine how sensitive the results of the welfare analysis are to these parameters.

Chapter 7: Results and Discussion

This chapter describes how the simulation model is solved and presents the quantitative results obtained from the welfare and sensitivity analyses described in chapter 6.

7.1. Simulation Model Outcome

The elasticities of supply and demand and the data (quantities and prices) described in section 5.1 are used to calculate the parameters of the linear demand (γ and δ from equation 5.5) and supply (α and β from equation 5.11) functions. Then the model is introduced into Excel and is solved as a linear programming model. The model finds the price that solves the market equilibrium where domestic demand (D) equals domestic supply (S) plus the volume of imports (L). Domestic demand is a function of the wholesale price of chicken ($D = \frac{\gamma}{\delta} + \delta P_{wholesale}$), and domestic supply ($S = \frac{\alpha}{\beta} + \beta M_c$) is a function of the marginal cost which is implied from the rental value of production quota and the farm price ($M_c = P_{farm} - Qr$). The farm price is obtained from the difference between the wholesale price and the processing margin ($P_{farm} = P_{wholesale} - P_{\text{margin}}$), assuming constant processing margins. Since the supply is also a function of the wholesale price ($S = \frac{\alpha}{\beta} + \beta (P_{wholesale} - P_{\text{margin}} - Qr)$), the model can be solved. The wholesale price of chicken is solved using the Excel Solver add-in. As mentioned in section 6.1.1, the level of domestic supply after trade liberalization for a supply-managed industry is determined where the adjusted residual marginal revenue ($MR - TRQ$) function intersects the marginal cost function (see figure 6.3).

7.2. One-good Model Results

The welfare effects of tariff-rate quota liberalization on the Canadian chicken market for the one-good model are displayed in table 7.1. The second column of table 7.1 lists the observed values (quantities and prices) used to calculate the baseline welfare measures.

Table 7.1: Welfare effects on the Canadian chicken market: one-good model

Variables	Base scenario	Quota Expansion	Risk Base scenario	Quota Expansion & Price Risk	5^{th}	95^{th}
Wholesale price	2.95	2.93	2.95	2.93	2.13	3.85
World price	1.93	1.93	1.89	1.75	0.94	2.66
Retail price	5.35	5.34	5.35	5.34	4.54	6.26
Farm price	1.64	1.62	1.64	1.62	1.21	1.83
Marginal cost	1.02	1.00	1.23	1.21	1.21	1.21
Consumption	941	945	941	945	945	739
Imports	73.1	86.5	73.1	86.5	86.5	0.00
Domestic Supply	868	858	868	858	858	858
Producer revenue	1423	1394	1423	1394	1038	1574
Import quota rents	74	86	87	102	103	0
Producer surplus	1070	1051	981	964	609	1144
Processor revenue	1134	1121	1134	1121	792	1730
Consumer surplus	5866	5894	5866	5894	6270	4270
Total welfare	8145	8152	8069	8081	7775	7144

Prices: C$/kg eviscerated weight
Consumption, imports, and domestic supply: 000,000 kg
Producer revenue, import quota rents, producer surplus, processor revenue, consumer surplus, and total welfare: C$ millions

As a result of import quota expansion, domestic supply declines from 868 million kg to 858 million kg, the marginal cost and the farm price decrease from C$1.02 to C$1.00 and from C$1.64 to C$1.62 respectively. Owing to lower domestic prices and supply, producer surplus declines from C$1070 million to C$1051 million. The wholesale price of chicken decreases from C$2.95 to C$2.93, and domestic consumption increases from 941 million kg to 945 million kg; therefore, consumer surplus increases from C$5866

million to C$5894 million. Given that total welfare increases from C$8145 million to C$8152 million, the overall welfare effect of quota liberalization is a gain for Canada.

As indicated in section 3.3, even though the Canadian chicken industry is a supply-managed industry that attempts to maintain price stability, increased market access will increase the Canadian chicken market's exposure to world price volatility. There are two base scenarios, one that does not take into account price risk (column 2) and one that has been adjusted for price risk (column 4). The fourth column of table 7.1 lists the results of the welfare calculations for the base scenario when price risk is considered. The most notable change between these two base scenarios is the increase of marginal cost from C$1.02 to C$1.23. Under price risk, the supply curve adjusted for the risk premium[5] is steeper than the one without risk premium resulting in a higher marginal cost. Consumer surplus and processor revenue for the two base scenarios are the same. Producer surplus when producers are risk averse is lower than when producers are risk neutral. Import quota rents have higher values in the base scenario with price risk than in the base scenario without risk. The loss in producer surplus outweighs the gain in import quota rents; therefore, total welfare is lower in the presence of price risk. The fifth column of table 7.1 reports the results of quota liberalization when world prices are stochastic. As a result of import quota expansion, import quota rents increase due to the lower world price. Change in processor revenue and consumer surplus is the same for the two scenarios (with and without risk). A risk-normal simulation model was performed using the risk-analysis software @RISK; the last two columns of table 7.1 report the 5th and 95th percentile values (low and high ends of the distribution, respectively) of the risk-normal simulation. Producer surplus fluctuates from C$609 million to C$1144 million,

[5] It has been assumed that Canadian chicken producers are risk averse.

while the consumer surplus varies from C$6270 million to C$4270 million due to stochastic prices. Processor revenue is not affected by price risk because of the assumption of constant processing costs. Note that the volume of imports shown in the 5th percentile column is constrained by the import quota level however without trade barriers, additional low-priced imports of chicken would enter the Canadian market displacing domestic supply and reducing domestic prices even more. Both the 5th and 95th percentile have lower total welfare compared to the baseline scenario and to the risk baseline scenario.

As discussed in section 4.4, it is necessary to calculate the water in the tariff in order to determine if the over-quota tariff reduction will have an effect on the Canadian chicken market. Table 7.2 presents the results of the calculation of the nominal rate of protection (NRP) and the water in the tariff (WIT) described in section 4.4, and the estimation of the potential nominal rate of protection and potential water in the tariff explained in section 5.3.3. According to table 7.2, new imports will enter the Canadian market only if the over-quota tariff is reduced by more than 182.66 percentage points (*i.e.* the new over quota is lower than 55.34%), given that the new landed-price at that over-quota rate tariff will be competitive. However, the over-quota tariff (according to the latest WTO draft modalities from 2008) will be reduced by 23.3%, which will bring down the over-quota tariff from 238% to 182%. This new over-quota tariff will still be prohibitive, which means that no imports over the minimum market access commitments will enter the Canadian market since the landed import prices will be uncompetitive. Consequently, there is no trade liberalizing effect due to the reduction of the over-quota tariff.

Table 7.2: Water and potential water in the tariff

	NRP	WIT	Potential NRP	Potential WIT
Over-quota tariff (238%)	55.34	182.66	21.32	216.68
Price risk	71.21	166.79	33.53	204.47
5 percentile	142.51	95.49	68.19	169.81
95 percentile	46.40	191.60	22.08	215.92
Over-quota tariff (182%)	55.34	127.21	21.32	161.22

All values are percentage values

The potential water in the tariff, which is calculated with an implied domestic wholesale price of chicken at the competitive level, tells us that if the over-quota tariff is reduced beyond 182.66 but less than 216.68 percentage points, out-of-quota imports will not enter the Canadian market. However, domestic prices would have to be reduced to competitive levels, which would affect the Canadian chicken market. The nominal rate of protection and the water in the tariff are also calculated considering the stochastic nature of world prices. The 5^{th} and 95^{th} values are reported in table 7.2. In the case that there is no water in the tariff (*i.e.* the nominal rate of protection and the over-quota tariff are equal), a fall in the world price of chicken will allow out-of-quota imports into Canada. If the lower end of the probability distribution of the world price is below the domestic price, an assumption about the marketing board production decision would have to be made (*e.g.* the marketing board could increase production to compensate for the loss associated with lower domestic prices). However, given that there is water in the over-quota tariff (even at the 5% level of the distribution), it is unlikely that the landed price (*i.e.* world price plus over-quota tariff) will be below the domestic price. According to table 7.2, the current over-quota tariff has a water in the tariff of 182.66%; therefore,

flows of over access imports into Canada caused by any falls in the world price are not expected. The only effect of tariff liberalization is the reduction of water in the tariff. The new water in the tariff and potential water in the tariff after the over-quota tariff reduction are shown in table 7.2.

7.3. Two-good Model Results

In order to solve the two-good model the procedure described in section 7.1 is used. The only difference is that the wholesale price of white meat and the wholesale price of dark meat are jointly solved. The welfare effects of TRQ liberalization for the two-good model are shown in table 7.3. In the case of white chicken meat, the most significant difference between the baselines of the one-good model and the two-good model is in the level of consumer surplus. The slope of the demand curve for white meat is steeper than the slope of the demand curve for chicken[6]; as a result, consumer surplus is greater for white meat (see figure 6.5). As shown in table 7.3, there is a noticeable increase in consumer surplus from C$8167 million to C$8258 million caused by the import quota expansion. At the farm level, chicken is produced and sold as a single product; white and dark chicken meats have the same supply function[7]. Therefore, producer surplus does not change between models[8].

[6] The area below the demand curve for white meat is greater than the area below the demand curve for chicken.
[7] The supply of each type of meat is separated according to a cut-out rate.
[8] Producer surplus of chicken is equal to the producer surplus calculated for white meat plus the producer surplus calculated for dark meat.

Table 7.3: Welfare effects on the Canadian chicken market: two-good model

Variables	Base scen.	Quota Exp.	Risk Base scen.	Quota Expansion & Price Risk	5th	95th
Wholesale price of white meat	4.91	4.88	4.91	4.88	3.32	6.31
Wholesale price of dark meat	1.99	2.00	1.99	2.00	1.26	2.73
World price of white meat	2.47	2.47	2.65	2.64	1.29	4.22
World price of dark meat	1.34	1.34	1.34	1.35	0.62	2.11
Retail price of white meat	14.83	14.8	14.8	14.8	13.2	16.2
Retail price of dark meat	4.54	4.55	4.54	4.55	3.81	5.28
Marginal cost of chicken	1.02	1.00	1.12	1.21	1.21	1.21
White Meat						
Consumption	559	564	559	564	564	339
Imports	60.7	71.8	60.7	71.8	71.8	0
Domestic Supply	498	493	498	493	493	493
Producer revenue	816	800	816	800	596	903
Import quota rents	148	173	138	161	30	0
Producer surplus	614	603	563	554	336	643
Processor revenue	1629	1602	1629	1602	1037	2206
Consumer surplus	8167	8258	8167	8258	8698	7853
Total welfare	10558	10637	10497	10575	10102	10702
Dark Meat						
Consumption	383	380	383	380.3	380.3	305
Imports	12.4	14.7	12.4	14.7	14.7	0.0
Domestic Supply	370	366	370	366	366	366
Producer revenue	607	594	607	594	442	670
Import quota rents	8	10	8	9	9	0
Producer surplus	456	448	418	411	259	487
Processor revenue	132	138	132	138	17	327
Consumer surplus	1454	1444	1454	1444	1585	1305
Total welfare	2050	2039	2012	2002	1870	2120
Aggregated two-good model (white + dark)						
Consumption	941	945	941	945	945	644
Imports	73.1	86.5	73.1	86.5	86.5	0.0
Domestic Supply	868	858	868	858	858	858
Producer revenue	1423	1394	1423	1394	1038	1574
Import quota rents	156	183	146	170	39	0
Producer surplus	1070	1051	981	964	596	1131
Processor revenue	1761	1740	1761	1740	1054	2533
Consumer surplus	9621	9701	9620	9701	10284	9158
Total welfare	12608	12675	12508	12576	11972	12822

Prices (C$/kg eviscerated); consumption, imports, and domestic supply (000,000 kg); producer revenue, import quota rents, producer surplus, processor revenue, consumer surplus, and total welfare (C$ millions)

As indicated in section 6.1.6, due to the increase of foreign low-priced white meat in the Canadian chicken market, the price of white meat decreases from C$4.91 to C$4.88 and its consumption increases. Since white and dark meats are substitutes, consumption of dark meat decreases. Lower quantity demanded for dark meat increases its price from C$1.99 to C$2.00. The effect of quota liberalization on processor revenue and consumer surplus is the same with or without price risk. However, producer surplus and import quota rents, as in the one-good case, are reduced by larger amounts when price risk is included in the model. As mentioned in section 3.3, the world prices of white and dark chicken meat have normal distributions; therefore, two risk-normal simulations were performed using @RISK. The last two columns of table 7.3 report the 5^{th} and 95^{th} percentile values of the simulation model. Producer surplus fluctuates from C$336 million to C$643 million, and consumer surplus varies from C$8698 million to C$7853 million. The 5^{th} percentile has lower total welfare compared to the baseline scenario and to the risk baseline scenario, and the 95^{th} percentile has a higher total welfare effect compared to the two baseline scenarios. In the case of dark chicken meat, the most significant difference between the one-good model and the two-good model is in the level of consumer surplus. The demand curve for dark meat (see figure 6.5) is to the left of the demand curve for white meat and the demand curve for chicken as an aggregated product, implying lower demand for dark meat. Therefore, consumer surplus for dark meat is smaller. As shown in table 7.3, contrary to the white meat case, there is a decrease in consumer surplus from C$1454 million to C$1444 million caused by quota liberalization. The overall welfare effect of quota liberalization with and without risk is negative for dark meat. Under price risk, producer surplus fluctuates from C$259 million

to C$487 million, and consumer surplus varies from C$1585 million to C$1305 million. The 5th percentile has lower total welfare, and the 95th percentile has a higher total welfare effect, compared to the two baseline scenarios.

The bottom of table 7.3 shows the aggregate results of the two-good model in which welfare totals from each single-good model are added together. The domestic supply and consumption levels are the same as in the one-good model. The only exceptions are the results shown in the 95th percentile, caused by higher domestic and world prices, which result in lower domestic consumption and no imports entering the Canadian market. Producer revenue does not change with respect to the one-good model. Processor revenue is larger in the differentiated model. Producer surplus is the same in both models, except by the 5th and 95th percentile values, which are higher in the one-good model. Import quota rents are higher in the two-good model; except for the 5th and 95th percentile values, which are higher in the one-good model. Consumer surplus is noticeably larger in the two-good model.

The comparison of welfare effects of quota liberalization between the one-good model and the two-good model is shown in table 7.4. The second and third columns report the changes with respect to the base scenario, and the last two columns report the changes with respect to the price-risk base scenario. Import quota rents increase in all cases after trade liberalization due to the increase on the volume of imports and lower domestic prices, but the increase is higher in the two-good model due to a larger gap between the domestic and the world price of white meat. Producer surplus decreases in both models by the same amount, but the decrease is smaller when producers are risk averse than when they are risk neutral. The decrease in processor revenue is larger in the

two-good model due to a bigger fall of the domestic prices of white meat. Consumer surplus is significantly higher in the two-good model primarily due to the difference between the slope of the demand curves for chicken and for white chicken meat. Overall welfare increases in both representations, but the increase is larger when price risk is included in the model.

Table 7.4: Welfare effects: one-good model vs. two-good model

	Quota Liberalization		Quota Liberalization & Price Risk	
	One-good model	**Two-good model**	**One-good model**	**Two-good model**
Δ Producer revenue	-29.16	-29.16	-29.16	-29.16
Δ Import quota rents	12.28	26.32	14.67	24.41
Δ Producer surplus	-19.00	-19.00	-16.88	-16.88
Δ Processor revenue	-13.16	-20.98	-13.16	-20.98
Δ Consumer surplus	27.51	81.25	27.51	81.25
Δ Total welfare	7.63	67.59	12.14	67.80

All values are changes: C$ millions

7.4. Sensitivity Analysis

The quantitative results that are obtained from the sensitivity analyses described in chapter 6 are shown in appendix I. Tables A.1, A.3, and A.5 show the sensitivity analyses results after import quota expansion for the one-good model, white meat (two-good model), and dark meat (two-good model) respectively. Tables A.2, A.4, and A.6 show the results for the same above representations, but considering price risk. Figure 7.1 illustrates the effects of the discount rate on producer surplus. The dashed bars illustrate the results under the assumption of risk neutrality and the solid bars represent risk aversion. As mentioned in section 6.2.1, a range of discount rates is used to estimate the

marginal cost in a perfectly competitive market. Figure 7.1 demonstrates that a higher discount rate (13%) significantly increases the level of producer surplus. In addition, a higher discount rate will establish a larger difference between producers that are risk neutral and producers that are risk averse. These results are intuitive because a higher discount rate, which provides a lower marginal cost, indicates a more productive industry. With a lower discount rate (7%), the marginal cost of Canadian chicken production is higher, which means that Canadian producers are less productive and therefore producer surplus is lower. A higher discount rate, which provides a lower marginal cost, reduces the effects of trade liberalization on producers because there is a smaller gap between world and domestic prices.

Figure 7.1: Effect of the discount rate on producer surplus

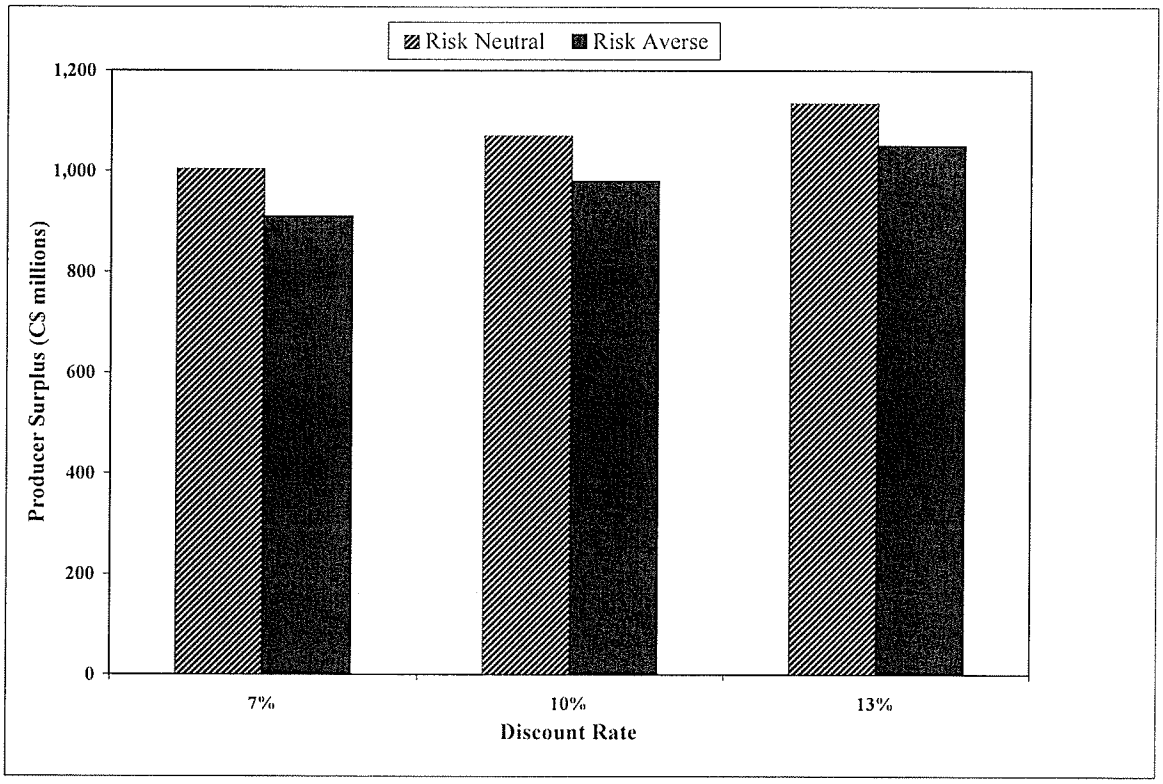


Figure 7.2 depicts the effects of the supply elasticity on producer surplus. The dashed bars illustrate the results under the assumption of risk neutrality and the solid bars represent risk aversion. As mentioned in section 6.2.2, a range of supply elasticities is used in the simulation model based on an estimate US long-run broiler supply. In the short run, an inelastic supply curve will better represent the supply response of producers, since there is insufficient time to change the level of output. However, Canadian chicken producers under the supply-managed system may have a more elastic supply response than the US chicken producers because of unused capacity at the farm-level (Moschini and Meilke 1991).

Figure 7.2: Effect of the supply elasticity on producer surplus

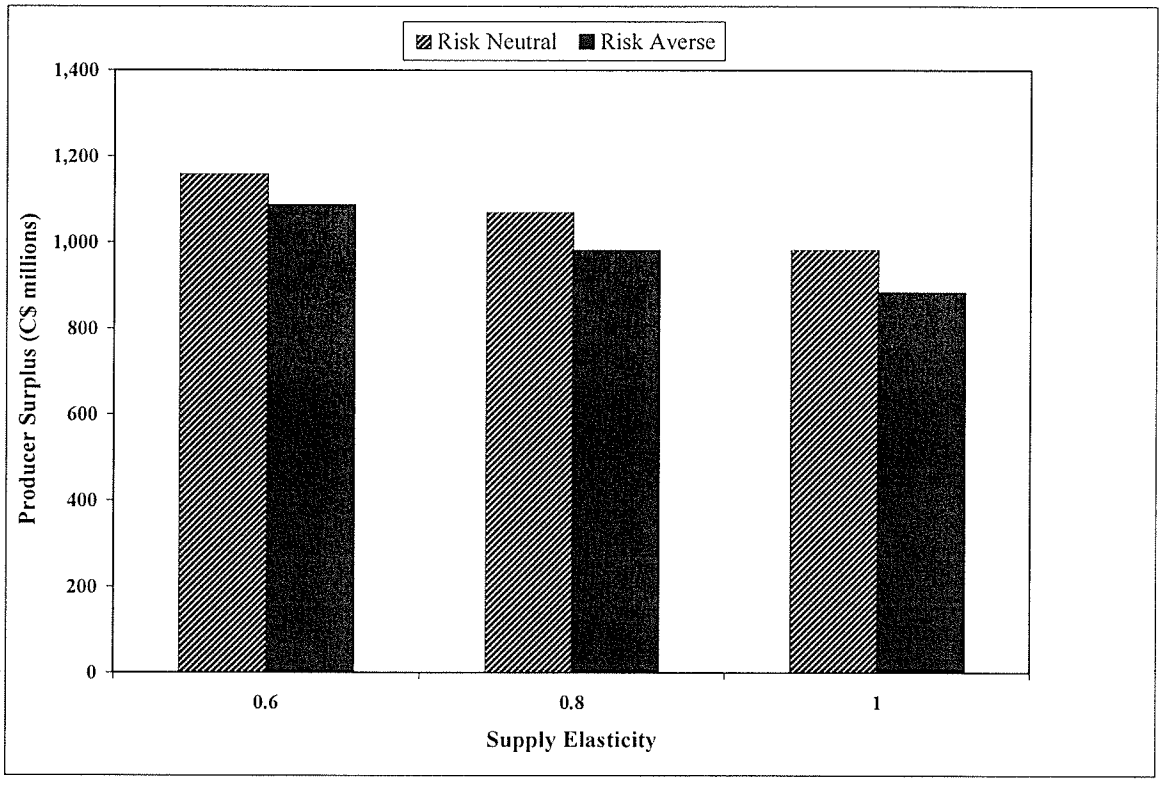
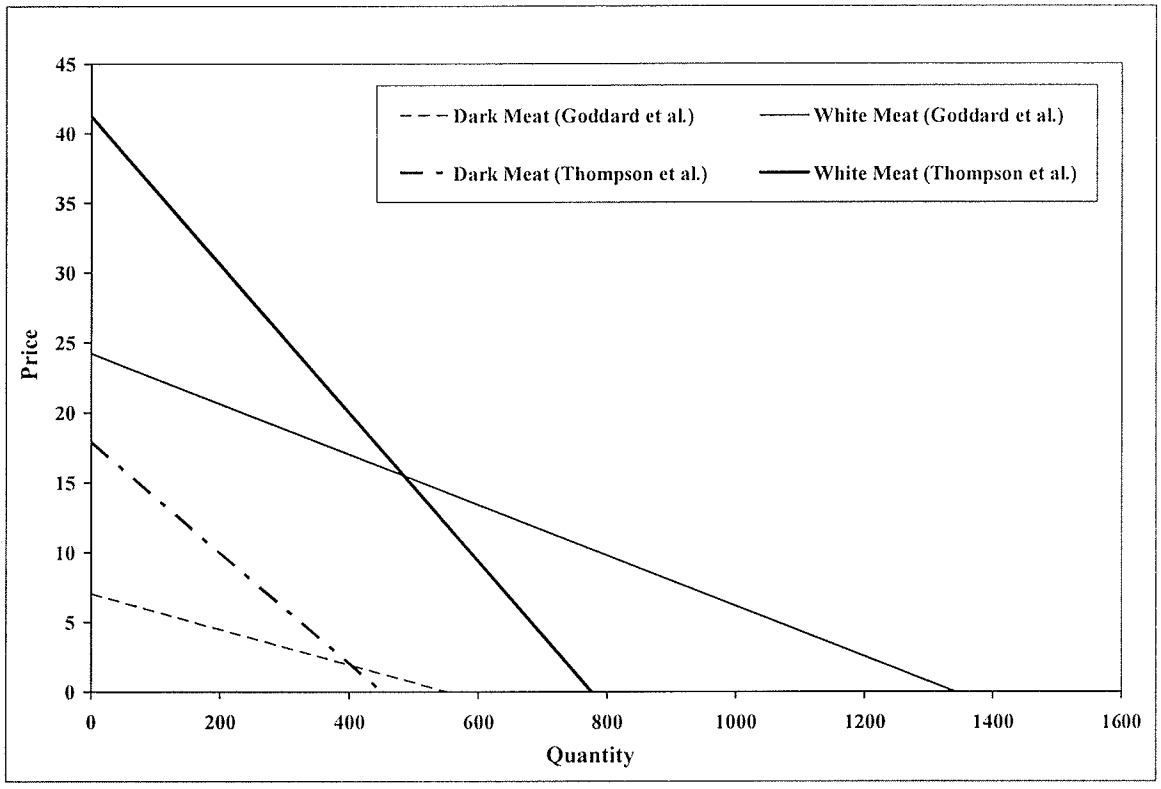


Figure 7.2 demonstrates that a more elastic supply curve decreases the level of producer surplus. As well, a more elastic supply response leads to a bigger difference between risk-neutral and risk-averse producers. A more inelastic supply response increases not only producer surplus but also consumer surplus and overall welfare. However, if Canadian chicken producers have a more elastic supply response, then the effect of trade liberalization is smaller because producers can adjust more easily to the increase of low-priced foreign chicken imports.

Figure 7.3 compares the demand curves of white and dark meats calculated with the own and cross price elasticities from Goddard *et al.* (2007) and from Thompson *et al.* (2008). When Thompson *et al.* (2008) own and cross price elasticities are used, the demands for white and dark meats are more inelastic.

Figure 7.3: Demand curve of white and dark meats



The relationship between the elasticity of demand for white and dark meats and the slope of the demand curve of each type of meat is fundamental in determining the welfare measures of the Canadian chicken market. Figure 7.4 shows the effects of the own and cross price elasticities of demand for white and dark meats on consumer surplus. The solid bars illustrate the results when the parameters are taken from Goddard *et al.* (see table 5.4), and the dashed bars illustrate the results when the parameters are from Thompson *et al.* (see table 5.4).

Figure 7.4: Effect of own and cross price elasticities of demand on consumer surplus

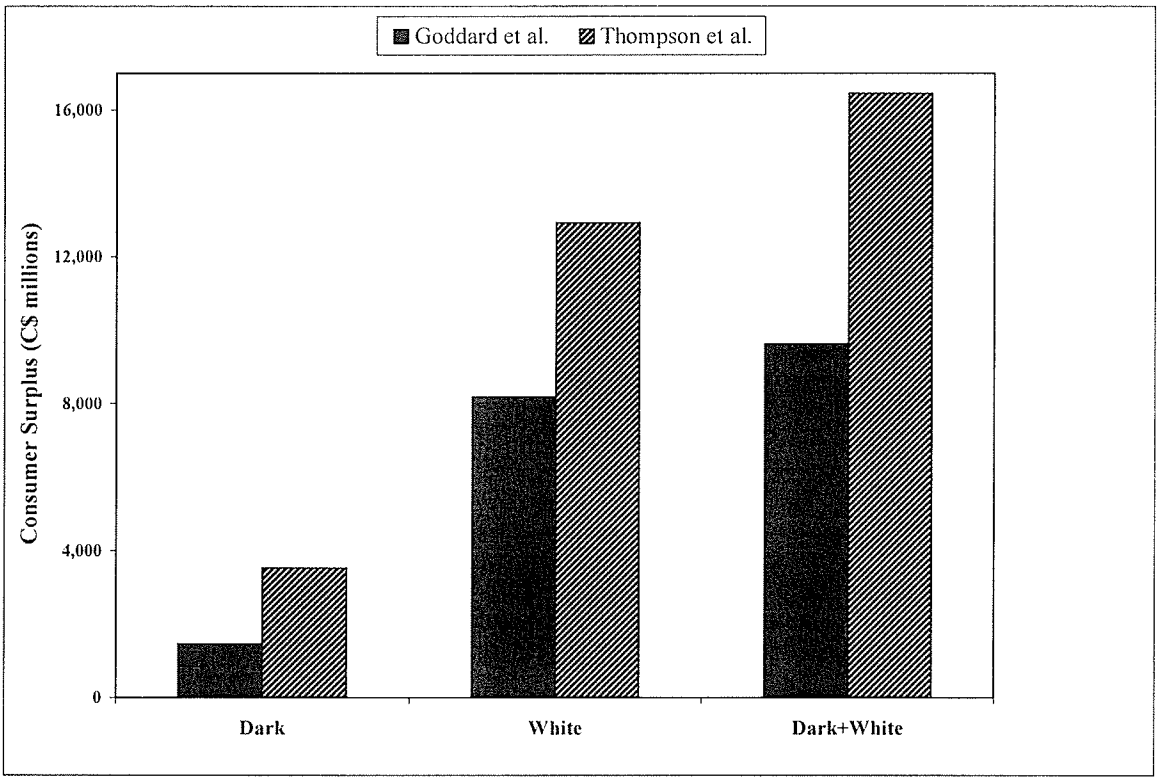


Figure 7.4 demonstrates that a more inelastic demand for white and dark meats increase the level of consumer surplus. Therefore, the aggregate consumer surplus of the

two-good model increases when the demand of each type of meat is more inelastic. Since consumer surplus is greater when the demand of white and dark meats are more inelastic, total welfare is greater.

7.5. Discussion

The welfare analysis is conducted using two representations of chicken (chicken as an aggregated product vs. chicken as differentiated products) in two different scenarios (with and without price risk). The model differentiates between white and dark chicken meat, which given the trends of chicken trade and consumption, is an important issue that significantly affects both processors and consumers. According to AAFC (2006), the Canadian chicken market is predominantly a white meat market, and for the most part Canadian chicken imports consist of white meat (see table 2.3). Consequently, an increase in the volume of low-priced foreign chicken imports will primarily affect the domestic wholesale price of white meat, changing the domestic supply and demand levels (see table 7.3). The results of the welfare analysis show that there is a redistribution of welfare among import quota-rent holders, processors, and consumers between the two models (table 7.4). Therefore, the representation of chicken as differentiated products seems to be an important consideration when modeling the Canadian chicken market. In addition, the disaggregated results for white and dark meats give valuable insights regarding the different effects of trade liberalization on agents in the supply chain. For example, in the case of white meat, import quota-rent holders and consumers benefit from the increase in the minimum market access. The increase in the foreign supply of low-priced white meat in the Canadian chicken market pushes down the domestic

wholesale price of white meat and increases its consumption. In the case of dark meat, the benefit for import quota-rent holders is minimal, and consumers of dark chicken meat only see the downside of trade liberalization since the price of dark meat increases, reducing its consumption.

The calculation of the water in the tariff demonstrates that the over-quota tariff exceeds the nominal rate of protection by a large amount, providing a barrier against imports even in the face of WTO proposals to reduce tariffs. If the over-quota tariff is not reduced by more than the amount of water in the tariff, neither the domestic price nor the volume of imports will change. The latest WTO draft modalities (WTO 2008) proposed an over-quota tariff reduction of 23.3% (for sensitive products, using the two-thirds deviation from the original formula). The resulting over-quota tariff will still be prohibitive; as a result, there is no tariff liberalizing effect. When world prices are stochastic, the predicted water in the tariff and potential water in the tariff cannot accurately determine how much the over-quota tariff can be cut without increasing imports into Canada. However, given that the current over-quota tariff has a water of approximately 180%, it is unlikely that lower world prices could generate flows of out-of-quota imports into Canada. If the over-quota tariff is reduced beyond the water in the tariff, but less than the potential water in the tariff, out-of-quota imports will not enter the Canadian market as long as the domestic prices are reduced to approach competitive levels. The potential reduction of the domestic prices could affect the Canadian chicken market.

When considering the potential effects of stochastic world prices on the Canadian chicken market, there is an overall larger welfare effect and a redistribution of welfare

between producers and import quota-rent holders after trade liberalization. Volatility in world prices leads to volatile imports if import barriers are reduced (see the sixth and seventh columns of table 7.1). Since the aim of the supply management system is to stabilize prices and producers' income, price volatility should be considered when modeling the Canadian chicken market. It is important to note that the risk premium used in this research (equation 5.13) may overstate the effect of price risk because it is based on world price volatility. The effects of world price fluctuations will only translate completely to Canadian producers if all tariffs are removed. However, imports are still subject to TRQs (although the import quota is expanded), and there is no trade liberalizing effect due to over-quota tariff reduction, *i.e.* trade liberalization is not complete. As long as there are trade barriers in place, the risk associated with stochastic world prices will be smaller than represented by the risk premium that is based on world price volatility.

Even though trade liberalization will not be complete, a DDA deal will still affect the Canadian chicken market. The expansion of the import quota allows low-priced imports of chicken products into Canada, reducing domestic prices. Lower domestic prices induce consumption; therefore, consumers benefit from the increase of minimum market access. Processors will see both sides of trade liberalization: they will benefit from lower domestic prices and increased consumption because processors surplus increases, but processor revenue will decrease because the gap between the world price and the domestic price is smaller. New imports displace domestic supply; the lower demand for domestic supply along with lower domestic prices reduces producer surplus. Thus, producers only see the downside of the increase in market access. The increase in

consumer surplus and import quota rents outweighs the loss in producer surplus and processor revenue; as a result, total welfare increases. The overall social welfare effect of trade liberalization is a gain for Canada.

Sensitivity analyses have been conducted with respect to the producer's discount rates, the supply elasticity, and the own and cross price elasticities of demand for white and dark meats for the two representations of chicken and the two liberalization scenarios. The results of the sensitivity analyses demonstrate that the welfare measures are sensitive to the assumed discount rate, which is used to estimate the marginal cost in a perfectly competitive market (*e.g.* a lower initial marginal cost obtained with a higher discount rate significantly increases the level of producer surplus). The discount rate can be used as measure of productivity of Canadian vs. US chicken producers because the marginal cost of chicken production for the two countries can be compared. If Canadian chicken producers are more productive than their US counterparts, then the effect of trade liberalization is smaller. The sensitivity analysis results with respect to the supply elasticity demonstrate that the elasticity of supply is an important parameter due to its relationship with the slope of the supply curve. If Canadian chicken producers have a more elastic supply response, then the effect of trade liberalization is smaller because producers can adjust more easily to the increase of low-priced foreign chicken imports. However, a more elastic supply curve decreases the level of producer surplus and makes the difference between risk-neutral and risk-averse producers more noticeable. The sensitivity analysis results with respect to the own and cross price elasticities of demand for white and dark meats demonstrate that a more inelastic demand for each type of meat increases the level of consumer surplus which increases the total welfare.

Chapter 8: Summary and Conclusion

8.1. Summary

Current WTO negotiations include proposals to improve market access that may affect the Canadian supply-managed industries. This thesis develops a partial equilibrium model of the Canadian chicken market to evaluate the potential effects of trade liberalization. Two baseline scenarios are generated to calculate welfare measures before trade liberalization. These baseline scenarios serve as starting points in calculating the distribution of welfare effects and the trade-offs in the Canadian chicken market following trade liberalization. The increase in market access proposed by the WTO negotiations will be realized by the reduction of tariffs and the expansion of the minimum market access commitments. Trade liberalization through tariff reduction has different effects than liberalization through import quota expansion (Boughner *et al.* 2000). Therefore, it is necessary to determine whether the import quota or one of the two tariffs is the effective tool (*i.e.* affects domestic prices and imports). The import quota is the effective tool in the Canadian chicken market (*i.e.* the import quota rate fill is above 100%). The model is built around a linear wholesale-level domestic demand equation, where trade is restricted, and a linear farm-level domestic supply function, where production controls are applied. An issue that analysts encounter when modeling a supply-manage industry is that there are no observable price and quantity combinations from which a farm-level supply curve can be deduced. In the supply-managed chicken industry, the price is predetermined with a live-price formula and the output is restricted with a production quota system. However, this issue can be addressed by constructing a supply function using an implied marginal cost obtained from the rental value of

production quotas. Given the patterns of consumption and trade of the Canadian chicken market, the simulation model represents chicken differentiated by cut (white and dark meat), and as an aggregated product. These two models are compared to evaluate how different market representations affect the distribution of welfare and the outcomes of trade liberalization when international prices are stochastic.

8.2. Conclusion

The liberalization of TRQs includes the reduction of tariffs and the expansion of the import quota. The elimination of the in-quota tariff will not have an effect on the Canadian chicken market because the import quota is binding and because the in-quota tariff on imports from the US (the largest foreign supplier of chicken products to Canada) under NAFTA obligations is zero percent. The reduction of the over-quota tariff could affect the Canadian chicken market if it is below the level of water in the tariff. The over-quota tariff reduction proposed in the latest WTO draft modalities for sensitive products results in an over-quota tariff that is within the current water in the tariff. As a result, there are no additional imports over the minimum market access commitments that enter the Canadian market. The results of the welfare analysis reveal that there is no tariff liberalization effect.

In contrast, quota liberalization will have an impact on Canadian chicken producers, processors, and consumers. Processors are negatively affected by the increase in the volume of imports, since processor revenue is reduced due to lower domestic prices. However, processors sell more because lower wholesale prices induce consumption, resulting in an increase in the processors surplus. The overall trade liberalization effect on

processors can be positive or negative, depending on whether the increase in consumption exceeds the decrease in the domestic prices. Assuming that the marketing margin is constant, lower wholesale prices will result in lower retail prices. Consumers will benefit from lower retail prices and they will consume more, resulting in higher consumer surplus. From the consumers' perspectives, trade liberalization is positive.

The aim of the supply management system is to stabilize prices and producer's income. The results of the welfare analysis show that the increase in market access violates these two pillars of the supply management system. Producers are negatively affected by trade liberalization since the increase of low-priced foreign chicken products in the Canadian market reduces the domestic price and the domestic supply; therefore, producer surplus is reduced. As expected, the quantitative results show that when import barriers are reduced, volatility in world prices could lead to volatile imports. Canadian chicken producers, who oppose over-quota tariff reduction and the increase in the minimum market access, may find these results supportive in their negotiating position at DDA negotiations. Even though Canadian chicken producers will be affected by trade liberalization, the supply-managed system could continue to exist even if the proposals of the WTO negotiations result in an agreement. The impact of trade liberalization on the value of production quotas for supply-managed industries, which have strong domestic political support, is difficult to estimate and it would depend on the policy responses by the Canadian federal and provincial governments.

The Canadian preference for white chicken meat, which is evident from its volume of consumption and the fact that Canadian imports of chicken are predominantly white meat (AAFC 2006), suggests that the representation of chicken as differentiated products

is more appropriate for Canadian chicken market models. The results of the welfare analysis demonstrate that there is a variation in the distribution of welfare among agents of the supply chain between the two representations of chicken: in the two-good model, there is a considerable increase in the level of consumer surplus while processor revenue is significantly lower. On the other hand, producer surplus and producer revenue do not change between models.

8.3. Policy Recommendations

Canadian supply-managed products, which have domestic political support, will be considered as sensitive products (House of Commons 2009) in the implementation of a DDA agreement. Therefore, this thesis assumes that Canadian chicken products are treated as sensitive products and are subject to smaller tariff cuts. This research treats chicken as differentiated products in an attempt to simulate the patterns of consumption and trade of the Canadian chicken market. Quantitative results were generated to provide a broad picture of the potential effects of trade liberalization to stakeholders and policymakers. Even though this economic analysis is conducted before the policy decisions are taken, the analysis is based on WTO proposals that are at this time the best estimates of what the final deal will look like. The goal of this research is to inform stakeholders involved in the negotiation process of the potential effects of the DDA negotiations before the process of policy design and negotiation is concluded.

The quantitative results show that the Canadian chicken market will be affected by trade liberalization and that there is a redistribution of welfare among agents of the supply chain even though trade liberalization is incomplete. If the main objective of

policy makers is to protect supply-managed industries, then they will have to ensure that these industries are treated as sensitive. If supply-managed products are not considered as sensitive products, then the results of the welfare analysis will be markedly different, not only because the import quota expansion will be greater but also because the reduction of the over-quota tariff will be more significant (from 238% to 71%). This could jeopardize the current supply management system. On the other hand, if the goal of policy makers is overall social welfare, then the results from this study suggest that the overall welfare effects of trade liberalization for Canada is positive, as total welfare increases.

8.4. Limitations and Future Study

This research develops a partial equilibrium model that is built around a linear supply equation that is a function of the marginal cost of chicken, and a linear demand equation that is a function of the wholesale price. In the one-good model, the demand is a function of the price of chicken, and in the two-good model, the demands for each type of meat are functions of the price of white and dark chicken. Economic theory tell us that the demand and supply of a product depend not only on the price of the product but also on other variables such as the price of inputs (in the case of supply), and the income and the price of substitutes (in the case of demand). Future studies may include more variables in the demand and supply functions in order to obtain results that are more realistic; however, this will lead to a significantly more complex analysis.

Trade liberalization scenarios in this thesis are based on the most recent WTO draft modalities that have not been agreed upon by negotiating parties. Future studies will be

able to rely on more up-to-date negotiation outcomes and will yield results that are more relevant.

This research assumes that processing and marketing margins are constant for the period from which the baseline data are drawn. The elasticity of demand used in the one-good model and the own-price and cross-price elasticities of demand used in the two-good model are all previously estimated and calculated at the retail level. In order to derive the wholesale-level demand and the farm-level demand curves it is necessary to assume fixed proportions between the retail and wholesale levels and between the wholesale and farm level. This assumption facilitates the analysis of a vertical marketing system, which is common in trade analysis (*e.g.* Gervais and Surprenant 2002, and Rude and Gervais 2006). However, constant processing and marketing margins cause the demand functions for the farm, wholesale, and retail levels to be parallel, which imply equal percentage changes for farm, wholesale, and retail prices caused by trade liberalization. As well, the parameters used in this research (supply and demand elasticities and producer's discount rate) are previously estimated values that are obtained from different sources and different methodologies, which may cause problems of consistency in the model. The sensitivity analysis helps to identify how sensitive the results of the model are to these parameters; however, it does not solve the problem. Future studies may address this issue by estimating their own parameters or by using available estimated values from consistent sources or methodologies to avoid inconsistency.

The model that differentiates chicken by cut allows only two types of chicken (white and dark chicken meats). However, chicken is consumed and traded in several different

forms. Although the shares of white and dark chicken meat are bigger than any other type of chicken products, a future study may consider a different approach to the issue of differentiation of chicken. It may expand the meat classification to include groups such as cooked, mechanically separated, fresh, frozen, further processed, white meat, dark meat, etc.

Finally, as mentioned in section 7.5, the effect of the risk premium associated with stochastic world prices may be overstated for a non-free trade market. The effect of world price variability is not likely to pass through to producers completely if the current level of protection is in place. Future studies could find a different approach to estimate the price risk effect faced by producers than the one used in this thesis.

References

Abler, D. 2006. Approaches to Measuring the Effects of Trade Agreements. Canadian Agriculture Trade Policy Research Network (CATPRN) Commissioned Paper CP2006-1.
Abbott, P. C., and P. L. Paarlberg. 1998. Tariff rate quotas: Structural and stability impacts in growing markets. *Agricultural Economics* 19: 257–67.
Agriculture and Agrifood Canada (AAFC). 2006. The Canadian Chicken Industry, Animal Industry Division Poultry Section http://www.agr.gc.ca/poultry/prindc2006_e.pdf (accessed February 10, 2009).
Agriculture and Agrifood Canada (AAFC). 2007. Poultry Marketplace. All Poultry Exports. http://www.agr.gc.ca/poultry/pexcty07.pdf (accessed May 25, 2009).
Agriculture and Agrifood Canada (AAFC). 2007. Poultry Marketplace. Canada's Poultry and Egg International Trade.
http://www.agr.gc.ca/poultry/tradebalance_122007_e.pdf (accessed May 25, 2009).
Agriculture and Agrifood Canada (AAFC). 2007. The Estimation of Food Demand Elasticities in Canada.
Agriculture and Agrifood Canada (AAFC). 2008. Grain Policy Division of Agriculture and Agrifood Canada.
Agriculture and Agrifood Canada (AAFC). 2008. Poultry Marketplace.
http://www.agr.gc.ca/poultry/index_eng.htm (accessed January 21, 2009).
Agriculture and Agrifood Canada (AAFC). 2009. Current Rates of Return in Canadian Farming by Farm Type. Farm Performance Review Series.
Alston, J., C. A. Carter, R. Green, and D. Pick. 1990. Whither Armington Trade Models? *American Journal of Agricultural Economics* 72 (2): 455-467.
Alston, J., and G. Scobie. 1987. A Differentiated Goods Model of the Effects of European Policies in International Poultry Markets. *Southern Journal of Agricultural Economics* 19 (1): 59-68.
Armington, P. S. 1969. A Theory of Demand for Products Distinguished by Place of Production. International Monetary Fund Staff Papers 16: 159-176.
Barichello, R. 1996. Capitalizing Government Program Benefits: Evidence of the Risk Associated with Holding Farm Quotas. In J. Antle and D. Sumner, eds. Essays in Honor of D. Gale Johnson, Vol. II, University of Chicago Press.
Barichello, R., and L. Zhang. 2008. Measuring Water in the Tariff with TRQs Imposed: Dairy Products in Canada. Paper presented to the Annual Meeting of the International Agricultural Trade Research Consortium, Scottsdale, AZ. December 8-9, 2008.
Boughner, D. S., H. de Gorter, and I. M. Sheldon. 2000. The economics of two-tier tariff-rate import quotas in agriculture. *Agricultural and Resource Economics Review* 29: 58–69.
Canada Border Service Agency. 2009. Custom Tariff Schedule. Section I: Live Animals, Animal Products. http://www.cbsa-asfc.gc.ca/trade-commerce/tariff-tarif/2009/t2009-06/ch02-eng.pdf (accessed January 16, 2009)
Chavas, J.-P. 1978. A Quarterly Econometric Model of the US Poultry and Egg Industry. Ph.D. thesis, Columbia: University of Missouri.
Chicken Farmers of Canada (CFC). 2005. Annual Report 2005.
http://www.chicken.ca/app/DocRepository/1/Annual_Report/AR2005.pdf (accessed February 26, 2009).

Chicken Farmers of Canada (CFC). 2007. Annual Report 2007. http://www.chicken.ca/app/wa/doc?docId=3921 (accessed February 26, 2009).
Chicken Farmers of Canada (CFC). 2008. Annual Report 2008. http://www.chicken.ca/app/wa/mediaEntry?mediaEntryId=5230 (accessed April 15, 2009).
Chicken Farmers of Canada (CFC). 2008. Chicken Data Booklet 2008. http://www.chicken.ca/app/wa/doc?docId=5279 (accessed February 26, 2009).
Chicken Farmers of Canada (CFC). 2009. Mihai Lupescu (Senior Policy Analyst), personal communication.
Chicken Farmers of Canada (CFC). 2009. Market Trends Published by Chicken Farmers of Canada. http://www.chicken.ca/app/wa/doc?docId=5705 (accessed June 25, 2009).
Chicken Farmers of Ontario (CFO). 2007. Annual report 2007. http://www.cfo.on.ca/_pdfs/2007AnnualReport.pdf (accessed February 26, 2009).
Department of Foreign Affairs and International Trade Canada (DFAIT). 2009. Export and Import Controls. Chicken and Chicken Products. http://www.international.gc.ca/controls-controles/prod/agri/chicken-poulet/notices-avis/757.aspx?lang=eng#3 (accessed November 26, 2009).
Economic Research Service (ERS). 2008. Broilers: 12-city composite wholesale price. Poultry Yearbook. USDA. Economics, Statistics, and Market Information System.
Federal Reserve Bank of St. Louis. 2009. Canada /U.S. Foreign Exchange Rate. http://research.stlouisfed.org/fred2/series/EXCAUS/downloaddata?cid=95
Food and Agriculture Organization of the United Nations (FAO). 2009. FAOSTAT. http://faostat.fao.org/site/535/default.aspx#ancor (accessed March 27, 2009).
Food and Agricultural Policy Research Institute (FAPRI). 2008. Elasticity Database. http://www.fapri.iastate.edu/tools/elasticity.aspx (accessed January 24, 2009).
FAPRI and Center for Agricultural and Rural Development (CARD). 2009. FAPRI/CARD International Livestock and Poultry Model. http://www.fapri.iastate.edu/models/livestock.aspx (accessed February 06, 2009).
Foreign Affairs and International Trade Canada. 2008. Export and Import Controls Bureau. http://www.dfait-maeci.gc.ca/trade/eicb/agric/chicken-en.asp (accessed January 23, 2009).
Gervais, J-P., and D. Surprenant. 2002. Evaluating the TRQ Import Licensing Mechanisms in the Canadian Chicken Industry. *Canadian Journal of Agricultural Economics* 51 (2003) 217–240
Goddard, E., B. Shank, C. Panter, T. Nilsson, and S. Cash. 2007. Canadian Chicken Industry: Consumer Preferences, Industry Structure and Producer Benefits from Investment in Research and Advertising. Project Report #07-04. Department of Rural Economy, University of Alberta.
Gunman, K., and B. Legault. 1995. Risk Preferences of Dairy and Hog Producers in Quebec. *Canadian Journal of Agricultural-Economics* 43(1):23-35.
House of Commons. 2009. Defending Supply Management at the WTO. Report of the Standing Committee on International Trade. 40th Parliament, 2nd Session. November 2009.

Hertel, T. W. (ed) 1997. Global Trade Analysis: Modeling and Applications. Cambridge University Press. https://www.gtap.agecon.purdue.edu/products/gtap_book.asp (accessed February 22, 2009).
Huff, K. M., K. D. Meilke, and R. Amadei. 2000. Canada–United States chicken trade: A re-evaluation. *Canadian Journal of Agricultural Economics* 48: 421–32.
International Food Policy Research Institute (IFPRI). 2008. High Food Prices: The What, Who, and How of Proposed Policy Actions.
Koo, W. W., and J. T. Golz. 1994. Competitiveness of Broiler Producers in North America under Alternative Free Trade Scenarios. *Agribusiness.* 10 (6): 503-511
Koo, W. W., and P. Kennedy. 2005. International trade and agriculture. MA: Blackwell Publishing.
Martin, W., and Wang, Z. 2004. Improving Market Access in Agriculture. Mimeo, World Bank, Washington.
McKitrick, R.R. 1998. The Econometric Critique of Computable General Equilibrium Modelling: The Role of Functional Forms. *Economic Modelling* 15: 543-573.
Moschini, G., and K. D. Meilke. 1991. Tariffication with Supply Management: The Case of the US-Canada Chicken Trade. *Canadian Journal of Agricultural Economics* 39: 55-48.
Organization for Economic Cooperation and Development (OECD). 2004. Risk Effects of PSE Crop Measures. Paris: OECD Publishing.
OECD and FAO. 2006. Documentation of the AGLINK-COSIMO Model. http://www.olis.oecd.org/olis/2006doc.nsf/LinkToFrench/NT00003D5E/$FILE/JT03214192.PDF (accessed November 18, 2009).
OECD and FAO. 2008. OECD-FAO Agricultural Outlook 2008-2017. http://www.oecd.org/dataoecd/54/15/40715381.pdf (accessed January 23, 2009).
Peterson, E., and D. Orden. 2004. Effects of Tariffs and Sanitary Barriers on High- and Low-Value Poultry Trade. International Food Policy Research Institute (IFPRI). MTID Discussion Paper 64.
Rude, J. and J-P., Gervais. 2006. Tariff -Rate Quota Liberalization: The Case of World Price Uncertainty and Supply Management. *Canadian Journal of Agricultural Economics* 54: 33–54.
Rude, J., and J-P., Gervais. 2000. Trade Liberalization in Supply-Managed Sectors. Canadian Agrifood Trade Research Network paper.
Rude, J., and K., Meilke. 2004. Developing Policy Relevant Agrifood Models. *Journal of Agricultural & Applied Economics* 36:369-382.
Stout, J., and D., Abler. 2003. ERS/Penn State trade model Documentation. ERS with the collaboration of Penn State University. http://trade.aers.psu.edu/pdf/ERS_Penn_State_Trade_Model_Documentation.pdf (accessed February 06, 2009).
Thompson, W., P. Charlebois, and G. Tallard. 2008. IATRC Annual Meeting. Washington Dc: The Ohio State University. http://aede.osu.edu/programs/Anderson/trade/ThompsonetalWTPCGT_CK_IATRC_2008_Submitted[1].pdf (accessed January 23, 2009).
United Nations. 2009. Department of Economic and Social Affairs. Food Price Volatility: how to help smallholder farmers manage risk and uncertainty.

http://www.un.org/esa/dsd/resources/res_pdfs/csd-17/csd17_crp_food_prices.pdf (accessed May 19, 2009).
United States Department of Agriculture (USDA). 2000. Estimation of Food Demand and Nutrient Elasticities from Household Survey Data. Technical Bulletin # 1887.
United States Department of Agriculture (USDA). 2008. A Report from the Economic Research Service. Livestock, Dairy, and Poultry Outlook 2008. Broilers 12-city composite weighted average. http://usda.mannlib.cornell.edu/usda/ers/LDP-M//2000s/2008/LDP-M-03-19-2008.pdf (accessed May 19, 2009).
United States Department of Agriculture (USDA). 2009. Foreign Agricultural Service. Production, Supply, and Distribution Online.
http://www.fas.usda.gov/psdonline/psdQuery.aspx
Von Arnim, R. and L. Taylor. 2007. World Bank CGE Macroeconomics and the Doha debate. New York, New School for Economic Research. April.
World Trade Organization (WTO). 2004. WTO Agriculture Negotiations. The issues, and where we are now.
http://www.wto.org/english/tratop_e/agric_e/agnegs_bkgrnd_e.pdf (accessed January 5, 2009).
World Trade Organization (WTO). 2008. Revised Draft Modalities for Agriculture. Committee on Agriculture Special Session. December 2008.
http://www.wto.org/english/tratop_e/agric_e/agchairtxt_dec08_a_e.pdf (accessed January 5, 2009).
Zhang, X. G. 2008. The Armington General Equilibrium Model: Properties, Implications, and Alternatives. Productivity Commission Staff Working Paper. Melbourne. February 2008.

Appendix I: Sensitivity Analysis

Table A.1: Quota expansion: one-good model

Variables	Marginal Cost			Elasticity of Supply		
	0.83 C$/kg (13% disc. rate)	1.02 C$/kg (10% disc. rate)	1.2 C$/kg (7% disc. rate)	0.6	0.8	1.0
Wholesale price	2.93	2.93	2.93	2.93	2.93	2.93
Landed price	1.93	1.93	1.93	1.93	1.93	1.93
Retail price	5.34	5.34	5.34	5.33	5.34	5.34
Farm price	1.63	1.62	1.62	1.62	1.62	1.63
Marginal cost	0.82	1.00	1.19	1.00	1.00	1.00
Consumption	944.2	944.7	945.1	945.4	944.7	944.2
Imports	86.5	86.5	86.5	86.5	86.5	86.5
Domestic Supply	857.7	858.2	858.6	858.9	858.2	857.7
Δ Producer revenue	-28.11	-29.16	-30.13	-30.86	-29.16	-28.01
Δ Import quota rents	12.47	12.28	12.11	11.99	12.28	12.48
Δ Producer surplus	-19.42	-19.00	-18.62	-21.48	-19.00	-17.31
Δ Processor revenue	-13.79	-13.16	-12.59	-12.16	-13.16	-13.84
Δ Consumer surplus	23.52	27.51	31.16	33.90	27.51	23.15
Δ Total welfare	2.77	7.63	12.07	12.24	7.63	4.48

Prices: C$/kg eviscerated weight
Consumption, imports, and domestic supply: 000,000 kg
Producer revenue, import quota rents, producer surplus, processor revenue, consumer surplus, and total welfare: C$ millions

Table A. 2: Quota expansion and price risk: one-good model

Variables	Marginal Cost			Elasticity of Supply		
	0.83 C$/kg (13% disc. rate)	1.02 C$/kg (10% disc. rate)	1.2 C$/kg (7% disc. rate)	0.6	0.8	1.0
Wholesale price	2.93	2.93	2.93	2.93	2.93	2.93
Landed price	1.75	1.75	1.75	1.75	1.75	1.75
Retail price	5.34	5.34	5.34	5.33	5.34	5.34
Farm price	1.63	1.62	1.62	1.62	1.62	1.63
Marginal cost	1.01	1.21	1.41	1.19	1.21	1.23
Consumption	944.2	944.67	945.11	945.44	944.67	944.2
Imports	86.5	86.5	86.5	86.5	86.5	86.5
Domestic Supply	857.7	858.17	858.61	858.94	858.17	857.7
Δ Producer revenue	-28.11	-29.16	-30.13	-30.86	-29.16	-28.01
Δ Import quota rents	14.85	14.67	14.50	14.37	14.67	14.87
Δ Producer surplus	-17.32	-16.88	-16.45	-19.67	-16.88	-14.87
Δ Processor revenue	-13.79	-13.16	-12.59	-12.16	-13.16	-13.84
Δ Consumer surplus	23.52	27.51	31.16	33.90	27.51	23.15
Δ Total welfare	7.26	12.14	16.62	16.44	12.14	9.30

Prices: C$/kg eviscerated weight
Consumption, imports, and domestic supply: 000,000 kg
Producer revenue, import quota rents, producer surplus, processor revenue, consumer surplus, and total welfare: C$ millions

Table A. 3: Quota expansion: two-good model, white chicken meat

Variables	Marginal Cost			Elasticity of Supply		
	0.83 C$/kg (13% disc. rate)	1.02 C$/kg (10% disc. rate)	1.2 C$/kg (7% disc. rate)	0.6	0.8	1.0
Wholesale price of white meat	4.88	4.88	4.88	4.87	4.88	4.88
Wholesale price of dark meat	2.00	2.00	2.00	2.00	2.00	2.00
World price of white meat	2.47	2.47	2.47	2.47	2.47	2.47
World price of dark meat	1.34	1.34	1.34	1.34	1.34	1.34
Retail price of white meat	14.80	14.80	14.80	14.80	14.80	14.80
Retail price of dark meat	4.55	4.55	4.55	4.55	4.55	4.56
Wholesale price of chicken	2.93	2.93	2.93	2.93	2.93	2.93
Retail price of chicken	5.34	5.34	5.34	5.33	5.34	5.34
Farm price of chicken	1.62	1.62	1.62	1.62	1.62	1.63
Marginal cost	0.82	1.00	1.19	1.00	1.00	1.00
Consumption	564.14	564.42	564.67	564.85	564.42	564.12
Imports	71.82	71.82	71.82	71.82	71.82	71.82
Domestic Supply	492.32	492.59	492.84	493.03	492.59	492.29
Δ Producer revenue	-15.67	-16.28	-16.84	-17.25	-16.28	-15.62
Δ Import quota rents	24.87	24.74	24.62	24.53	24.74	24.88
Δ Producer surplus	-10.80	-10.59	-10.40	-12.01	-10.59	-9.62
Δ Processor revenue	-27.95	-26.90	-25.94	-25.22	-26.90	-28.04
Δ Consumer surplus	86.59	91.12	95.27	98.37	91.12	86.17
Δ Total welfare	72.71	78.38	83.55	85.67	78.38	73.40

Prices: C$/kg eviscerated weight
Consumption, imports, and domestic supply: 000,000 kg
Producer revenue, import quota rents, producer surplus, processor revenue, consumer surplus, and total welfare: C$ millions

Table A. 4: Quota expansion and price risk: two-good model, white chicken meat

Variables	Marginal Cost			Elasticity of Supply		
	0.83 C$/kg (13% disc. rate)	1.02 C$/kg (10% disc. rate)	1.2 C$/kg (7% disc. rate)	0.6	0.8	1.0
Wholesale price of white meat	4.88	4.88	4.88	4.87	4.88	4.88
Wholesale price of dark meat	2.00	2.00	2.00	2.00	2.00	2.00
World price of white meat	2.64	2.64	2.64	2.65	2.65	2.64
World price of dark meat	1.35	1.35	1.35	1.34	1.34	1.34
Retail price of white meat	14.80	14.80	14.80	14.80	14.80	14.80
Retail price of dark meat	4.55	4.55	4.55	4.55	4.55	4.56
Wholesale price of chicken	2.93	2.93	2.93	2.93	2.93	2.93
Retail price of chicken	5.34	5.34	5.34	5.33	5.34	5.34
Farm price of chicken	1.63	1.62	1.62	1.62	1.62	1.63
Marginal cost	1.01	1.21	1.41	1.19	1.12	1.23
Consumption	564.14	564.42	564.67	564.85	564.42	564.12
Imports	71.82	71.82	71.82	71.82	71.82	71.82
Domestic Supply	492.32	492.59	492.84	493.03	492.59	492.29
Δ Producer revenue	-15.67	-16.28	-16.84	-17.25	-16.28	-15.62
Δ Import quota rents	23.00	22.87	22.75	22.66	22.87	23.01
Δ Producer surplus	-9.63	-9.40	-9.19	-11.00	-9.40	-8.25
Δ Processor revenue	-27.95	-26.90	-25.94	-25.22	-26.90	-28.04
Δ Consumer surplus	86.59	91.12	95.27	98.37	91.12	86.17
Δ Total welfare	72.01	77.69	82.89	84.81	77.69	72.89

Prices: C$/kg eviscerated weight
Consumption, imports, and domestic supply: 000,000 kg
Producer revenue, import quota rents, producer surplus, processor revenue, consumer surplus, and total welfare: C$ millions

Table A. 5: Quota expansion: two-good model, dark chicken meat

Variables	Marginal Cost			Elasticity of Supply		
	0.83 C$/kg (13% disc. rate)	1.02 C$/kg (10% disc. rate)	1.2 C$/kg (7% disc. rate)	0.6	0.8	1.0
Wholesale price of white meat	4.88	4.88	4.88	4.87	4.88	4.88
Wholesale price of dark meat	2.00	2.00	2.00	2.00	2.00	2.00
World price of white meat	2.47	2.47	2.47	2.47	2.47	2.47
World price of dark meat	1.34	1.34	1.34	1.34	1.34	1.34
Retail price of white meat	14.80	14.80	14.80	14.80	14.80	14.80
Retail price of dark meat	4.55	4.55	4.55	4.55	4.55	4.56
Wholesale price of chicken	2.93	2.93	2.93	2.93	2.93	2.93
Retail price of chicken	5.34	5.34	5.34	5.33	5.34	5.34
Farm price of chicken	1.62	1.62	1.62	1.62	1.62	1.63
Marginal cost	0.82	1.00	1.19	1.00	1.00	1.00
Consumption	380.05	380.26	380.44	380.58	380.26	380.03
Imports	14.68	14.68	14.68	14.68	14.68	14.68
Domestic Supply	365.38	365.58	365.77	365.91	365.58	365.36
Δ Producer revenue	-12.43	-12.88	-13.30	-13.61	-12.88	-12.39
Δ Import quota rents	1.60	1.58	1.56	1.55	1.58	1.61
Δ Producer surplus	-8.62	-8.41	-8.22	-9.47	-8.41	-7.69
Δ Processor revenue	5.62	5.92	6.19	6.39	5.92	5.59
Δ Consumer surplus	-10.94	-9.88	-8.90	-8.17	-9.88	-11.04
Δ Total welfare	-12.34	-10.79	-9.37	-9.70	-10.79	-11.53

Prices: C$/kg eviscerated weight
Consumption, imports, and domestic supply: 000,000 kg
Producer revenue, import quota rents, producer surplus, processor revenue, consumer surplus, and total welfare: C$ millions

Table A. 6: Quota expansion and price risk: two-good model, dark chicken meat

Variables	Marginal Cost			Elasticity of Supply		
	0.83 C$/kg (13% disc. rate)	1.02 C$/kg (10% disc. rate)	1.2 C$/kg (7% disc. rate)	0.6	0.8	1.0
Wholesale price of white meat	4.88	4.88	4.88	4.87	4.88	4.88
Wholesale price of dark meat	2.00	2.00	2.00	2.00	2.00	2.00
World price of white meat	2.64	2.65	2.64	2.47	2.65	2.65
World price of dark meat	1.35	1.35	1.35	1.35	1.35	1.35
Retail price of white meat	14.80	14.80	14.80	14.80	14.80	14.80
Retail price of dark meat	4.55	4.55	4.55	4.55	4.55	4.56
Wholesale price of chicken	2.93	2.93	2.93	2.93	2.93	2.93
Retail price of chicken	5.34	5.34	5.34	5.33	5.34	5.34
Farm price of chicken	1.63	1.62	1.62	1.62	1.62	1.63
Marginal cost	1.01	1.12	1.41	1.19	1.12	1.23
Consumption	380.05	380.26	380.44	380.58	380.26	380.03
Imports	14.68	14.68	14.68	14.68	14.68	14.68
Domestic Supply	365.38	365.58	365.77	365.91	365.58	365.36
Δ Producer revenue	-12.43	-12.88	-13.30	-13.61	-12.88	-12.39
Δ Import quota rents	1.56	1.54	1.52	1.50	1.54	1.56
Δ Producer surplus	-7.70	-7.48	-7.27	-8.67	-7.48	-6.62
Δ Processor revenue	5.62	5.92	6.19	6.39	5.92	5.59
Δ Consumer surplus	-10.94	-9.88	-8.90	-8.17	-9.88	-11.04
Δ Total welfare	-11.46	-9.90	-8.46	-8.94	-9.90	-10.50

Prices: C$/kg eviscerated weight
Consumption, imports, and domestic supply: 000,000 kg
Producer revenue, import quota rents, producer surplus, processor revenue, consumer surplus, and total welfare: C$ millions